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ARTICLE

Nonlinear Analysis of Progressive Collapse of Reinforced Concrete (RC) Building by Different Kinds of Column Removal

Wenchen Ma* **Lei Jia**

Department of Civil and Environmental Engineering and Construction, University of Nevada, Las Vegas, 4505 S. Maryland Parkway, Las Vegas, NV 89154, USA

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ABSTRACT

Building collapse mostly can be caused by the loss of loading capacity in a primary structural component, resulting in the failure of surrounding elements, which in turn cause a failure propagation. Progressive collapses may be accidental, due to design deficiencies or errors, material failure or natural phenomenon (e.g. earthquakes) but it can be prevented by upgrade the concrete components' material[1,2]. Well-engineered RC buildings generally have a good performance under normal loading conditions. However, faulty design, construction errors, material deterioration, and overloading are always occurred. When part of structure fails, the total load in the whole system will not disappear, which means the load will be redistributed unevenly to the adjacent part of structure. This phenomenon revealed that sustained high stresses in RC elements can lead to catastrophic collapse. Due to very few of papers did the research on the RC elements under high stress level sustained load, relevant experiments should be performed in this area. This paper gives the suggestions about how to apply the load in an experiment if researchers want to know the behavior of elements near to collapse especially focus on RC columns.

1. Introduction

A four-story building (Figure 1a) is designed following the U.S. codes ASCE 7-10 (2010) [3] and ACI 318-14 (2014) [4]. The building, assumed with office occupancy, is located in a non-seismic region. It has five bays in each direction with 28 ft span length (Fig. 1b). The story height is 14 ft at the first floor and 12 ft at all other floors. The structural system of this building is non-prestressed two-way slabs with beams spanning between supports on all sides. Assume the moment can be transferred between slabs and beams totally. The second step is designing the beam, column and slab cross section of this building based on structural analysis software SAP2000 [5]. This structure was designed to carry only vertical load. Use the control load combination 1.2D+1.6L (IBC 2015). The gravity load includes 112.5 psf self-weight of slab for all floors with additional superimposed dead load 17 psf for roof and 20 psf for floor accounting for partition walls, floor finishes, tiles, water proofing, cable wires, plumbing pipes, etc.

**Corresponding Author:*
Wenchen Ma,
Male, born July 1992, is a Ph.D student majoring in civil engineering concentrate on structural engineering at UNLV;
Email: maw2@unlv.nevada.edu

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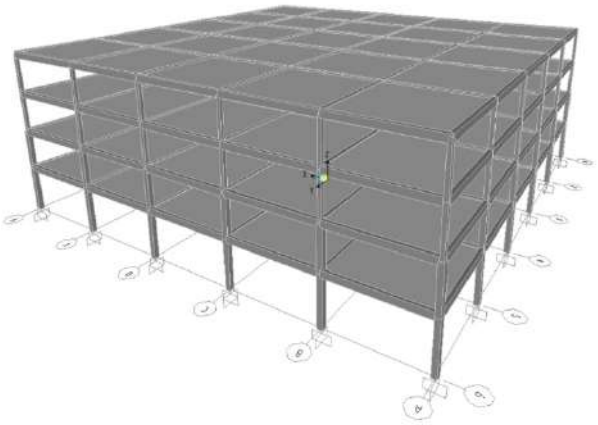
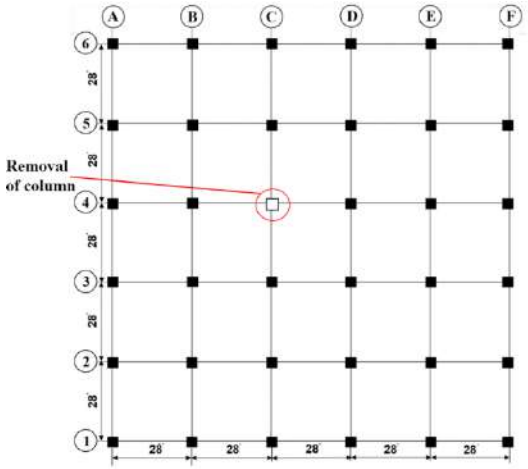


(a)



(b)

Figure 1. Prototype RC frame building: (a) 3D view and (b) Floor plan

2. Elastic Analysis of Whole Building

For live load, use 20 psf for the roof and 50 psf for the floor separately (ASCE 7-10). All the members in this prototype structure were constructed using Grade 60 reinforcement and concrete with 5500 psi as specified compressive strength. Due to the change of moment, shear and axial force of members after one of the first-floor column been removed need to be considered, member's maximum moment, shear and axial force next to the column will be removed before it has been removed are required as well. In order to obtain the maximum moment, shear and axial force of the members surrounding the column will be removed, the most unfavorable condition should be considered. In this structure, assume dead load and superimposed dead load will maintain unchanged, applies on all spans and all floors of the whole structure. However, for live load, based on the symmetry of live load patterns, four different live load patterns have been determined finally as shown in Figure 2.

