First International Conference on Construction in the 21st Century (CITC2002)
"Challenges and Opportunities in Management and Technology"
25-26 April,2002, Miami, Florida, USA

FORECASTING ORGANIZATIONAL PERFORMANCE UNDER FLUCTUATING ECONOMY

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ABSTRACT
The Asian financial crisis has adversely affected many of the domestic construction organizations in Malaysia, bringing some of the organizations to the brink of bankruptcy. It demonstrates that a construction organization's performance is sensitive to the prevailing economic conditions. This paper seeks to model the dynamic impact of the economy on the performance of a publicly listed construction organization in Malaysia. Firstly, a diagrammatic model consisting of two interconnected causal loop diagrams is developed to represent the organization's capacity and its financial balance sheet. The diagrams provide a clearer understanding of the interactions between the country's economy and its financial, technical and managerial capabilities within the organization. Next, the causal loop diagrams are converted into a mathematical model using specialized software. Simulation results from the model are validated against historical time series data. Graphical plots of the simulation model and results from sensitivity analysis indicate that the model is capable of replicating the general behavior of the organization. The model will be used as a tool for predicting future organizational performance based on the expected fluctuations in the economy.

KEYWORDS
Construction Company, Performance Modeling, System Dynamics, Forecasting, Malaysia

1. INTRODUCTION

The Asian financial crisis that started in 1997 is the 'biggest economic shock' that the region has suffered since the Great Depression. During the crisis, many of the Southeast Asian countries, including Malaysia has lost approximately twenty to thirty percent of their gross domestic product (GDP) (ADB, 2000). This adversely affected the construction industry in Malaysia causing many construction organizations to experience severe financial difficulties, with resulting ripple effects in all sectors of the economy. In response, the Malaysian government had taken various steps to stimulate economic recovery, i.e. increasing its public spending on infrastructure projects in the hope of boosting spending and government sponsored house ownership campaigns. For example, the government has recently revived several large-scale infrastructure projects such as the Monorail project in Kuala Lumpur and the Bakun dam project in Sarawak.

From 1990 to 1997, the Malaysian construction industry experienced impressive growth due to the increase in the volume of construction work as part of the preparation for the Commonwealth Games in 1998. Many major infrastructure projects such as the Bukit Jalil Games Village, the Kuala Lumpur International Airport, the STAR and PUTRA Light Rail Transit System and numerous highways were constructed during this period. In addition, many hotels and shopping malls were also built to cater to the expected influx of foreign tourists during the Commonwealth Games. With the completion of many infrastructure projects in 1997 and the compounding effect of the Asian financial crisis, the construction industry experienced a sudden contraction in the volume of work. As a result many domestic construction organizations are experiencing severe financial difficulty. For example, of the thirty-three construction organizations listed on the Kuala Lumpur Stock Exchange's (KLSE) Main Board in October 2000, at least five organizations were in technical bankruptcy with their net worth dipping into the negative zone. This demonstrates that the performance of construction organization is highly dependent on the state of the economy.

The prevailing state of the national economy has hampered the growth of many local construction organizations, thus reducing the overall competitive strength of these organizations. Economic indicators for 1999 shows that despite the higher growth experienced by all major production sectors in Malaysia since 1997, the construction sector's growth remained lackadaisical (ADB, 2000). In the past, the government had endeavored to improve the performance of local construction organizations by insisting on technological transfer using measures such as: (i) mandatory joint ventures; (ii) mandatory subcontracting; and (iii) specified training of local personnel (Ofori, 2000), particularly in the construction of infrastructure projects. However, such governmental intervention is expected to decrease with the advent of the General Agreement on Trade in Services (GATS). Furthermore, technology transfer efforts through joint ventures in the past has not been satisfactory as most international firms have either been reluctant to effect the transfer due to a lack of incentive.

2. OBJECTIVE AND SCOPE OF RESEARCH

This paper forms the first part of a research which is aimed at providing decision makers of publicly listed construction organizations with a tool for forecasting the impact of policy changes on organizational performance subjected to economic influences. A case study is conducted on an average performing organization from thirty-three organizations listed on the Kuala Lumpur Stock Exchange (KLSE) Main Board. These organizations were chosen because they represent some of the largest construction organizations in Malaysia which are expected to compete directly with more sophisticated foreign contractors with the gradual liberalization of the industry. The specific objectives of this research include: (a) identifying various factors that influence construction organization's performance in Malaysia, (b) quantifying and examining the impact of these factors on organization's performance in the past, and (c) constructing a system dynamic model of the organization to forecast future organizational performance.

