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Conceptualising the nexus of projects, finance and capacity in construction business

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Abstract This paper addresses a research question on why construction companies fail in their business. Starting with the concept of growth and capacity underinvestment archetype, a new and operational systems thinking model is developed. The conceptual systems thinking model includes a set of causal structure that can explain various modes (including the growth and failure modes) of business performance of small and medium construction companies. Mainly the three components – projects, finance and capacity – and the understanding of their nexus (or causal inter-relationships) are found to be sufficient to reveal different performance modes in construction business. Further, the three operational aspects, namely, the business growth or decline process; the situation of financial and other capacity resource consumption; and the management of projects, finance and other capacity resources have been identified as the inter-related core and integral aspects of construction business. The three inter-related core aspects could actually include and explain different possible range of business situations, policies and practices in a construction company.

Keywords performance of construction business, projects, finance, capacity, systems thinking

1 Introduction

Construction firms in any progressive economy generally count to a large number. A generally observed pattern is such that the small and medium size firms would relatively

be huge in numbers in comparison to the large ones, whereas the output generated by the few large ones would be disproportionately higher than that of small ones (Ofori, 1990). Probably because of the low barrier to entry (CIDB, 2006; Dikmen et al., 2010) and the huge volume of indicated construction works in the industry, small and medium entrepreneurs are attracted to construction business. However, it has been observed that the failure and bankruptcy rate of such firms is very high irrespective of whether they are in developing (Abu Bakar, 1993; Enshassi et al., 2006) or developed economy (Russell and Casey, 1992; Wood, 2015). As such, it has been observed that running a small and medium construction firm and sustaining it with a progressive performance is highly challenging.

Majority of research that inquired into the issue of business failure in construction have explored different sets of causative factors. These factors include the external forces in industry, and internal situational and management related factors, most of which are associated with the management of finance and cash flow (Kangari, 1988; Hillebrandt and Cannon, 1990; Kale and Arditi, 1998; Arditi et al., 2000; Alaka et al., 2017). These studies do provide insight into the factors and their respective influences in the performance of construction firms. The reductionist inquiries attempt to simplify the state-of-affairs, but individual factors would not affect the entire business unilaterally and independently – it seems that an important sort of collective or integrative inquiries is missing.

Strategic management (SM) of construction firms could provide a more integrated framework that helps steer the business to achieve the intended goals. SM is relatively a new framework for management in construction business because it is managed more as project-based operations rather than as an entire firm as such (Chinowsky, 2001). However, the need for SM has been identified in order to better manage a construction business (Betts and Ofori, 1992; Chinowsky and Meredith, 2000; Price and Newson,

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2003). The SM approach could help formulate and implement better strategies for the success of construction business. However, scholars have identified some drawbacks in SM frameworks and approaches. The dimension of time has not been operationally incorporated in even the later developments in the subject area of SM – the models are generally static in essence (Bianchi et al., 2015) and they ignore the time variant complexity in managerial decision making (Bisbe and Malagueño, 2012; Gary et al., 2008). As such, SM models are less realistic in representing the concept, process and outcome, and therefore the strategic learning from such models could be largely compromised (Linard et al., 2002).

In this paper, a slightly different approach is taken to understand the growth and failure of construction firms. Using the principles of systems thinking approach (as explained by Senge, 1990 or Sterman, 2000), a conceptual model is developed to explain different performance modes – including the growth and failure modes – of small and medium construction businesses. The conceptual model includes a set of generic causal feedback loop structure with operational variables that are relevant to construction business.

There are a few notable studies in which the approach of system dynamics (SD) has been used to study the competitiveness and performance of construction firms. Dangerfield et al. (2010) and Gilkinson and Dangerfield (2013) assessed the utility of SD modeling approach to understand the dynamics of competitiveness of construction firms. Ogunlana et al. (2003) developed an SD model to come up with a set of broader strategic policies in order to enhance the performance of a construction firm. Tang and Ogunlana (2003a) developed another set of SD model to replicate a level of operational details of a construction firm, and using the same model Tang and Ogunlana (2003b) explored another set of broader strategic policies in order to enhance the performance of the construction firm. The models reported in the last three studies explored the policies such as forming joint ventures, development of management information system, establishing construction industry development board, and implementing quality assurance system and regional construction market for construction firms. These policy options, in essence, include a mix of broad and exogenous courses of policies. There is a need of more finely operationalised model to explore a bit more realistic and endogenous policies to be used by construction firms. As such, in this paper, the research aim has been conceptualised in a different way in terms of understanding different performance modes of construction firms. The model is developed to carefully capture an overall but closer functional and operational essence of construction business. With the model, one can conceptualise the time variant performance behavior of a construction company operating in a range of business environments with different sets of management policies and practices.

