A CAUSAL MAPPING APPROACH FOR THE ANALYSIS OF CONSTRUCTION DISPUTES

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ABSTRACT

A CAUSAL MAPPING APPROACH FOR THE ANALYSIS OF CONSTRUCTION DISPUTES

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Containing various work disciplines, numerous stakeholders, and relatively extensive procedures due to its nature, disputes are frequently encountered in construction projects. The fact that disputes can have devastating effects on success of projects in terms of both time and cost to both parties involved when not dealt with care, makes a clear understanding of how and why disputes occur in construction projects an important research topic. Previous studies on this subject has mostly yielded only exhaustive lists of possible causes (sources) for disputes so far, and thus they are far from providing satisfactory explanations on the dynamics that bring these causes together to form a dispute. In order to attend to this research gap, this study aims at providing an alternative approach to understanding of underlying causes of disputes, their interactions with each other, and their overall effect on the occurrence of disputes through causal map analysis. For this purpose, a causal map was drawn as a result of a workshop attended by domain experts and analysed to understand alternative paths for dispute occurrence. Although the technique can be applied to any type of project or industry, for the purpose of this study, disputes in projects con-

tracted through FIDIC Yellow Book (1999 Edition) are considered only. Findings of the study can be useful both for the academia to uncover a better understanding of construction disputes, and for the professional practitioners in the field to be able to take proactive measures in an effort to avoid disputes, or to be used as a post-mortem analysis tool.

Keywords: construction, contract management, dispute, causal map

ÖZ

İNŞAAT İHTİLAFLARININ NEDENSEL HARİTALAMA YÖNTEMİYLE ANALİZİ

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Doğası gereği çeşitli iş kolları, çok sayıda paydaş, ve görece kapsamlı prosedürler barındıran inşaat projelerinde ihtilaflar oldukça sık görülmektedir. Dikkatlice ele alınmadığında projenin başarısı üzerinde hem parasal hem de zaman olarak yıkıcı etkileri olması, projelerde ihtilafların nasıl ve neden oluştuğunun açık bir şekilde kavranmasını önemli bir araştırma konusu haline getirir. Bu konudaki önceki çalışmalar çoğunlukla sadece ihtilafların sebeplerine dair uzun listeler ortaya koymuş ve bu yüzden de ihtilafların sebeplerini bir araya getiren ve ihtilaf oluşmasına sebep olan dinamiklere dair tatmin edici bir açıklama ortaya koymaktan uzak kalmışlardır. Literatürdeki bu boşluğu doldurmak adına, bu çalışma; ihtilafların sebeplerini, bunların birbirleriyle etkileşimini, ve ihtilafların meydana gelmesi üzerindeki toplam etkilerini anlamak yolunda nedensel haritalama tekniğiyle alternatif bir yaklaşım ortaya koymayı amaç edinmiştir. Çalışma kapsamında, alan uzmanlarının katılımıyla gerçekleştirilen çalıştay sonucunda bir nedensel harita oluşturulmuş ve ihtilafların oluşumunun farklı yollarını anlamak için analiz edilmiştir. Her ne kadar bu teknik herhangi bir projeye ya da endüstriye uygulanabilirse de, çalışmanın amacı doğrultusunda sadece FIDIC Sarı

Kitap (1999 Yayımı) ile sözleşme edilen projeler gözetilmiştir. Çalışmanın sonuçları hem inşaat projelerindeki ihtilafların daha iyi anlaşılmaası doğrultusunda akademisyenler, hem de ihtilafları önleme gayretiyle ön alıcı tedbirler almak ya da proje sonrası bir analiz aracı olarak profesyonel uygulayıcılar tarafından kullanılabilir.

Anahtar Kelimeler: inşaat, sözleşme yönetimi, ihtilaf, nedensel haritalama

to my father, my mother, my sister, my dear wife, Günce, and her future sibling

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LIST OF ABBREVIATIONS

ADR	Alternative Dispute Resolution
ARCOM	Association of Researchers in Construction Management
ASCE	American Society of Civil Engineers
DAB	Dispute Adjudication Board
DE	Decision Explorer Software
DPI	Dispute Potential Index
EIA	Environmental Impact Assessment
EOT	Extension of Time
EPC	Engineering, Procurement and Construction
FIDIC	The International Federation of Consulting Engineers
IEEE	Institute of Electrical and Electronics Engineers
IPC	Interim Payment Certificate
KNN	K Nearest Neighbour
LD	Liquidated Damages
OR	Operational Research
SODA	Strategic Options Development and Analysis
TL	Turkish Lira (currency)
TUİK	Turkish Statistical Institute
USA	United States of America
USD	United State Dollars (currency)

CHAPTER 1

INTRODUCTION

1.1 Construction Disputes

Construction business and construction projects involve different work disciplines, and various stakeholders such as contractor(s), subcontractor(s), project managers (Engineer), owners (Employer), and other third parties as appropriate, each of which has different interests and perspectives, constantly aiming at maximizing their own benefits. When this system of highly interacting stakeholders is combined with the usually long and complex contractual documents employed in the construction industry, one can confidently say that conflicts between the parties becomes inevitable as it is "inevitable in human relationships" (Rhys Jones, 1994). This view is also emphasized by Yiu and Cheung (2006) stating that due to great differences in interests of the parties of construction projects, conflicts in the construction industry sometimes appear to be inevitable at times. In fact, with its reputation for being highly litigious, construction industry, quite paradoxically, has been a leader both in occurrence of disputes and disputes resolution systems it employs (Groton et al., 2005; Keil, 1999; Michel, 1998).

Conflicts are defined as "serious disagreement and argument about something important" in Dictionary (2019) and when filed and communicated in a contractual context, such conflicts turn into claims, which can be simply described as "a request for compensation for damages incurred by any party to the contract" (Semple et al., 1994). While some of the conflicts, and claims, if filed, are amicably and thus smoothly resolved without causing significant problems, some may have further implications which result in a substantially prolonged process for resolution, if a resolution or an

agreement is eventually reached. This study focuses on the occurrence of the latter case, which are called disputes.

Regarding the differences between the conflict and dispute, there exist a misperception among professionals of the construction sector as these two terms have been used interchangeably, especially within this industry (Acharya et al., 2006). Nevertheless, Fenn et al. (1997) views conflict and dispute as two different notions. Conflicts arise whenever there is disparity of interests and it can be overseen to prevent occurrence of dispute as a result of conflict. Disputes, on the other side, can be associated with specific judicial issues that require resolution, and are one of the main causes preventing successful completion of a construction project.

Literature survey to identify which situations are actually considered as a dispute returns definitions based on the concepts of conflict and different perspectives. Mururu (1991) defines the dispute as formation of a position to be maintained in a conflict, and quite similarly, Marriott and Brown (1999) views the dispute as a class or kind of conflict requiring resolution. Providing a very basic definition, Hellard (1987) simply states that disputes in construction are the contrariety of interest, values, or objectives. Jentzen and Spittler (1992) and Tillet (1991) also provides a very similar definition and link the construction dispute to differences in perspectives, interests, needs or goals.

As seen on the above definitions, they are all generic explanations to disputes without providing any clear definition or criteria that can be used to determine whether a given case is a dispute or not. This view is also shared by Reid and Ellis (2007) where it is stated that there is no decisive meaning of a dispute and the existence of a dispute is subjective as it requires a common-sense approach which relies on the facts, the law and policy considerations. As suggested by Cheung and Yiu (2006), it might be possibly due to complex nature and intertwined underlying causes of disputes. Another suitable approach within the context of this study is obtained from Diekmann and Girard (1995) where the dispute is defined as "any contract question or controversy that must be settled beyond the job-site management staff". This definition is a bit more clear as it indicates any issue or conflict that can be resolved on site should not be considered as a dispute. For the purpose of the study, it is adapted together with a

more detailed and recent definition of dispute by Love et al. (2011) to obtain a comprehensive and distinctive definition such as; "Disputes are contractual events where the issue relevant to the performance of the contract (project) cannot be resolved by mutual agreement of upper managements and each party forms an entrenched and contrary opinion with respect to the issue that requires resolution". This definition tones in quite nicely with the scope and purpose of this study as it focus only disputes related to the performance of the contract and thus implementation of the project, and purely behavioural situations and conflicts are not included.

Considering the above definitions with the continuum model for risk, conflict, claim, and dispute by Acharya et al. (2006) (Figure 1.1), it can be concluded that the model confirms both the generic and the detailed recent definitions adapted from Diekmann and Girard (1995) and Love et al. (2011) by showing the claims as arising from conflicts that are not clearly managed, and dispute as a consequence of claim(s) that are not clearly resolved. In this respect, the model also clearly distinguishes between conflicts, claims, and disputes; and shows that a dispute cannot exist until a claim is filed, submitted, and it is rejected by the recipient party.

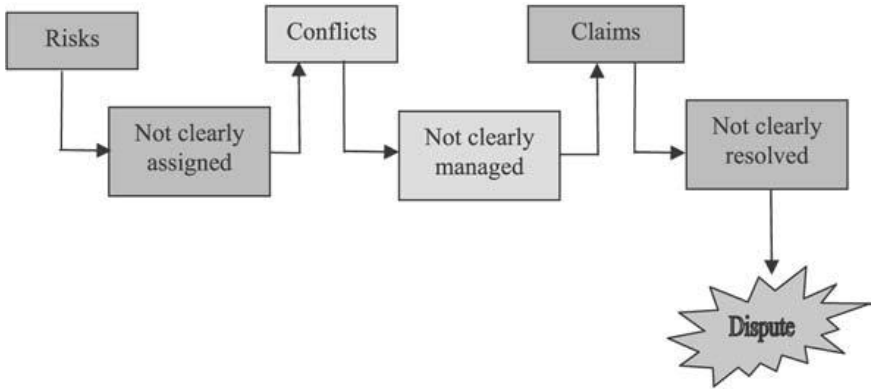

Figure 1.1: Risk, conflict, claim and dispute continuum model (Acharya et al., 2006)

1.2 Cost of Disputes

As explained above, disputes are prolonged processes that require resolution consuming a great deal of resources of parties along the way, and also adversely affecting the

performance and development of the overall construction industry. To provide an insight on the scale of the amounts subject to disputes, a recent report by Arcadis (2019) reveals that global average dispute value has fluctuated between 30 and 42 millions of US Dollars between the years 2011 and 2018 (Figure 1.2) with a current average value of 33 millions USD, where the value can be defined as the entitlement for the claimed work or incident in addition to what is included in the contract.

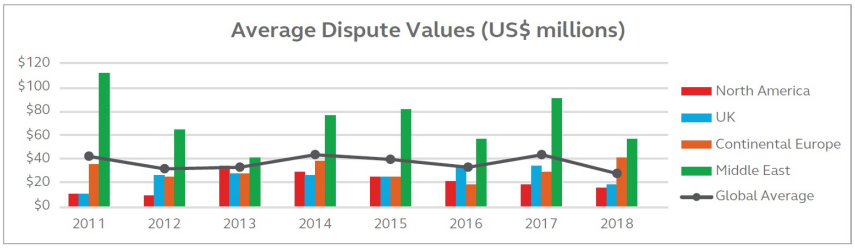

Figure 1.2: Average dispute values (Arcadis, 2019)

The report also indicates that average length of a dispute has increased from around 11 months in 2011 to 17 months in 2018 (Figure 1.3), where the the length is defined as the period starting with the formalization of the request for compensation (claim) under the contract and ending with the the time of settlement.

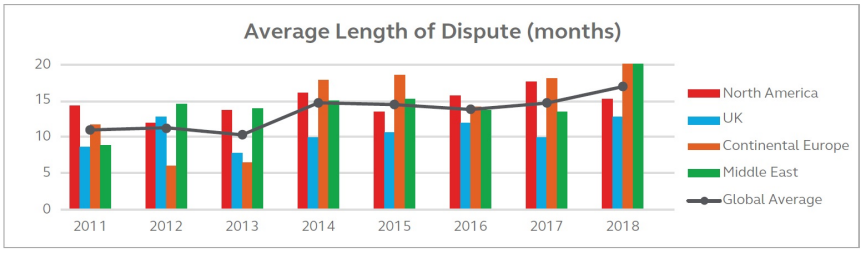

Figure 1.3: Average length of disputes (Arcadis, 2019)

In addition to the remarkable values subject to disputes itself, to show the significance of the issue for the construction industry, adverse effects of disputes on the project and contract implementation and performance must also be taken into account. At this point, we must note, however, that although the construction industry is intensely focused on quantitative effects, it is observed that parties taking part in procurement or construction of major projects have not successfully analysed the real costs related to occurrences of disputes in terms of both severity and frequency (Adrian, 1988). With

this respect, and to be able to present those in a tangible manner, all such effects are considered as a "cost" and cost of disputes are usually studied within the context of "Transactional Costs". Transactional costs are the costs encountered at the stage prior to contract such as the costs of carrying out a market research, investigating financial opportunities, carrying out a feasibility study, and similar; and the costs that incur in the post-contract stage such as the costs of contract administration, administration of change orders and claims, dispute resolution and incentive management, resolving disputes and managing incentives (Li et al., 2012). Based on this classification, costs related to disputes and their resolution are among the post-contract transactional costs. Li et al. (2015) views the disputes a a major contributor to the post-contract transactional costs stating that disputes doesn't only reduce the project management efficiency but they also generate higher transaction costs. It must also be noted that while pre-contract transactional costs are borne solely by the Employer (owner), post-contract costs apply both to the Employer and to the Contractor. Li et al. (2012) considers transaction costs as a parameter to measure project performance and further hypothesizes that one is likely to achieve a strong project performance if transaction costs are low. Yates (1999) draws attention to the high costs that conflicts and disputes in the construction industry bring along, and divides these costs into two categories as "directs costs" such as costs related to lawyers, consultants, management time, and delays in completion, and "indirect costs" including deterioration of business relationships, results of mistrust between participants, and lack of teamwork. According to Love et al. (2010) direct costs related to disputes vary between 0.5 and 5 percent of total contract amount of the project. In his study involving six case studies, Whittington (2008) finds that the post-contact transaction costs for the design-bid-build project delivery system changes between 8.9% and 14.7% of the contract value with an average of 12.6%; where the range for the design-build project delivery system is 3.4% to 14.3%, with an average of 9.5%. If we consider these findings for an average scale construction project with a contract value of multi million US Dollars, we can easily reach a direct cost of some hundred thousand US Dollars, which can go as high as millions of US Dollars depending on the scale of the project.

Although the above figures are quite significant, their definition dictates only the costs that are closely linked to the dispute itself are concerned. With a broader perspective,

it is apparent that disputes have multifaceted effects on projects, which significantly hinder the progress and implementation, in addition to the costs that can be directly measured. To be able to account for such effects that are not explicit and thus not easy to measure, series of studies conducted at The University of Texas at Austin (Gebken II, 2006; Gebken and Gibson, 2006; Gebken et al., 2005) included the "hidden costs" as a third category for transactional costs, as well as direct and indirect costs. Despite these "hidden" costs can also be considered as "indirect" cost to some degree, study considers hidden costs to a much more broader context. These hidden costs are further studied by Lu et al. (2015) to build a framework of such costs. According to the study, despite it is not easy to accurately measure the hidden loss caused by disputes, such costs has an important role in decisions for dispute resolution. In the framework for hidden costs, Lu et al. (2015) list twelve variables, of which ten is obtained via a literature survey and other two are identified through semi-structured interviews. These variables, as adapted from Lu et al. (2015) are listed in Table 1.1.

Table 1.1: Framework for hidden transactional costs (adapted from (Lu et al., 2015)

Variable	**Explanation**	**Source**
Time loss of claim personnel	Claim personnel caanot carry out other works as they are assigned to settle the dispute, causing time losses.	(Gebken II, 2006; Hughes et al., 2006; Marzouk and Moamen, 2009; Yates, 1999)
Difficulty in executing judgements	Losses are caused by difficulties encountered in performance of judgements	Semi-structured interviews (Lu et al., 2015)
Time loss of claim personnel	Claim personnel cannot carry out other works as they are assigned to settle the dispute, causing time losses.	(Gebken II, 2006; Hughes et al., 2006; Marzouk and Moamen, 2009; Yates, 1999)
Delayed recovery of money	Losses occur both due to time value of money and funding costs.	(Gebken II, 2006)
Project Delay	Delay in project caused by dispute and its resolution generates loss.	(Gebken II, 2006; Gebken and Gibson, 2006; Gebken et al., 2005; Marzouk and Moamen, 2009; Sambasivan and Soon, 2007; Yates, 1999)
Quality loss of follow-up work	Dispute causes quality defects in follow-up work yielding loss	(Gebken II, 2006; Gebken and Gibson, 2006; Gebken et al., 2005)

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Table 1.1 – continued from previous page

Variable	Explanation	Source
Reputation damage	Damage caused by the dispute on reputation results in decreased competitiveness for the Contractors, and in difficulties in employing qualified Contractors for the owners (Employers)	(Gebken II, 2006; Gebken and Gibson, 2006; Gebken et al., 2005; Marzouk and Moamen, 2009; Nieto-Morote and Ruz-Villa, 2012; Cialdini et al., 2004; Yiu et al., 2011)
Lack of future cooperation	Absence of future cooperation between the parties decreases the chance of doing business together in the future and generates loss.	(Li et al., 2013; Marzouk and Moamen, 2009; Tsai and Chi, 2009)
Effect on other cooperation	Dispute may also adversely affect the cooperation between the parties in other projects, producing loss.	(Marzouk and Moamen, 2009),
Trust damage	In case of the trust damage due to dispute, parties tend to take stringent measures against each other in an effort to protect their own interests, which in turn causes losses.	(Yates, 1999; Zaghloul and Hartman, 2003)
Reduction in working efficiency of the project	The decrease in project working efficiency caused by the dispute gives rise to loss.	(Gebken II, 2006; Gebken et al., 2005)
Emotional costs	Dealing with disputes also adversely affects the emotions of the personnel, also reflecting into their personal life, and causing mistakes which in turn producing loss.	(Gebken II, 2006)
Expenditure spent on favourable measures taken	In order to resolve the dispute and keep cooperative relationship, the parties may take some favourable measures such as paying for expenses of dining, entertainment, and gifts, which results in losses.	Semi-structured interviews (Lu et al., 2015)
Difficulty in executing judgements	Losses are caused by difficulties encountered in performance of judgements	Semi-structured interviews (Lu et al., 2015)

It is important to note that although Lu et al. (2015) determines lack of future collaboration and reputation damage, especially that of Contractor's, as the most notable

variables contributing to the hidden transactional costs of dispute resolution, obviously other variables also have a significant disruptive effect for the parties of the contract and the construction industry as they all produce great amount of hidden loss. In light of the above findings, taking into account all direct, indirect, and hidden costs and their associated losses; we can conclude that the cost of dispute and dispute resolution can be quite remarkable for the parties involved, and especially due to hidden losses that cannot be calculated directly, it might even exceed the amounts received after the settlement/resolution (Lu et al., 2015).

1.3 Dispute Response

Having a reputation for being prone to disputes and thus highly litigious, construction industry has incorporated several methods to deal with disputes with an aim to reduce their major adverse impact and associated costs and losses to the construction projects. While the main focus of earlier forms of contracts was to protect rights of parties in case of a lawsuit thus pointing out to litigation as the sole contractual resolution for a dispute, in the past decades there has been a transition toward a more beneficial and practical use of contract clauses as the legal methods of construction conflict resolution started to become more of a dissatisfaction for the stakeholders (Stipanowich, 1997). This transition started with inclusion of first the *Arbitration* as an alternative dispute resolution (ADR) technique being a possible substitute for litigation. However, despite being a faster route than the litigation, as the costs associated with this technique is quite high, both the employers and the contractors within the industry tried to abstain from using arbitration as a dispute resolution method. This resulted in adoption of other common ADR techniques such as *Conciliation*, *Executive Tribunal*, *Mediation*, *Dispute Review Boards*, *Dispute Review Advisors*, *Mini-trials*, all of which can be considered as non-binding for the parties. Relatviely binding ADR techniques mainly include *Adjudication*, *Expert Determination* (Fenn et al., 1997; Cheung, 1999).

When we consider this transition of techniques together with the construction dispute resolution steps given in Figure 1.4, we see that the move is toward less binding, less

costly and less time-consuming techniques where the hostility and cost are also reduced. At this point, however, it is important to note that the efficacy of a method on the resolution of a dispute is somewhat positively linked with the level of bindingness of that method, since any party dissatisfied with the outcome of a resolution will be likely to escalate the dispute to a higher level, depending on his position against the other party. With this respect, it can be said that less costly and less time consuming ADR techniques (including *Standing Neutral* and *Negotiation* as well) may easily fail to resolve a conflict due to their non-binding nature. Therefore, a further transition of dispute response to the very first step, "Prevention", which is also called as "Dispute Avoidance", becomes not only inevitable but also logical with the principle "prevention is better than cure" (Fisher, 1988).

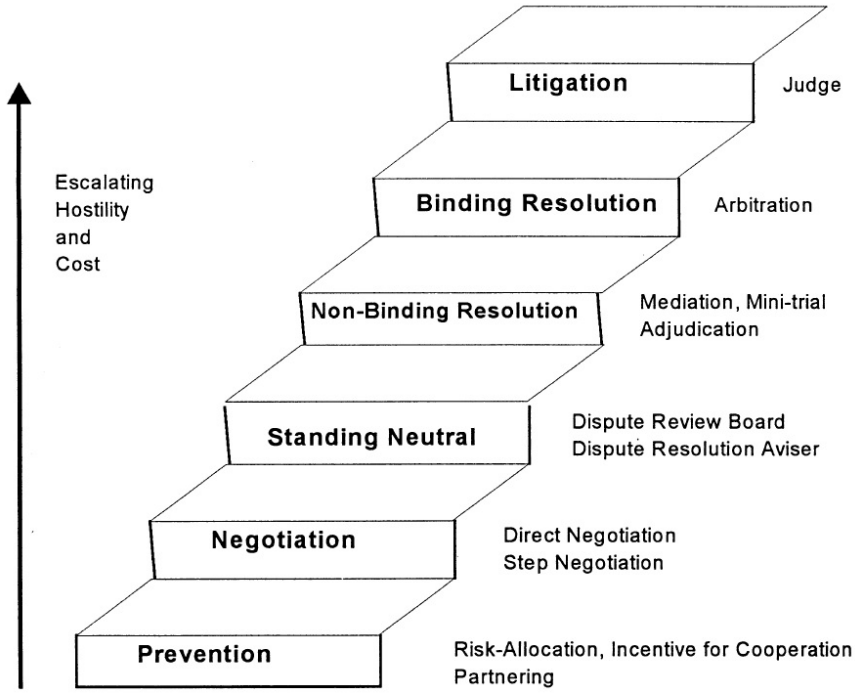

Figure 1.4: Construction Dispute Resolution Steps (Adapted from Groton (1992))

Despite sharing the broad consent view that complete elimination of dispute is practically not possible (Hellard, 1987; Langford et al., 1992; Smith, 1992; Cheung and Suen, 2002b,a), it must be noted that number of studies (Treacy, 1995; Turner, 1994; Currie, 1991; Jannadia et al., 2000; Jones, 1991; Allen, 1993) confirms occurrence of costly disputes can be prevented through proper contractual approach and fair allocation of risks between the parties. Compared to other other methods of alternative

dispute resolution, dispute prevention (avoidance) is not actually an ADR, but it is rather a strategy that must be mutually followed and committed by the parties of a contract to avoid disputes and their serious impact on the project success to the extent possible.

