

REGENERATIVE MECHANISMS TO RESOLVE CONTRACTOR COMMITMENT CHALLENGES IN PROJECT DELIVERY

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Performance of participants on a contract is important for its successful delivery. It is an indication of competency, measure of productivity and quality levels of the project. Lack of contractors' commitment is observed to be one of the major barriers in effective execution of contracts and consequent successful project delivery. This investigation was aimed at to explore how contractor commitment challenges can be resolved to improve their performance in the project delivery. A questionnaire survey was conducted among 88 stakeholders that include clients, architects, contractors, quantity surveyors, structural engineers and project managers. Stratified random sampling technique was used for the selection of respondents and the survey was administered through post and e-mail. The contractor commitment challenge variables were evaluated by using Likert scale. The inter-linkage among the variables was established based on literature findings and relevant statistical tests. Followed by System Dynamics (SD) principle based on System thinking approach, was adopted to extract the causal feedback mechanisms that cause contractor commitment challenges and to evolve plausible policy interventions to resolve the challenges. Findings suggest that lack of experience, skill, inadequate supervision, and lack of control over the subcontractors leads to contractor's inefficiency. Poor planning and scheduling, poor professional management, poor execution of projects, ineffective/outdated equipment, and inefficiency of labour force result in poor quality of work and delay. In addition, design and documentation challenges disrupt the contractors' schedule. These hinder contractor commitment. However, four policy/strategic interventions were evolved based on dynamic hypotheses: they are the causal feedback relationships among (1) contractor efficiency and capacity building; (2) professional management; (3) construction methods; and (4) involvement of the contractor and client in the design process. These would enable the contractors to meet their commitment and overcome their challenges and improve their efficiency in project delivery.

Keywords: Contractor, Commitment, Delay, Performance, Project, System Dynamics

1. INTRODUCTION

Contractor commitment is a pledge by the contractor to deliver the project successfully relative to key performance criteria. There is always certain amount of risk inherent in the award of construction of a project to a contractor notwithstanding the positive attributes, ability and experience of the contractor because of the commitment variability on account of emergence specific scenarios and context. Consequently, delay in successful realisation of the projects and cost overruns may be experienced. However, it is of interest to all parties relative to a contract that a project is delivered within the initial stipulated time, cost and specifications. There are several uncontrollable factors that influence project delivery time. In most cases, these factors adversely impact on the delivery of the project. Some of the factors that influence project delivery can be categorised under client related factors, contractor related factors, consultant and design related factors, material and equipment related factors (Al-Moumani, 2000; Andawei, 2002; Dainty et al. 2002; Odeh and Battaineh, 2002; Lim and Ling, 2002; Frimpong et al. 2003; Fox, Marsh, and Cockerham, 2003; Griffith and Watson, 2004; Mbamali, Aiyetan, and Kehinde, 2005; Tam and Tam, 2006; Sambasivan and Soon, 2007; Doloi, 2009a). These hinder contractor commitment. However, four policy/strategic interventions were evolved based on dynamic hypotheses, they are the causal feedback relationships among (1) contractor efficiency and capacity building; (2) professional management; (3) construction methods; and (4) involvement of the contractor and client in the design process. These would enable the contractors to meet their commitment and overcome their challenges and improve their efficiency in project delivery.

2. LITERATURE REVIEW

Contractors are essentially responsible for the actual construction activities. Honouring of contractual agreements by contractors plays a major role in the successful project delivery (Ndekugri, Braimah, and Gameson, 2008). However, according to Chan and Kumaraswamy (1997) and Satyanarayana and Iyer (1996) lack of commitment may lead to project delays. Evidence from literature has shown that a number of factors contribute to the lack of commitment of the contractors.