After live load patterns have been determined, the boundary condition is also an important part of this model. Due to the load path of whole system is slab to beam to column, assume moments and shear force can be transferred from slab to beam smoothly. It is very important to make sure slab-beam connection is fixed. This can be achieved by mesh the beam and the edge of slab with the same number of elements, which all elements are sharing the same nodes and the same degree of freedom. Assign "automatic area mesh" in SAP 2000, divide the beam and area edge with both 35 elements, then choose do not create edge constraints. In this way, all the force can be transferred and this is the same as real world.

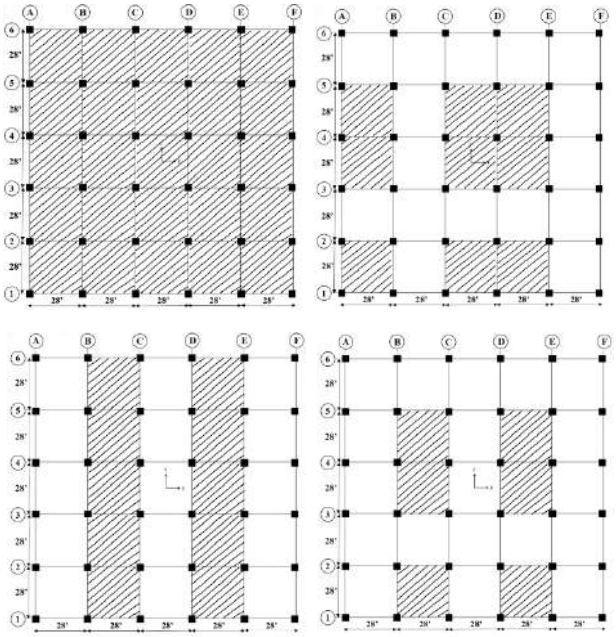


Figure 2. Live load patterns

All beam-column connections in this model are fixed connections and all supports are fixed as well. Based on the four live load patterns shown in Figure 2, assign an envelope of both four load combinations (dead load plus live load) to obtain moment envelope, shear force envelope and axial force envelope of whole structure as shown in Figure 3.1 to Figure 3.3.

From the analysis result shown above, for floor levels, the maximum negative moment -2179.5 kip·in appears at joint 5C on the third floor in x-z direction. The maximum positive moment appears at the third floor between node 4B and 4C, which value is 1115.4 kip·in. Maximum negative moment and maximum positive moment for the roof level are -1730.2 kip·in and 806.5 kip·in respectively.

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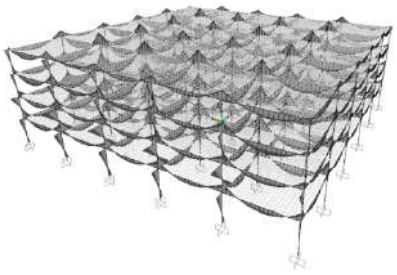


Figure 3.1 Moment envelope

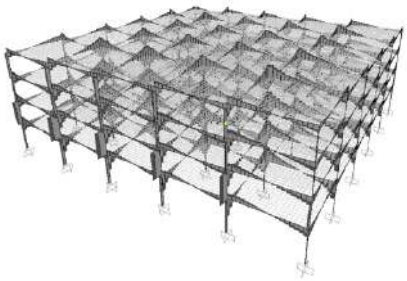


Figure 3.2 Shear envelope

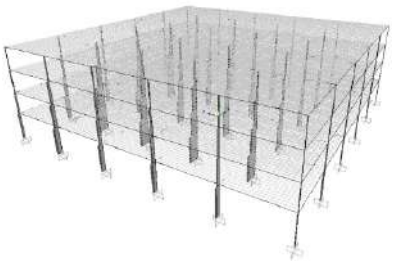
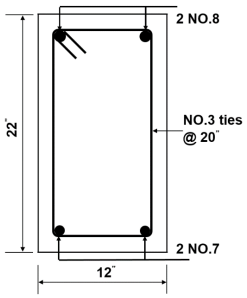
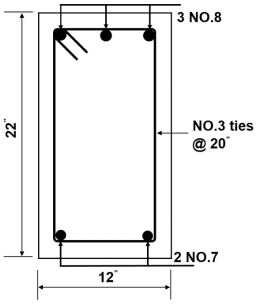