3. SYSTEM DYNAMICS IN ORGANIZATION STUDY

An organization's overall performance is influenced by existing organization structure and both formal and informal policies that the organization employs. A construction organization is a complex system with many interrelated components. This research utilizes the system thinking paradigm to provide a holistic approach in the modeling of complex organizational relationships and the dynamic interactions between various organizational components over a time period. System thinking " … replaces a reductionist, partial, narrow, short-term view of a system with a holistic, broad, long-term, dynamic view …" (Sterman, 1994). Lyneis (1982) provides three reasons why system thinking is required to study organization, particularly in the area of policy planning and design. These reasons are:

a) Organization behavior is affected by many interactions between parts of the organization, and the organization and the environment.
b) Interactions tend to be more important than components
c) Long-term results may differ from short-term results

System dynamics is a continuous simulation technique that was first introduced by Forrester (1961), and has been used successfully in the study of organizational performance. Coyle (1996) defines system dynamics as a method that:

> 'deals with the time-dependent behavior of managed systems with the aim of describing the system and understanding, through qualitative and quantitative model, how information feedback governs its behavior,

and designing robust information feedback structures and control policies through simulation and optimization.'

System dynamics has been applied in the study of growth cycles in fledging high-technology market (Morecroft, 1986), in the modeling of growth strategy in a biotechnology startup firm (Morecroft *et al.*, 1991), in the measuring of the value of information in a business firm (Clark and Augustine, 1992) and in the evaluation of an engineering firm's performance (Koul and Vrat, 1991). A review of current literature in construction management shows that few researchers have undertaken to study the dynamics and complexities involved in managing construction organization. Most current studies of system dynamics in the field of construction have been limited to projects (Love *et al.*, 2000, Ng *et al*., 1998, Chang *et al*., 1991 and Ogunlana *et al.*, 1995). The exceptions to the emphasis on projects are found in recent works by Fayyaz (1998), which applied the system dynamics approach to the investigation of managerial performance in Pakistan's building construction industry, and Bajracharya *et al.* (2000) who studied the effects of organizational constraints on training activities in the Nepalese construction industry. The current research significantly expands Fayyaz's (1998) work to include the modeling of an organization's financial balance sheet. This study focuses specifically on the performance of an APO and its interaction with its stakeholders and the prevailing economic environment.

4. RESEARCH METHODOLOGY

A structured five-stage approach suggested by Coyle (1996) is adopted as the methodology for this research. His structured approach is coupled with Saeed's (1995) learning cycle (Figure 2) to provide an overview of the expected outcomes from each of the five stages. The structured approach should be viewed as a continuously expanding cycle of pattern recognition, system identification, experimentation and conceptualization with specific set of outcomes at each core competency. Each specific outcome provides additional information for better understanding of the organization structure and potential leverage for system improvement, thus underscoring the appropriateness of the approach.