Alwi and Hampson (2003) and Sweis, Sweis, Hammad, Abu (2008) observe that contractor's inability and inefficiency cause delay and influence project delivery, which was corroborated by other scholars. According to Olawale and Sun (2010), non-performance of contractors/subcontractors within four key principles namely preventive, predictive, corrective and organizational support are major impediments in successful project delivery. Besides, a common set of contractor ability criteria, which includes engineering/construction, procurement/contract, project management, human resources, quality management systems, health and safety, plant/equipment, financial strength, and public relations also influence project deliver (Pongpeng, and Liston, 2003). Inadequate experience of contractor, contractors' inability and inefficiency, poor labour productivity, lack of control over subcontractor and financial difficulties faced by the contractors contribute to the commitment challenges faced by the contractors and

adversely impact the project delivery (Sweis, Sweis, Hammad, Abu, 2008). Lack of trades' skill, poor distribution of labour, inadequate number of supervisors/foremen, inexperienced inspectors, late supervision, and shortage of manpower (skilled, semi-skilled, unskilled labour) are the factors that adversely influence the delivery of projects on time (Satyanarayana and Iyer, 1996; Odeh and Battaineh, 2002; Alwi and Hampson, 2003; Sambasivan and Soon, 2007; Sweis et al., 2008). Besides, lack of skill and competency of human resource in their disposal, such as subcontractor or labourers are the major factors that adversely affect project delivery time (Satyanarayana and Iyer, 1996; Odeh and Battaineh, 2002; Alwi and Hampson, 2003;; Sambasivan and Soon, 2007; Sweis et al. 2008).

Satyanarayana and Iyer (1996), Odeh and Battaineh (2002), Sambasivan and Soon (2007), and Sweis, et al. (2008) observe that professional management challenges faced by contractors hamper their commitment, and consequently contribute to delay in the delivery of projects. The professional management factors, which contribute to delay in project delivery are poor site management and supervision, delay in material delivery by vendors, and site accidents due to lack of safety measures. Similarly, according to Alwi Hampson (2003), Odeh and Battaineh (2002) and Sweis et al. (2008) project execution could negatively impact the contractor commitment on project delivery. According to them, too much overtime for labour, inappropriate construction methods and mistake during construction, equipment shortage, poor equipment choice/ ineffective equipment, outdated equipment and poor site layout do not allow the contractor to honour their commitments for successful project delivery (Odeh and Battaineh, 2002; Alwi and Hampson, 2003; Sweis *et al.*, 2008).

Design and documentation is also a factor mentioned in the literature which significantly influence contractor commitment and in turn influence project delivery (Odeh and Battaineh, 2002; Alwi and Hampson, 2003; Sweis *et al.*, 2008). Poor quality site documentation, unclear site drawings supplied, slow drawing revision and distribution, design changes, poor designs, and too many change orders from owner are some of the design and documentation factors, which impact on the contractor commitment and cause delay in project delivery (Odeh and Battaineh, 2002; Alwi and Hampson, 2003; Sweis et al., 2008).

Besides, improper and inadequate material supply, which impedes on the speed of construction of a project relative to on time delivery. Poor quality of the material, poor material handling on site, poorly scheduled delivery of material to site, inappropriateness/misuse of material, poor storage, etc., do not allow the contractor to keep the project on schedule and thus fail in his commitment to deliver the project in time and within the estimated budget (Alwi and Hampson, 2003).

However, it is seen that although many of these factors are interlinked and have cause and effect relationships (Assaf and Al-Hejji, 2006; Sambasivan and Soon, 2007), explicit studies relating to causal feedback relations and their influence on construction delay are found to be limited. So, the importance of early identification of contractor commitment challenges and establishing of inter-linkage among the factors and development of mechanism for resolving contractor commitment issues and major delay reducing remedies have been stressed (Alaghbari, Razali, Kadir, Ernawat, 2007; Das, 2015; Sweis et al., 2008).

3. RESEARCH METHODS

The investigation follows a survey research method and qualitative System Dynamics (SD) modelling approach. Using the perception of professionals in organisations, relative to construction projects in four major cities in South Africa namely, Bloemfontein, Cape Town, Durban, and Port Elizabeth, a survey was conducted and 88 responses were obtained that include architects (9), master builders (18), quantity surveyors (23), and structural engineers (23), clients (12) and project managers (3).

Relative to sample selection, probability sampling technique was employed. Random sampling was used for the group of respondents that include architects, master builders, and clients. For quantity surveyors, and structural engineers, systematic stratified random sampling technique was used and for project managers convenient sampling technique was adopted. The survey was administered by asking the respondents to complete and return a questionnaire through post or e-mail. The contractor commitment challenge variables were evaluated by using Likert scale. The inter-linkage among the variables was established based on literature findings and relevant statistical tests.