1.4 Objective and Scope of the Thesis

Avoiding also the costs associated with dispute resolution, the hostility between parties, and further damages incurred despite the resolution, dispute prevention (avoidance) seems to be a quite promising way of avoiding associated value and revenue losses as well. At the same time, avoiding disputes requires a thorough and clear grasp of the events and circumstances giving rise to disputes which in turn should enable parties of the contract identify the issues and aspects that must be focused on and paid attention. Despite the extensive study on the causes and occurrences of construction disputes that mainly resulted in possible several underlying causes, lack of a clear understanding of how those causes come together and affect each other to form a dispute prevents any practical use of findings. With such a perspective, this study aims at exploring causes of disputes and their interaction with each other through a causal mapping approach to facilitate identification of critical issues and conditions giving rise to disputes. It is believed that detection of such critical aspects will eventually help both practising professionals in the field of contract and project management, and fellow researchers have a clear understanding of occurrences of disputes, and serve as a pivotal tool for proactive actions to avoid disputes.

Profound approach of causal mapping makes this technique suitable for a wide range of fields from project management (Edkins et al., 2007; Maytorena et al., 2007; Williams et al., 2003) to researches related to political and social issues (Ackermann and Eden, 2011). However, for the purpose of this study, a type of contract that has a worldwide recognition and a project type that has a relatively complex nature is decided to be adopted. For this reason, only the disputes (as defined in Section 1.1, Paragraph 6) in construction projects contracted through FIDIC Yellow Book (Plant and Design-Build Contract) are concerned. Also, dispute resolution is not within the scope of this study but the methods are explained to discuss their efficacy and as-

sociated costs incurred thereof, with an effort to emphasize the significance of the issue.

Following chapters of the study includes an extensive literature review regarding related previous work on construction disputes and assess the research gap therewith. Literature review is followed by the comprehensive introduction of the causal mapping technique itself; starting from the roots of the technique to cover its types, basics of the method, uses, and available software. Once all related background information is presented, research methodology of the study is explained including specifically how the causal mapping is adopted and used, and design of the workshop to obtain information. Next, findings of the study using the specific software is presented, discussed, and reviewed. Final chapter of the study provides the conclusions where summary of the findings, benefits for the practitioners, and contribution to the literature are noted along with the limitations of the study, and recommendations for further studies on the specific subject.

CHAPTER 2

LITERATURE REVIEW ON CONSTRUCTION DISPUTES

2.1 Causes of Disputes

Causes of disputes and conflicts has been a major focus for the previous studies related to construction disputes as they are inevitably seen as the roots to the occurrence of disputes. As these also play a central role to the study, a great amount of literature review is dedicated to obtain these causes, which are also called as "sources", "root cause", "primary cause", "factors" of disputes by a various researchers. At this point, it is essential to note that, within the context of this study, "causes" can be explained as specific issues or events that might directly play a role in the occurrence of a disputes, whereas "sources" are expressed in a broader context and they should be considered as problem (or conflict) areas creating room for disputes to occur. For the purpose of the study, any factor contributing to a dispute is considered to be falling into one of the two categories; meaning it is considered either as a "source", or a "cause".

Starting with the factors that can be considered as "sources" of disputes; a quite thorough overview is provided by Diekmann and Girard (1995) where three main dispute areas are given as *people, process*, and *project*. Mitkus and Mitkus (2014) lists three sources of disputes as *communication (as the major one), unfair behaviour, and effect of psychological defences*. Cheung and Yiu (2006) also shows a similar view where four main sources of dispute are given as *management, communication, people, and contract documents*. Proposing a model where it is indicated that avoidance of complex and highly costly disputes can be achieved through planning and problem solving skills of the project organization rather than through contractual terms, Mitropoulos and Howell (2001) considers *project uncertainty, contractual problems,*

opportunistic behaviour, contractor's financial position, and *cost of conflict and culture* among the significant sources of disputes. Another similar perception is also provided by Rhys Jones (1994) where ten main sources of disputes are given as *management, culture, communications, design, economics, tendering pressure, law, unrealistic expectations, contracts*, and *workmanship*. Spittler and Jentzen (1992) views *ambiguous contract documents, competitive/adversarial attitude, and dissimilar perceptions of fairness by the participants* as three main dispute sources. *Poor collaboration, opportunistic behaviour, affective conflict, risk and uncertainty,* and *contract incompleteness* are among the sources of disputes according to Cheung (2014). Being more specific compared to others, Chan and Suen (2005) list the problem areas of dispute as; *payments, variations, extension of time, quality of works, project scope definition, risk allocation, technical specifications, management, unrealistic client expectations, availability of information, unclear contractual terms, unfamiliarity with local conditions, difference in way of doing things, poor communication, adversarial approach in handling conflicts, lack of team spirit, previous working relationships, lack of knowledge of local legal system, conflict of laws*, and *jurisdictional problems*.

Table 2.1: Sources of construction disputes

Reference	**Dispute Sources**
Diekmann and Girard (1995)	*Main dispute areas:* People, Process, and Project
Mitkus and Mitkus (2014)	Communication, Unfair behaviour, Effect of psychological defences
Cheung and Yiu (2006)	Management, Communication, People, Contract documents
Rhys Jones (1994)	Management, Culture, Communications, Design, Economics, Tendering Pressure, Law, Unrealistic Expectations, Contracts, Workmanship
Mitropoulos and Howell (2001)	Project uncertainty, Contractual problems, Opportunistic behaviour, Contractor's financial Position, Cost of conflict and culture
Chan and Suen (2005)	Payments, Variations, Extension of time, Quality of works, Project scope definition, Risk allocation, Technical specifications, Management, Unrealistic client expectations, Availability of information, Unclear contractual terms, Unfamiliarity with local conditions, Difference in way of doing things, Poor communication, Adversarial approach in handling conflicts, Lack of team spirit, Previous working relationships, Lack of knowledge of local legal system, Conflict of laws, Jurisdictional problems

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Table 2.1 – continued from previous page

Reference	Dispute Sources
Spittler and Jentzen (1992)	Ambiguous contract documents, Competitive/adversarial attitude, Dissimilar perceptions of fairness by the participants
Cheung (2014)	Poor collaboration, Opportunistic behaviour, Affective conflict, Risk and uncertainty, Contract incompleteness

Results of the literature survey generates a more exhaustive list (see Table 2.2) for the "causes" of disputes, despite several overlaps can be easily observed among these causes in different studies. Providing a very broad context, Bristow and Vasilopoulos (1995), and Sykes (1996) state that construction disputes occur due to *unrealistic expectations*, *lack of team spirit*, and *misunderstandings*. A similar view is shared by Yiu and Cheung (2007) where *unrealistic expectations* are considered as one of the major causes of disputes together with *delay*. Sheridan (2003) lists *valuation of variations*, *valuation of final account*, and *failure to comply with payment provisions* among major causes of construction disputes. A similar view locating the variations as quite central is provided by Kumaraswamy (1997) where ten *general types* of disputes are given as; *variations due to site conditions, variations due to client changes, variations due to design errors, unforeseen ground conditions, ambiguities in contract documents, variations due to external events, inferences with utility lines, exceptional inclement weather, delayed design information*, and *delayed site possession*. Findings of Yates (1999) for the causes of disputes such as *variations, ambiguities in contract documents, inclement weather, late issue of design information/drawings, delayed possession of site, delay by other contractors employed by the client, postponement of part of the project* mostly overlap with those of Kumaraswamy (1997). According to Semple et al. (1994), *increase in scope, weather/cold, restricted access*, and *acceleration* are the main causes of disputes. Along with extension of time claims, which, in fact, is a type of claim rather than a cause, Waldron (2006) lists *variations to scope, contract interpretation, site conditions, late, incomplete or substandard information, obtaining approvals, site access, quality of design*, and *availability of resources* as causes of disputes. According to Adriaanse (2005), causes of disputes are *material/-workmanship quality, delays, variations, cost increase*, and *different interpretations of the contract provisions*. Hewitt (1991) covers *change of scope, change conditions,*

delay, disruption, acceleration, and *termination* as six major types of disputes, which are considered as causes of disputes within the context of this study. Acharya et al. (2006) perceives "*conflicting factors*" as causes of disputes and divides these into five groups according to their source of stimuli, which are; *owner, consultant, contractor, third parties*, and *other project specific matters*. Further to this, specific causes are also given under each group (Table 2.2), among which the most significant ones are stated as *differing site conditions, public interruption, differences in change order evaluation, design errors, excessive contract quantities variation*, and *double meaning of specifications*. Ashworth (2005) also categorize causes of disputes according to their root areas from which they originate. These are, *general, employer, consultants, contractors, subcontractors,* and *suppliers*. In a study to differentiate between dispute factors and categories, Ilter (2012) considers *variations, late instructions by the employer, inadequate/incomplete specifications, unclear contractual terms, adversarial approach in handling conflicts, unclear scope definition, poor communication, unfamiliarity with local conditions*, and *technical inadequacy of the contractor* as the factors contributing to occurrence of disputes.

Proposing a different approach, Busby and Hughes (2004) suggests the concept of "pathogens" as the main factors contributing to disputes where they can be defined as moderately steady incidents that exists for a considerable amount of time before occurrence of a dispute. Despite not being seen as an obvious stage in a recognizable order of failures leading to dispute, pathogens are closely linked with the dispute, and can be identified as prime causes of a dispute upon the occurrence of a dispute. Busby and Hughes (2004) categorizes pathogens as *practice, task, circumstance, organisation, system, industry*, and *tool*.

Table 2.2: Causes of construction disputes (Adapted from Kumaraswamy (1997)

Reference	**Causes of Disputes**
Bristow and Vasilopoulos (1995) and Sykes (1996)	*Primary causes of claims*:Unrealistic expectations, Lack of team spirit, Misunderstandings
Yiu and Cheung (2007)	Unrealistic expectations, Delay
Sheridan (2003)	Valuation of variations, Valuation of final account, Failure to comply with payment provisions

Continued on next page

Table 2.2 – continued from previous page

Reference	Causes of Disputes
Adriaanse (2005)	Material/workmanship quality, Delays, Variations, Cost increase, Different interpretations of the contract provisions
Semple et al. (1994)	Increase in scope, Weather/cold, Restricted access, Acceleration
Kumaraswamy (1997)	Variations due to site conditions, Variations due to client changes, Variations due to design errors, Unforeseen ground conditions, Ambiguities in contract documents, Variations due to external events, Inferences with utility lines, Exceptional inclement weather, Delayed design information, Delayed site possession
Yates (1999)	Variations, Ambiguities in contract documents, Inclement weather, Late issue of design information/drawings, Delayed possession of site, Delay by other contractors employed by the client, Postponement of part of the project
Waldron (2006)	Extension of time claims, Variations to scope, Contract interpretation, Site conditions, Late, incomplete or substandard information, Obtaining approvals, Site access, Quality of design, Availability of resources
Hewitt (1991)	Change of scope, Change conditions, Delay, Disruption, Acceleration, Termination
Acharya et al. (2006)	*Conflicts Caused by Owner*: Confusing requirements of owner, Excessive change orders, Supremacy of owner/consultant, Unclear project scope definition, Site access delays, Lack of space in construction site, Financial failure of owner, Unbalanced risks, Owner furnished material, Delay in decision by owner, Late handover of construction site, Owner-furnished equipment *Conflicts Caused by Consultant*: Defective design, Errors and omission in design, Excessive extra work, Differing site condition, Excessive quantity variations, Specification related *Conflicts Caused by Contractor*: Financial failure of contractor, Slow work of contractor, Incompetent contractor, Major defects in maintenance, Local people interruptions/protests, Subcontractor inefficiency, Non-payment to subcontractor, Mentality of contractor, Defective construction (quality) *Conflicts Caused by Third Parties*: Change in government codes, Labour disputes/union strikes, Adverse weather/acts of god, Market Inflation, Public disorder, Third party delays

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Table 2.2 – continued from previous page

Reference	Causes of Disputes
	Conflicts Caused by other project specific matter: Conflicts in document, Change order negotiation, Issue of security of construction site, Lack of communication, Accident/safety, Labour, equipment, material shortage, Interpretation of escalation/de-escalation, Necessity of environment improvement, Negligence or negative attitudes of project participants, Environmental hazards, Excessive correspondence, Inadequate administration of project participants, Material testing technique, Difference in construction technique, Acceleration or suspension of work
Ashworth (2005)	General (contracts, communication, fragmented structure of the sector, tendering practices) Employer (scope, variations, changes made in standard contracts, interventions to the PM, payment delays) Consultants (design errors, inexperience, late/inadequate instructions, lack of coordination, inadequate responsibility descriptions) Contractors (insufficient site management, inadequate planning, quality, problems with subcontractors, delay in paying subcontractors, insufficient coordination of subcontractors Subcontractors (failure to oblige by contractual requirements, quality) Suppliers (low performance products)
Ilter (2012)	Variations, Late instructions by the employer, Inadequate/incomplete specifications, Unclear contractual terms, Adversarial approach in handling conflicts, Unclear scope definition, Poor communication, Unfamiliarity with local conditions, Technical inadequacy of the contractor
Busby and Hughes (2004)	*Pathogens*: *practice* – stemming from people's deliberate practices *task* – stemming from the nature of the task being performed *circumstance* – stemming from the situation or environment the project was operating in *organisation* – stemming from organisational structure or operation *system* – stemming from an organisational system *industry* – stemming from structural property of the industry *tool* – stemming from technical characteristic of the tool.

Brief overview of Table 2.2 shows that *variations* and thus increase in work scope are among the mostly noted causes of disputes. Another major cause according to the table is *delays*, such as late handover of site by the Employer, Contractor's slow

progress, Consultant (Engineer) being late to instruct. *Ambiguities in contract documents* are also one of the mostly noted causes of disputes, which are observed as *double meaning of specification, contract interpretation, different interpretations*. Table indicates that quality of design, expressed as design errors and omissions, is among the major causes of disputes as well.

2.2 Types of Disputes

One of the most prominent findings of the literature review for construction disputes is that there is no basis or a structure that clearly and distinctively describes what factors are actually considered as "causes" and what attributes actually describe the "type of dispute". This might be primarily due to multifaceted nature and interconnected underlying causes of disputes (Cheung and Yiu, 2006). Totterdill (1991) categorizes disputes intro three types being *technical, legal*, and *managerial*, which can also be seen as sources of disputes as per explanation for sources of disputes given in **Section 2.1**. Through reviews of building dispute judgements in supreme courts of New South Wales and Victoria (Australia) from 1989–1990, Watts and Scrivener (1993) detected 59 different categories of disputes within 117 dispute sources. These 59 categories of dispute were further classified as six generic types, which are; *determination of the agreement, payment related, the site and execution of work, time related, final certificate and final payment*, and *tort related*. *Contract terms, payments, variations, extensions of time, nomination, re-nomination*, and *availability of information* was identified by Heath et al. (1994) as seven main types of disputes. Instead of using the term "types of disputes", Conlin et al. (1996)recognized *payment, performance, delay, negligence, quality*, and *administration* as "headings of disputes". With a specific reference to the construction contract itself, Semple et al. (1994) viewed *premium time, equipment costs, financing costs, loss of revenue, loss of productivity*, and *site overhead* as "common categories of compensation" for disputed claims. In a study involving analysis of a total of 233 construction disputes in United Kingdom where mediation were employed Brooker (2002) reported that disputes that involve *payment, delay, defect/quality*, and *professional negligence* are the most commonly occurred dispute types. A relatively different approach in this sense is provided by

Cheung and Pang (2013) where construction disputes are considered to be either *contractual* or *speculative*. Contractual disputes, arising from incomplete contracts are listed as risks, uncertainties, and collaborative conflicts whereas speculative dispute is associated with opportunistic behaviour or affective conflict.

Table 2.3: Types of construction disputes

Reference	**Dispute Type**
Totterdill (1991)	Technical, Legal, Managerial
Watts and Scrivener (1993)	Determination of the agreement, Payment related, The site and execution of work, Time related, Final certificate and final payment, Tort related
Heath et al. (1994)	Contract terms, Payments, Variations, Extensions of time, Nomination, Re-nomination, Availability of information
Conlin et al. (1996)	Payment, Performance, Delay, Negligence, Quality, Administration
Semple et al. (1994)	Premium time, Equipment costs, Financing Costs, Loss of revenue, Loss of productivity, Site overhead
Brooker (2002)	Payment, Delay, Defect/quality, Professional negligence
Cheung and Pang (2013)	Contractual, Speculative

Assessment of Table 2.3, where types of disputes by various authors as explained above are summarized, it is observed that a consensus regarding dispute types and how to distinguish between different types of disputes does not exist. Furthermore, some of the types such as *premium time, equipment costs, financing costs, loss of revenue, loss of productivity*, and *site overhead* (Semple et al., 1994) are not actually stated as a type of a dispute but are rather ingredients of a dispute compensation in terms of different types of costs considered for the calculation of amount of a claim or dispute. Also, *professional negligence* stated by Brooker (2002) is a quite broad term which can in fact include any type of dispute.

With a main purpose of differentiating between dispute factors from dispute categories (types), mixed and interchanging use of the terms "factors" and "categories" was extensively studied by Ilter (2012). Study suggests an enhancement to dispute terminology by clearly separating dispute factors and categories, while identifying the relations between these factors and categories through an empirical study. With a sound and clear approach, study considers only the *type of compensation* that is

being requested from the other party to establish different dispute types, regardless of the causes or factors contributing to the occurrence of a dispute. Based on the main indexes of successful project delivery, which are targeted time, budgeted cost, and specified quality (Chan and Kumaraswamy, 1997); and covering all other types given in Table 2.3, ***extension of time***, ***payments***, and ***quality of works*** are accurately considered as the types of disputes by Ilter (2012). Study also finds that the the most frequently observed dispute type was extension of time. Payments were the second most frequent dispute type followed by quality of works.

2.3 Different Approaches for Understanding Construction Disputes

While the literature regarding what contributes to disputes provides a very extensive list of factors, although without a clear framework, disputes continue to manifest in projects (Love et al., 2011) and thus it is essential to understand the relationship between these factors (causes) to reduce the incidents of disputes (Love et al., 2008). With this respect, in addition to the works focusing mainly on causes and types of disputes, occurrence of disputes has also been the subject of many studies to provide a better understanding of the dynamics behind "how" and "why" disputes occur.

In an effort to conceptualise the occurrence of construction disputes, and as an alternative to the conventional subject matter approach, Cheung and Pang (2013) proposes an anatomy of construction disputes together with identification of key factors playing significant role in the occurrence of disputes. For the creation of the proposed anatomy study uses fault-tree methodology as an analytical technique to determine the major components contributing to the happening of a construction dispute. To account for the subjectivity of human judgements, a linguistic-based fuzzy evaluation is also adopted. At the end of the study, fuzzy occurrence likelihood of the dispute is calculated. A critical view of this study in the context of occurrence of construction dispute reveals that due to the nature of the fault-tree methodology, factors contributing to disputes are assumed as independent basic events without repetition and thus a lack of interaction between the factors.

Another study by Cheung (2014) also aiming at conceptualizing construction dis-

putes taking into account contextual factors integrates subject matter and diagnostic approach to propose a new approach based on the concepts of bounded rationality and opportunism. Based on the data collected through surveys, study divides disputes into two main types, which are *Contractual Disputes*, and *Speculative Disputes*. The anatomy provided as a result of the study (Figure 2.1) shows that *Contract Incompleteness* (due to bounded rationality) is the main source of both contractual and speculative disputes. Study concludes that disputes occur mostly due to contractual incompleteness combined with the opportunistic behaviour, which is considered under people factor.

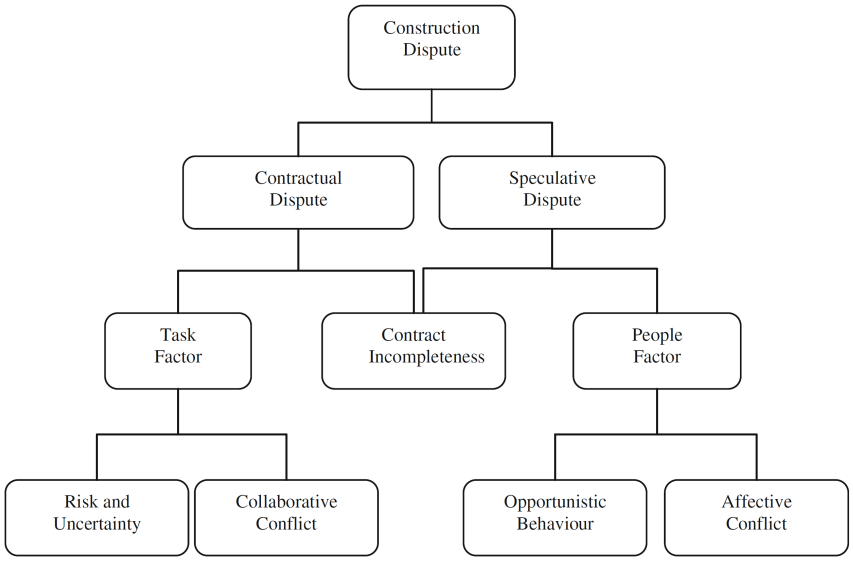

Figure 2.1: Anatomy of Disputes (Cheung, 2014)

With an effort to move beyond consideration of only the discrete factors playing role in construction disputes and to understand the interaction between those, Mitropoulos and Howell (2001) suggests a process model based on the comparative analysis of 24 construction disputes from 14 projects of a state transportation department. For the purpose of the study data were collected through review of project documents and interviews with project participants. To determine the differences and similar points between the cases, the analysis paid particular attention to the events and foundations of the initial problem, the way contract parties used to handle the disagreement, the scale of dispute that occurred due to failure to solve the initial disagreement, and the dispute escalation stage. Based on this consideration, analysis found out that there

was not one predominant cause contributing solely to occurrence of disputes but it is rather a combination of several major factors. On the contrary to work by Cheung (2014), the model developed in this study shows that the avoidance of disputes that are complex and high-cost disputes is not much related to the contractual terms but it is mostly related to the planning and problem solving skills of the organizations. Study also provides recommendations in four main areas to prevent disputes, which are; reducing uncertainty, and contractual problems, increasing ability to solve problems, and establishment of alternative dispute resolution processes.

Considering specifically the environmental disputes in construction projects caused by third parties, study by Creed and Joon (2009) employs a risk management approach to provide a *Risk Index Model* to minimize such disputes. Study involves a multi-criteria decision-making process based on an analytic hierarchy process during which an environmental risk index for the occurrence of a construction dispute related to environmental issues is calculated with weighed factors. Proposed approach determines management criteria through information obtained from project evaluation processes and uses them in the environmental risk management process.

A more recent study by Love et al. (2011), focusing on causal discovery and inference of construction projects disputes proposes the concept of "pathogens" as factors contributing to disputes due to limited knowns about the fundamental hidden situations, and causal chains to indicate the relations between these pathogens. Using the information obtained through interviews with professionals from the industry, during which 58 dispute examples are revealed, study employs an interpretative research methodology based on an analytic induction. Although an interrelation between these pathogens are expressed, causal chains are built separately for different factors and it is concluded that pathogens that are related to *circumstance, practice,* and *task performance* covers a significant portion of disputes.

Locating the issue of *change* and major change orders into the very centre of the study as the most significant contributor to construction disputes, Chen (2008) has created a knowledge-sharing model to be used for information sharing and thus help the parties of a contract to minimize controversial construction disputes manifested as a result of change, through serving as a means of prior warning for the probability of severe

disputes. Study is based on data obtained from investigation of USA court records in a nationwide scale. For the development of the model first a comprehensive database is created, and then K Nearest Neighbour (KNN) pattern classification was applied to ensure integration of statistical rules and probability to fit the demands of the model. As a results, study provides a percentage that represents the size and scale of the change.

Another study exploring whether disputes are predictable or not is provided by Diekmann and Girard (1995). Taking into account different project characteristics that are basically categorized as *people*, *process*, and *project*, which are then further divided into several other subcategories, study uses data of 159 construction projects collected through surveys that measured both qualitative and quantitative views of construction contract disputes. In order to provide a final dispute score called *Dispute Potential Index* (DPI) that predicts the projects with high probability of having disputes, a logistic regression method is employed. Despite stating that all project characteristics (process, people, and project) have a role in the occurrence of a dispute, study concludes that *people* aspect is the most critical one to avoid disputes. This work was later formed as a base for a more recent study (Molenaar et al., 2000) where the authors introduced latent variables using structural equation model with the aim of providing an insight into the relation between the variables that was not available in the prior study.