On the methodological front, as it has been stated earlier, the principles of systems thinking have been used to develop a set of causal feedback loop model. The model is conceptual in essence, and it provides a set of testable propositions. The variables, their causal relationships and feedback loops were developed by using rather an *a priori* approach with rationalist perspective. The incorporated *a priori* knowledge is reflected as nothing but the very basic and rational understanding in each of the causal links and feedback loops. The combinations of feedback loops with intuitive individual causal links could create a complex system model of construction business, the behavior of which, in overall, would be difficult to comprehend intuitively. The used set of *a priori* knowledge was based on several informal discussions with managers and owners of different construction companies along with the first author's relevant work experience in the industry. Therefore, the epistemological stand of this research is the understanding that *a priori* knowledge would obviously not be dependent on detail empirical investigation, but it does not mean that *a priori* knowledge would be independent of experience from which the knowledge was derived (BounJour, 2014).

2 Growth and capacity underinvestment

The initial and basic theoretical underpinning of the model developed in this paper is the archetype of growth and capacity underinvestment (GCU) (Fig. 1). Senge (1990) first developed the concept of the archetype and lately Morecroft (2007) elaborated it at a great length with a reference to Forrester's market growth model.

The GCU archetype basically represents a phenomenon of limits to growth of business firms (see Fig. 1), and it can be better used to explain different modes of business performance including growth and failure. The main loop in this archetype is the growth loop (R1 in Fig. 1) which explains how firms would grow in business in a virtuous sense – that means *ceteris paribus*, more the growth effort, more would be the demand of the firm's product, and more the demand, there would be more effort for growth in turn.

The first balancing loop in the archetype (B1 in Fig. 1) explains how the growth is affected by the process of growth itself. The growth induced demand would create internal limiting factors such as used-up capacities to produce the products to fulfil customer demand. This would create the effect/impact of limiting factors such as defects in quality or longer delivery delay which if continued would affect customer satisfaction, and it would eventually reduce the customer demand. Lower customer demand means less requirement of effort in growth and less the growth effort lower the customer demand in turn – it is in this way the virtuous growth loop could turn into a vicious deteriorating loop that could pull down the performance of the business.

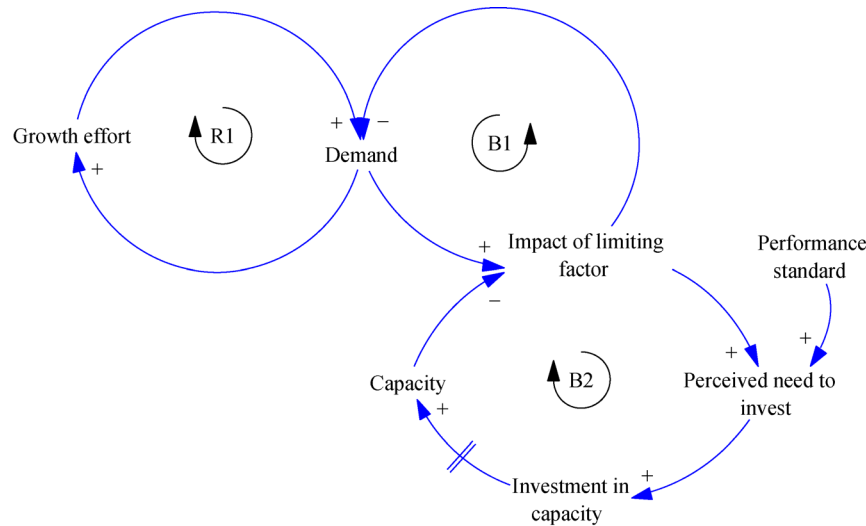


Fig. 1 The growth and capacity underinvestment archetype (Source: Senge, 1990)

To address the impact of limiting factors, capacity needs to be increased to produce more as per the growing demand and desired performance standard. It needs investment to increase the capacity. If the investment actually increases the capacity in sync with the need of growing demand, then probably it could address the effect/impact of limiting factors. However, there would be a time delay in getting the capacity ready for use even after the investment has been made, and the time delay would play a tricky role in keeping the system out of sync. Because of the delay, investment in capacity cannot reduce the impact of limiting factors immediately, and when the newly added capacity is ready for use, the impact would be too high to be addressed by the added capacity. This creates the perception that despite the addition of capacity, the situation has not improved, and may be, it would not further improve. Probably because of this type of experience or may be due to the conscious effort in cost cutting, the general tendency of business firms would be to invest minimum in the capacity or overstretch the capacity resources for saving, or at times, they work for short-term gain without investing in the capacity for the long run. However, the emphasis on 'saving' or 'short-term focus' amidst the existing capacity constraints could worsen the impact of limiting factors and it would lead to rapid decline and deterioration of the product demand and business growth.

Another context is, decision makers may have strategic emphasis on aggressive growth and due to the emphasis and effort, they indeed realize growth for some extended period of time. Out of the illusion created by their success – that means their experience and belief that putting more effort for growth would lead to more growth, it would condition their mind-set to ignore the other facets of the system that are also important in supporting the growth. They might rationalise the emphasis on growth and get

engrossed into the success. However, in the growth process, overlooking the other “difficult” facets of the system such as the strained capacity might eventually create a serious effect on the business performance. This effect could turn the very process of their success into the other way round.

To manage the business, the company executives could work with different sets of policies. For example, regular upfront adjustment in capacity, or stretching the capacity use, or generating saving by overlooking the capacity issues, or adjusting the goal for performance, or even giving emphasis on aggressive growth. Depending on the policies that the executives take, the GCU archetype can be utilized to explain a wide range of business performance patterns (Kim, 2000; Morecroft, 2007) – three of which are shown in Fig. 2.