Followed by SD principle based on System thinking approach (Forrester, 1968; Stermann, 2000) was adopted to extract the causal feedback mechanisms that cause contractor commitment challenges, and to evolve plausible policy interventions to resolve the challenges. SD principle was adopted because its rigorous structural framework assists in eliciting and displaying information used to build a conceptual model (Forrester, 1994; Lane and Oliva, 1998).

4. RESULTS, CONCEPTUAL MODELS AND DISCUSSIONS

4.1 Factors Influencing Contactor Commitment

Table 1 presents the mean score of the of the various factors under different attributes like contractor ability, professional management by the contactor, design documentation, and project execution that influence contractor commitment in a five point Likert scale (1 indicates least influential and 5 indicates most influential). It is revealed that since all factors have a mean score more than 3, they have been considered for developing the causal feedback relationships and examining their implication on the project delivery. The causal feedback relationships among the factors are considered separately under each attribute and conceptual SD models were developed by using SD modelling principles.

Table 1. Factors influencing Contractors lack of commitment

Factors influencing lack of contractor commitment	Index based on Likert scale mean value	Sources
Contractor's inability and inefficiency		
Lack of trades' skill	3.98	Alwi, and Hampson, (2003); Sweis et al., (2008)
Poor distribution of labour	3.62	
Supervision too late	4.01	
Too few supervisors/foremen	4.25	

Lack of subcontractor's skill	3.52	
Inexperienced inspectors	3.03	
Shortage of manpower (skilled, semi-skilled, unskilled labour)	3.45	
Ambiguity in estimations	3.76	Satyanarayana and Iyer (1996); Odeh and Battaine (2002);
Inadequate experience of contractor	3.15	
Poor labour productivity	3.76	Sambasivan and Soon (2007); Sweis et al., (2008)
Lack of control over subcontractor	3.85	
Delay caused by subcontractors	3.91	
Financial difficulties faced by the contractor	3.18	
Professional Management		
Poor site management and supervision	3.92	Odeh, Battaine (2002); Alwi, and Hampson, (2003); Sweis et al., (2008);
Delay in material delivery by vendors	3.73	
Site accidents due to lack of safety measures	3.54	
Lack of motivation for contractor	3.40	
Poor planning and scheduling	3.73	Satyanarayana and Iyer (1996); Chan and Kumaraswamy (1997);
Poor provision of information to project participants	3.21	Odeh, Battaine (2002); Sweis et al., (2008)
Poor coordination among project participants	3.33	
Slow in making decisions	3.46	
Execution		
Too much overtime for labour	3.87	Odeh, Battaine (2002); Alwi, and Hampson, (2003); Sweis et al., (2008)
Inappropriate construction methods and mistake during construction	3.05	
Equipment shortage	3.91	
Poor equipment choice/ineffective equipment	3.27	
Outdated equipment	3.74	
Poor site layout	3.28	
Design and Documentation		
Poor quality site documentation	3.37	Odeh, Battaine (2002); Alwi, and Hampson, (2003); Sweis et al., (2008)
Unclear specifications	3.12	
Unclear site drawings supplied	3.37	
Slow drawing revision and distribution	3.37	
Design changes	3.12	
Poor Design	3.37	
Too many change orders from owner	3.37	

4.2 Causal Feedback Relations Causing Contractor Commitment Challenges and Mechanisms to Resolve the Challenges

4.2.1 Contractor ability and efficiency

The contractor ability significantly influences contractor commitment. The survey findings suggest that with mean score higher than 3.5; various contractor ability related factors as shown in Table 1 significantly influence contractor commitment and cause the contractor to weaver from his commitments. Besides, the factors develop a chain of causality and feedback relationships among themselves. As seen in Figure 1 lack of experience leads to inadequate supervision and lack of control over the subcontractors. Delay is caused because of the lack of control of the contractor over the subcontractors and lack of skill availability from the subcontractor. Besides, lack of experience also