Fault tree framework was another method used by Cheung and Yiu (2006) to understand and predict occurrence of disputes. In this model, authors conceptualized the construction dispute to have three main elements, which are contract, provisions, triggering events and conflict that cane be used to evaluate failures of s system. In addition, a fuzzy fault tree model was utilised to examine the probability of occurrence of a construction dispute through using a hypothetical case. Initial framework of the study is given in Figure 2.2.

Effectively taking into account the interaction between the factors contributing to disputes, a very influential and practical work related to construction disputes is found in the study by (Ackermann et al., 1997), where qualitative and quantitative methods are combined together to serve as a tool to defend a disruption and delay claim. Cognitive

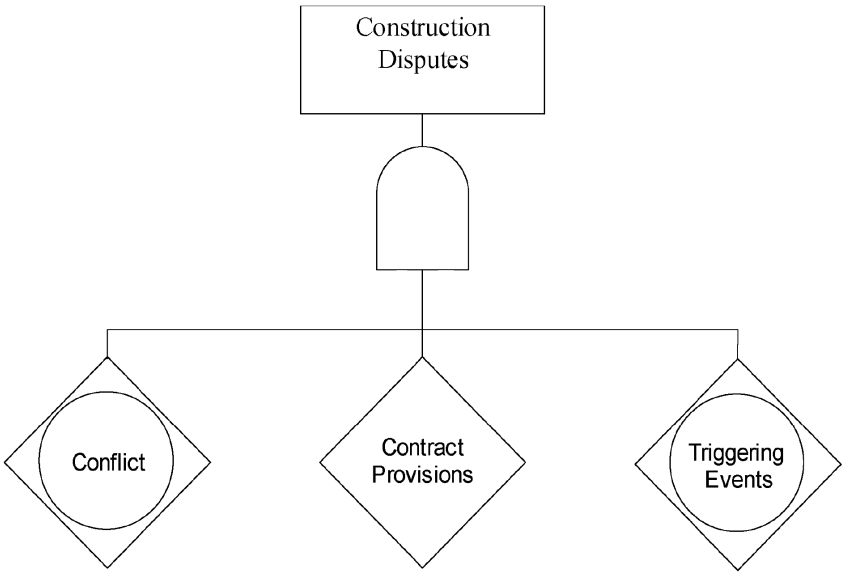

Figure 2.2: Fault tree for occurrence of construction disputes (Cheung and Yiu, 2006)

maps formed the qualitative method of the work while for the quantitative methods influence models and system dynamics simulation modelling were employed. Authors worked together with the company to obtain project information and their views that must be reflected on the cognitive (causal) map. This map were then further refined through reviews and once the map reflected the views correctly, it was quantified using system dynamics modelling. The process followed for the complete modelling is shown in Figure 2.3.

As a summary, literature review for construction disputes identifies various causes and returns exhaustive lists of factors contributing to the occurrence of disputes as shown in Tables 2.1 and 2.2. Besides, number of authors attempted to conceptualize this phenomenon adopting different methods such as process models (Mitropoulos and Howell, 2001), fuzzy fault trees (Cheung and Pang, 2013; Cheung and Yiu, 2006), analytic hierarchy process (Creed and Joon, 2009), subject matter and diagnostic approach (Cheung, 2014), analytic induction (Love et al., 2011), logistic regression (Diekmann and Girard, 1995), structural equation modelling (Molenaar et al., 2000), cognitive mapping, and system dynamic simulation modeeling (Ackermann et al., 1997). It is observed that, although the occurrence of a dispute is considered to be combination of several factors affecting/triggering others, none of the approaches are able to effectively establish interactions between the variables and take their effect

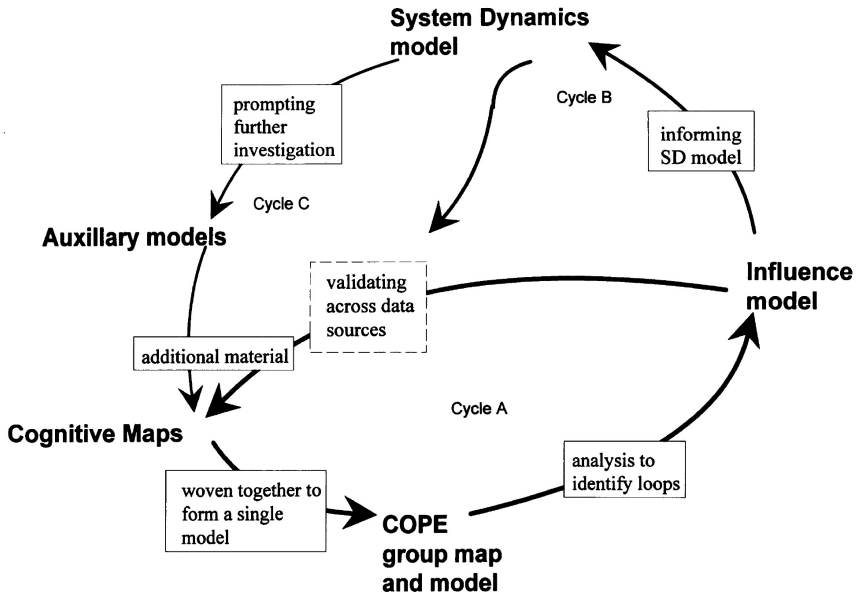

Figure 2.3: Cyclical process for modelling delay and disruption (Ackermann et al., 1997)

into account for the occurrences of disputes, except for the approach given in the work by Ackermann et al. (1997). However, despite proving the applicability and practical use of the cognitive (causal) mapping, the study by Ackermann et al. (1997) itself has certain limitations as the methodology was applied as a post-mortem tool to defend only a given claim case and thus lacks providing insight for understanding the occurrence of construction disputes overall. With such a perspective, this study aims at attending to this research gap identifying the interactions between the factors and taking those into account in an wholly manner for the occurrence of disputes.

CHAPTER 3

CAUSAL MAPPING AS A RESEARCH METHOD

3.1 Causal Mapping

Causal maps are simply graphical representations showing an individual's or a group's conceptions or network of conceptions for a certain issue. Quite similar to the geographical maps, they offer a simplified view of something that is larger and more complex in the sense that they create an impression of the "mental landscape" of an individual (or a group)(Scherp, 2013). With this respect, they are considered to serve as an alternative to other methods of communicating, suggesting that cognitive (causal) mapping provides a tool for displaying, through the use of diagrams, an assemblage of items taken as fundamental components of thinking at a given time (Eden, 1992).

Practically speaking, causal maps are in principal directed graphs where perceptions of situations are represented as statements (nodes, or joints) and these statements are connected through causal links (Eden, 1992). Within the map, links between the nodes are represented with arrows indicating a causal relationship between the nodes, which are also called concepts. These causal links can be either positive, indicating that the concept at the tail of the arrow positively affects the concept at the head of the arrow; or negative, showing that one concept negatively affects the other. Positive causal relations are shown with (+), and negative relations are shown with (-) at the head of the arrow. A typical example of a causal map is given in Figure 3.1.

Causal mapping, among other methods such as influence diagrams (Richardson et al., 1981) and repertory grids (Fransella et al., 2004), has its place in a broader group of techniques which are, in overall, referred to as ***cognitive mapping***(Huff, 1990; Ax-

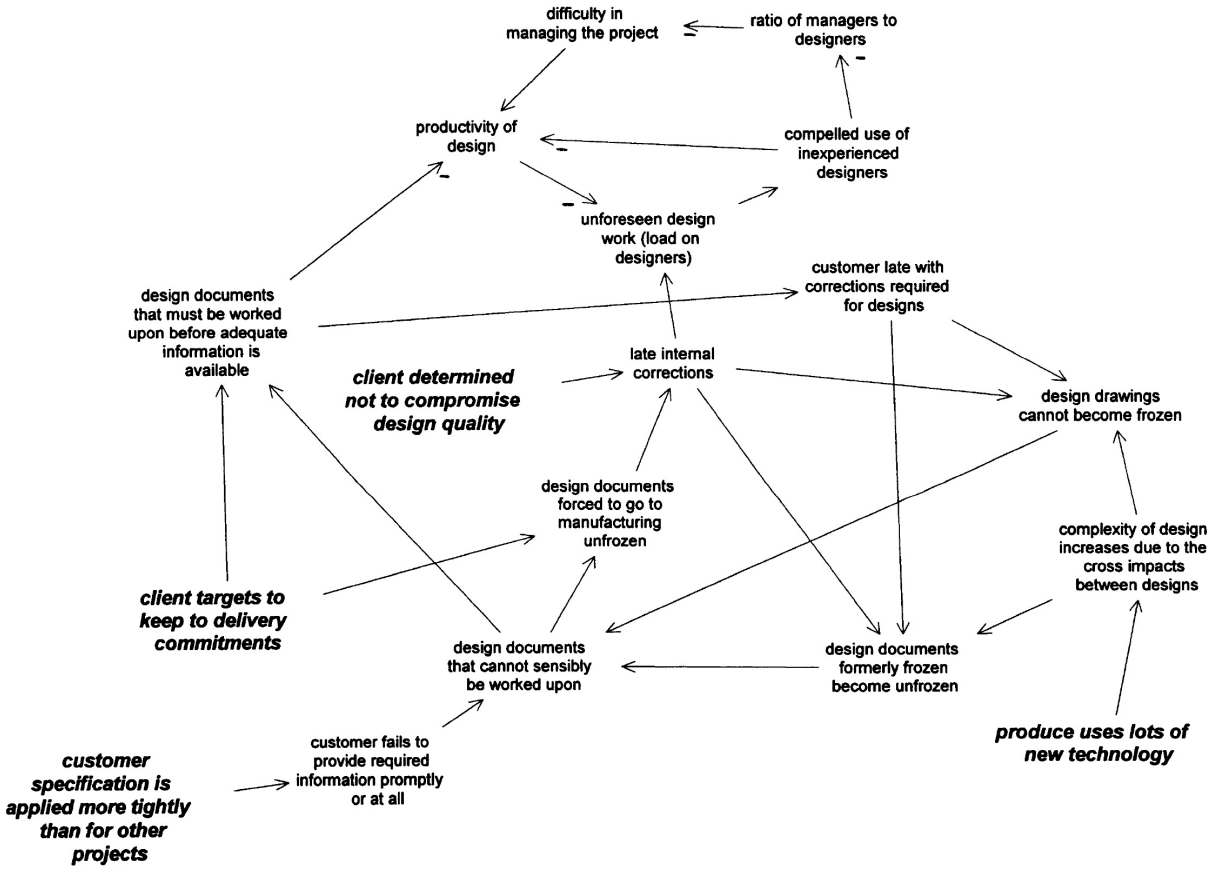

Figure 3.1: Causal map example (Ackermann et al., 1997)

elrod, 2015; Tolman, 1948). Cognitive mapping, in short, is a technique that is used to reveal and actively shape the mental models, or belief systems (cognitive models, mind maps) that people utilise to perceive, contextualize, simplify, and make sense of problems that are complex otherwise (Ackermann and Eden, 2010). Despite various methods and approaches exist to causal mapping (Narayanan and Armstrong, 2005; Eden et al., 1998; Huff, 1990), for the purpose of this study, the approach developed by Eden and colleagues (Bryson et al., 2014; Ackermann and Eden, 2011; Eden, 1988, 1992) which is an interactive decision-support tool enabling capture and analyse of complex problems (Georgiou, 2010) is explained, and followed as a method.

Adopting psychologist George Kelly's *Personal Construct Theory* (Kelly, 1955) as its primary foundation, Eden's approach has its roots in psychology (Ackermann and Eden, 2001; Eden, 1988). Providing a comprehensive foundation for understanding how individuals make sense of their experiences, according to the Theory of Personal Construct, people actively and constantly anticipate events and issues through a hypothesising process as to what might occur in the future based on existing experience and through consequently testing these hypotheses (Kelly, 1955). As a result of this constant process, new constructs are added to the existing set of constructs, and thus it can be postulated that people make sense of their world by comparing and contrasting facts, observations, events, etc. to find out their meaning and to help route what is forthcoming (Ackermann and Eden, 2010). Among the 11 corollaries proposed by Kelly, three of them are significant for Eden's approach. These are; *individuality* (people perceive happenings in unique ways), *commonality* (using shared understanding of different perceptions a common language is developed), and *sociality* (consensus built upon a joint understanding on a common consequence). Locating these three corollaries as pivotal points for cognitive mapping, Eden's approach enables creating of causal maps that;

- "represent how individual project actors perceive situations *(individuality)*
- can be shared and woven together to form a single interconnected whole *(commonality)*
- provide researchers (and practitioners) with a holistic view of the project that can be used to improve understanding, which can be used as a basis for nego-

tiation and reaching shared agreement for action *(sociality)*" (Ackermann and Alexander, 2016)

In addition to the Kelly's Personal Construct Theory, Eden's approach also includes Weick's study on *sense making* (Weick, 1995), views of McHugh's concerning the *sociology of defining situations* (McHugh, 1968), and *conceptualization for problem definition* by Ackoff and Emery (1972) (Ackermann and Alexander, 2016).

3.2 Types of Causal Maps

Although there is a wide span of various attitudes to causal mapping as provided by Narayanan and Armstrong (2005); Eden et al. (1998); Huff (1990), a prominent view imposing different methodological reflections where the causal maps are considered to be either ***idiographic*** or ***nomothetic*** is suggested by Eden and Ackermann (1998). Despite there are number of issues that distinguishes the two main types (approaches) to causal mapping, main difference that should be particularly focused on is that the two approaches have sort of opposing eventual purposes. That is, idiographic causal mapping aims at developing a toned grasp of a situation (Cossette and Audet, 1992) and thus reaching at comprehensive understanding of a phenomena, while nomothetic method is concerned with uncovering themes or patterns in a map that be generalised statistically (Hodgkinson and Clarkson, 2005).

To provide a detailed explanation; **idiographic approach** focuses on a relatively small sample size combined with a semi-structured data elicitation technique to explore details of an issue (Bryson et al., 2004). With this respect, a researcher adopting this approach can more comprehensively explore details about a given situation or phenomena, and still allow participants to offer data that are different than the areas initially determined by the researcher, which in turn enables uncovering of understandings that are unique . Initial results of this method is the highly rich raw data that is quite useful when the main purpose is comprehensive understanding of a certain issue or phenomena. In this type of approach, analyses are carried out straight on the raw data without the need for using coding as a first stage. This results in maintaining richness of data and deepness of insights collected through raw data.

In contrary to idiographic maps, with the aim of accomplishing significance for its findings and thus uncovering patterns that are statistically generalizable, **nomothetic** approach requires a large sample size (Miles et al., 1994). Unlike to idiographic approach, as explained by Ackermann and Alexander (2016), highly structured data elicitation is highly valuable in nomothetic approach together with coding of data as both enable reduction of dissimilarities and as a result decrease the volume of data in analysis preparations (Narayanan and Armstrong, 2005).

Due to this highly distinctive approaches considered for the two types of causal mapping, resulting maps are also highly different. In the nomothetic mapping, due to the nature of the approach as explained above, there are usually fewer statements on nomothetic maps with shorter words used to explain the express the statement, together with smaller number of links between the statements. Thereforce, it can be confidently said that the data is less rich in nomothetic maps compared to idiographic maps, which results in hindering of meaning and clarity of insights (Eden et al., 1998; Ackermann and Alexander, 2016). On the other hand, handling and analysis of relatively rich data and its meaning can be considered as a major drawback of idiographic mapping approach as noted by Hodgkinson and Clarkson (2005).

Considering different, and moreover opposing, aims of the two approaches, there is no point to seek for an approach that is superior to the other one. What can be concluded here is if one is aiming at reaching a detailed understanding of an issue or a phenomena, then idiographic mapping should be the approach to opt for. And if the main purpose is to uncover patterns or themes in a mapping then nomothetic approach would be more suitable. Since this study aims at providing a comprehensive and thus a better understanding of the occurrence of construction disputes, idiographic approach is adopted for the purpose of the study.

3.3 Uses of Causal Mapping

Originated first in the field of Operational Research (OR) and strategy making, causal (cognitive) mapping method adopted in this study has recently become closely related with a group of "soft" operational research techniques that are called Problem Struc-

turing Methods (Rosenhead and Mingers, 2001). Crossing beyond its origins in the OR, this method has been widely employed to assist industries and academics through various uses. Furthermore, its recognition and attendance to subjective data enable causal mapping to effectively reach at mental models and hence acknowledgement of "soft" (intangible) elements such as social issues and politics (Ackermann and Eden, 2011), of which influences and complications can be substantial. At this point, it must also be noted that causal mapping forms an essential component of the Strategic Options Development and Analysis (SODA), which is basically an approach enabling complete exploration of challenging situations before making a decision where the process is conducted through causal mapping (Ackermann and Eden, 2010).

Outside the development in OR and strategy making, recently causal mapping has also started to be a component of research designs aiming to study projects. Role of mapping in modelling projects that had significant challenge such as disruptions and delays caused by client is reported as a particularly important application in the operation research literature (Ackermann and Alexander, 2016). As an example to this use, in their study both Williams et al. (2003) and Ackermann et al. (1997) show how causal mapping technique was applied to support and defend claims that are subject to litigation through acquiring a systemic and in-depth understanding of projects.

Another study, reported in OR literature, is provided by Howick et al. (2008) where the use of causal maps as the base for creation of quantitative systems dynamics model through detecting the triggers and feedback loops of disruption and delays in projects is shown. In addition to its use as a post mortem analysis and decision making support tool, a proactive use of the technique in management of ongoing projects is also reported in OR. Identification and management of risks (Ackermann et al., 2014), identification of scenarios for testing of policy options (Howick and Eden, 2001), and development of a risk filter based on litigation models (Ackermann et al., 2007) are among significant examples of this proactive use of the causal mapping method.

As for the literature on project management domain regarding use of causal mapping, the role of the technique together with the content analysis in comprehending how people involved in projects understand the project management is reported by Edkins et al. (2007). Within the same domain, we see the use of causal mapping as a tool for

gathering data in an inquiry into the process of risk identification by project participants as studied by Maytorena et al. (2007). Moreover, the technique was applied by Williams et al. (1995) to discover the effects of working in parallel in projects, and a more recent study by Williams (2016) employs causal mapping to investigate the systemic aspects of factors affecting successes of projects.

In addition to the studies in academic literature, Ackermann and Eden (2010) identifies six basic areas where causal mapping can be used to present ideas in a graphical form rather than linear, to conduct approximate analyses, to share ideas and thoughts more easily (as more statements and links are captured on one single page), to enable a more objective position taken, to acquire unique and implicit knowledge and experience, and to improve capability for interviewing.

In light of the studies noted above, we can conclude that there is a significant body of work and studies which investigate and consider causal mapping as a research technique, especially in the management as in the domain of operational research and strategy making, and recently the technique is also being explored and used in the field of project management.

3.4 Available Software

Number of statements (nodes, concepts) in a causal map can significantly change depending on the issue and it may vary between a few concepts for a relatively straightforward issue to include hundreds in more complex phenomena. Although the picture might be clear for smaller maps with few concepts, use of a computer software becomes not only inevitable but also a must as it is practically not possible to keep track of all the concepts and links, and to analyse them manually. Even if it can be done for a map that have comprehensible number of concepts, still there is a room for error and it would take much more time to do so manually.

Searching through the computer tools/aids available to be used for purposes of causal mapping, we see that there is, in fact, only a small number of software that is readily available for use. These software can be classified in accordance with the type of mapping. For nomothetic maps, where revelation of a theme or pattern within a map

is the main concern, *CMAP* is one of the major software that can be used. In the case of idiographic mapping aiming at reaching at a deeper and better understanding of a phenomena, we come across two software, which are *Decision Explorer*, and *Dialogue Mapping*. Since this study focuses on the use of idiographic causal mapping to analyse and understand construction disputes, only the software that is developed for idiographic mapping technique is considered. Among these two, due to its wide options available for analysis of the map and its recent track record for being used in a project management framework (Ackermann et al., 2014; Edkins et al., 2007), Decision Explorer was utilised for this study.

Decision Explorer allows by default three different types of links between the concepts. These are *Causal*, *Connotative*, and *Temporal* links that can be selected while creating a link between the concepts. Causal links simply shows that one concept leads to, or affects in some way, another concept. These links are one-directional in nature and can be either positive (+) or negative (-) as represented on arrows. Connotative links, on the other hand, just associates the two concepts in some way that are is not as obvious as in the case of direct causal links. They are bi-directional and represented by a straight line between the concepts it relates. The other type of link that the software allows by default is the temporal links. Unlike the first two types of links, temporal links indicate that a concept follows in time from another instead of a direct immediate affect. These links are also one-directional represented in the software via arrow with a "T" on top. At this point, it must be noted, however, for the purposes of analysis, Decision Explorer software treats all links as causal, only exception being the connotative links as it is a bi-directional links that also creates a loop between two concepts.

Having an interface that is easy-to-use, Decision Explorer also includes several analysis tools that can be used to explore the map in depth and uncover hidden dynamics of an issue that is not so easy to detect. Despite the various tools that are available within the software, for the purpose of this study only the tools used for *Domain Analysis, Centrality Analysis, Loop Analysis,* and *Cluster Analysis* is considered to suffice.

Domain analysis basically counts all the links (both inward and outward) around a statement (concept) and returns a list of all the concepts with their links counts, al-

lowing detection of busy concepts with a higher number of links. Centrality analysis, on the other hand considers the links at a band level and returns a weighted score with respect to number of links around a concept. In this sense, compared to Domain Analysis, Centrality Analysis provides a more comprehensive view of a concept throughout the map. As implied by its title, Loop Analysis detects the loops within a map allowing one to have an insight into the feedback mechanisms that is actually taking place behind the occurrence of an phenomena. Cluster Analysis considers only the similarities of links between the concepts to form clusters that have no overlapping concepts, which can be used to identify concepts that are somewhat similar in nature in terms of occurrence of an issue. Further considerations of these analysis within the context of this study are provided in detail in Chapter 5 along with the analyses of the map.

CHAPTER 4

RESEARCH DESIGN AND METHODOLOGY

In an effort to explore a more comprehensive understanding of the occurrence of disputes in construction, the study covers developing of an idiographic causal map of the phenomena from scratch. Once completed and agreed on, the map is later analysed using a specific computer software (Decision Explorer). For this purpose, a series of steps such as; building an initial map, holding an expert workshop, review of map by experts, and finalization of the map prior to analyses are followed as summarized in Figure 4.1. This chapter outlines and explains the steps and methodology adopted for the construction and analysis of the map.

4.1 Building the Initial Map

Building an initial map that is to be later revised and finalized as per expert views forms the first step of the research methodology adopted for this study. With this respect, first the concepts (statements) of the map needed to be determined. Although the concepts of a map are usually tapped and identified during workshops or through records of interviews as in the studies by Edkins et al. (2007); Ackermann et al. (2014), due to the lack of time of the available experts, following an approach similar to the "Litigation Case" by Ackermann et al. (1997) where an initial map is built through review of project documents, it was decided that to begin with an *initial map* is constructed based on contractual framework and clauses of FIDIC Yellow Book, author's previous experience, and common practice across the construction industry; as otherwise it would possibly take several days of experts time, which in practice would not be possible.