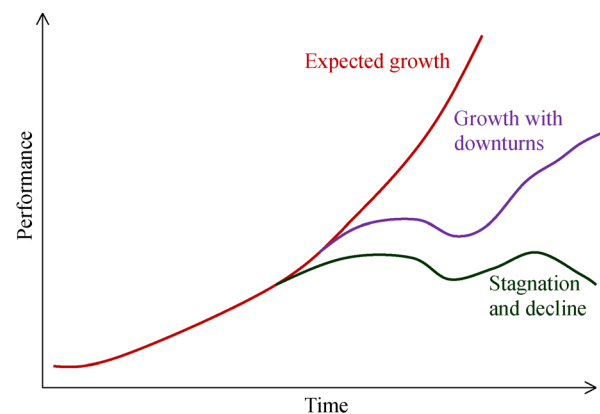


Fig. 2 Patterns of business performance as explained by the GCU archetype

3 Use of the GCU archetype to understand the performance of construction business

To understand the performance of construction business, a specific contextual elaboration of the generic GCU archetype is needed. Construction is basically a project based business, and corporate performance of the business depends on the turnover generated by ongoing projects over the given time period. The scope of research in this paper covers the modeling of corporate performance from the perspective of “owners” of a small and a medium size construction company. Figure 3 shows one of the generic concepts on the growth of a typical construction company.

The reinforcing loop R1 (in Fig. 3) presents a growth process based on a better market reputation due to the track record of successful execution of projects. Better market reputation provides broader clientele that would naturally increase the prospect of potential new projects, and this would encourage the business owners to put more effort into winning new projects. The new projects would then be implemented as ongoing projects, and more successful execution of ongoing projects means more market reputation in turn.

Loop R2 presents another growth process, which is rather related to the general behavior of the company owners. They work for turnover and profit, and the more they get it, the more they desire for it and put more effort to get it more.

The growth processes as explained by the two reinforcing loops R1 and R2 could also generate internal constraints in the company. As the company grows, there would be more need for efforts in winning new projects and in the execution of ongoing projects. These efforts require resources – the more the quantum of efforts, the more the resources they will consume. In this research, the resources are broadly divided into financial resources and

other capacity resources. Other capacity resources include the resources required for operations of the company, and for the management and execution of projects.

The balancing loops from B1 to B6 in Fig. 4 show that the efforts consume the cash and other capacity resources, and thus the stocks of these resources would get depleted and their availability would be reduced. The less the availability of these cash and other capacity resources, the less effective the efforts would tend to be, and as a result, the growth loops (R1 and R2) could turn into declining loops, which could eventually pull down the business into the state of poor performance. Therefore, the limiting effects of the balancing loops from B1 to B6 could be detrimental to the system if they are not properly checked.

4 How construction firms manage projects and finance?

As mentioned in the previous section, the efforts in winning new projects and in the execution of ongoing projects require financial resources. The more the quantum of efforts the more would be the consumption of the resources, and as a result, the operational cash balance would get depleted. Maintaining sufficient operational cash balance, or in other words, the cash flow management is one of the most challenging tasks in construction business. As shown in Fig. 5, cash availability could be maintained either by minimising/delaying cash expenditure (loops B2 and B3) or by managing the cash balance (loop B7). The cash balance could be managed by withdrawing cash from the reserve of the company's working capital or by borrowing from financial institutions (loop B8). Borrowing would increase the working capital, but it might take time to arrange the indicated amount to be borrowed, and it has to be paid back eventually with the