contributes to lack of availability of skill with the contractor through a disruptive causal feedback mechanism IB1. Poor skill and poor financial management in addition to inaccurate or ambiguous estimate make the contractor face financial difficulties (IB1A), which contributes to the inefficiency of the contractor. Similarly, shortage of skilled manpower is a key challenge faced by the contractor. Due to shortage of man power, the contractor fails to appropriately apportion labour in the project, which essentially leads to poor labour productivity as shown by causal feedback mechanism IB2. However, skill and competency building can assist in reducing the inefficiency of the contractor. Skill training, financial management training will, enhance the finance management capacity of the contractor that may find ways to reduce the financial difficulties (IRA1). Skill training and internship will make the contractor more competent to handle shortage of manpower and labour productivity. Subcontracting experience before handling jobs as a contractor is expected to deal with the challenges related to subcontractors such as control, delay and lack of skill (IR1C). All the three aspects will enhance the capacity and competence of the contractor eventually leading to increase in efficiency of contractor.

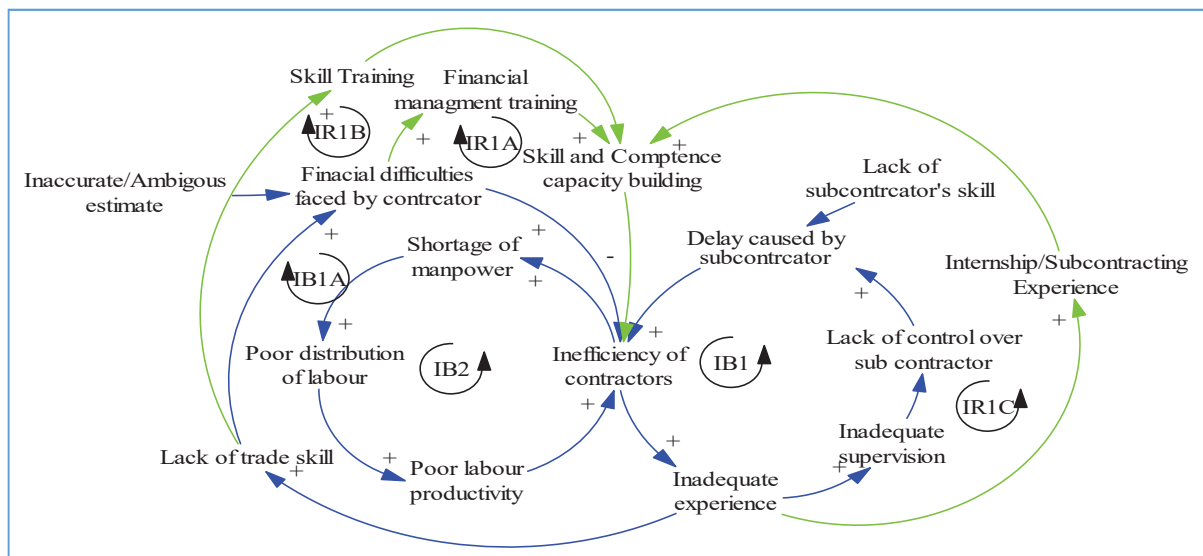


Figure 1. Causal feedback relationship for contractor efficiency in projects (Blue lines show the challenges and green lines show the interventions)

4.2.2 Professional management

Professional management is one of major elements in the contractor commitment. Poor professional management is influenced by two important mechanisms. First, poor planning and scheduling in project in addition to lack of proper facilities for information transfer lead to poor communication and coordination, which essentially create delay in decision making. Consequently, the project is not managed as it is

envisaged. This phenomenon is presented by a disruptive mechanism PB1 (Figure 2). Similarly, on the other hand lack of professionalism lead to lower morale and motivation of the contractor. The lack of motivation may lead to poor management of site (as shown by feedback mechanism PB2), which in fact can be exacerbated by the delay in material delivery due to poor planning and scheduling and consequent poor coordination and communication (feedback mechanism PB1A). Thus, these two major disruptive feedback mechanisms bolster poor professional management of the projects and force the contractors to fail to keep their commitments. However, if the capacity of the contractors is enhanced through capacity building as discussed in earlier sections (cf4.1.1), it will assist the contractors to adept in project management skill and techniques to prepare appropriate plans and schedules. Besides, available information communication transfer facilities in addition to capacity building, it will reduce poor coordination and communication and enhance decision making. The net result shall be enhancement in professional management of the projects (PR1). Again, appropriate coordination and communication facilities will enable reduction in delay in material delivery leading to better site management through reinforcing mechanism PR1A. Similarly, capacity building of contractors will act as incentives and rewards for the contractors that will boost the morale and motivate the contractors. The increase in motivation will cause better site management and consequently lead to professional management of the projects through feedback mechanism as shown by PR2, which will further bolster by the increase in the health and safety measures through feedback mechanism PR2A. Thus, the poor professional management of projects by contractors, which are essentially augmented by disruptive mechanisms PB1 and PB2 can be countered by feedback mechanisms PR1 and PR2. So, as shown in the Figure 2, if the capacity of the contractors is enhanced in addition to improvement in information and communication facilities, then the projects shall be managed more professionally; that will enable the contractors to keep their commitments.