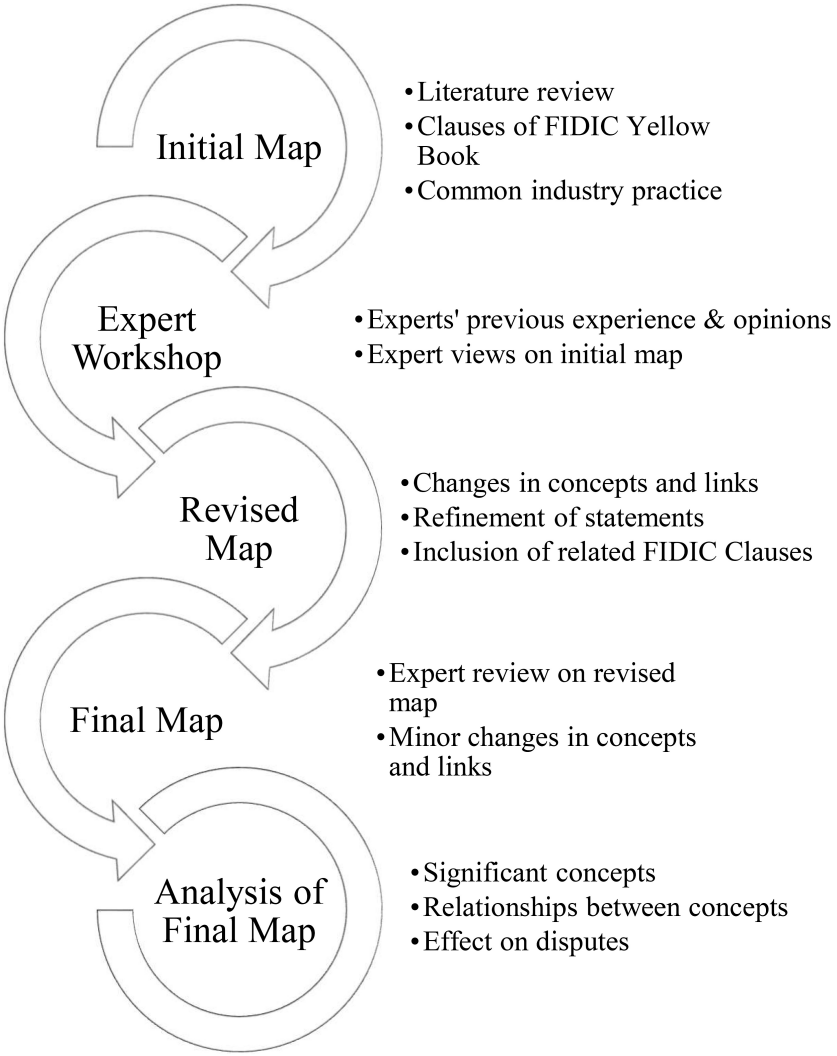

Figure 4.1: Research steps

In order to identify the concepts of the initial map through previous works, an extensive literature survey regarding disputes in construction business was conducted with a specific focus on causes/sources of disputes and also considering other factors contributing to occurrence of disputes. Results of this literature review are summarised in Tables 2.1 and 2.2 given in Chapter 2. The findings are then thoroughly reviewed to detect overlapping causes and sources to avoid any duplications or any missing aspects. Also, with the consideration that only construction disputes in projects that are contracted under FIDIC Yellow Book is concerned within the scope of this study, factors that are either not applicable or irrelevant in such an allocation of risks and responsibilities as defined in FIDIC Yellow Book are excluded. As a result of this

study a total of 66 concepts are identified and as many of the expressions used to describe these causes/sources covered a broad concept instead of pointing out to a specific cause, these expressions are also refined to put the statement into perspective so that causal relations between the concepts are clearly observed and understood by all.

Once the concepts identified through literature are refined, they are categorized into different types in order to induce an initial clustering. This would enable investigation of the initial clustering after the analysis of the map. For this purpose, the approach by Diekmann and Girard (1995) where the sources of disputes are considered to be lying within either *Process, Project*, or *People* is used. Another quite nicely matching view in this regard is provided by Totterdill (1991) where it is noted that a dispute can manifest as a result of either a *Legal*, *Technical*, or a *Managerial* issue. Combining these two, three main categories are identified to be Process (Contractual), Project (Technical), and People (Managerial). Again following the approach by Diekmann and Girard (1995), Process is further divided into two other subcategories as *Pre-Construction Studies*, and *Construction Contract*; Project as *External* and *Internal*, and People as *Employer (Owner), Contractor, Engineer,* and *Business Relationship*. A schematic view of these concepts used for the development of the initial map is given in Figure 4.2. In addition to the categorization of dispute sources/causes, to embed this initial clustering in the software Decision Explorer as well, different colours for concept boxes and statements within the concepts are used in the styling of these eight group as shown in Figure 4.3, where the legend of different clusters are also given at the bottom of the scheme.

After the identification and refinement of the concepts of the initial map, then the causal links between the concepts are to be established. For this purpose, author's years of previous experience in the field of construction and contract management was utilised together with causal relations identified through literature and the correlative relations of the concepts as given in FIDIC Yellow Book form of contract. It should be noted that the main aim of this task is not to obtain a map that completely reflects the occurrence of disputes, but to build and illustrate an initial view that takes into account as many different scenarios as possible with considerations of the risk and responsibilities given in FIDIC Yellow Book combined with previous experience and

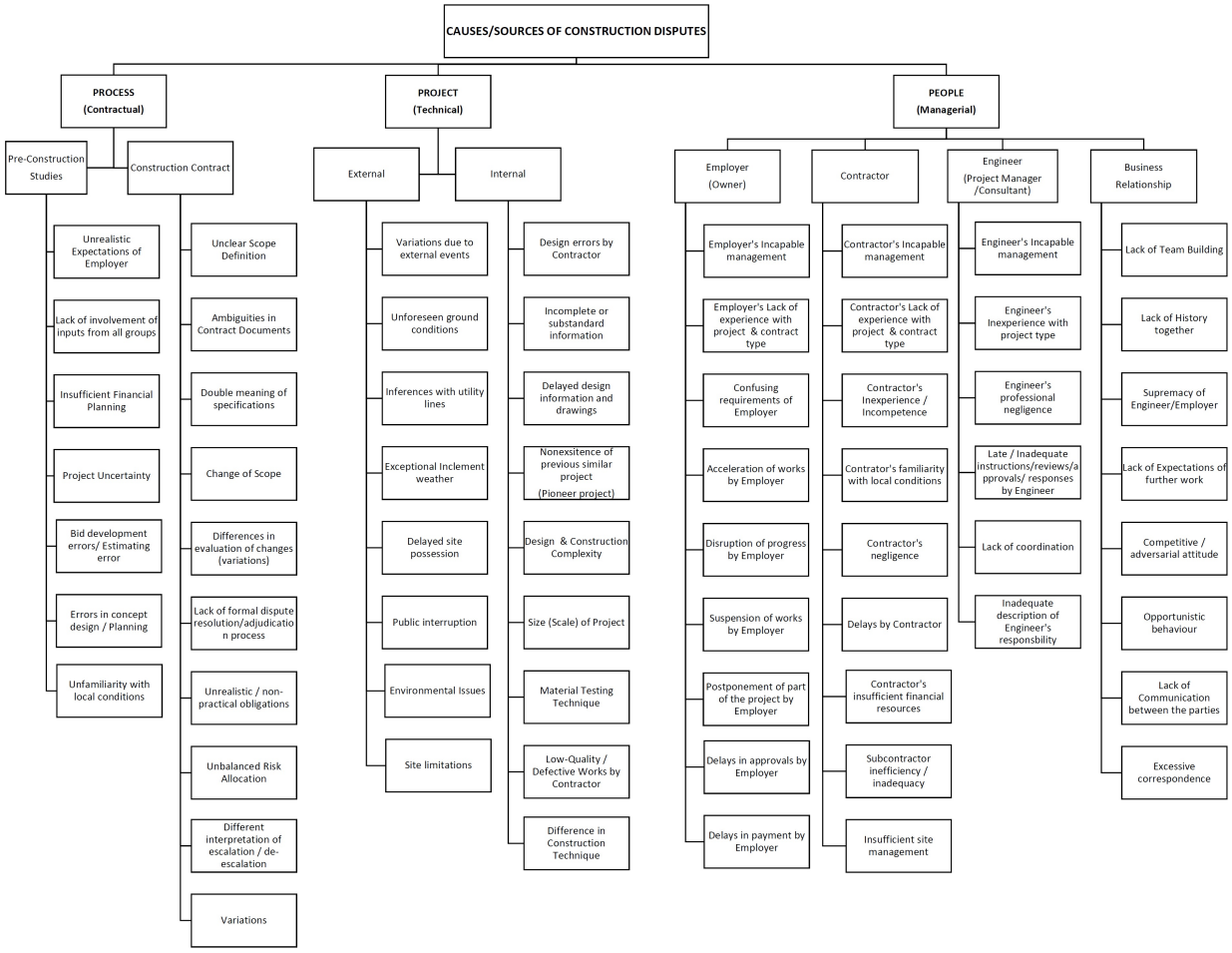

Figure 4.2: Sources and Causes of Disputes

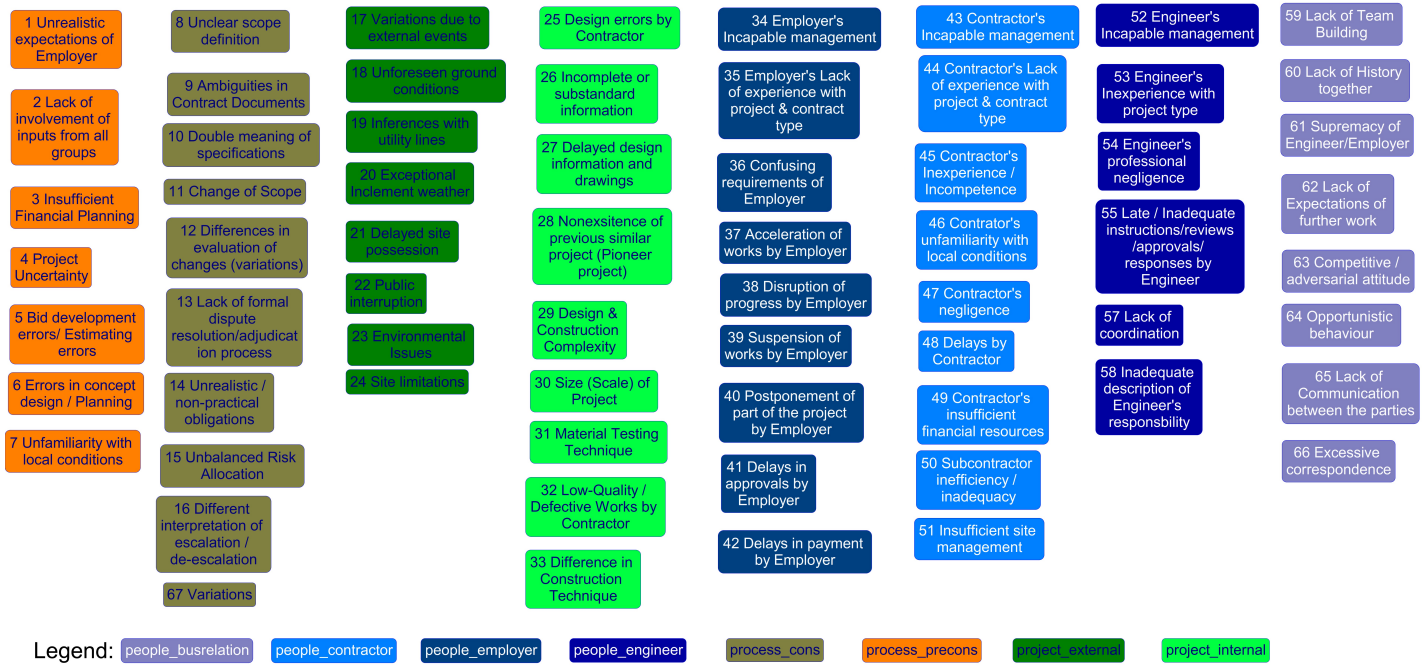

Figure 4.3: Schematic view of initial map without links

common industrial practice. With this approach, an initial map which the experts can clearly reflect on and criticise and comment to reach a causal map that enables a comprehensive view and grasp of the occurrence of construction disputes is built. For the establishment of the links in this initial map, mostly direct causal links are used except for few cases where the effect of one concept on the other is bi-directional and thus connotative links are inserted. This initial map is given in **Appendix A**.

4.2 Knowledge Elicitation with Designing an Expert Workshop

Allowing acquisition, study, and management of vast amounts of qualitative data through mapping, causal maps can have various sources regarding data elicitation (Ackermann and Alexander, 2016). These can be either through interviews (Bryson et al., 2004), through documents (Eden and Ackermann, 2004), or through workshops as in the study by (Ackermann et al., 2014). Following an augmented approach of these cases; in order to assess, revise and enhance the initial map that is built based on previous experience and documents as explained above, a half-day expert workshop consisting of two sessions was held with the attendance of experts who have extensive previous experience in the field of construction, and in contract management in particular. Background of the experts is given in Section 4.2.1 below. As for the record of the workshop, in addition to the notes taken during the workshop, in order to avoid any loss of data or statement, entire workshop was recorded via a voice recorder with the permission of the experts. Extensive summary of the workshop based on this record is provided in Section 4.3.

To serve as an introduction aiming at enabling experts become familiar with the study and the causal mapping technique, in the first session of the workshop, first the objective and the scope of the study was introduced to the experts and main considerations as to what is considered as a dispute within the context of this study are shared. Causal mapping technique, its use, and its principles are explained to the experts together with different types of causal relations that can exist between the concepts. As part of the objective of the study, the Decision Explorer software, the analysis tools (domain, central, cluster, loop) it provides, and the expected outputs as a result of these analysis are also presented on a sample map analysis.

Following the introductory presentation, experts were then allowed and encouraged to brainstorm on the occurrence of construction disputes. Aim of this semi-structured session was to allow experts discuss the phenomena freely based on their previous experience. To support the brainstorm and help experts open up to express their thinking clearly, they were asked the questions *"Why do you think disputes occur in construction?"*, *"Can you share a previous experience where you highly relate to occurrence of disputes?"*, *"Based on your previous experience how do you think disputes mostly occur in construction business?"*, as appropriate. In addition to these open-up questions, the process of ***laddering*** by Vygotsky (1980) was also employed to explore explanations and underlying causes (laddering down), and consequences and relations (laddering up). For this purpose, experts were continuously asked the questions *"In your opinion, what factors play significant role in the occurrence of disputes?"*, *"In the experience you shared, what underlying issues played key role?"*, *"How do you relate these factors to result in a dispute?"*.

In the second session of the workshop, initial causal map was presented to the experts on projection screen so that all the experts can view the map. Since follow up of the map might not be easy due to the number of concept included in the map, print-outs of the schematic view of the concepts without links *(Figure 4.3)*, and the initial map with links *(Appendix A* were also handed out to the experts at the beginning of this session. Main purpose of this second session is to attain experts views and comments on the initial map for revision and enhancement of the map through review of the concepts overall, detecting any irrelevant concepts or statements within concepts, identifying any missing concepts that must be included on the map, correcting any links between the concepts that are not correct in the opinion of the experts, and addition of any missing links.

Although the Decision Explorer also provides an additional module to enable group decision allowing attendants make changes on the map simultaneously and anonymously, in order to ensure consensus between the experts this module was not used. Instead of it, facilitator (author of this study) handled the map during the workshop. As a fundamental aspect of causal mapping technique, presenting the map to the experts allowed them to reflect their thoughts and insight on the issue visually through a causal map assisting them identify the concepts and relations they have in mind

as a result of their previous experience. With this respect, experts were first asked to review the concepts on the map in light of the sources/causes/factors of construction disputes that were discussed during the first session, and share their opinion on whether there is any irrelevant or poorly stated (unclear) concepts, or any concepts that are critical for the occurrence of the disputes but not included on the map.

Once the review of map concepts by experts are completed and noted, experts were asked to assess the links between the concepts to identify any relations that is either incorrect or missing in their opinion as per their previous experience. However, given the number of concepts on the map and the complexity due to causal links, a thorough review of the links and thus the map to ensure all aspects and relations are reflected on the map requires quite a significant time. With this respect, during this session of the workshop, experts were asked to identify significant errors or omissions on the causal relations they can identify within the remaining time of the workshop. With regards to a through review of the links and the initial map by the experts, initial map was revised by the author as per expert views shared during the workshop and the resulting map was sent to the experts together with schematic view of concepts to obtain their opinion on this revised map. By doing so, it was ensured that the experts had enough time with the map to check whether their thoughts and views are correctly reflected on the revised map. In order to assist the experts in tracking the causal relations easily and to ensure sound communication of these relations, links between the concepts were also transformed into a matrix form and sent to experts so that they can note on this matrix the changes and corrections that must be made on the revised map. Based on this second round of expert views, necessary changes are made on the revised map to obtain a final map that can be used for the analysis of occurrence of construction disputes through causal mapping. Details of the expert views obtained in this second round and changes carried out on revised map accordingly are explained in Section 4.4.

4.2.1 Background of Experts

Although a contract is signed generally between two parties, construction projects involve various stakeholders due to the nature of the industry and the complexity of

the works, all having different interests while taking part in a project. Considering the occurrence of disputes in construction from this point of view where all conflicting interests acts together, and as suggested by literature, any or all of the parties can initiate or play a role in conflicts resulting in claims and disputes. With this respect, it is essential to include perspectives of all stakeholders involved in a construction project to ensure rigour in understanding of occurrence of disputes. Bearing this in mind, while contacting the experts to be invited to the workshop, attention was paid to make sure that experts provide a background that is capable of representing perspectives of these various parties. Taking into account this study covers only the disputes in project that are contracted through FIDIC Yellow Book, these parties in our case are basically the Engineer, Employer, Contractor, and other possible third parties such as consultants hired either by the Contractor, or the Employer. With this consideration, and as per the availability of professionals that can share expert views it is decided that the workshop to be held with the attendance of five experts with backgrounds that are capable of covering all these parties' views. Another important consideration with respect to expert backgrounds was to ensure the relevance with the construction disputes and experience working with FIDIC forms of contract.

Further to the initial reflection on the background of the experts contacted and invited to the workshop, to take a record of information on expert background that is of particular importance for the purpose of this study as explained above, an *Expert Information Sheet* to be filled separately by each expert was handed out to the experts during the workshop. Besides the personal and contact information, experts were asked to provide information regarding their *current role* (Contract Manager, Project Manager etc.) in the sector, *years of experience* in the industry, *party they represent* during the workshop (Contractor, Engineer, Consultant, Client etc.). In order to ensure relevance of the background, experts were also asked to evaluate their level of experience with management of claims and settlement of disputes in construction project, and with FIDIC forms of contract. For this evaluation, a scale of 1 to 5 was decided; 1 being "very low" and 5 representing "very high". Designated as Expert A, B, C, D, and E; background of these experts are given below.

Working as a professor at a university, Expert A has 20 years of experience within the industry where she mostly represented the consultant while attending the work-

shop and responding to the questions. Expert A contributed to the study with a very high level of experience in management of claims and settlement of disputes in construction, and a high level of experience working with FIDIC forms of contract. Also working as a professor and representing mostly the view of a consultant during the workshop, Expert B has 40 years of experience in the construction industry. While evaluating his level of experience with management of claims and settlement of disputes as very high, he has a high level of experience working with FIDIC forms of contract. With his 15 years of experience in construction industry, Expert C has previously worked for all the parties involved in a construction project and thus his views represented all those of contractor, engineer, and consultant. Expert C noted his level of experience as high both for management of claims and settlements of disputes, and working with FIDIC forms of contract. Despite having a moderate level of experience of working with FIDIC forms of contract, and experience with management of claims and settlement of disputes in construction, Expert D also highly contributed towards building a final causal map through his views and opinions based on his previous experience of 40 years within construction industry where he works both as an academician and a consultant. Having a quite extensive experience and a special focus on construction claims and disputes and thus setting forth a very high level of experience both with management of claims and settlement of disputes in construction projects and working with FIDIC forms of contract, Expert E is currently a part-time instructor at a university. With his 30 years of experience in the industry, background of Expert E enabled him to provide responses both from contractor's and employer's point of view. Summary of expert backgrounds are given in Table 4.1.

Table 4.1: Summary of Expert Backgrounds

Information / Expert	**A**	**B**	**C**	**D**	**E**
Current role/title	Professor	Professor	Contract director	Academic (Dr.)	Instructor
Years of experience in the industry	20	40	15	40	30
Level of Experience with claims and disputes *(1: very low, 5: very high)*	5	5	4	3	5
Level of experience with FIDIC forms of contract *(1: very low, 5: very high)*	4	4	4	1	5
Party represented at workshop	Consultant	Consultant	Employer, Engineer Contractor	Consultant	Contractor, Employer

4.3 Assessment of Expert Views and Revision of Initial Map

In this section, views by experts on the occurrence of disputes that are stated during the workshop are summarized in detail. Emphasize on these issues and aspects is of particular importance since they serve as pivotal points to be considered in the way of a better understanding of the subject. These views shared by experts also form the fundamental reflections necessary for the revision and enhancement of the initial causal map and therefore, at the end of each expert view reflections of the view on the initial map are also explained.

4.3.1 First Session of the Expert Workshop

During the first session of the workshop, experts were asked to share their experiences from previous cases that are specific to occurrences of disputes, also providing a perspective through explaining the background of the issue as to "why disputes occur in construction projects". First of these cases was given by Expert A stating that *change* is the very fundamental factor contributing to occurrence of disputes. According to the expert changes result from the unexpected events that couldn't be foreseen at the beginning and they can manifest as a change of a price, change of scope, or change of geotechnical conditions, which can also be referred to as change orders, variation orders, or simply variations within contractual context. Expert further explained that the cases of change is usually combined with the vagueness of the contract terms related to the handling of this change, which in turn causing conflicts and disagreements between the parties. Example from previous case given by the expert involved construction of a large hospital building, where the contract was awarded through "lowest cost bidder" procedure with an unreasonably low and thus unrealistic total contract amount. For this reason, with the aim of obtaining prices that are higher than the ones in the signed contract, contractor constantly pursued potential issues that can be subject to change. One of the main issues caused these change requests were related to errors and omissions in design resulting in new work items to be added to the original contract, for which a new price must be determined. At this point, however, related contract clause stated that new prices must be derived by *reasonable adjustment* of the existing *similar prices* in the contract. Here, different interpretations of

the expressions *reasonable adjustment* and *similar prices* caused disagreements and conflicts between the contractor and the employer as to how new prices must be calculated, and eventually the issue turned into a dispute. Although it is apparent that this example shows a delivery method similar to FIDIC Red Book where payments are based on unit prices and their actual quantities, it still has major reflections for building a causal map concerned with FIDIC Yellow Book as the main issue here is not the change of prices particularly but the overall concept of change must be considered. First implication of this view on the initial map is that the concepts 11 "Change of Scope" and 67 "Variations" are merged into one concept named "Changes and Variations" to cover for all such types of situations that are essentially related to change. In addition to this, concept 12 "Differences in evaluation of changes (variations)" was also revised as "*Vagueness of Contract Clauses related to determination of changes/variations*" to reflect Expert's opinion. This view also suggests a positive link between the concepts "Changes and Variations" and "Vagueness of Contract Clauses related to changes/variations". Regarding variations, and changes, in a later note Expert B stated that in one of his previous projects, previously foreseen bored piles to support the excavation was changed to soil nails as per studies of the contractor which significantly reduced the budget and thus considered as Value Engineering (FIDIC Yellow Book, Article 13.2) requiring the saved amount to be equally shared between the contractor an the employer. However, a dispute occurred between the parties upon disagreements over calculation of the saved amount as to what was originally included and what has actually changed. This previous experience of Expert B also confirms the above reflections on the map as all such issues are governed under Variations and Adjustment (Clause 13) of FIDIC Yellow Book.