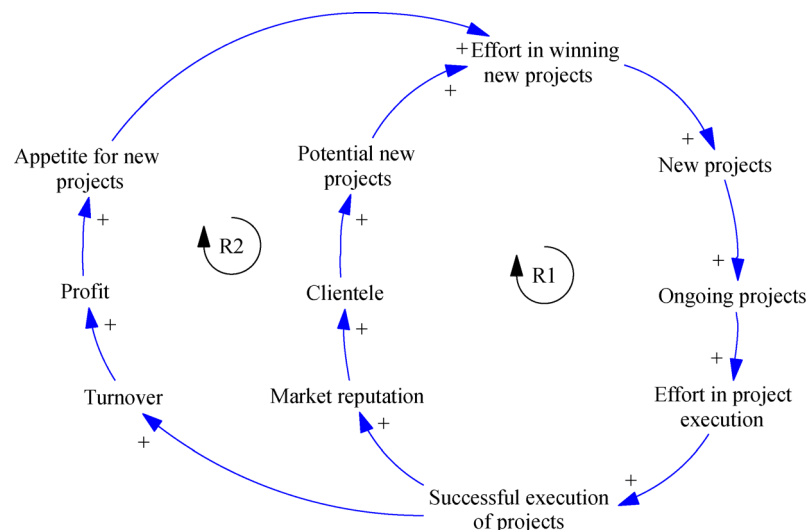


Fig. 3 The growth process of construction company

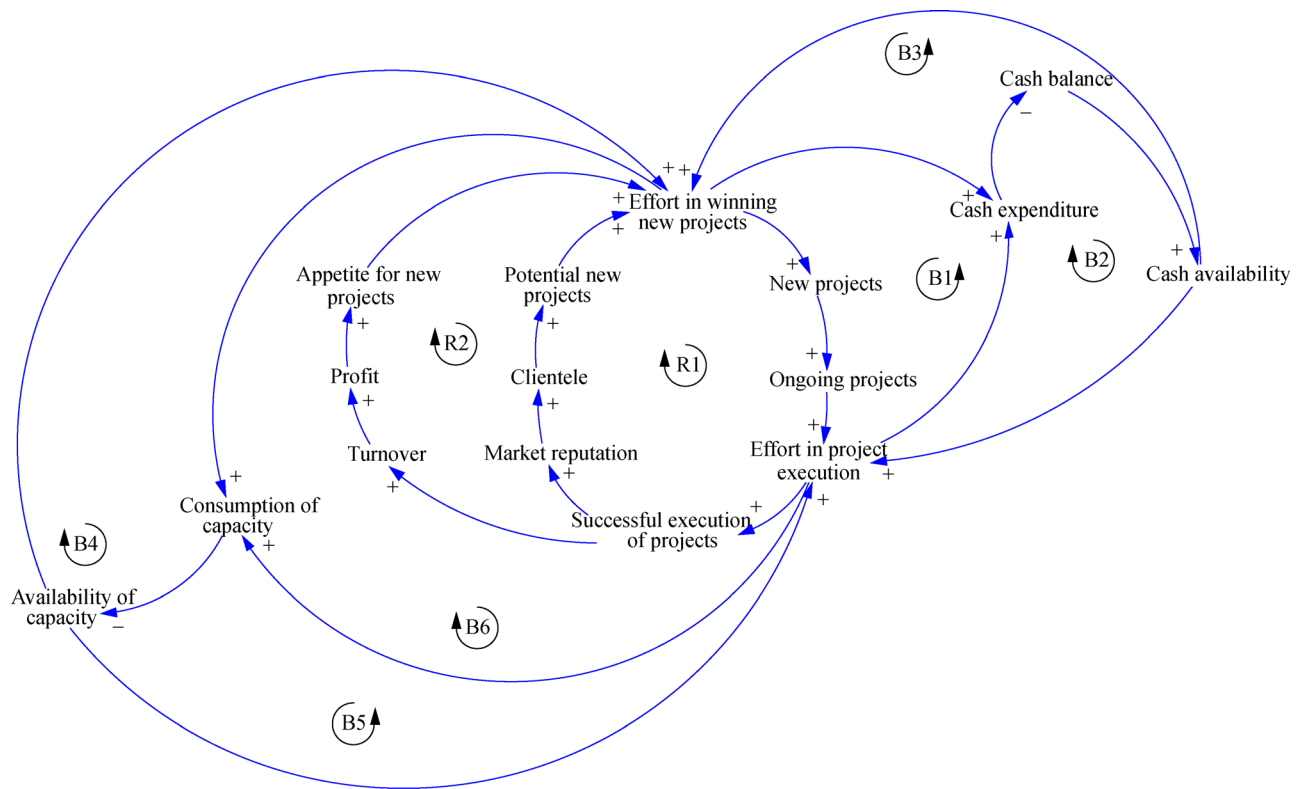


Fig. 4 Limits to the growth process

interest amounts. On the other hand, the main source of working capital would be the turnover in terms of successive payments gained in the process of projects execution. The working capital could also be increased by reinvesting the retained earnings (loop B12) from the balance of profit after deducting the dividend payments to shareholders of the company (loop B13). In some cases, equity investment could also be sought to increase the working capital reserve.

5 How construction firms manage projects and the capacity?

As mentioned before, “capacity” in this research means the capacity to acquire, possess, and effectively use all the resources (except the financial ones) that are required for operations of the company, and for the management and execution of projects. Similarly to the financial resources, the efforts in winning new projects and in the execution of ongoing projects require other capacity resources. The more the quantum of efforts the more would be the consumption of capacity, and as a result, the balance of available capacity would get depleted. Capacity availability could be maintained either by minimising the consumption of capacity (loops B4 and B5) or by managing the capacity balance (see Fig. 6). Capacity

balance could be increased by acquiring the indicated capacity for potential new projects (loop B9) and for ongoing projects (loop B10) with the support of the allocated budget for capacity acquisition. However, there would be a time delay in the process of making investment and acquiring the capacity to effectively increase its availability. The budget for capacity acquisition has to be arranged from the reserve of working capital. Moreover, there would be expenditures on the costs of consumption/use of capacity and on the overhead to maintain the capacity balance, and these expenditures would actually deplete the reserve of working capital (loop B11).