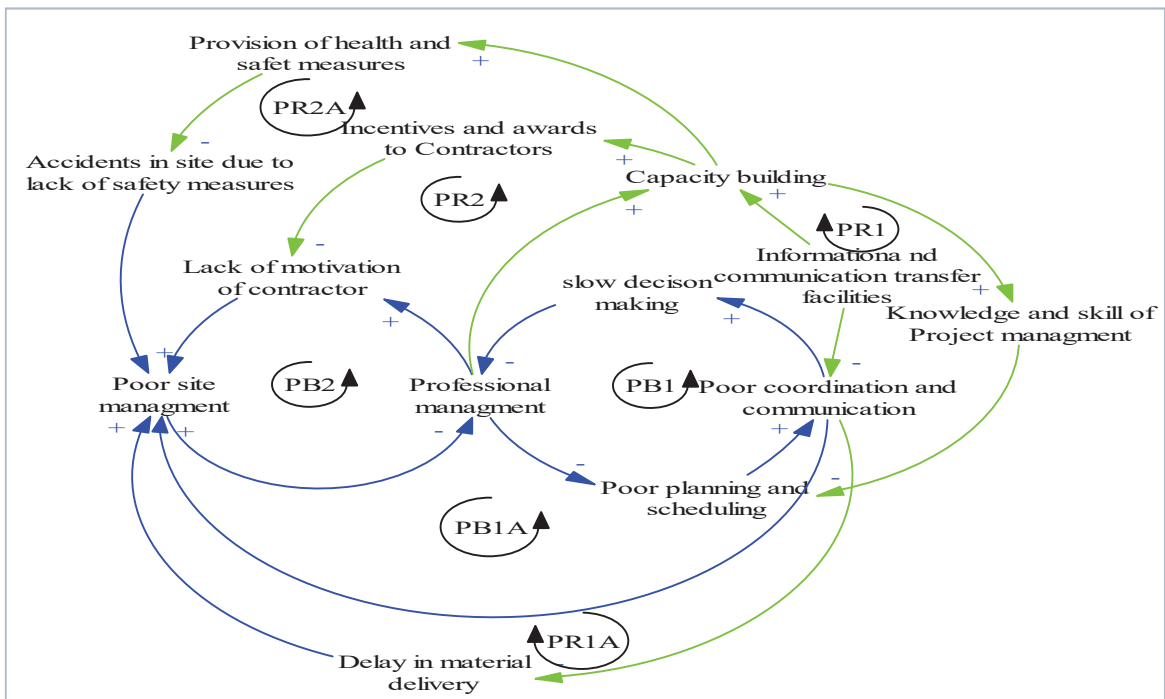


Figure 2. Causal feedback relationship for professional management of projects by the contractors

4.2.3 Project execution

Challenges in execution of project significantly influence the contractor commitment in project. As shown in Figure 3, poor execution of projects is caused by ineffective/outdated equipment's, inefficiency of labour force and poor planning and scheduling and site planning. Ineffective or outdate equipment if used along with the excessive overtime of labourers lead to efficiency of labourers resulting in poor execution of the project through a disruptive mechanism EB1. Similarly, poor planning cause shortage of equipment that hampers the smooth execution of the projects (feedback mechanism EB2). Poor planning also cause poor site layout, which reduces the outputs of labour force and aggravate the challenges of project execution through a feedback mechanism shown by EB3. The situation gets exacerbated further if appropriate construction methods are not used in construction, which essentially create errors and delay in the projects (EB4). Thus, as observed and because of the four dominant disruptive mechanisms, project execution suffers forcing the contractors to waver away from their commitments.