Another example given by Expert A from the same project was related to definition of scope and method of measurement for a work item price, and thus payment, as to what is included within that price and what is not, and how the quantities are measured. In the drawings "shear legs" made of reinforcement bars were included but the definition of the price stated only load-bearing reinforcement bars are to be considered for the payment and all other elements and bars that are not load-bearing shall not be considered. As the weight of the reinforcement bars used for the shear legs were significant to the Contractor, he argued that shear legs are also part of the load bearing

structure and they must also be considered for payments. On the contrary, employer stated that these elements are used only until the pour of concrete and there is no further load-bearing function and rejected contractor's claim. In further explanation, Expert A also suggested that unclear design documents can also introduce ambiguities causing conflicts and disputes. Expert E also shared his view on this example and stated that the main cause of such conflicts and disputes should be sought in the contract clauses related to "Terms and Definitions" where all such definitions must be clearly noted to avoid any misinterpretation. Even in such a case, Expert E explained, if an agreement cannot be reached within these definitions then the standard industry practice must be considered but this time the country and industry must be clearly noted. To reflect on this view shared by Experts A and E, concept 26 "Incomplete or substandard information" is revised as "Incomplete, substandard, or unclear information". Also, to include the terms and definitions noted by Expert E, a new concept "*Inadequate terms and definitions*" is added to the map under the category of Process - Construction Contract.

Concurrent delays was another aspect raised by Expert A for the occurrence of disputes stating that several minor delays come together to have an overall effect on the progress and cause delays on completion of the project. According to the expert these delays can be either from contractor's, employer's, or third parties' side. As all these minor delays have a concurrent nature and a joint effect, disagreements arise in determination of actual causes and amounts of delays and by which party it was caused. Expert A further noted that these delays themselves does not cause a dispute alone but they contribute to disputes in combination with the lack of a proper work schedule that is regularly and realistically updated through which results of delays can be measured. This view is also shared by Expert B noting that the works schedule are not being actually used but only stays on paper. Expert C has also explained that this might be caused by inadequate definition of requirements for works schedule and he emphasized on the fact that it is not possible to write everything in a contract document. Another point to this particular issue added by Expert C was that lack of a proper works schedule might also be due to lack of contractual enforcement in the case of a related breach, and thus contractors can act more freely in their allocation of manpower and progress of works. In order to reflect this expert view a new concept

"Lack of proper works schedule and related contractual enforcement" is added to the initial map under the category of Process - Construction Contract.

As a previous experience, a waste water project implemented under FIDIC was also explained by Expert C. In that particular project, construction site was in the close vicinity of stream bed and as a result of heavy rains, part of the project was flooded and the contractor argued it was a disastrous event and must be considered as a force majeure. Because the flooded area was only a part of the whole construction site and there was no clear distinction in the contract as to at which point such an event is deemed to form a force majeure this issue manifested as a dispute between the contractor and the employer. As a further note, Expert C also noted that whenever there is an ambiguity in the contract terms, then a room for claim and later for a dispute is created. This view shared by Expert C was reflected on the map as a new concept "Inadequate definition of force majeure" under the category of Process - Construction Contract.

In a further explanation by Expert A regarding unclear, ambiguous, and vague contract terms, it is asserted that what actually causes disputes is the combination of such terms with the characteristics and thus behaviour of not only the contractor but also the employer. Returning back to the previous example given by the expert, it was explained that contractor also used his political power in defence of his claims, which in turn forced the employer to first reject the claims pushing the contractor to initiate DAB process. Employer accepted contractor's claims only after the decision of DAB where the contractor was acknowledged to be right in his claims. A similar view considering the unbalanced power of the employer depending on country's conditions was also shared by Expert D later in this session. These views shared by experts confirm the concepts 61 "Supremacy of Engineer/Employer" and 64 "Opportunistic Behaviour", that are already included in the initial map.

A similar view in this sense was shared by Expert B for the engineer stating that although the engineer is one of the most important parties of a contract as defined in FIDIC, unfortunately the consulting companies in Turkey working as engineers are not acting objectively and neutral between the contractor and the employer being non-compliant to responsibilities and duties of the engineer. According to Expert B,

instead of proposing reasonable and justifiable solutions to the claims/disputes and thus being part of the solution, engineers keep repeating the statements and follow the advocacy of employers with an aim to maintain good relations and ensure future works with the employer. Another example on this issue was also shared by Expert C was a construction project in Riyadh (Saudi Arabia) where the employer applied penalty to the engineer for causing delays and the issue between the employer and the engineer turned into a dispute which also affected the progress of the contractor and manifested as a prolonged dispute between the contractor and the employer as well. Assessment of these expert views shows that they confirm the concepts 54 "Engineer's professional negligence", and 55 "Late/Inadequate instructions/reviews/approvals/determinations by Engineer".

Suggesting a very comprehensive view, Expert E noted that in any project the main purpose of a contract must be to balance between the "needs" and "wants", and the better a balance is established the more efficiently a contract will perform. Pointing out to the unbalanced risk allocation as being one of the major sources of conflicts and disputes, Expert E noted that such a balance between *needs* and *wants* also enables a proper and balanced risk allocation between the parties. Specifically referring to Article 2.4 Employer's Financial Arrangements of FIDIC Yellow Book, Expert E noted that contractor has the right to request from the employer evidence of his financial arrangements showing that employer is able to pay the contract price, and in case of employer's failure to do so then then contractor is entitled to a lawful termination of the contract. However, Expert E continued, employers that are government entities don't take this term seriously and this causes disputes between the parties. This view shared by Expert E confirms the suitability of the concept 61 "Supremacy of Engineer/Employer".

According to Expert E, another major source of construction disputes is created when the original forms of contracts are inadequately modified through particular conditions. Whenever a deletion, addition, or modification of a clause is to be made special attention must be given to avoid any modifications that are against the original structure and logic of the contract which also affect the other clauses and unintendedly making them either non-applicable or preventing them from being effective. Example given by the expert explained that if you delete the time extension clause in favour of

the employer, then you will not be actually able to apply and enforce liquidated damages to the contractor. In accordance with this expert view, a new concept "*Improper modification of contract forms through particular conditions*" is added to the initial map.

Selection of wrong delivery (and thus contract) type was also stated among fundamental sources of disputes by Expert E. As the main differences in procurement strategies in different types of FIDIC forms of contract (re-measured, lump-sum, and EPC) are not thoroughly understood, sometimes employers choose the wrong contract type that is not suitable for the actual set-up of procurement and this makes disputes inevitable. As an example, Expert E stated that bill of quantities which is the basis for calculation of payments are included in a lump-sum (FIDIC Yellow Book) contract and this is completely against the contract type causing disputes between the parties. This view shared by Expert E was also agreed by Expert D and it is reflected on the map through introducing a new concept "*Selection of wrong contract (delivery) type*".

Expert D emphasized on the differing subsoil conditions providing an example from a project in Gaziantep (Turkey). In that particular project, employer carried out a soil survey prior to tendering and provided the results as a reports as part of tender documents to the bidders. However, during execution of the project, while excavations contractor encountered a different soil type than specified in the soil report provided by the employer and this caused a dispute between the parties. Expert E noted that this is considered under *Unforeseen Ground Conditions* in FIDIC. In order to account for this expert views, concept 18 "Unforeseen ground conditions" was revised as "*Unforeseen ground conditions / Wrong soil class reported by Employer*" which is governed under clause 4.12 of FIDIC Yellow Book.

Disagreements over determination of payments in interim payment certificates (IPC) was another previous experience example given by Expert C for the occurrence of construction disputes. Due to ambiguities in schedule of payments, engineer withheld a major portion of the interim payment certificate amount showing the fact that mechanical equipment for a floor is not completely installed as a reason, despite contractor purchased all the equipment, brought them on site and already installed a significant amount. According to Expert C, there should be a further breakdown of

schedules in particular conditions to account for purchase and transport of materials/equipment to site to avoid putting all the financial burden on the contractors which in turn causes problems in payments, progress of works on site, and later on disputes between parties. This expert view is reflected on the map as a new concept "*Inadequate Schedule of payments*", which is governed under clause 14.4 and 14.5 of FIDIC Yellow Book.

Expert B stated that one of the recent cases he was involved was related to foreign exchange risks. Contract amount was in Turkish Lira and due to high increase in the USD/TL rate, Contractor encountered problems purchasing electromechanical equipment and especially those that must be imported from abroad, for which reason contractor requested price adjustments. In a response, Expert E noted that this type of problems and disputes occur especially when the governing Clause of FIDIC Yellow Book (13.8) is omitted through particular conditions. Expert B further explained that the clause was omitted and the calculation of inflation in terms of practices in Turkey based on the figures provided by Turkish Statistical Institute (TUİK) is included instead, which in turn caused disputes between the parties. This view commonly shared by experts was reflect on the map as new concept "*Lack of adequate contract clauses for changes in costs and currency rates*"

Having a broad experience working with internationally-funded construction projects, Expert C noted that requirements of institution(s) financing the project may also cause disputes. As such institutions tend to have strict requirements that can be in terms of health, safety and environment, quality of works, and other additional procedures to be followed during the implementation, employers are obliged to include such requirements in tender documents, which can be quite troublesome for contractors to fully comply when they are not clearly understood and considered in the contract price, and thus cause disputes between the parties. Although the effect of strict requirements by the financing institution(s) are reflected on in tender/contract documents, since those institutions should be considered as some sort of a party to the contract, this aspect shared by Expert C is noted in the form of a new concept on the map under the category of People - Business Relationship as "Strict requirements of financing institution(s)".

Late notices was noted as another important factor contributing to occurrence of construction disputes by Expert E. It is further explained that this factor holds true for the employer, contractor, and engineer; and in the case of failure to meet deadlines for notices specified in the contract disagreements and disputes occur. This view shared by Expert E is reflected as two new concepts in the map as "*Late notices by Employer*", under the category of People-Employer, and as "*Late notices by Contractor*" under the category of People-Contractor. Late notices by Engineer is already considered under concept 55 "*Late/Inadequate instructions/reviews/approvals/determinations by Engineer*" and it is confirmed with this view. Expert E also noted that sometimes engineer may deliberately be late in notices especially for extension of time (EOT) claims with a purpose of enabling contractual omission of the related clause and thus liquidated damages (LD), later to request general compensation through litigation, which can be significantly higher than the amount of LD that would have applied otherwise. This view can be considered to be covered under concept 54 "Engineer's Professional Negligence". Providing a further note on the issue, Expert D stated besides the late notices, late payments by employer can also be cause of disputes confirming the concept 42 "*Delays in payment by Employer*" that is already included in the initial map.

Termination of the contract and *acceleration* of works were other two causes of disputes shared both by Expert A and Expert B that were commonly agreed on by other experts during first session of the workshop. While determination of rightfulness is the main problem in terminations, calculation of the impact was the main factor in acceleration of works, as stated by Expert A, and B. Providing a brief explanation on the issue, Expert E stated that depending on the underlying reasons there are mainly two types of termination, which are; termination due to continued breach of contract, and termination for convenience. Whereas proceedings of the termination for convenience is relatively straightforward, terminations due to continued breach of contract forms a more complicated case directly contributing to the occurrence of a dispute. Providing an example from previous cases, Expert A noted that one of the main problems with this case is the inadequate notices by the employer caused by unclear/subjective terms regarding at which point a contractor must be considered to be at breach of the contract. To reflect these views, the concept "*Late notices by*

Employer" is revised as "*Late/Inadequate notices by Employer*", and a new concept, "*Termination of the contract by Employer*" is added to the map. As suggested by Expert E, unclear/subjective terms regarding breach of the contract are also included in a new concept as "*Unclear/Subjective termination reasons*" which is governed under Clause 15.2.

4.3.2 Second Session of the Expert Workshop

In the second session of the workshop, initial map is presented to the experts both on the screen and also on the print-outs that are handed out to the expert at the beginning of the session. For convenience, in addition to the initial map, concepts are also presented to the expert in a schematic form as per original categorization such as Process, Project, and People. Expert were then asked to elaborate on the map by means of agreeing or disagreeing on the existing concepts and links, and also suggesting new concepts and links to be included in the map, taking also into account major factors contributing to the disputes that are mentioned in the first session. Contrary to the first session, instead of long explanations enabling observation of chain of events, experts were requested to provide brief notes along with their views. After allowing expert some time with the map and the schematic view of the concepts to familiarize themselves with, expert views are taken. As the views shared during first session, expert views in the second session also formed the pivotal points to be considered for the revision of the initial map. As a commonly shared view by experts, various concepts are found to be too broad that doesn't indicate and positive or negative implications on the occurrence of a dispute and thus must be further specified. These are also noted during the second session of the workshop and taken into account during revision of the initial map. Another major suggestion by the experts were to include governing FIDIC Yellow Book clauses under each concept, whenever possible, to also enable some sort of mapping of the relations between related clauses. This suggestion is also called up and governing FIDIC Clauses are added at the end of concepts in parenthesis as appropriate.

As the opening view, Expert E explained that the concepts on the map can significantly vary with different type of contract, and agreed with concept 5 "Bid develop-

ment errors / Estimating Errors" as it indeed holds true for delivery type of FIDIC Yellow Book. In an additional note, Expert E emphasized on the importance of priority of documents (Clause 1.5) as a significant sources of disputes and this aspect is included in the revised map as a new concept "*Deviations from priority of documents*". Also, as suggested by the Experts C, and B, concept 9 "Ambiguities in Contract Documents" is revised as "*Ambiguities in Contract Clauses*". Impact of contractor being a joint venture on the frequency of occurrence of disputes was brought up by Expert A, and this issue was also discussed between the experts which resulted in that affect being minimal, and thus it is not considered for the revision of the map.

Reviewing through the concepts, Expert E suggested that in concept 13 "Lack of formal dispute resolution/adjudication process", only *dispute resolution* must be noted as adjudication process is in fact one type of dispute resolution and this view is reflected in the related concept. As a later comment, Expert E argued that concept 18 "Unforeseen ground conditions" must be considered as an internal design factor rather than an external one as this information is a direct input for the design itself. As per suggestion of the expert, concept 18 moved under Project - Internal category. Also as a Project-External factor, Expert E suggested that licenses and permits must also be included in the map as a significant cause of disputes from his previous experience. With this respect, a new concept "Licenses and Permits" are added under Project-External category. This concept is covered under clauses 1.13 and 2.2 of FIDIC Yellow Book. In a later remark, it was also suggested by Expert E that concepts 29, 30, and 31 actually directly and positively affects the concept 5 "Bid Development Errors / Estimating Errors" and thus new positive links between these concepts are established. It was also proposed by Expert E that the concepts 39, 40, 41, and 42 must in fact be considered as prevention of progress by the employer and accordingly these concepts are merged under concept 38 "Prevention of progress by Employer". Another critics of Expert A on the initial map was despite being a very frequent source of dispute, nominated subcontractors are not included in the map. It was noted that especially the interface issues and the unclear description of the responsibilities governing nominated subcontractors are quite significant. As suggested by Experts E, and C, a new concept "Inadequate nominated subcontractor responsibilities" under Process-Construction Contract category, which is also considered to

be positively linked with concepts 56 "Inadequate terms and definitions" and 15 "Unbalanced Risk Allocation".

Expert A stated that delayed handover of site is one of the commonly encountered reasons in previous cases and thus confirmed the suitability of Concept 21 "Delayed site possession". Providing an additional comment on this concept, Expert C explained that in one of his previous project, site was handed over partially and this caused a dispute between the parties. For this reason, concept 21 is revised as "*Delayed/Partial site possession*".

Elaborating on the concept 23 "Environmental Issues", both Experts A and B stated that this terms is a bit broad and thus doesn't provide as it doesn't indicate a specific aspect that causes disputes. They further suggested that this can be considered as improper Environmental Impact Assessment (EIA) reports that actually caused cancellation of licenses for some previous hydro-electrical power plants which ended up as disputes. To reflect this view, concept 23 is revised as "Improper Environmental Impact Assessment". On this same subject, Expert E also explained that unclear requirements for occupational health and safety must also be considered as a dispute factor as they may lead to termination of the contract. To account for this view, a new concept "*Unclear Occupational Health and Safety Requirements*" is added under Project-Internal category. This aspect is covered in FIDIC Yellow Book under clauses 6.4, 6.7, 6.9. Also, as noted, a positive link between this concept and concept 76 "Termination of the contract by Employer" is created.

4.3.3 Review of Map Concepts

With the aim of enhancing the map, in addition to the expert views explained above, all the concepts are further reviewed and revised to ensure that each content is contractually suitable and clear to the reader, and there is no overlapping or unnecessary concepts. Based on expert views, concepts that are not seen as important by the experts such as 19 *Inference with utility lines*, 22 *Public Interruption*, 28 *Non-existence of previous similar project (Pioneer project)*, 33 *Difference in Construction Technique*, 46 *Contrator's unfamiliarity with local conditions*, 51 *Insufficient site management*, 53 *Engineer's Inexperience with project type*, 59 *Lack of team building* are removed

from the map. In addition to this review, colours of concept styles were also changed to enable an easy view for the readers.

4.4 Finalisation of the Causal Map

As given in detail in Section 4.2, initial map was revised as per the steps explained in Sections 4.3.1 to 4.3.3 and the resulting map (Appendix C) was sent to the experts together with its schematic view (Appendix B) to obtain their second round of comments and views on the map. Based on these views obtained from the experts, necessary changes are made on the revised map to reach a final map that can be used for causal map analysis. Reviews of experts are considered in three main groups as to whether they are related to the concepts, or the links between the concepts, or the initial clustering of concepts. Necessary changes made on the revised map in accordance with expert reviews explained below under these three types of comments.

As the first group of comments that are related to the concepts itself, statement of concept 10 was changed as "*Ambiguous meaning of specifications*" instead of "Double meaning of specifications" as suggested by the experts. Also, to be in line with FIDIC terminology, concept 31 was changed as "*Tests on Completion*". As per another expert view, it is observed that the concept 12 (Vagueness of Contract Clauses related to determination of changes/variations) already covers the concept 72 (Lack of adequate contract clauses for changes in costs and currency rates) causing a duplication of concepts. With this respect, these two concepts are merged so that only concept 12 is included on the map. Similarly, it was pointed out by the experts that the concepts 43 (Contractor's Incapable management), 44 (Contractor's Lack of experience with project and contract type), and 45 (Contractor's Inexperience/Incompetence) are somewhat overlapping. In order to avoid this overlapping and duplication, concepts 44 and 45 are merged together to become "Contractor's inexperience/incompetence with project and contract type". Concept 43 remained on the map as a contractor that is both experienced and competent can still have an incapable management for a particular project. As suggested by the Experts, to use a statement that is more clear, concept 2 (Lack of involvement of inputs from all groups) was changed as *Lack of involvement of inputs from all project stakeholders*. Here the stakeholders mean all

the parties together with the Employer itself that have a direct or indirect interest on the project. Also it is recommended by the experts that for the concepts 34, 43, and 52 instead of the word "incapable" it would be more suitable to use "poor" and thus these concepts are revised accordingly. Similarly, concept 65 (Lack of Communication between the parties) was revised as *Poor communication between the parties* as noted by experts. As the last comment for the concept statements, concept 62 was revised as *No expectations of further work*.

Regarding the links between the concepts, a new causal link is established between concepts 35 "Employer's Lack of experience with project & contract type" and 58 "Inadequate description of Engineer's responsibility" as suggested by the experts. Expert also stated that a causal relation between the concepts 48 (Delays by Contractor), and 76 (Termination of the contract by Employer) should exist and thus a new direct causal link between these two concepts are built on the map.

As for the reflection of comments on the revised map regarding the initial clustering, concept 15 (Unbalanced Risk Allocation) was moved under the category of Process, Pre-construction Studies as here it is considered that an unbalanced risk scenario is created during this stage instead of arising from the contract itself.

In summary, initial map has been revised in terms of the following aspects;

- Missing concepts (causes) as suggested by experts are added to the map. It is observed that these concepts are mostly related to the contractual terms and fell under the category of *Process - Construction Contract*.
- Concepts that are not seen as much related to the occurrence of disputes or not having a significant effect are removed from the map. Majority of the concepts removed from the map belongs to the category of Project - External.
- Concepts that were seen as overlapping by the experts are merged together to form new inclusive concepts to avoid confusion and duplicates of statements.
- Concepts with an unclear/vague, or a broad meaning are refined to point out to a more accurate cause/source of dispute. In addition, wording of some concepts are changed in order to be in line with contractual terminology.

- Missing links between the concepts are added to the initial map as per expert reviews obtained both during workshop and through the second round of expert reviews on the revised map. Similarly, links that are not considered to be as influential or strong are removed from the map.
- As suggested by the experts, also to reveal and visualize the relationships between governing FIDIC Yellow Book contract clauses, clause numbers that are closely linked with the causes/sources are added to the concept statements.

Carrying out the changes on the revised map as per expert views as explained above, now we have reached a final map on which causal map analysis can be performed. Final map, and its schematic view for ease of view, are given in **Appendix D**, and **Appendix E**, respectively. Despite the extensive comments shared by the experts on the initial map during workshop (Section 4.3), the fact that expert views obtained on the revised map required only minor changes shows that the opinions and thoughts of the experts on the occurrence of construction dispute are successfully reflected on the revised map. This, in turn, ensures the reliability of the final map to be used for the analysis.

CHAPTER 5

RESEARCH FINDINGS

5.1 Analyses of the Causal Map

Once we have reached a final causal map starting from an initial map revised as per expert views through the steps explained in Chapter 4, this map is analysed using the software Decision Explorer (DE) to explore the dynamics behind occurrence of construction disputes and in particular the relations between concepts (causes, sources, factors of disputes) and their overall effect on the phenomena. For this purpose, DE provides a variety of analysis tools that are readily available within the software and can be executed on a causal map that is built with DE. Although the software has number of analysis tools, for the purpose of this study, *Domain, Central, Cluster*, and *Loop* analysis are considered to be sufficient. In this section, these analysis tools as applied on the final causal map is explained together with their results yielded by software DE.

5.1.1 Domain Analysis

Carrying out a very fundamental review of concepts on the map, *Domain* analysis considers each concept separately and counts all the links around each concept to return a list of all concepts in the order of concept numbers where incoming, outgoing, connotative, and total number of links of each concept are shown (Banxia, 2017). With this respect, this analysis is used to immediately determine busy concepts with higher link densities. Identification of such busy concepts can then be used to determine possible key concepts (causes) of construction disputes that might require further examination. Since it might not be easy to examine the extensive list of all the

concepts to determine the concepts with highest number of links immediately around them, DE also allows the users to list only the top concepts with highest link densities. Carrying out this analysis for top 10 concepts on the final map, we obtain the resulting list shown in Figure 5.1.

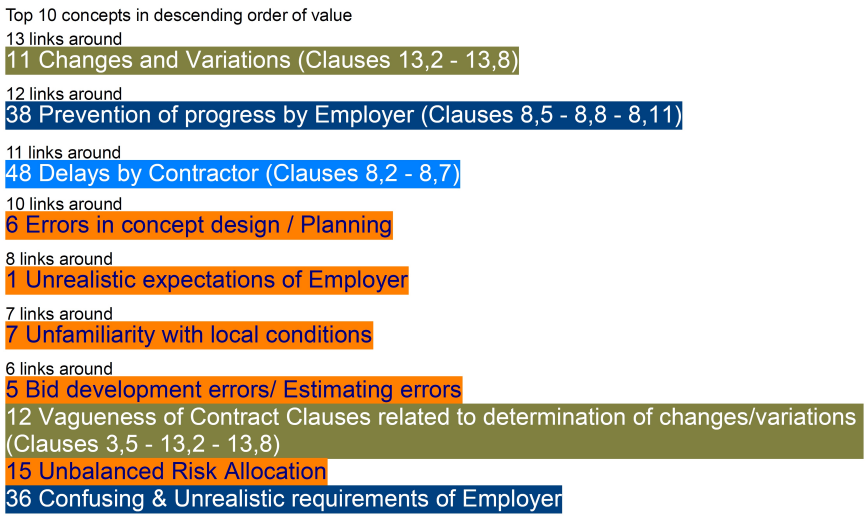

Figure 5.1: Result of Domain Analysis

As can bee seen in Figure 5.1, the most busy concept, that is; the concept with highest number of immediate links around it, is concept 11 (Changes and Variations). This is followed by concept 38 (Prevention of progress by Employer) having 12 links. The third most busy node is concept 48 (Delays by Contractor) with 11 links. Having 10 links around it, concept 6 (Errors in concept design and Planning) ranks fourth. It is followed by concept 1 (Unrealistic expectations of Employer) with total links of 8. Next highly busy concept is concept 7 (Unfamiliarity with local conditions) with 7 links around it. The last four concepts with a high density of links have 6 links around them and they are concepts 5 (Bid development errors/ Estimating errors), 12 (Vagueness of Contract Clauses related to determination of changes/variations), 15 (Unbalanced Risk Allocation), and 36 (Confusing and Unrealistic requirements of Employer).