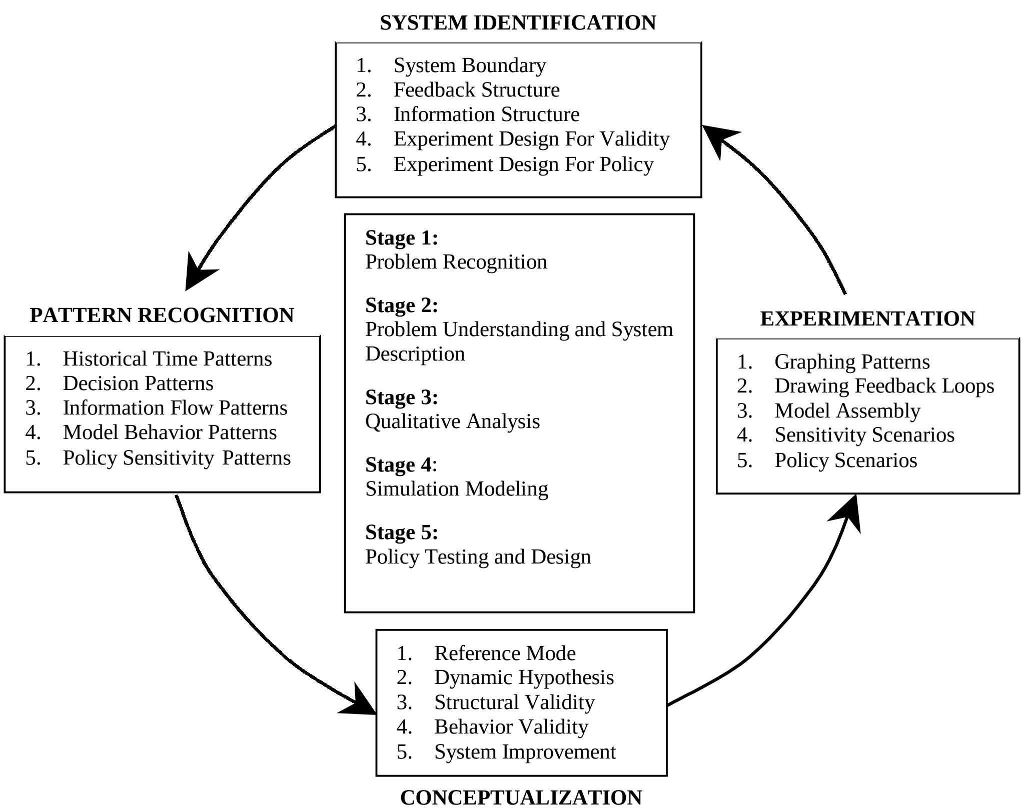

Figure 2: Research Methodology
(Sources: Coyle, 1996 and Saeed, 1995 adapted)

5. FINDINGS AND DISCUSSION

5.1 Problem Recognition

In system dynamics, a reference mode represents the dynamic behavior of a system. It provides a reference behavior to determine the validity of a simulation model. In order to construct the reference mode for this study, an average performing construction organization (APO) is selected from among the thirty-three construction organizations listed on the Kuala Lumpur Stock Exchange (KLSE) Main Board as of October 2000 for in-depth study. The performance of thirty three construction organizations listed on the Kuala Lumpur Stock Exchange Main Board were evaluated using six financial ratios proposed by Kangari et al. (1992). These ratios represent the performance of the construction organizations in three different areas, namely liquidity (current ratio and total liabilities/net worth ratio), efficiency (total assets/revenues and revenues/net working capital ratios) and profitability (return on total assets and return on net worth). Specific details of the evaluation and the complete reference mode are found in Tang (2001).

5.2 Dynamic Hypothesis

The dynamic hypothesis is derived from the literature review, interviews conducted with the APO's top-level management and through the modeler's interaction with industry practitioners in Malaysia. Two interrelated causal loop diagrams represent the dynamic hypothesis for the APO. Figure 3 shows the causal loop diagram for the APO's organizational capacity. The causal loop diagram for financial balance sheet (Figure 4) illustrates the causal relationship between various accounts in the balance sheet caused by the changes in annual volume of construction work, financing and investment activities

5.3 Model Formulation

The model is formulated from the dynamic hypothesis discussed above. In view of the complex relationships that exist within every organization, it is difficult to fully comprehend the dynamic behavior caused by exogenous variables without the assistance of specialized software. The model in this research is built using the STELLA Research software. Firstly, a suitable level of aggregation is carefully selected to ensure that the model built sufficiently represents all the essential parameters and decision points without being overly simplistic or unnecessarily complicated. In order to fulfill an important objective of this research, which is to identify and formulate policies to improve construction organization's performance, all the variables used are aggregated at the level of policy makers in top level management. In aggregating the endogenous variables, several assumptions are made to facilitate the building of the system dynamics model. Most of the assumptions are described in detail in the model formulation (Tang, 2001). Next, the extent of the model, or its boundary is carefully selected. The model should include all the important decision points within the control of the top management and exclude environmental variables, which are beyond the organization's influence. The final model formulated consists of nine sectors. Each sector typically consists of an array of building blocks such as stocks, flow, converter and connectors, which could be translated into a series of equations. Due to the complexity of the detailed model, it will not be discussed in this paper. However, a complete listing of all the equations used in the model is available from the authors for interested readers.