However, strong professional management of the projects and knowledge about the appropriate construction methods, appropriate technology and equipment could assist in resolving the challenge. Professional management generally assists in proper planning and scheduling. Proper planning and scheduling alleviates the challenges of project execution in three ways. First, it makes provision for availability of adequate and appropriate equipment's with the aid of availability of finance, which neutralizes the negative effect of the ineffective and outdated of equipment and improve the execution process (Feedback mechanism ER1A). Second, the availability of equipment also

reduces the effects of shortage of equipment (ER1B). Third, proper planning improves the site planning scenario, which essentially enhances the efficiencies of the labour force (feedback mechanism ER1C) and also saves the additional expenditure because of the excessive overtime by labourers'. Besides, if the capacity of the contractors is build, which essentially enhances the knowledge and competency of the contractors about the equipment, technology and construction methods, then contractor will be able to reduce the errors and delay caused by the challenges of use of improper construction methods. Essentially, this mechanism neutralizes the negative effects of the disruptive mechanism EB4. Also, such a mechanism reinforces the mechanism ER1B and counteracts the challenges of poor execution of projects. Therefore professional management and knowledge and competency of the contractor remain at the core to improve project execution, which consequently will ease the challenges of contractor commitment in the projects.

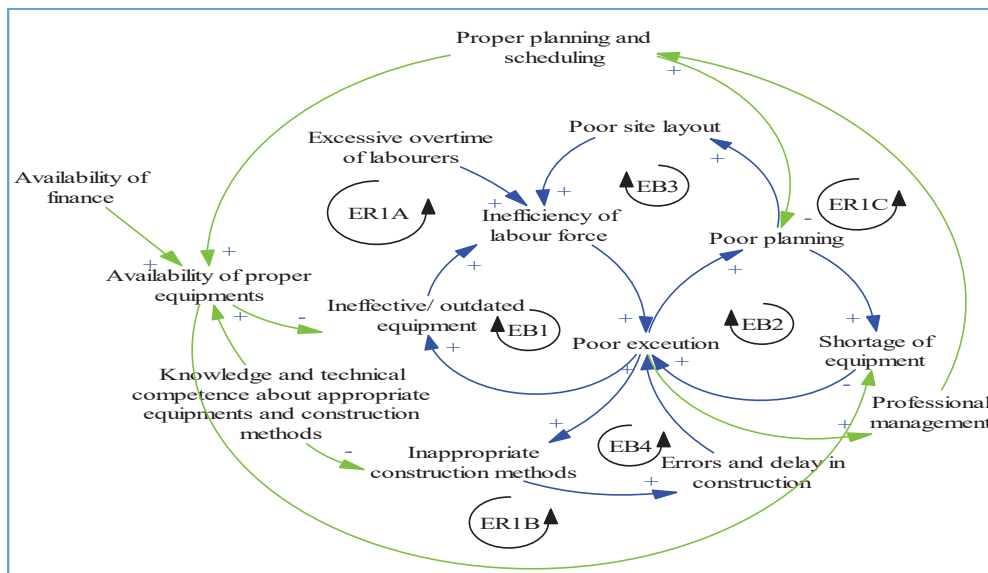


Figure 3. Causal feedback relationship for Execution of projects by the contractors

4.2.4 Design and documentation

Design and documentation are essentially the responsibilities of the consultants and designers. However, client has significant influence on them. Poor design can create all sorts of challenges in the construction including influencing contractor commitment as shown in different mechanism in Figure (4). Poor design can happen because of the incompetency of the consultants; however, more often design changes at the client's behest are the major causes of poor design. The reason being the client's uncertainty or lack of clarity on the final outcome may make the consultant unsure about the design. So, design changes lead to poor design and consequently there shall be lack of appropriate details in design, drawings and material specification, which essentially disrupts the contractor's work schedule and commitment through a feedback mechanism DB1. Simultaneously, lack of details in design, drawing and material specification on account of poor design leads to unclear site drawing and poor documentation. The slow

revision of design and drawing and their slow distribution also aggravates the poor documentation scenario. Poor quality design, drawing and specification documents generally make the contractor lose clarity in construction and consequently the construction work gets interrupted through a feedback mechanism DB2.