Placing the concept 11 (Changes and Variations), which belongs to the group Process - Construction Contract, at the top, result of this analysis shows the significance of construction contract in the occurrence of construction dispute. In addition, high rankings of concepts 38 (Prevention of progress by Employer) and 48 (Delays by

Contractor) reveal the importance of people factor. It is also worth noting that, despite having lower rankings, concepts 6, 1, 7, 5, and 15 in the category of *Pre-construction studies* indicate that initial poor studies prior to tendering and construction such as; concept design and planning, getting familiar with local conditions, bid development and estimating, and risk allocation may contribute to occurrence of disputes.

At this point, however, it must be noted that domain analysis takes into account only the links that are immediately connected to each concept resulting in a very local view of a concept within the map, thus provides results that must be considered cautiously and verified through further analysis.

5.1.2 Centrality Analysis

Despite being similar to domain analysis, the *Centrality* analysis calculates the results for not just those concepts that immediately link into the specified concepts but it also takes into account those which link through them. With this respect, instead of just its immediate vicinity , centrality analysis provides some more reliable insight into discovering the centrality of the concept in the whole causal map model. Providing a centrality score as a result that is independent of direction, the analysis uses a scoring system for calculation where for each level away from the central concept, the score attached to the number of concepts is reduced. In other words, the total number of concepts immediately linking into the central concept is divided by 1, number of those concepts that link into these second level of concepts is divided by two and so on up to a final level of 7. As in the case of domain analysis, in addition to listing all the concepts with their centrality scores, it is also possible to list top concepts with highest scores (Banxia, 2017). Carrying out centrality analysis using DE software to obtain top 10 concepts with highest centrality scores we obtain the list of concepts given in Figure 5.2.

Comparing the results of centrality analysis with that of domain analysis in the previous section, it is immediately observed that concept 11 (Changes and Variations) is again the highest ranking concept with a centrality score of 30 out of 55 concepts it is connected throughout the map, confirming the great effect of changes and variations on the occurrence of disputes. Ranking as the third busiest concept in domain

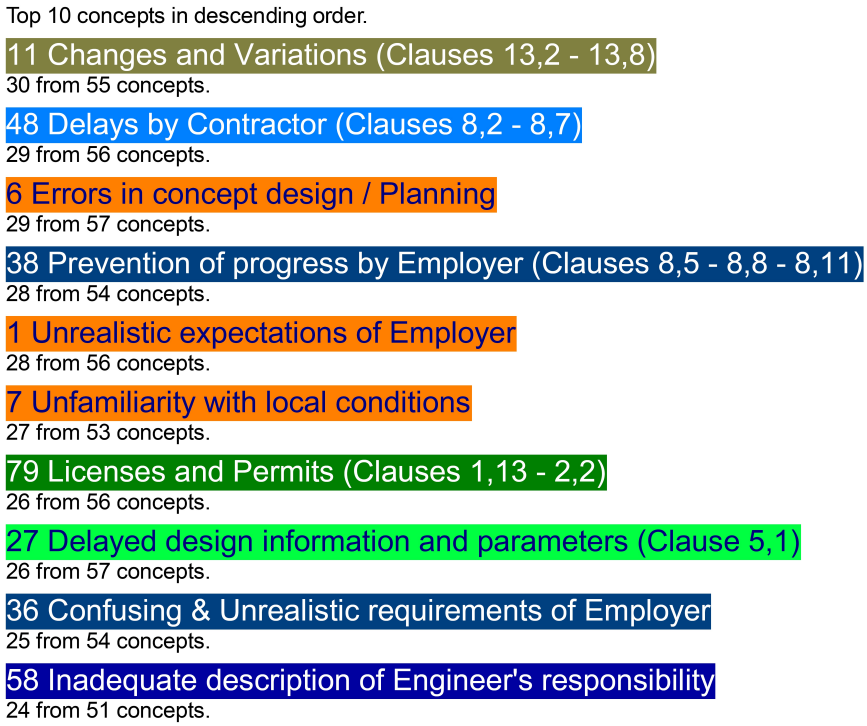

Figure 5.2: Result of Central Analysis

analysis, concept 48 (Delays by Contractor) is determined to be the second most significant contributor as per results of centrality analysis where the concept has a centrality score of 30 from 56 concepts. Similarly, concept 6 (Errors in concept design / Planning) is the third central concept while it was the fourth busiest node as per domain analysis. Being the second most significant factor in results of domain analysis, concept 38 (Prevention of progress by Employer) is found to be the fourth in centrality analysis. Maintaining same rankings in both analysis, concept 1 ((Unrealistic expectations of Employer) and concept 7 (Unfamiliarity with local conditions) are among the significant causes of disputes as per centrality analysis, ranking 5th and 6th, respectively. Being not one of the busiest concepts in domain analysis, in the centrality analysis we see concept 79 (Licenses and Permits) as the 7th concept with a score of 26 from 56 concepts. Also, concept 27 (Delayed design information and parameters) was not among the top 10 highly dense concepts in results of domain analysis, but as per central analysis this concept is found to be having the 8th highest centrality score. Shown in the results of both domain and central analysis, concept 36 (Confusing and unrealistic requirements of Employer is again among the

top concepts highly contributing to occurrence of construction disputes. The last of the top 10 concepts found in centrality analysis is concept 58 (Inadequate description of Engineer's responsibility) that was not included in the results of domain analysis.

5.1.3 Cluster Analysis

Another analysis carried out on the final map is the *Cluster* analysis. Basically breaking down the map model into more manageable parts, this analysis is quite useful for identifying key areas, isolated concepts which require further links, or small relatively unlinked groups of concepts (which may require further connections) since models become complex through the capturing of huge amounts of qualitative data and they can no longer be easily understood when mapped on the screen (Banxia, 2017). Being one of the major drawbacks of the DE software and the analysis it provides, the software (and thus the cluster analysis), is completely incapable of taking into account the concept text and meaning, despite the underlying assumption is that the meaning of a concept is gained both from its content and from the concepts to which it is linked. With this respect, the analysis returns a list of suggestions of exclusive topic areas that are mutually exclusive (i.e. doesn't overlap with each other). These suggested topic areas are mutually exclusive because the analysis basically aims at determining relatively isolated islands of concepts with minimum bridges in between.

In the case of this study, the cluster analysis yielded various clusters some of which included critical concepts that were already determined through domain and central analysis. However, apart from breaking down the whole map into smaller and thus more manageable parts, it was not possible to detect any themes of patterns. With this respect, no interpretations that would be useful for the purpose of this study could be made based on the clusters created by the software, and thus the results of this analysis are not included.

5.1.4 Loop Analysis

Loop analysis is one of the readily available and powerful causal map analysis tools within DE software and its main purpose is to detect whether any loops formed within a map. Once completed, the analysis writes the loops in a set which can be displayed as a list of concepts or mapped on the screen. Loops are quite important when analysing a causal map as they provide insights into cyclic processes within a map for the occurrence or non-occurrence of an issue providing a visual feedback mechanism. In addition to this, existence of a loop within a map is also of interest as any loop can be also formed due to a mapping mistake which might yield erroneous results. As the loop analysis on the final map built for the purpose of this study returned no loops, further explanation of a loop analysis and the insights it might provide are not included here.

5.2 Discussion of Results

In order to identify the most significant factors/causes contributing to occurrence of construction disputes we have used first the *domain* and then the *centrality* analysis DE software provides. Although the results of the both analysis have yielded a similar list for top 10 highly influential, considering the effect of a concept in a broader view and thus throughout the whole map, we consider the results of centrality analysis for further investigation of the concepts.

Although the identification of top concepts and thus causes for the occurrence of disputes provides sound insight and therefore can be quite useful for dispute avoidance; these concepts are further studied to reveal other factors (concepts) leading up to them and play a role in manifestation of a conflict as a dispute. Exploring this relationship between the causes, in fact, forms one of the main objectives of this study. For this purpose, "Explanations", and "Consequences" commands of DE software is used. Explanations command takes a selected concepts and traces its inward links down to either tails or branch points, and displays the result as a list of explanations for various routes it followed during tracing. Similarly the consequence command takes a given concept as starting point and following through its outward links, it identifies the con-

cepts the selected concept is leading to. As the concepts are already connected to each other as appropriate on the causal map, among the top 10 concepts identified through centrality analysis, only the top 5 concepts are considered for further review. These are; **Changes and Variations** (11), **Delays by Contractor** (48), **Errors in concept design / Planning** (6), **Prevention of progress by Employer** (38), and **Unrealistic expectations of Employer** (1). Depending on the position of a concept on the map as to whether it is a tail (few to none inward links), or a head (few to none outward links), either explanations (for heads), or consequences (for tails) command is used.

Starting with the highest ranking concept, *Changes and Variations* (Concept 11), which has only one outward link and thus being a head, there are 11 different routes leading up to this concept (Figure 5.3).

Reviewing some of these routes it is seen that Changes and Variations may be caused by *inadequate nominated subcontractor responsibility* (81), which in turn may be given rise by *inadequate terms and definitions* (56). Other two routes suggests that changes and variations may occur directly due to either *confusing and unrealistic requirements of Employer* (36), or *incomplete, substandard, or unclear information* (26). As per another route that is relatively longer, changes and variations arise due to *errors in concept design and planning* (6) which might be caused by *unfamiliarity with local conditions* (7).

Proceeding with concept 48, Delays by Contractor, which is also a head and thus required explanation command, resulting list given in Figure 5.4 shows that this concept might be reached through 8 different routes.

As per this result, delays by contractor might directly occur due to either, *inadequate schedule of payments* (71), *lack of proper works schedule and related contractual enforcement* (67), or simply by *poor management by contractor* (43). Another cause of delays by contractor is shown as *site limitations* (24), which can result from employer's *unfamiliarity with local conditions* (7). Other explanation of this concept shows that delays by contractor might be occurring due to *contractor's negligence* (47) and this can be resulting from the fact that contractor has *no expectations of further work* (62) with the employer.

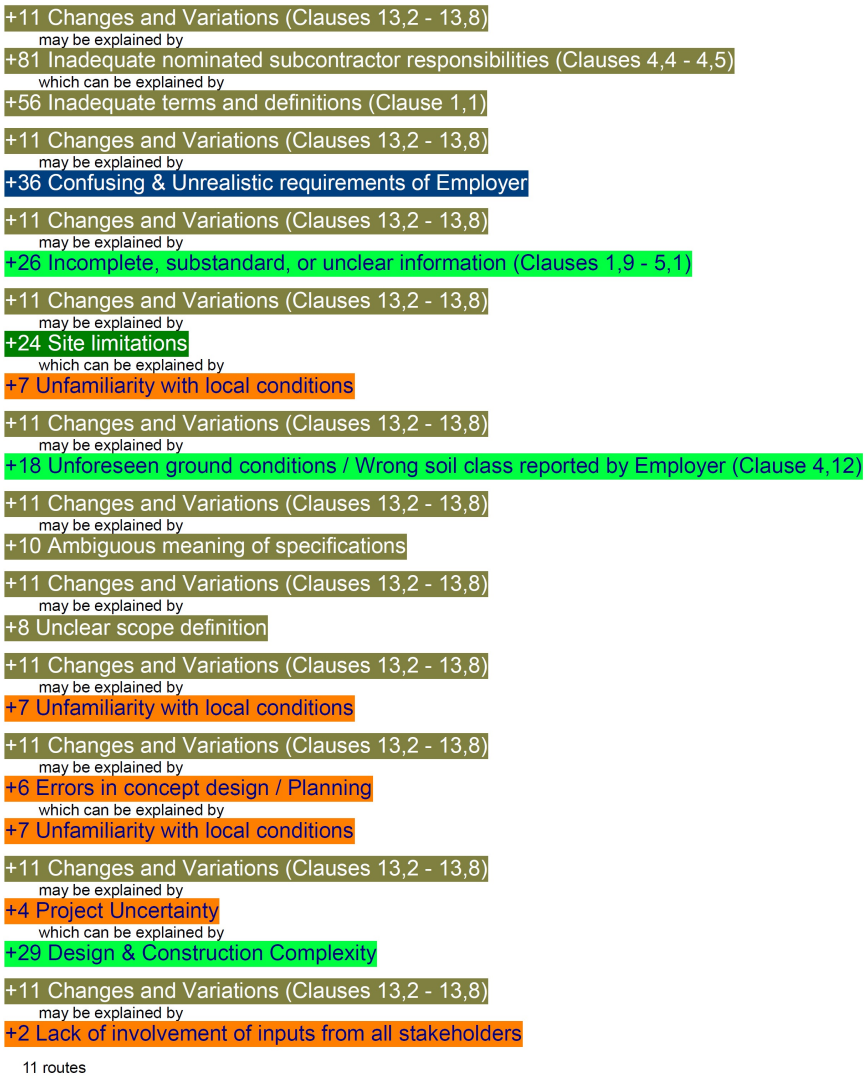

Figure 5.3: Explanations for Changes and Variations (11)

The next concept we have identified to be playing a significant role in the occurrence of construction dispute is concept 6 Errors in concept design and planning. Positioned as a tail with only one inward link (Concept 7, Unfamiliarity with local conditions), *consequence* command is used for further review of this concept to reveal which concepts it leads to.

Resulting list given in Figure 5.5 shows that there are total of 9 routes this concept effects others. Assessing some of them, it is observed that errors in concept design and planning may lead to *lack of proper works schedule and related contractual enforcement* (67), which in turn causes *delays by contractor*. Another important route

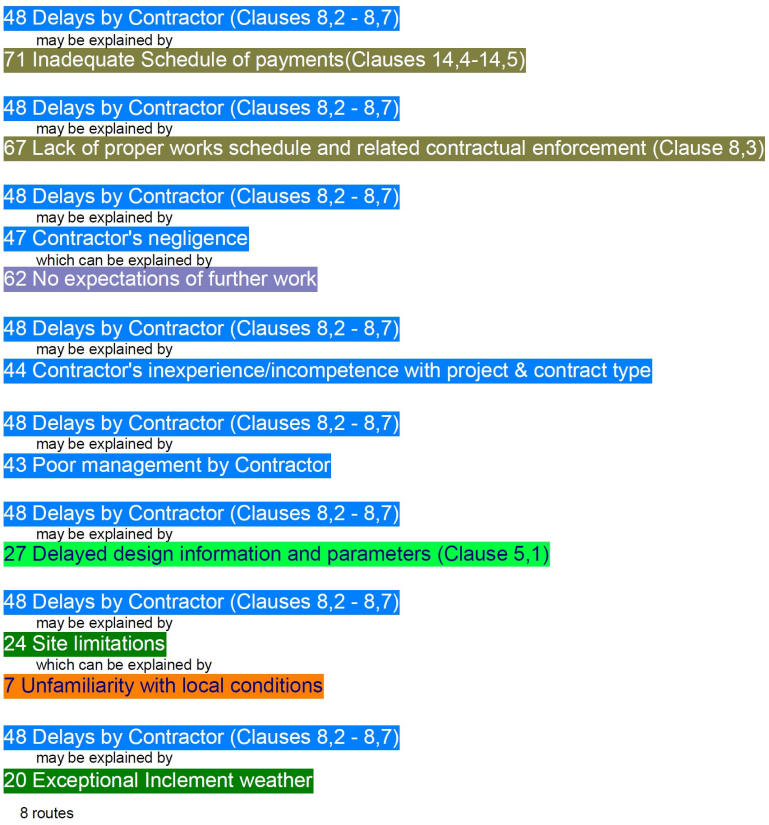

Figure 5.4: Explanations for Delays by Contractor (48)

shows that this concept can also directly lead to *changes and variations*(11), which is the most influential concept as per both centrality and domain analysis. Also, errors in concept design and planning may give rise to *Employer's request for acceleration of works* (37), and it highly likely that this in turn causes *low-quality/defective works by contractor* (32). Another route suggests that errors in concept design and planning may also lead to *design errors by contractor* (25), which can cause *prevention of progress by employer* (38), and this in turn creates room for *opportunistic behaviour* (64).

Positioned as a head and thus investigated through explanations command, concept 38 Prevention of progress by Employer is another top concept that is further reviewed.

Assessing the resulting list for explanations (Figure 5.6), among the total of 9 routes leading up to this concept, we see that prevention of progress by employer may be a direct result of either *lack of history together* (60), *lack of coordination* (57), or

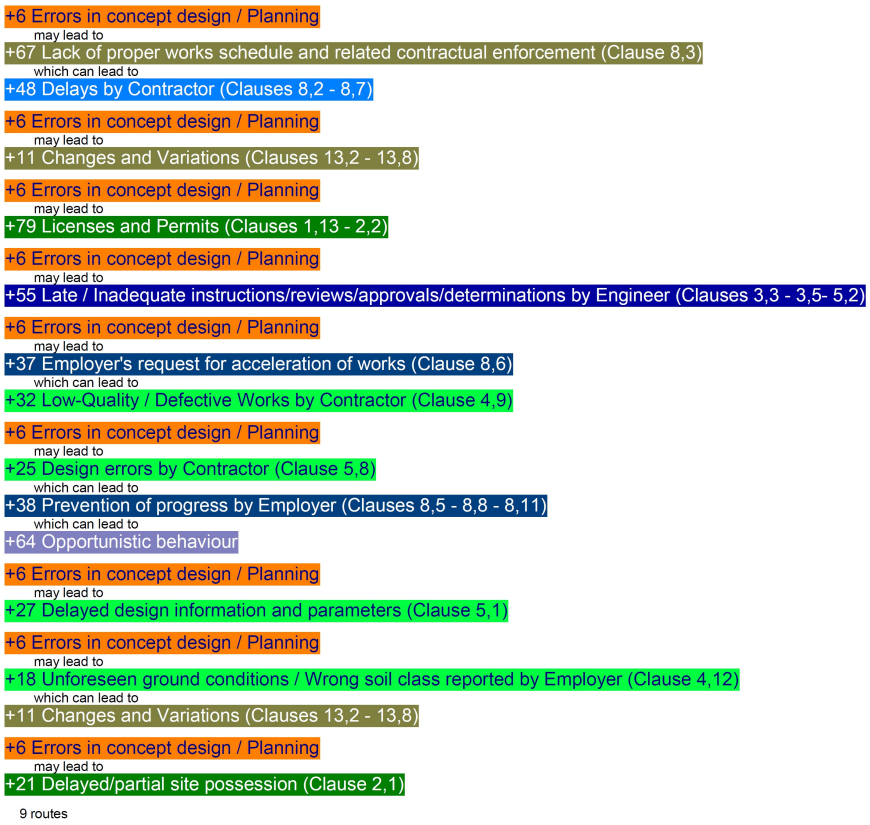

Figure 5.5: Consequences of Errors in concept design and planning (6)

confusing and unrealistic requirements of employer (36). One of the routes suggests that employer might prevent progress because of *contractor's negligence* (47) arising from *no expectations of further work* (62). Also putting the Engineer into the picture, another route shows that prevention of progress by employer might occur due to *poor management by employer* (34), which in turn might be a result of *poor management by engineer* (52).

The last of the top 5 most significant causes/factors is concept 1 Unrealistic expectations of Employer. This concept has significantly few inward links compared to outward links, therefore it is reviewed using consequence command. Assessment of the results given in Figure 5.7 shows that this concept affects other concepts in 9 different routes in total.

Some of the the concepts *unrealistic expectations of employer* might directly lead to are *inadequate description of Engineer's responsibility* (58), *selection of wrong contract (delivery) type* (70), and *unbalanced risk allocation* (15). One of the other longer

Figure 5.6: Explanations for Prevention of progress by Employer (38)

routes suggests that unrealistic expectations of employer may lead to *request for acceleration of works by employer* (37), which in turn results in *low-quality/defective works by contractor* (32). Other longer route indicates that unrealistic expectations of employer may lead to prevention of progress by employer (38), which in turn gives rise to *opportunistic behaviour* (64).

In addition to the explanations and consequences returned as a list by the DE software, it is also possible to map these results for any concept to enable a better tracking and review of the routes the concept is either affected by or leads to. Showing only the interested part of the map for a specific purpose, mapping consequences or explanations of only a significant concept can reveal better insights into the occurrence of

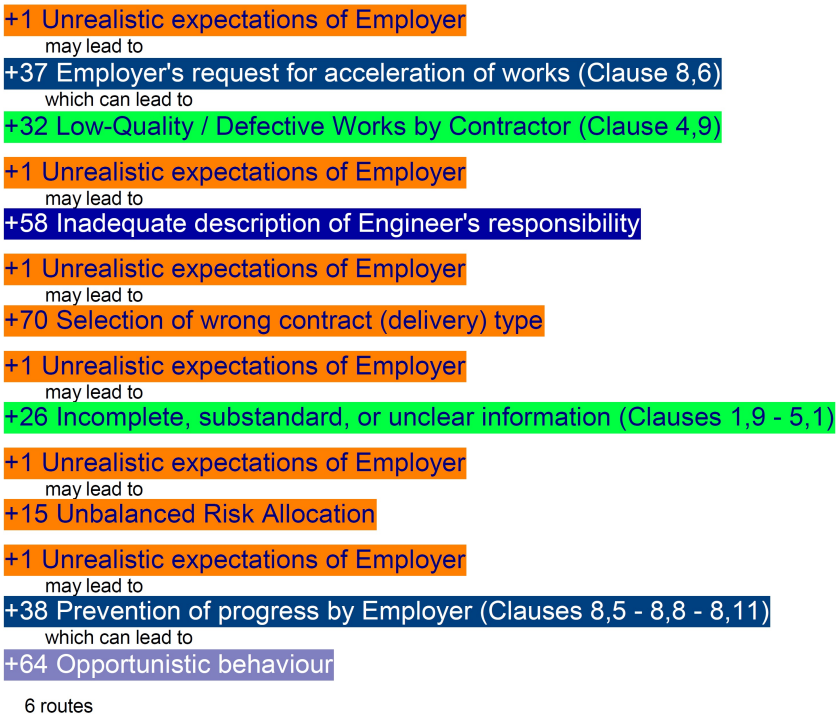

Figure 5.7: Consequences of unrealistic expectations of employer (1)

that specific cause. As an example, map of consequences for concept "Unrealistic expectations of the employer" is given in Figure 5.8.

An overview of the explanations and consequences given above for the five most significant concepts shows that they either result from or lead to a series of other concepts (causes) for occurrence of a dispute. Besides, all such series of other concepts that are not so significant as a result of analysis are also related to each other either directly or through other causes. With this respect, it can be said that despite being the most influential ones on the causal map, these identified causes itself are not solely the causes of construction disputes. Rather, all such causes affect others in some way to provide a combination of more than one cause for a dispute to occur.

Also, mapping of only the top five concepts (Figure 5.9) to reveal the causal relations between concepts such as the link between concept 1 (Unrealistic expectations of Employer), and 38 (Prevention of progress by Employer), and between concept 6 (Errors in concept design and planning) and 11 (Changes and variations) shows even close and direct relations among the most significant causes obtained through analysis.