5.4 Model Validation and Sensitivity Analysis

In this stage, the formulated model is executed and the simulation results are compared with the reference mode to ascertain its validity. The primary purpose of model validation is to 'ensure that the model captures the general dynamics of system behavior and produce results that are as close as possible to their real occurrences' (Rodrigues and Williams, 1998). A system dynamics model is described as being valid if it is structurally sound and the results correspond with the behavior being observed in a real system. In the present study, structural validity is attained firstly by evaluating every relationship and feedback loop in the dynamic hypothesis to ensure that they capture the general dynamic behavior of a construction organization. Secondly, the parameters and equations used in the system dynamics model are investigated to ensure that the parameters match the effect of corresponding variables in the dynamic hypothesis. In addition, all the model assumptions are reviewed by comparing them with information collected for corresponding parts in the real system, i.e. through published reports and interview. In some variables, the assumptions are alternatively verified by comparing them with descriptions of decision-making and organizational relationships found in relevant literature. Careful evaluation of the model using the approaches discussed above did not reveal any extraordinary or illogical parameters or equations in the variables, thus verifying that the model is generally valid.

A model is considered behaviorally validated if simulation results display similar behavioral patterns when compared with observed behavior in a real system. In the present study, behavioral validation is attained by comparing the results generated from a base run of the model with the time series data collected from historical records or reference mode. The behavioral similarity between the results produced by the model and the reference mode for six quantitative variables indicate that model is behaviorally valid. Visual comparison of the graphical plots of a few important variables, such as the number of projects under construction and human resources against the time-series data gathered during interview with the organization's top level management provide additional support for model validation.