6 The nexus of projects, finance and capacity

Figure 7 presents the overall model that portrays the complex interacting nexus of projects, finance and capacity. Clearly, there are three inter-related aspects in the overall model. First is the business growth or decline process (Fig. 3); second, the situation of finance and other capacity resource consumption due to the operations, and growth or decline (Fig. 4); and third, the management of projects, finance and other capacity resources to deal with the situations of operations, and the growth or decline

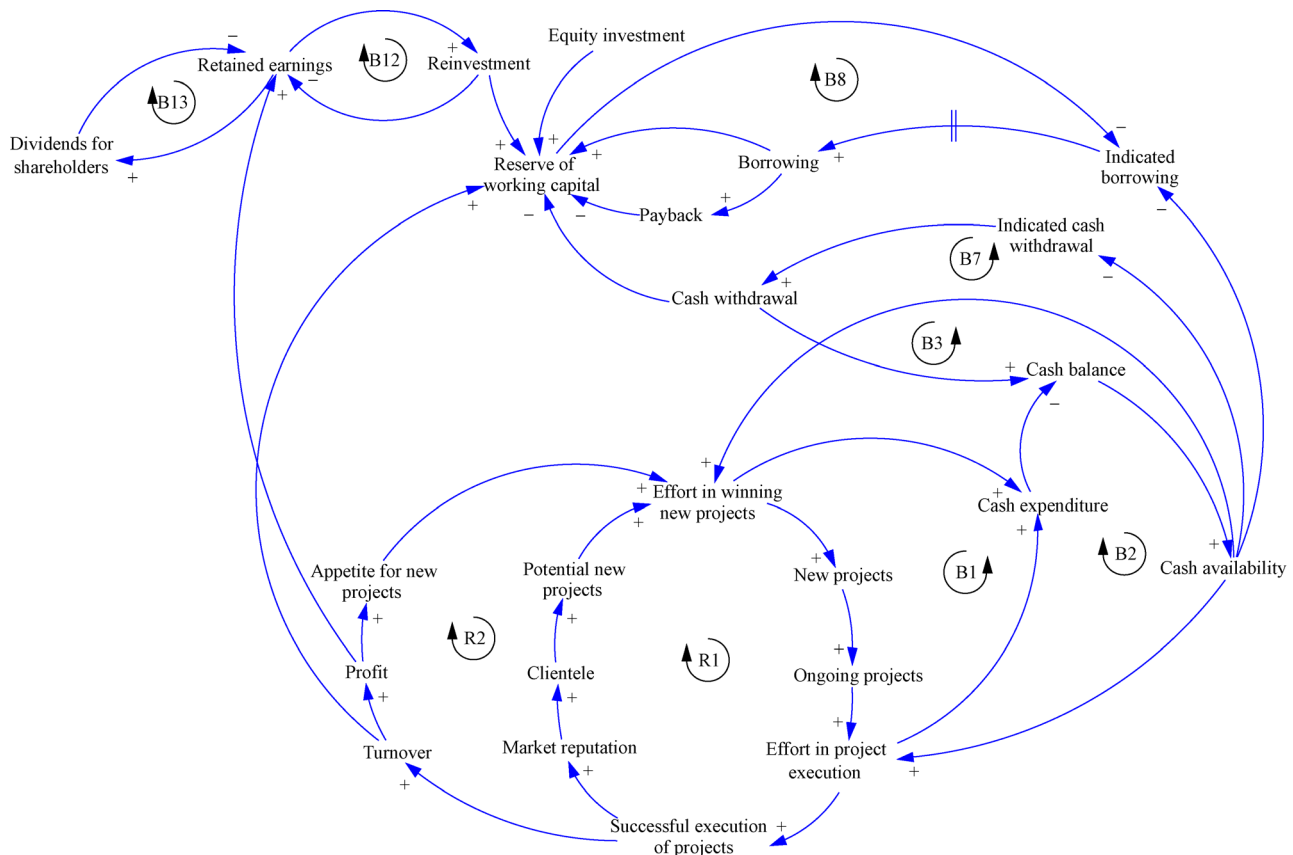


Fig. 5 Managing projects and finance

(Figs. 5 and 6). Here the operations mean the operations at both the company and project levels.

These three inter-related aspects could be taken as the core and integral parts of construction business. The company owners actually struggle to manage them but most probably with limited knowledge about how they are interrelated and how the policies or practices used by the company affect the balance of the inter-relationships. There could be a diverse range of situations the construction firms have to deal by using different policies and business practices. Some of the example situations are presented below.

1) Generally the owners in construction business would be looking to acquire more and more new projects. Even if some of the owners prefer to move slowly, they would be concerned that new projects are needed to sustain the business in coming years. The market is uncertain and competition is fierce. That's why they pay more attention and put more effort into winning new projects. With this particular mode of work, the owner's executive capacity would be constrained to give required time and effort for ongoing projects, and it affects the execution of ongoing projects. At times, the owners could also be a little bit desperate to win new projects and for that they might even compromise on their profit margin. This type of practice

might strain the regular turnover and financial health of the company particularly when there is no opportunity to play around to get additional high value scope variations in ongoing project works.

2) Growth would be one of the main emphases of the owners in construction business. This would be truer when the owners have tasted the success of business in last few years. Their appetite for more new projects might divert their time and effort from the ongoing projects due to which the execution of the projects might be affected. More emphasis on growth and success might also give them less time to arrange for the additional capacity required for more projects. Therefore it is generally observed that contractors tend to gobble more than they could actually chew and swallow.