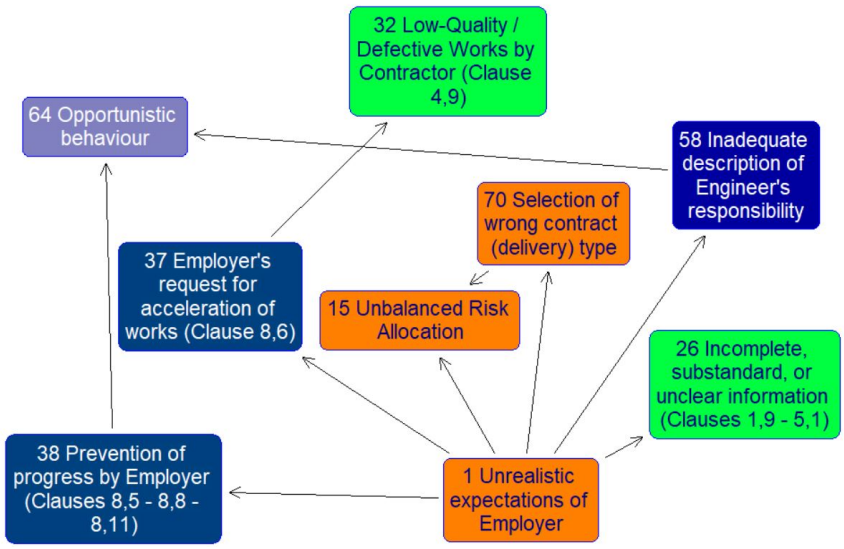

Figure 5.8: Consequences of unrealistic expectations of employer - Map

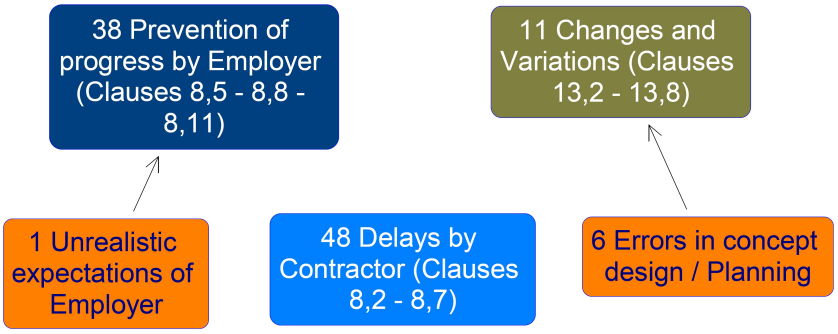

Figure 5.9: Map of most significant concepts

Furthermore, considering only the consequences of most significant concepts, it is observed that *Changes and Variations* (11) is directly linked to *Vagueness of contract clauses related to determination of changes/variations* (12) showing that changes and variations doesn't contribute to occurrence of disputes alone but there should also be vagueness in contract clauses governing determination of changes and variations. Similarly, *delays by contractor* (48) leads to *termination of contract by employer* (76), and *employer's request for acceleration of works* (37) and thus *low-quality/defective works* (32) for the manifestation of a dispute.

As a result, although a number of concepts (causes/sources) are identified to be most significant for the occurrence of construction disputes, further analyses of these con-

cepts reveal a highly interrelated configuration of causes of disputes. This shows that the construction disputes occur not only due to existence of certain causes, despite playing a major role, but a series of other causes also must come into the picture for a conflict to manifest as a dispute between the parties. This is also confirmed by the direct link between the most significant factors showing how various issues must arise together for a dispute to occur. Regarding the initial grouping of dispute causes/sources, review of the explanations and consequences of the most significant concepts indicate that these groups also have a direct causal effect on each other through links between the concepts of these groups. Also, an overview of the most significant causes with regards to this initial groups, it is observed that the studies carried out by Employer during pre-construction phase are as much important as the construction contract itself and the parties involved in the implementation of the project.

CHAPTER 6

CONCLUSIONS

6.1 Summary of Findings

Focusing on exploration of disputes in construction projects contracted through FIDIC Yellow Book, this study aims at providing an alternative approach to the phenomena through causal mapping developed by Ackermann and Eden (Ackermann and Eden, 2011; Eden, 1988, 1992). For this purpose, an initial map is built on the findings of an extensive literature survey on construction disputes using Decision Explorer software (Banxia, 2017). This map is then revised based on the views and comments of experts obtained through an expert workshop. A final causal map is built as per the second round of comments obtained from experts on the revised map and this final map is analysed using Decision Explorer.

As a result of *domain*, and *centrality* analyses enabled by the DE software, ten most significant concepts, and thus causes/sources of disputes are identified to be as *Changes and Variations* (11), *Delays by Contractor* (48), *Errors in concept design/planning* (6), *Prevention of progress by Employer* (38), *Unrealistic expectations of Employer* (1), *Unfamiliarity with local conditions* (7), *Licenses and Permits* (79), *Delayed design information and parameters* (27), *Confusing and Unrealistic requirements of Employer* (36), and *Inadequate description of Engineer's responsibility* (58), in descending order. Following the domain and centrality analyses, *cluster* and *loop* analyses were carried out on the final map model. However, no useful interpretations could be obtained from the results of these analysis as cluster analysis did not return any meaningful results that could contribute to the study and no loops were formed within the map.

In an effort to reveal the relationships between the most significant factors contributing to occurrence of disputes, top five of the ten most influential concepts are considered for further investigation. For this purpose, the commands *explanations*, and *consequences* of the software are used to further explore these map concepts. Analysing the resulting lists of these commands, it is observed that the concepts identified to be most significant are either caused by or leading to a series of other underlying concepts, and thus causes, indicating a high interaction between the concepts. Moreover, mapping the top five concepts, a direct link between the concepts *Unrealistic expectations of Employer* (1), and *Prevention of progress by Employer* (38), and between *Errors in concept design and planning* (6) and *Changes and variations* (11) show even a more direct interaction between these causes. In addition, observing the consequences of these most significant causes, it is seen that even though being a head with few outward links, concepts such as *Changes and Variations* (11) and *Delays by Contractor* (48) should be combined with other concepts for a dispute to occur. In summary, the main findings of this study can be listed as follows:

- The most significant causes of construction disputes in projects contracted through FIDIC Yellow Book are; *Changes and Variations*, *Delays by Contractor*, *Errors in concept design/planning*, *Prevention of progress by Employer*, and *Unrealistic expectations of Employer*.
- Considering the dispute source/cause group types determined earlier, it is seen that studies carried out during pre-construction stage is as much important as the construction contract itself, and the people factor.
- Causal relations between the concepts indicate that the different categories of dispute causes/sources highly affect each other in addition to the links within a category.
- Investigating the roots and consequences of most significant concepts, it is observed that these concepts are not solely the causes of a dispute, but rather they need to combine with a series of other causes for a dispute to occur.
- Tracking the roots and consequences of the most significant causes, it is possible to gain useful insight into occurrence of disputes, which in turn can be beneficial for dispute avoidance.

6.1.1 Contributions to Theory

Unlike many of the previous studies focused on construction disputes yielding only the causes that play significant role in the occurrence of disputes as a result, this study provides a further insight into the issue through investigating the relations between the factors in addition to identification of these. Demonstrating practical application of a powerful qualitative research technique, causal mapping, as an alternative approach for analysing and investigation of complex and multifaceted problems, and the analytical techniques available, the study also contributes to the literature in the domain of project management.

6.1.2 Contributions to Practice

Providing a comprehensive insight into the occurrence of construction disputes, findings of these study and the causal mapping technique itself can be used by professionals in the fields of project, and contract management as a tool to identify possible dispute sources in advance and take proper proactive measures. Similarly, it can also be used for evaluation of project risk at the initial phases of a project. In addition to serving as a proactive tool, this method can also be used for post-mortem analysis of construction disputes and other project problems encountered. In a broader view, due to vast qualitative data the method is capable of capturing and structuring, it can also be used as a tool for knowledge/information sharing and management.

6.2 Limitations of the Research

Despite being a profound method that has been extensively applied bot in operational research and recently in project management, the methodology adopted for the study has certain limitations. Forming also one of its core strengths, since causal mapping technique is purely qualitative, no numerical (quantitative) assessment of the impacts could be made directly through mapping but it rather provides input for other quantitative models such as system dynamics. Another limitation to the study is the subjectivity of the causal map since a completely different map model can be built

based on views of different experts in the field, which would in turn yield different results. This holds true for the facilitator of the workshop. Since facilitating an expert workshop to effectively acquire expert views on the issue requires good interview and communication skills, and significant relevant previous experience, different results would have been obtained with an highly experienced facilitator.

Being a limitation both for the study and the causal mapping technique itself, building of a map from scratch requires quite significant time due to generally high number of concepts and complexity of relations between these. For this reason, initial map that was constructed based on literature review instead of expert views to expedite the process can also be considered to induce biased views of experts in some sense. With this respect, results of the study should not be considered as conclusive, but it demonstrates application of the causal mapping technique to construction disputes and reflects a certain view on the issue. It must also be noted that although the technique can be applied to any other project, causal map built for the purpose of this study takes into account only the projects contracted through FIDIC Yellow Book. Therefore, map model would be entirely different for different contract types and responsibility structures between the parties involved.

6.3 Recommendations for Further Studies

Also noted as one of the limitations to this study, developing a final map that can be used for reliable analysis is highly time consuming. With this respect, searching for methods to reduce the time and efforts required for the construction of a causal map would pave the way for not only a wider recognition and use of the technique but also result in more efficient and thorough capturing of data in limited time of experts. Parallel to this, it is anticipated that further attempts to causal mapping of construction disputes where the initial map is also constructed based on expert views, are highly likely to include feedback loops which would reveal further insights into the dynamics of occurrence of construction disputes.

As previously used for quantifying a litigation case (Ackermann et al., 1997), causal mapping can also be used for quantification of claims filing combined with other

quantitative methods such as system dynamics. Also, current approach to causal mapping provides a cross sectional perspective that is considering the issue only at a given time. A longitudinal approach enabling evolving of the map model over time in this sense can be useful for consideration and analysis of the map for different phases throughout the course of project implementation.

REFERENCES

Acharya, N. K., Lee, Y. D., & Im, H. M. (2006). Conflicting factors in construction projects: Korean perspective. *Engineering, Construction and Architectural Management*, 13(6), 543–566.

Ackermann, F. & Alexander, J. (2016). Researching complex projects: Using causal mapping to take a systems perspective. *International Journal of Project Management*, 34(6), 891–901.

Ackermann, F. & Eden, C. (2001). Soda–journey making and mapping in practice. In Rosenhead, J. & Mingers, J., editors, *Rational Analysis for a Problematic World Revisited*, chapter 3. John Wiley & Sons, Chichester.

Ackermann, F. & Eden, C. (2010). *Strategic Options Development and Analysis*, pages 135–190. Springer London, London.

Ackermann, F. & Eden, C. (2011). *Making strategy: Mapping out strategic success*. Sage, London.

Ackermann, F., Eden, C., & Williams, T. (1997). Modeling for Litigation: Mixing Qualitative and Quantitative Approaches. *Interfaces*, 27(2), 48–65.

Ackermann, F., Eden, C., Williams, T., & Howick, S. (2007). Systemic risk assessment: a case study. *Journal of the Operational Research Society*, 58(1), 39–51.

Ackermann, F., Howick, S., Quigley, J., Walls, L., & Houghton, T. (2014). Systemic risk elicitation: Using causal maps to engage stakeholders and build a comprehensive view of risks. *European Journal of Operational Research*, 238(1), 290 – 299.

Ackoff, R. L. & Emery, F. E. (1972). *On Purposeful Systems*. Tavistock Publications, London, U.K.

Adriaanse, J. (2005). *Construction Contract Law: The Essentials*. Palgrave-MacMillan, New York, NY.

Adrian, J. (1988). *Construction Claims: A Quantitative Approach*. Prentice-Hall, New Jersey.

Allen, R. K. (1993). Dispute avoidance and resolution for consulting engineers.

Arcadis (2019). Global construction disputes report 2019. Retrieved from https://www.arcadis.com/en/united-kingdom/our-perspectives/2019/june/global-construction-disputes-report-2019/.

Ashworth, A. (2005). *Contractual Procedures in the Construction Industry*. Pearson Longman, New York, NY.

Axelrod, R. (2015). *Structure of decision: The cognitive maps of political elites*. Princeton university press, Princeton, N.J.

Banxia (2017). *Decision Explorer: User's Guide Version 3.5.0*. Banxia Software Limited, Kendal, UK.

Bristow, D. & Vasilopoulos, R. (1995). The new ccdc2: facilitating dispute resolution of construction projects. *Construction Law J.*, 11(2), 95–117.

Brooker, P. (2002). Construction lawyers' attitudes and experience with adr. *Construction Law Journal*, 18(2), 97–116.

Bryson, J. M., Ackermann, F., & Eden, C. (2014). *Visual strategy: Strategy mapping for public and nonprofit organizations*. John Wiley & Sons.

Bryson, J. M., Ackermann, F., Eden, C., & Finn, C. B. (2004). *Visible thinking: Unlocking causal mapping for practical business results*. John Wiley & Sons.

Busby, J. & Hughes, E. (2004). Projects, pathogens and incubation periods. *International Journal of Project Management*, 22(5), 425–434.

Chan, D. W. & Kumaraswamy, M. M. (1997). A comparative study of causes of time overruns in hong kong construction projects. *International Journal of project management*, 15(1), 55–63.

Chan, E. H. & Suen, H. C. (2005). Dispute resolution management for international construction projects in china. *Management decision*, 43(4), 589–602.

Chen, J. H. (2008). KNN based knowledge-sharing model for severe change order disputes in construction. *Automation in Construction*, 17(6), 773–779.

Cheung, S. & Suen, H. (2002a). The contributions of neutral third party towards amicable construction dispute resolution. *Int. Constr. Law Rev.*, 19(1), 79–86.

Cheung, S. & Suen, H. (2002b). A multi-attribute utility model for dispute resolution strategy selection. *Construction Management and Economics*, 20(7), 557–568.

Cheung, S.-O. (1999). Critical factors affecting the use of alternative dispute resolution processes in construction. *International Journal of Project Management*, 17(3), 189 – 194.

Cheung, S. O. (2014). *Construction Dispute Research: Conceptualisation, Avoidance and Resolution*. Springer.

Cheung, S. O. & Pang, K. H. Y. (2013). Anatomy of Construction Disputes. *Journal of Construction Engineering and Management*, 139(1), 15–23.

Cheung, S. O. & Yiu, T. W. (2006). Are construction disputes inevitable? *IEEE Transactions on Engineering Management*, 53(3), 456–470.

Cialdini, R., Petrova, P., & Goldstein, N. (2004). The hidden costs of organizational dishonesty. *MIT Sloan Management Review*, 45(3), 67–73+95.

Conlin, J., Langford, D., & Kennedy, P. (1996). The sources, causes and effects of construction disputes: A research project. *CIB REPORT*, pages 69–75.

Cossette, P. & Audet, M. (1992). Mapping of an idiosyncratic schema. *Journal of Management Studies*, 29(3), 325–347.

Creed, S. E. & Joon, H. P. (2009). Risk index model for minimizing environmental disputes in construction. *Journal of Construction Engineering and Management*, 135(1), 34–41.

Currie, O. (1991). Avoiding, managing and winning construction disputes. *Int. Constr. Law Rev.*, 8(3), 344–369.

Dictionary, C. (2019). In collinsdictionary.com. Retrieved from www.collinsdictionary.com/dictionary/english/conflict.

Diekmann, J. E. & Girard, M. J. (1995). Are Contract Disputes Predictable? *Journal of Construction Engineering and Management*, 121(4), 355–363.

Eden, C. (1988). Cognitive mapping. *European Journal of Operational Research*, 36(1), 1 – 13.

Eden, C. (1992). On the nature of cognitive maps. *Journal of Management Studies*, 29(3), 261–265.

Eden, C. & Ackermann, F. (1998). *Analysing and comparing idiographic causal maps*, pages 192–209. Sage London.

Eden, C. & Ackermann, F. (2004). Cognitive mapping expert views for policy analysis in the public sector. *European Journal of Operational Research*, 152(3), 615 – 630.

Eden, C., Spender, J.-C., & Spender, J. (1998). *Managerial and organizational cognition: theory, methods and research*. Sage.

Edkins, A. J., Kurul, E., Maytorena-Sanchez, E., & Rintala, K. (2007). The application of cognitive mapping methodologies in project management research. *International Journal of Project Management*, 25(8), 762 – 772.

Fenn, P., Lowe, D., & Speck, C. (1997). Conflict and dispute in construction. *Construction Management and Economics*, 15(6), 513–518.

Fisher, J. (1988). Prevention is better than cure, or how to avoid costly mistakes in hong kong construction contracts. *The International Construction Law Review, July/Oct*, pages 342–348.

Fransella, F., Bell, R., & Bannister, D. (2004). *A manual for repertory grid technique*. John Wiley & Sons.

Gebken, R. J., Gibson, E., & Groton, J. P. (2005). Dispute resolution transactional cost quantification: What does resolving a construction dispute really cost? In *Construction Research Congress 2005: Broadening Perspectives-Proceedings of the Congress*, pages 889–898.

Gebken, R. J. & Gibson, G. E. (2006). Quantification of costs for dispute resolution procedures in the construction industry. *Journal of Professional Issues in Engineering Education and Practice*, 132(3), 264–271.

Gebken II, R. J. (2006). *Quantification of transactional dispute resolution costs for the United States construction industry*. PhD thesis, The University of Texas at Austin.

Georgiou, I. (2010). Cognitive mapping and strategic options development and analysis (soda). *Wiley Encyclopedia of Operations Research and Management Science*.

Groton, J. (1992). *Supplementary to alternative dispute resolution in the construction industry*. Wiley Law Publications, USA.

Groton, J., Blumenfeld, A., & Ratterman, D. (2005). How to keep your project out of litigation, arbitration, and even mediation. In *CII Annual Conference-Leadership of Tomorrow: Bridging the Gap, Grapevine, Texas*.

Heath, B., Hills, B., & Berry, M. (1994). The nature and origin of conflict within the construction process. *CIB REPORT*, pages 35–35.

Hellard, R. (1987). *Managing Construction Conflict*. Longman Scientific Tech, U.K.: Harlow.

Hewitt, R. (1991). *Winning contract disputes: Strategic planning for major litigation*. Ernst & Young.

Hodgkinson, G. P. & Clarkson, G. P. (2005). What have we learned from almost 30 years of research on causal mapping? methodological lessons and choices for the information systems and information technology communities. In *Causal mapping for research in information technology*, pages 46–80. IGI Global.

Howick, S. & Eden, C. (2001). The impact of disruption and delay when compressing large projects: going for incentives? *Journal of the Operational Research Society*, 52(1), 26–34.

Howick, S., Eden, C., Ackermann, F., & Williams, T. (2008). Building confidence in models for multiple audiences: The modelling cascade. *European Journal of Operational Research*, 186(3), 1068 – 1083.

Huff, A. S. (1990). *Mapping strategic thought*. John Wiley & Sons.

Hughes, W., Hillebrandt, P. M., Greenwood, D., & Kwawu, W. (2006). *Procurement in the construction industry: the impact and cost of alternative market and supply processes*. Routledge.

Ilter, D. (2012). Identification of the relations between dispute factors and dispute categories in construction projects. *International Journal of Law in the Built Environment*, 4(1), 45–59.

Jannadia, M., Assaf, S., Bubshait, A., & Naji, A. (2000). Contractual methods for dispute avoidance and resolution (dar). *International Journal of Project Management*, 18(1), 41–49. cited By 35.

Jentzen, G. H. & Spittler, J. (1992). Dispute resolution: managing construction conflict with step negotiations,. *AACE Int. Trans*, page D.9. 1–D.9.10.

Jones, L. S. (1991). Zero-based contracts for dispute avoidance. In *Preparing for Construction in the 21st Century*, pages 710–714. ASCE.

Keil, J. H. (1999). Hybrid ADR in the construction industry. *Dispute Resolution Journal*, 54(3), 14.

Kelly, G. A. (1955). *The psychology of personal constructs. Volume 1: A theory of personality*. WW Norton and Company.

Kumaraswamy, M. (1997). Common categories and causes of construction claims. *Construction Law Journal*, 13(1), 21–34.

Langford, D., Kennedy, P., & Somerville, J. (1992). Contingency management of conflict: Analysis of contract interfaces. *Proc. 1st Int. Construction Conflict Management and Resolution Conf., U.K.*, pages 151–161.

Li, H., Arditi, D., & Wang, Z. (2012). Transaction-related issues and construction project performance. *Construction Management and Economics*, 30(2), 151–164.

Li, H., Arditi, D., & Wang, Z. (2013). Factors that affect transaction costs in construction projects. *Journal of Construction Engineering and Management*, 139(1), 60–68.

Li, H., Arditi, D., & Wang, Z. (2015). Determinants of transaction costs in construction projects. *Journal of Civil Engineering and Management*, 21(5), 548–558.

Love, P., Davis, P., Ellis, J., & Cheung, S. O. (2010). Dispute causation: Identification of pathogenic influences in construction. *Engineering, Construction and Architectural Management*, 17(4), 404–423.

Love, P., Davis, P., London, K., & Jasper, T. (2008). Causal modelling of construction disputes. In *Proceedings of the 24th Annual Conference of ARCOM (Association of Researchers in Construction Management)*.

Love, P. E., Davis, P. R., Cheung, S. O., & Irani, Z. (2011). Causal discovery and inference of project disputes. *IEEE Transactions on Engineering Management*, 58(3), 400–411.

Lu, W., Zhang, L., & Pan, J. (2015). Identification and analyses of hidden transaction costs in project dispute resolutions. *International Journal of Project Management*, 33(3), 711–718.

Marriott, A. & Brown, H. (1999). *ADR Principles and Practice*. U.K.: Sweet and Maxwell, London.

Marzouk, M. & Moamen, M. (2009). A framework for estimating negotiation amounts in construction projects. *Construction Innovation*, 9(2), 133–148.

Maytorena, E., Winch, G. M., Freeman, J., & Kiely, T. (2007). The influence of experience and information search styles on project risk identification performance. *IEEE Transactions on Engineering Management*, 54(2), 315–326.

McHugh, P. (1968). *Defining the situation: The organization of meaning in social interaction*. Bobbs-Merrill.

Michel, H. L. (1998). Feature—the next 25 years: The future of the construction industry. *Journal of Management in Engineering*, 14(5), 26–31.

Miles, M. B., Huberman, A. M., Huberman, M. A., & Huberman, M. (1994). *Qualitative data analysis: An expanded sourcebook*. Sage.

Mitkus, S. & Mitkus, T. (2014). Causes of conflicts in a construction industry: A communicational approach. *Procedia - Social and Behavioral Sciences*, 110, 777 – 786.

Mitropoulos, P. & Howell, G. (2001). Model for understanding, preventing and resolving project disputes. *J. Construction Eng. Manag*, 127(3), 223–231.

Molenaar, K., Washington, S., & Diekmann, J. (2000). Structural Equation Model of Construction Contract Dispute Potential. *Journal of Construction Engineering and Management*, 126(4), 268–277.

Mururu, N. (1991). Anatomy of a dispute,. *Arbitration, November*, page 262–264.

Narayanan, V. & Armstrong, D. (2005). *Causal mapping for research in information technology*. IGI Global.

Nieto-Morote, A. & Ruz-Villa, F. (2012). A fuzzy multi-criteria decision-making model for construction contractor prequalification. *Automation in Construction*, 25, 8 – 19.

Reid, A. & Ellis, R. C. (2007). Common sense applied to the definition of a dispute. *Structural Survey*, 25(3/4), 239.

Rhys Jones, S. (1994). How constructive is construction law? *Construction Law Journal*, 10, 28–28.

Richardson, G. P., Pugh, A. L., et al. (1981). *Introduction to system dynamics modeling with DYNAMO*, volume 48. MIT press Cambridge, MA.