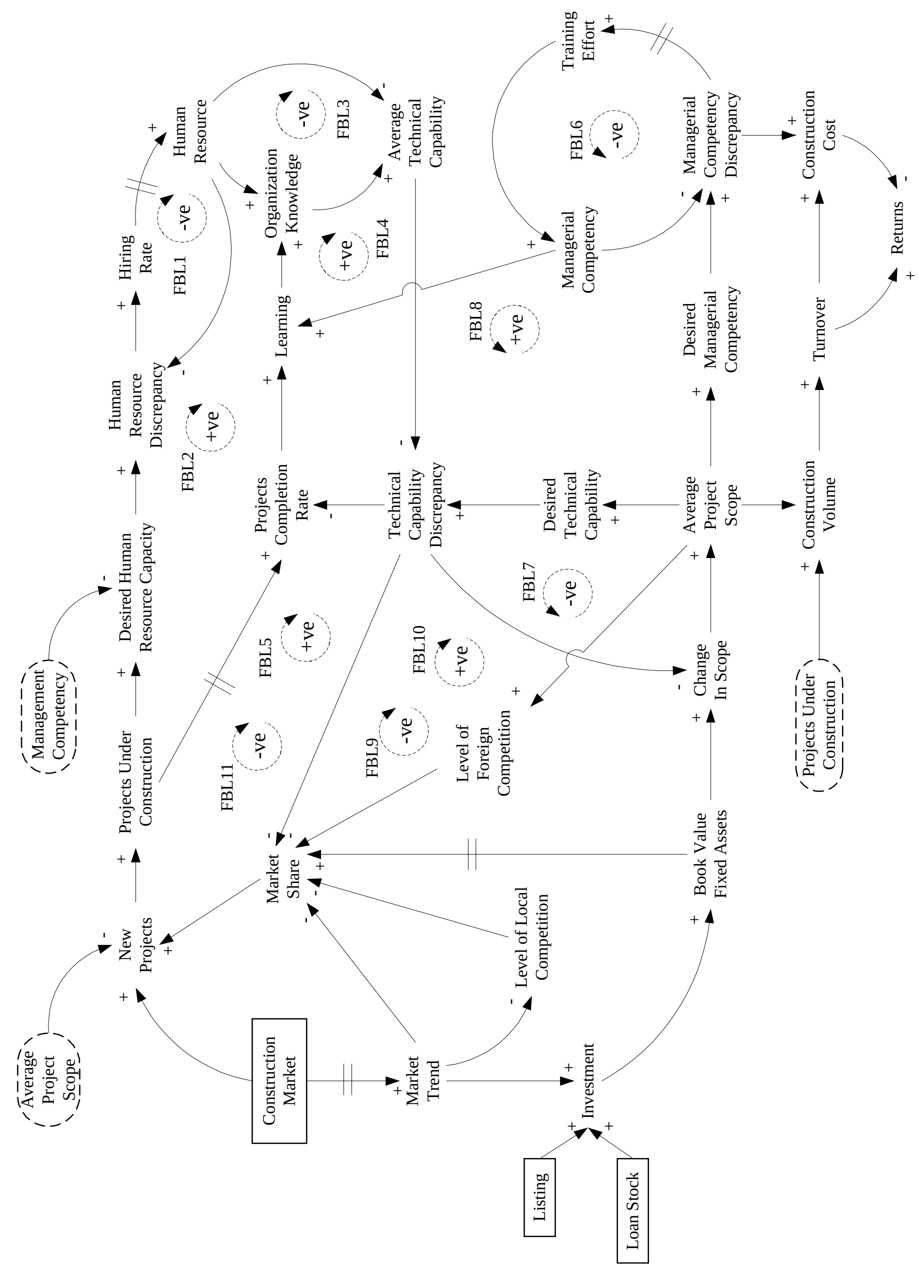

Figure 3: Organizational Capacity Feedback Loop Diagram

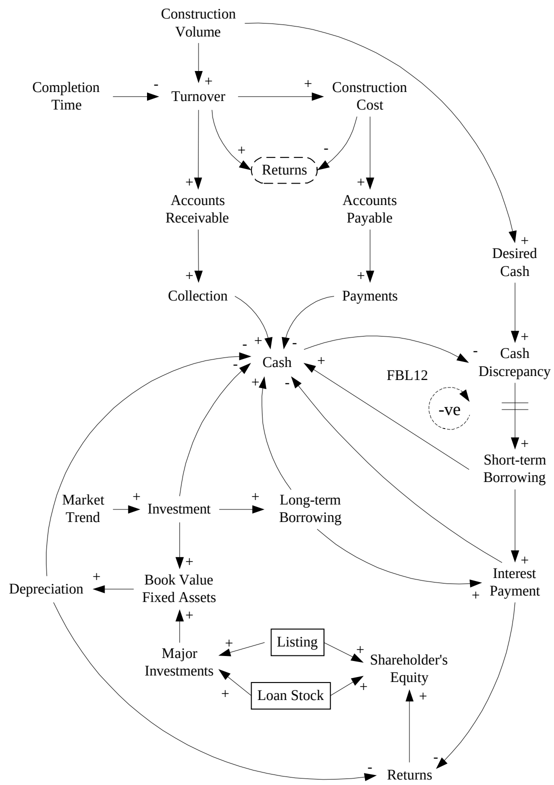

Figure 4: Financial Balance Sheet Feedback Loop Diagram

Sensitivity analysis is conducted to test the robustness of the model by ensuring that uncertainties and estimating errors do not significantly affect the overall behavior of the model. It tests the limits of the model and its ability to adjust itself in response to the changes. A model is considered robust if its behavior does not change drastically when a parameter or behavioral relationship is altered. Extensive tests conducted on the model indicate that the model is generally not sensitive to either a twenty-five percent increase or decrease in the value of the parameters. Doubling the value of the parameters has some effects on the model. However, it does not change the overall behavior of the model. Results from the sensitivity analysis on the parameters suggest that a few of the variables provide potential leverage points for model improvement.

5.5 Policy Testing and Design

When the model is validated, it is simulated for an additional fifteen years to generate the forecasted organizational performance. This duration is selected because historical records indicate that a typical business cycle for the construction industry in Malaysia is approximately eleven years. The model is simulated with the assumption that there will not be any major capital influx during this period. This means that external forces acting on the APO are limited to the construction market and the conversion of existing loan stock to ordinary shares in 2002. The forecast assumes that the country's construction market will grow in tandem with the projected economic recovery, followed by a sudden decline in year 2008.

The long-term behavior of the model as a result of the business cycles in construction is depicted through graphical plots of the six performance variables (Figure 5, 6 and 7). The forecast results indicate that the organization will continue to grow and expand. However, the organization's profitability is declining gradually even though its net profit is rising. The model also suggests that the APO is highly susceptible to the growth and shrinkage of the domestic construction industry. This confirms earlier observations that construction organizations are highly dependent on the country's state of economy, regardless of size and experience