3) Many times owners in construction business believe in the practice of overstressing the capacity resources. The rationale is that a bit of stress would increase productivity and it would also help in cutting costs. However if the availability of capacity is overstretched especially in the situation of uncertain and stressful work environment, it would create serious impact in the effort on projects, affecting the regular turnover of payment and increasing the costs and cash expenditures.

4) On the side of financial management, the policies on

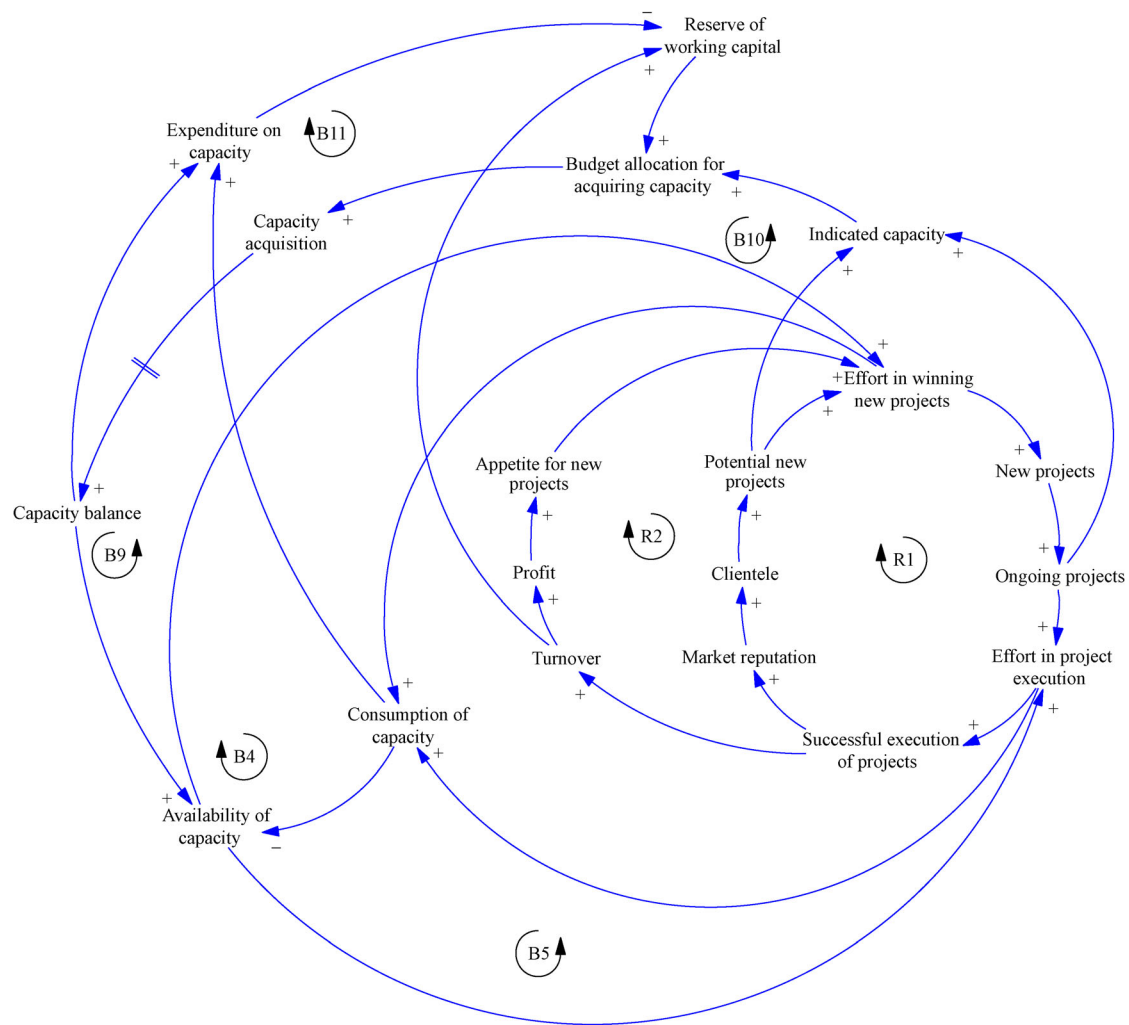


Fig. 6 Managing projects and the capacity

retained earnings would also affect the corporate health of the business. The proportion of reinvestment or even the additional equity investment affects the reserve of working capital that would be used for capacity investment and cash flow arrangements. Some of the owners might want to enjoy large proportion of dividends, and some others might largely apportion the turnover for cash farming. This could create the cash starved situation in the business and such practice could be viable only in the environment where contractors can stiffly command the deferring of accounts payable.

5) Leveraging the higher return on investment (RoI), contractors would also work with the borrowed amount to maintain the working capital. In the event of no or moderate risks it could sustain the working RoI, but at times the higher unexpected costs of business and project operations might pull down the RoI value to an alarming level.