Rosenhead, J. & Mingers, J. (2001). *Rational analysis for a problematic world revisited*. John Wiley and Sons, 2nd edition.

Sambasivan, M. & Soon, Y. W. (2007). Causes and effects of delays in malaysian construction industry. *International Journal of Project Management*, 25(5), 517 – 526.

Scherp, H. Å. (2013). Quantifying qualitative data using cognitive maps. *International Journal of Research and Method in Education*, 36(1), 67–81.

Semple, C., Hartman, F. T., & Jergeas, G. (1994). Construction Claims and Disputes: Causes and Cost/Time Overruns. *Journal of Construction Engineering and Management*, 120(4), 785–795.

Sheridan, P. (2003). Claims and disputes in construction. *Construction Law Journal*, 12(1), 3–13.

Smith, M. (1992). Facing up to conflict in construction. *Proc. UMIST Conf.*, pages 120–125.

Spittler, J. & Jentzen, G. (1992). Dispute resolution: managing construction conflict with step negotiations. *AACE Int. Trans.*, page D.9. 1–D.9.10.

Stipanowich, T. J. (1997). At the cutting edge: conflict avoidance and resolution in the us construction industry. *Construction Management and Economics*, 15(6), 505–512.

Sykes, J. (1996). Claims and disputes in construction. *Construction Law J.*, 12(1), 3–13.

Tillet, G. (1991). *Resolving Conflict: A Practical Approach*. Sydney Univ. Press, Sydney, Australia.

Tolman, E. C. (1948). Cognitive maps in rats and men. *Psychological Review*, 55(4), 189–208.

Totterdill, B. (1991). Does the construction industry need alternative dispute resolution? the opinion of an engineer. *Construction Law Journal*, 7(3), 189–199.

Treacy, T. (1995). Use of alternative dispute resolution in the construction industry. *Journal of Management in Engineering*, 11(1), 58–63.

Tsai, J.-S. & Chi, C. S. (2009). Influences of chinese cultural orientations and conflict management styles on construction dispute resolving strategies. *Journal of Construction Engineering and Management*, 135(10), 955–964.

Turner, R. (1994). Avoidance and resolution of construction disputes-prior to and during the construction process. *Int. Construction Law Rev.*, 11, 384–394.

Vygotsky, L. S. (1980). *Mind in society: The development of higher psychological processes*. Harvard University Press.

Waldron, B. D. (2006). Scope for improvement: A survey of pressure points in australian construction and infrastructure projects. *A Report Prepared for the Australian Constructors Association by Blake Dawson Waldron Lawyers, Sydney, Australia*.

Watts, V. M. & Scrivener, J. C. (1993). Review of australian building disputes settled by litigation: Fifty-nine different categories of dispute recognized within a total of 117 sources of dispute from building dispute judgments in supreme courts of new south wales and victoria from 1989–1990. *Building Research and Information*, 21(1), 59–63.

Weick, K. E. (1995). *Sensemaking in organizations*. Sage Publications, Thousand Oaks.

Whittington, J. (2008). The transaction cost economics of highway project delivery: design-build contracting in three states.

Williams, T. (2016). Identifying success factors in construction projects: A case study. *Project Management Journal*, 47(1), 97–112.

Williams, T., Ackermann, F., & Eden, C. (2003). Structuring a delay and disruption claim: An application of cause-mapping and system dynamics. *European Journal of Operational Research*, 148(1), 192–204.

Williams, T., Eden, C., Ackermann, F., & Tait, A. (1995). Vicious circles of parallelism. *International Journal of Project Management*, 13(3), 151 – 155.

Yates, D. (1999). Conflict and disputes in the development process: A transaction cost economics perspective. Working Paper.

Yiu, K. T. & Cheung, S. O. (2006). A catastrophe model of construction conflict behavior. *Building and Environment*, 41(4), 438 – 447.

Yiu, T. W. & Cheung, S. O. (2007). Behavioral transition: A framework for the construction conflict–tension relationship. *IEEE Transactions on Engineering Management*, 54(3), 498–505.

Yiu, T. W., Keung, C. W., & Wong, K. L. (2011). Application of equity sensitivity theory to problem-solving approaches in construction dispute negotiation. *Journal of Management in Engineering*, 27(1), 40–47.

Zaghloul, R. & Hartman, F. (2003). Construction contracts: the cost of mistrust. *International Journal of Project Management*, 21(6), 419 – 424. Selected papers from the Fifth Biennial Conference of the International Research Network for Organizing by Projects. Renesse, Seeland, The Netherlands, 28-31 May 2002.

Appendix A

INITIAL CAUSAL MAP

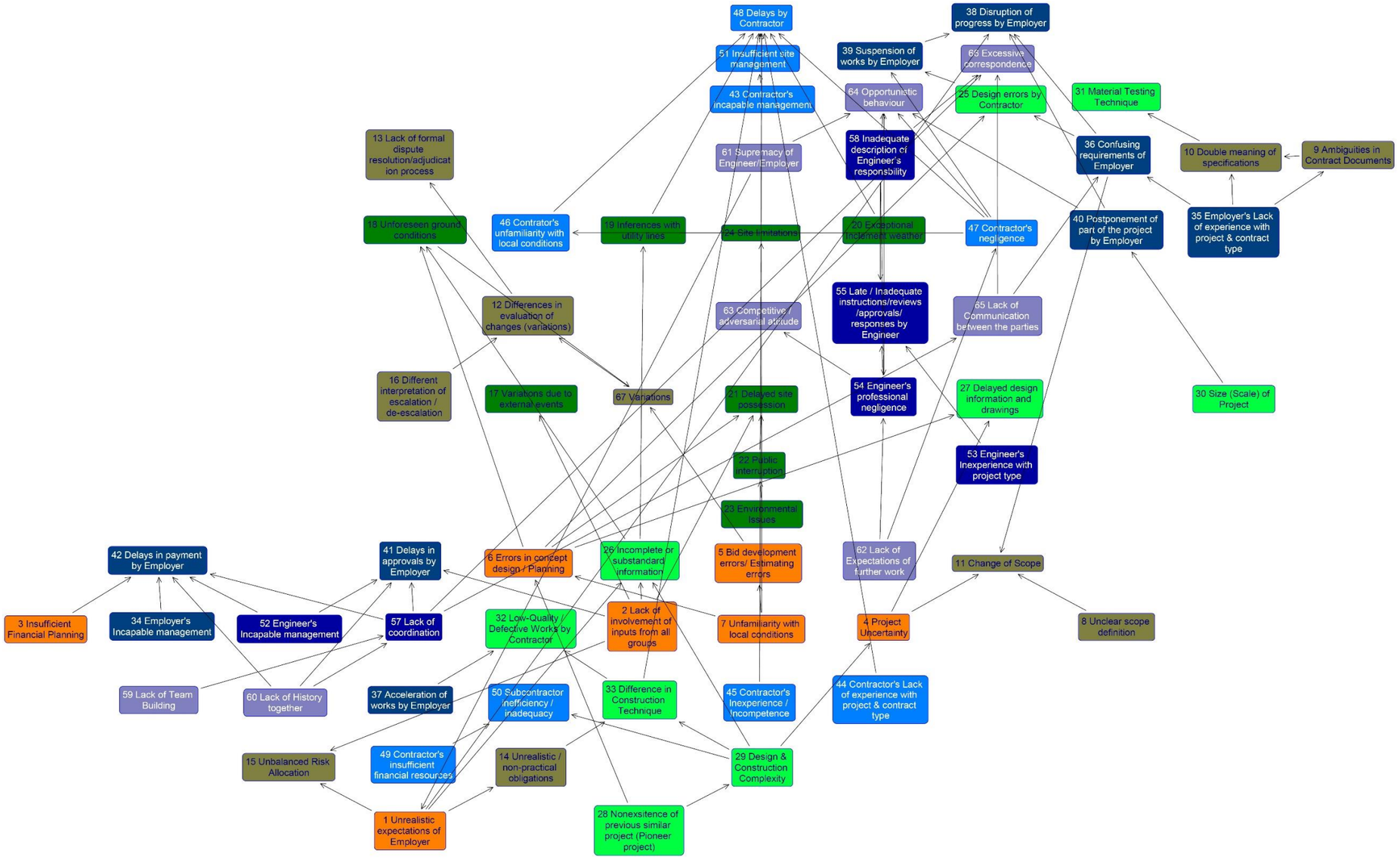

Figure A.1: Initial Causal Map

Appendix B

REVISED CAUSAL MAP - SCHEMATIC VIEW

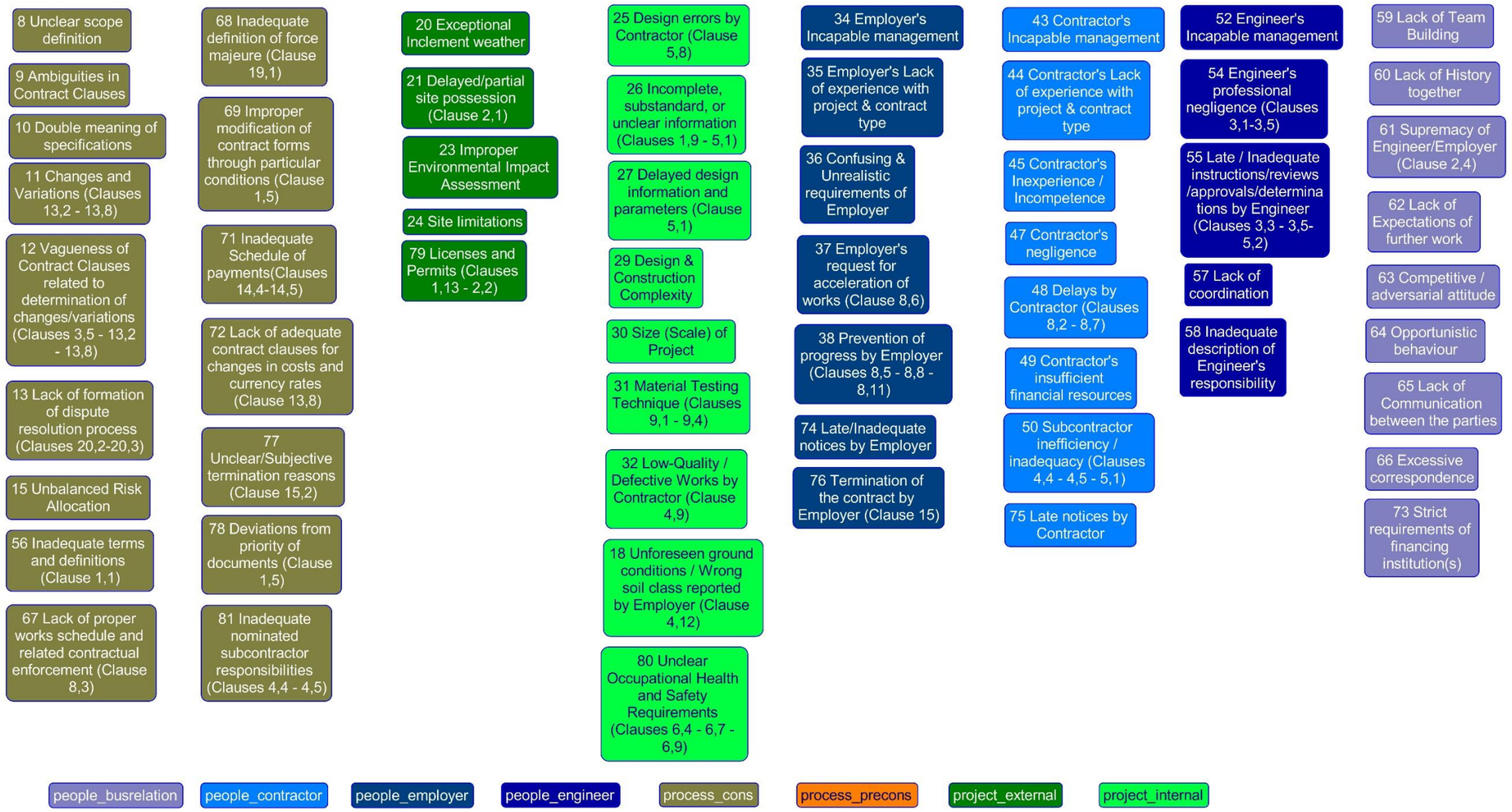

Figure B.1: Revised Causal Map - Schematic View

Appendix C

REVISED CAUSAL MAP

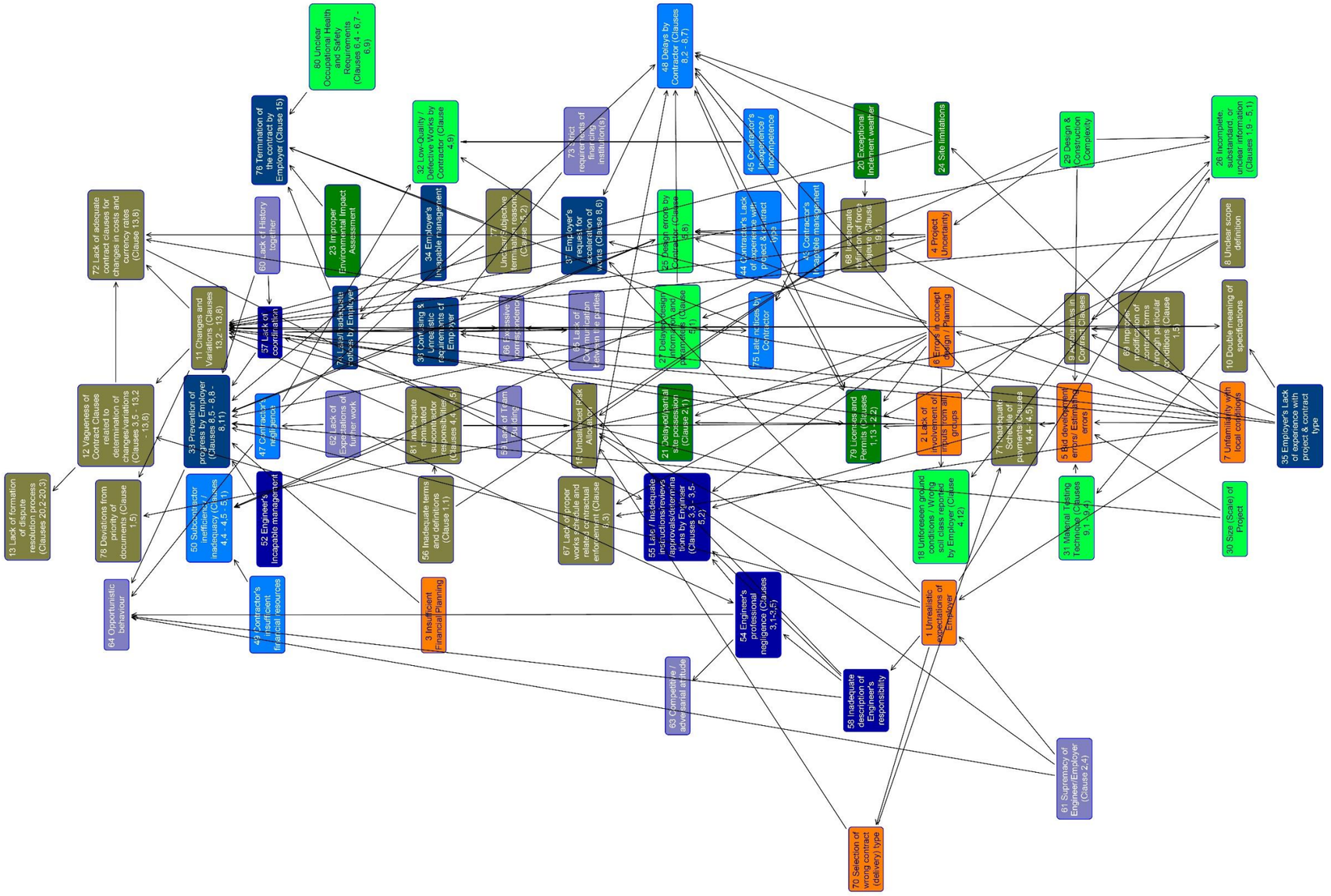

Figure C.1: Revised Causal Map

Appendix D

FINAL CAUSAL MAP

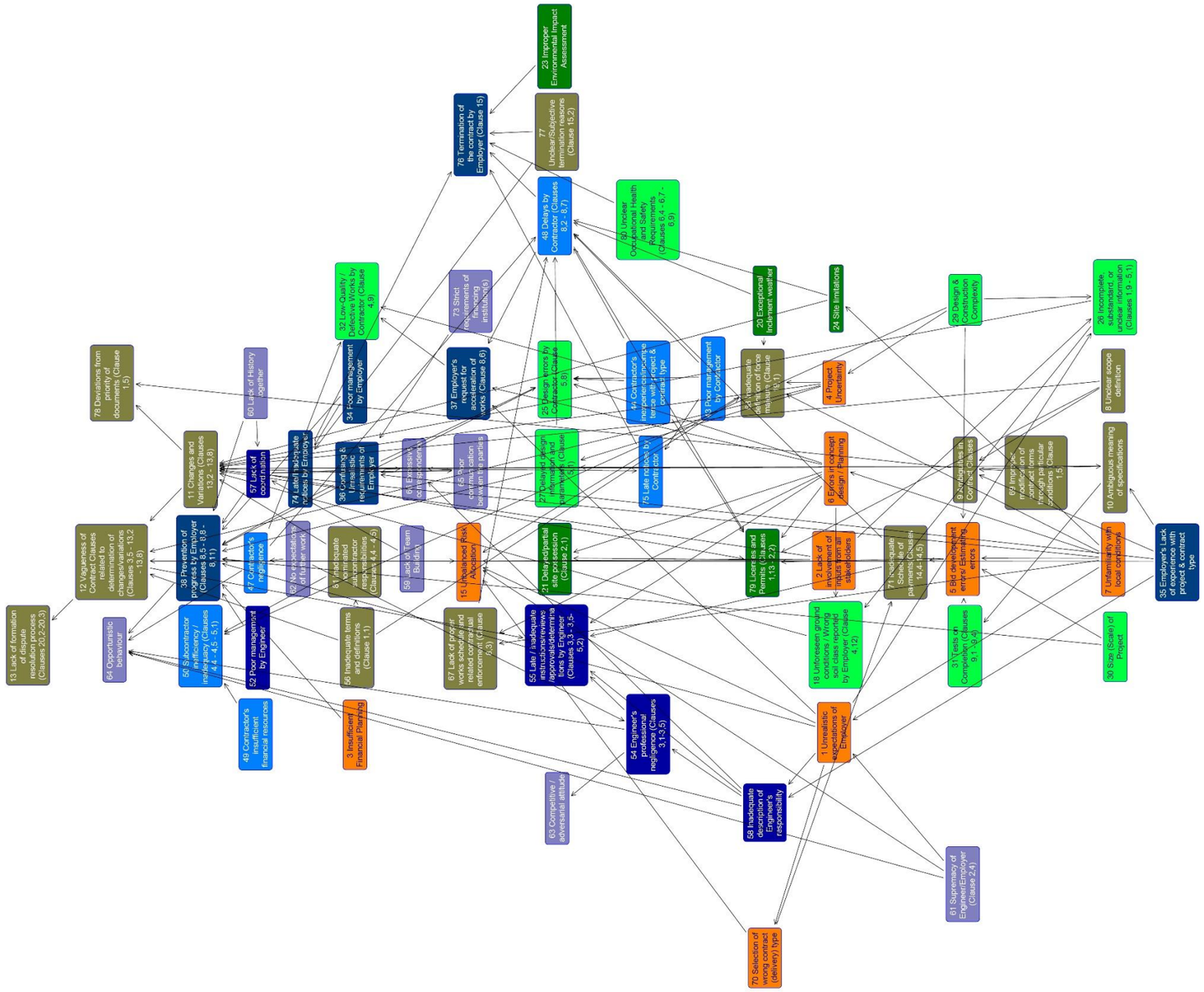

Figure D.1: Final Causal Map

Appendix E

SCHEMATIC VIEW OF FINAL CAUSAL MAP

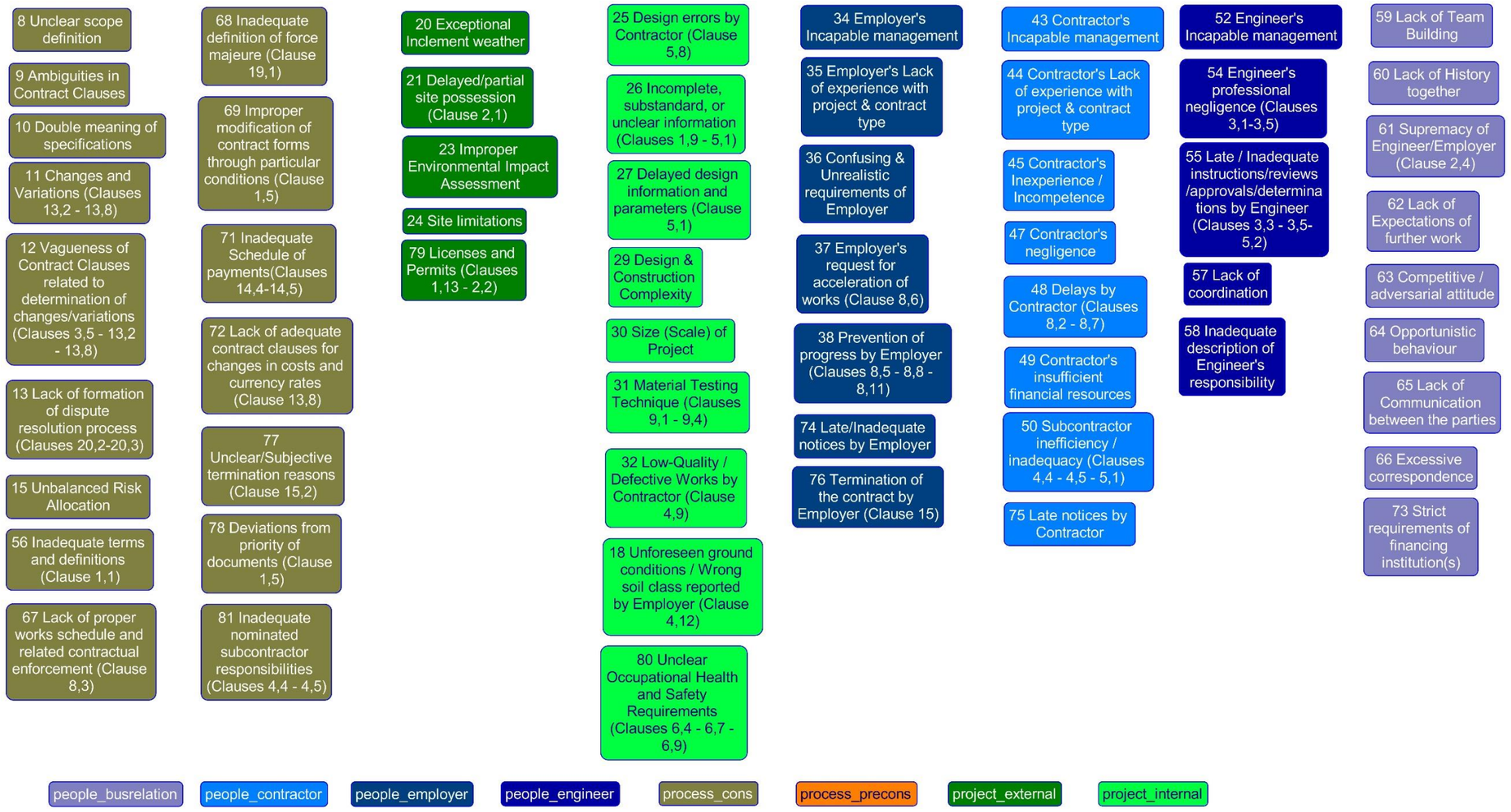

Figure E.1: Schematic View of Final Causal Map