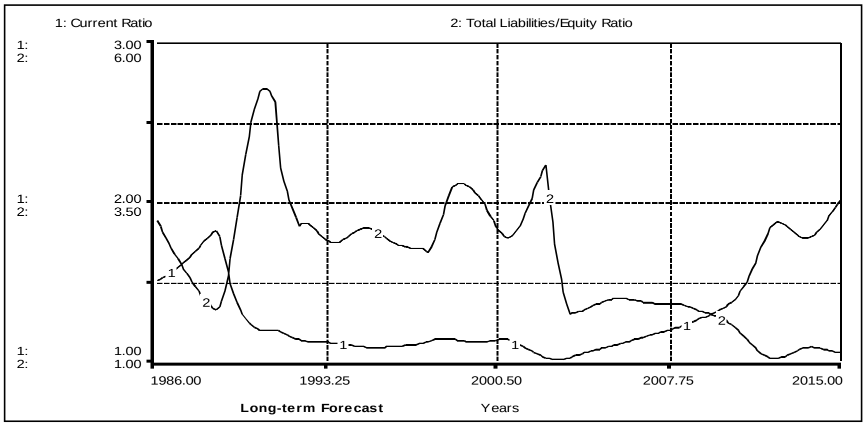

Figure 5: Long-term Forecast of Liquidity Ratios

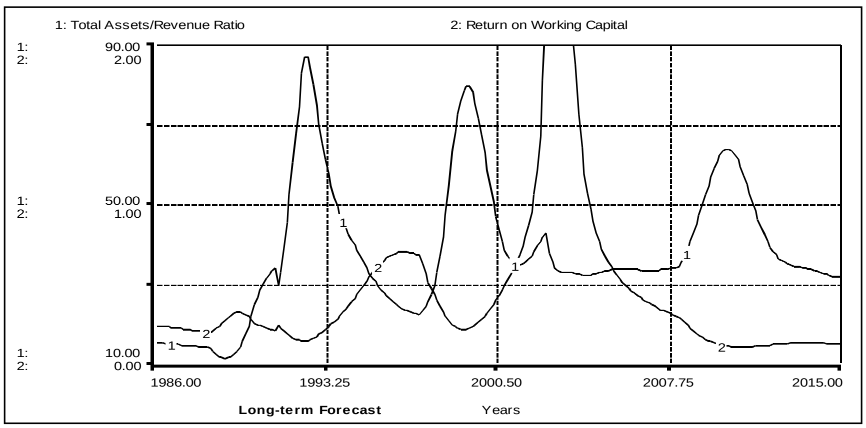

Figure 6: Long-term Forecast of Efficiency Ratios

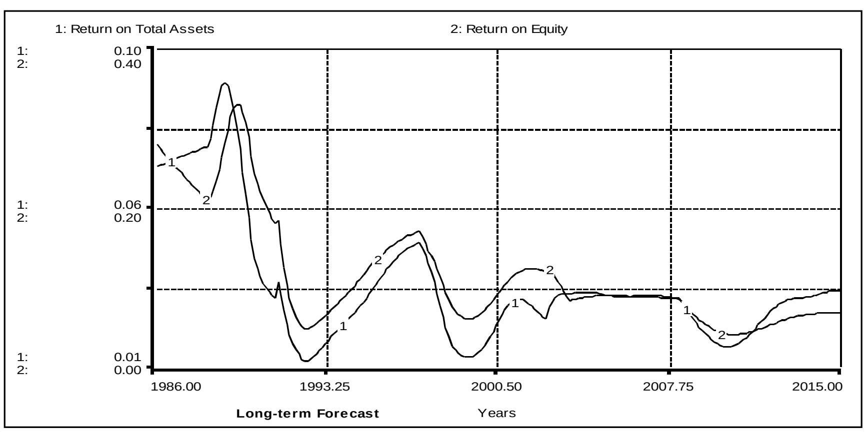

Figure 7: Long-term Forecast of Profitability Ratios

Using the base run performance forecasted by the formulated model as shown above, various organizational improvement policies could be tested and evaluated by comparing the changes in organizational performance relative to the base run performance. Our future work will utilize the model to assist top-level managers to evaluate the value of various performance improvement policies.

6. CONCLUSION

This paper briefly discusses the formulation of a system dynamic model for forecasting the performance of a publicly listed construction organization in Malaysia. The concept of system dynamic modeling was employed to provide a holistic view of a construction organization and its interactions with the country's economy. Although the model constructed is meant to represent the complex structure of the APO being studied, the basic structure presented in this paper could be applied to any other construction organization by changing various parameters and graphical functions to suit the organization being studied. The model could be used to provide high-level managers and researchers of construction organization with a tool for testing the effects of various policy changes on organizational performance. In our future research, various performance improvement policies will be tested using the model to evaluate the effectiveness and efficiency of the policies and combination of policies under the forecasted economic scenario.

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