From a reductionist perspective, the individual five situations given above could be analyzed independently by

dissecting each of them from the rest of the system. However, from Fig. 7 it can be clearly seen that they invariably are the parts and parcels of the nexus of projects, finance and capacity. The policies and practices in the management of projects as mentioned in the first and second examples above affect the capacities, project execution, turnover, and the financial situation of the business. The capacity management practice as mentioned in the third example affects the projects, their turnover and again the financial situation of the business. The financial management practices as explained in the fourth and fifth examples affect the capacities and then the project winning and execution processes which would eventually influence the turnover and the financial situations in turn.

Lastly, it can be deduced that the three inter-related aspects could actually include and explain the different possible range of business situations, policies and practices in a construction company. Policies related to projects affect the capacity and financial resource consumption for their execution, and the project execution generates

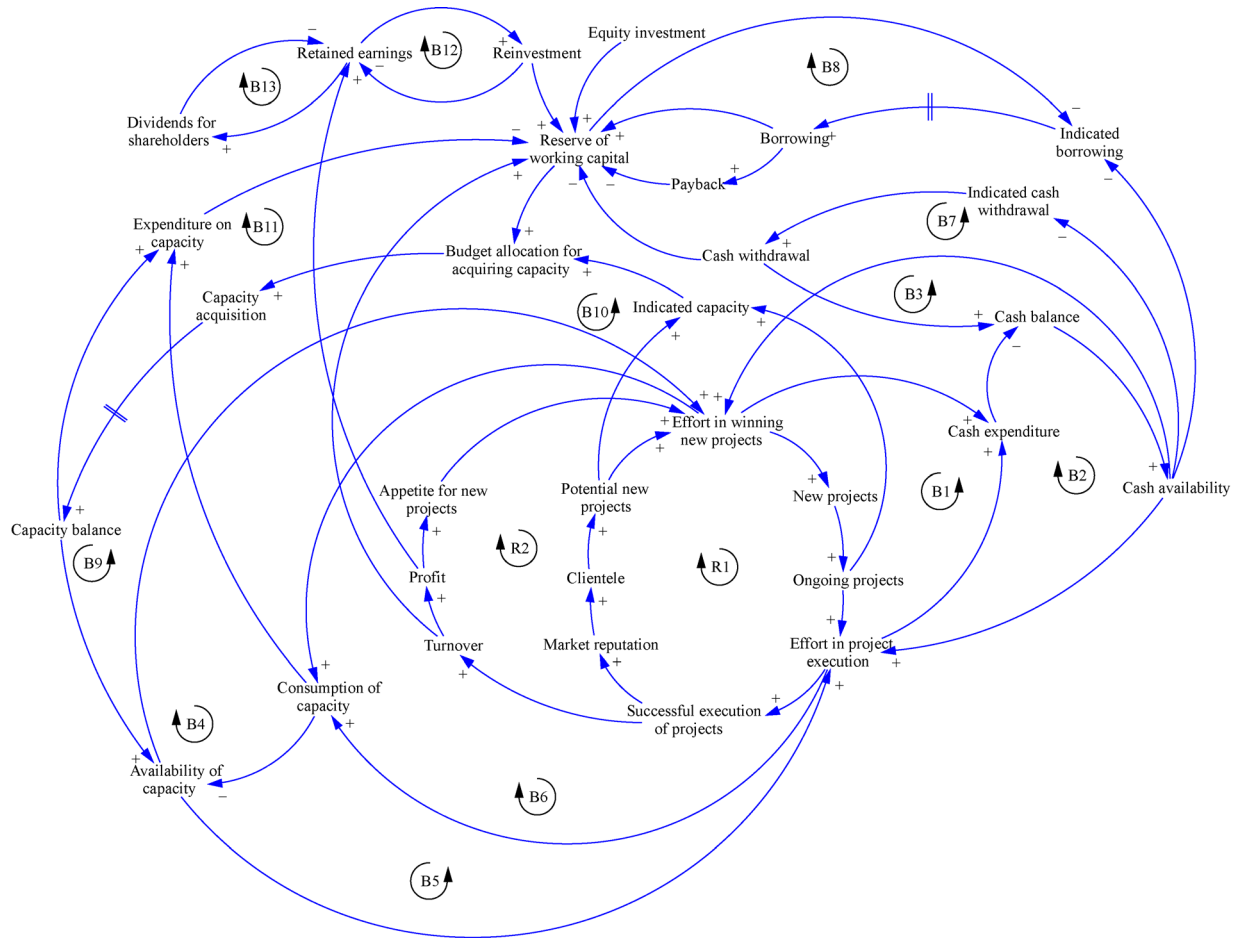


Fig. 7 The nexus of projects, finance and capacity

revenues, turnover and financial resources which could be used for operations and capacity acquisitions. The financial and capacity acquisition status eventually affects the policies related to projects in turn. Likewise, the policies related to financial resources affect the acquisition of capacity resources and this would influence the execution of projects which eventually affect the financial resources in turn. Furthermore, the policies related to acquisition and management of capacity affect the project execution processes which influence the revenues, turnover, and the financial resources, and again it eventually affects the capacity acquisition and management.

7 Conclusions

In this paper, using the tool of systems thinking approach, the concept of the interrelationship between projects, finance and capacity have been developed in the operational terms of a construction business. The generic growth and capacity underinvestment archetype has been used to initiate a theoretical argument for the development of detailed systems thinking model. The model can explain

different possible performance modes of construction firms in a diverse range of business situations, policies and practices.