However, conversely involvement of the contractor and client in the design process, and coordination and communication among the client, consultant and contractor could ease the challenge. The clients' involvement in the design process shall lead to the consultant(s) to understand the clients demands and consequently the number of changes that can occur from clients side will be minimized and thus resulting in improvement on the design through feedback mechanism DR1. Similarly the contractors, involvement in the design process particularly with regards to detailing in design, drawings and specifications will enhance the clarity in the specifications in the site drawings and materials use (DR2). Clarity in the drawings and specification in other words good quality documentation enable the contractors to work without much interruption. Besides, coordination and communication among the clients, consultants and contractors assists in minimizing the design changes as well as enhances the progress in revision and distributions of designs, drawings and other changes that may occur. In other words coordination and communication among the three stakeholders also strengthens the feedback mechanisms DR1 and DR2. Thus, it is seen that disruptive feedback mechanisms DB1 and DB2, which make the contractors to fail to keep their commitments are balanced by reinforcing mechanisms DR1 and DR2, which enable them to honour their commitments because of design related challenges.

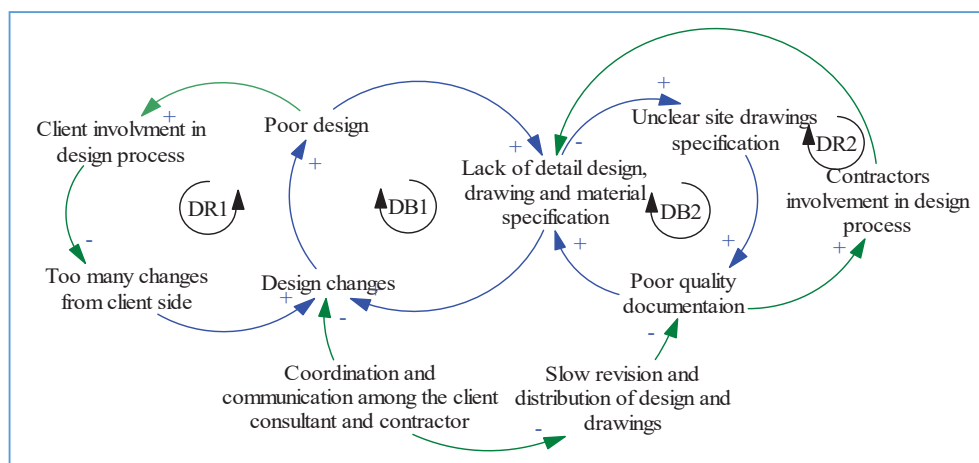


Figure 4. Causal feedback relationship for contractor commitments because of design and documentation challenges

The findings of the conceptual SD models show that the influence of various disruptive mechanisms caused because of different contractor linked factors suggested by various investigators (Odeh and Battaineh, 2002; Alwi and Hampson, 2003; Sweis *et al.*, 2008) can be negated by the policy interventions that can be developed based on the reinforcing mechanisms extracted through the SD Conceptual models. As suggested by

Das (2015) and Aiyetan and Das (2015), use of conceptual models to understand the interlinkage among the factors influencing contractor commitment and development of the contractor commitment impeding and strengthening mechanisms will assist in development of policy interventions to alleviate contractor commitment challenges in construction. Such mechanisms would enable the contractors and other related stakeholders to take steps to resolve contractor commitment challenges through qualitative understanding in a cost effective way and without making elaborate quantitative investigation that could be time consuming and expensive.

5 CONCLUSIONS

Contractor commitment in construction projects is a major issue faced in the construction industry. A number of attributes and factors are responsible for reduced contractor commitments, which adversely influence successful project delivery within the stipulated time and budget. Several studies have been conducted to understand the causes of lack of contractor commitments; however the studies related to the inter-linkage and causal relationship among the factors influencing contractors' commitment are limited. However, this investigation shows that the causal feedback mechanisms among the factors can make the contractors and other stakeholders understand the contractor commitment challenges and engender strategic interventions to resolve these challenges qualitatively. As found from this investigation, the challenges and resolution mechanisms seem to work in a chain of causality and isolated policy interventions may not achieve the desired results, i.e., improve contractors' commitment and successful project delivery.

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