The systems thinking model is basically conceptual in essence, and it can further be developed as a full-fledged system dynamics simulation model with more operational details. Using the simulation model, experimental studies can be conducted for doing what-if analyses. Such studies would be beneficial to develop more understanding about the causes of business failure and probable strategic policies to deal with failures in different situations.

References

- Abu Bakar A H (1993). Growth trend for construction companies: A malaysian experience. In: Proceedings of CIB Symposium. 93, 1: 524–543
- Alaka H A, Oyedele L O, Owolabi H A, Bilal M, Ajayi S O, Akinade O O (2017). Insolvency of small civil engineering firms: Critical strategic factors. Journal of Professional Issues in Engineering Education and Practice, 143(3): 04016026

- Arditi D, Koksai A, Kale S (2000). Business failures in the construction industry. *Engineering, Construction, and Architectural Management*, 7(2): 120–132
- Betts M, Ofori G (1992). Strategic planning for competitive advantage in construction. *Construction Management and Economics*, 10(6): 511–532
- Bianchi C, Cosenz F, Marinković M (2015). Designing dynamic performance management systems to foster SME competitiveness according to a sustainable development perspective: Empirical evidences from a case-study. *International Journal of Business Performance Management*, 16(1): 84–108
- Bisbe J, Malagueño R (2012). Using strategic performance measurement systems for strategy formulation: Does it work in dynamic environments? *Management Accounting Research*, 23(4): 296–311
- BounJour L (2014). In: Steup M, Turri J, Sosa E, eds. *Contemporary Debates in Epistemology*. London: Wiley Blackwell
- Chinowsky P S (2001). Construction management practices are slowly changing. *Leadership and Management in Engineering*, 1(2): 17–22
- Chinowsky P S, Meredith J (2000). Strategic management in construction. *Journal of Construction Engineering and Management*, 126(1): 1–9
- CIDB (2006). *Malaysia Construction Industry Master Plan*. CIDB, Malaysia
- Dangerfield B, Green S, Austin S (2010). Understanding construction competitiveness: The contribution of system dynamics. *Construction Innovation*, 10(4): 408–420
- Dikmen I M, Birgonul T, Ozorhon B, Sapci N E (2010). Using analytic network process to assess business failure risks of construction firms. *Engineering, Construction, and Architectural Management*, 17(4): 369–386
- Enshassi A, Al-Hallaq K, Mohamed S (2006). Causes of contractor's business failure in developing countries: The case of Palestine. *Journal of Construction in Developing Countries*, 11(2): 1–14
- Gary M S, Kunc M, Morecroft J D W, Rockart S F (2008). System dynamics and strategy. *System Dynamics Review*, 24(4): 407–429
- Gilkinson N, Dangerfield B (2013). Some results from a system dynamics model of construction sector competitiveness. *Mathematical and Computer Modelling*, 57(9–10): 2032–2043
- Hillebrandt P M, Cannon J (1990). *The Modern Construction Firm*. Basingstoke: Macmillan
- Kale S, Arditi D (1998). Business failures: Liabilities of newness, adolescence, and smallness. *Journal of Construction Engineering and Management*, 124(6): 458–464
- Kangari R (1988). Business failure in construction industry. *Journal of Construction Engineering and Management*, 114(2): 172–190
- Kim D H (2000). Growth and underinvestment: The role of relative delay. *Systems Architectures*, III: 13–15
- Linard K, Flemin C, Dvorsky L (2002). System dynamics as the link between corporate vision and key performance indicators. In: *Proceedings of the 2002 International System Dynamics Conference*, Palermo
- Morecroft J D W (2007). *Strategic Modelling and Business Dynamics: A Feedback Systems Approach*. London: John Wiley & Sons
- Ofori G (1990). *The Construction Industry: Aspects of its Economics and Management*. Singapore: Singapore University Press
- Ogunlana S O, Li H, Sukhera F A (2003). System dynamics approach to exploring performance enhancement in a construction organization. *Journal of Construction Engineering and Management*, 129(5): 528–536
- Price A D F, Newson E (2003). Strategic management: Consideration of paradoxes, processes, and associated concepts as applied to construction. *Journal of Management Engineering*, 19(4): 183–192
- Russell J S, Casey J Jr (1992). Design engineer/contractor bankruptcy: Considerations for debtor and creditors. *Journal of Management Engineering*, 8(3): 278–297
- Senge P M (1990). *The Fifth Discipline: The Art and Practice of the Learning Organisation*. New York: Currency Double Day
- Sterman J D (2000). *Business Dynamics: Systems Thinking and Modeling for a Complex World*. New York: Irwin McGraw Hill
- Tang Y H, Ogunlana S O (2003a). Modelling the dynamic performance of a construction organization. *Construction Management and Economics*, 21(2): 127–136
- Tang Y H, Ogunlana S O (2003b). Selecting superior performance improvement policies. *Construction Management and Economics*, 21(3): 247–256
- Wood M (2015). *Insolvency Statistics*. London: The Insolvency Service