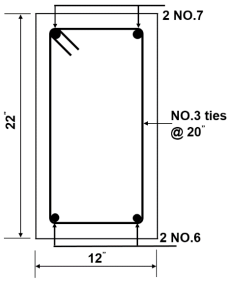
Figure 3.3 Axial load envelope



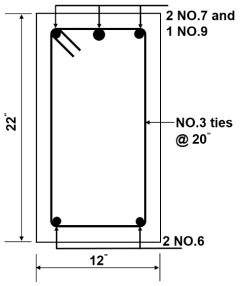
Floor beam section Positive moment



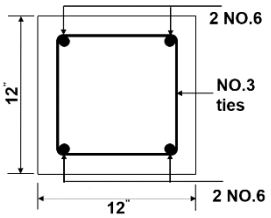
Floor beam section Negative moment



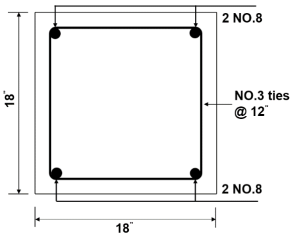
Roof beam section Positive moment



Roof beam section Negative moment



Top two layers column



Bottom two layers column

Figure 4. Design section of beam and column

Then, the beam and column sections based on the maximum value of the envelope of moment are designed, shear and axial load as it is shown in Figure 4. Divide the slab into column strip which width is 7 ft and middle strip 14 ft. For column strip negative moment, use NO.4 @ 12", for middle strip negative moment, use NO.4 @ 18", for column strip positive moment, use NO.4 @ 15", for middle strip positive moment: use NO.4 @ 15" as well. However, ACI code provides minimum reinforcement for the slab is 0.194 in^2/ft for two-way slab with grade 60 steel. Modify the design result to use NO.4 @ 12" for the whole slab. The reinforcement distribution for one 28'x

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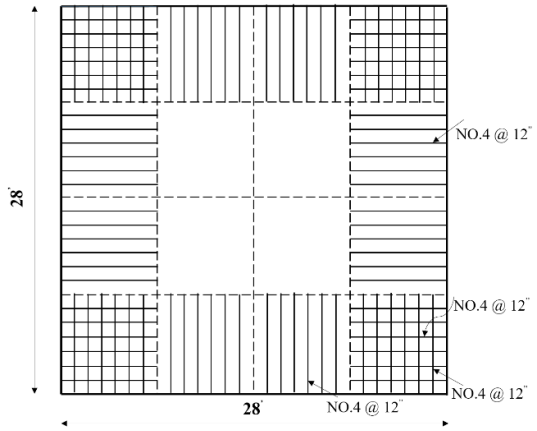
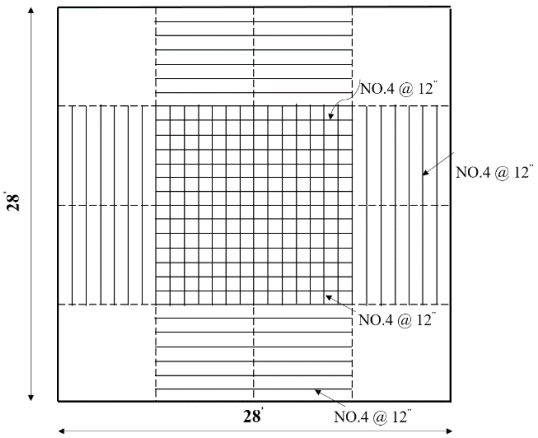
28' slab is shown in Figure 5.



(a)



(b)

Figure 5. Reinforcement distribution of slab: (a) Negative and (b) Positive

3. Plastic Analysis of Prototype Structure After Column Removal

After one column of the first level has been removed, some corresponding elements will enter to the plastic stage. Due to the limitation of structural design software, the result of plastic analysis of structure is not very well. However, finite element software ABAQUS can solve this problem, this software is commonly used in many related areas [6-8]. Concrete and steel properties are shown in Figure 6 and 7.

Table 1. Concrete Damage Plasticity parameters

Dilation Angle	Eccentricity	f_{b0}/f_{c0}	K	Viscosity Parameter
30	0.1	1.16	0.667	0

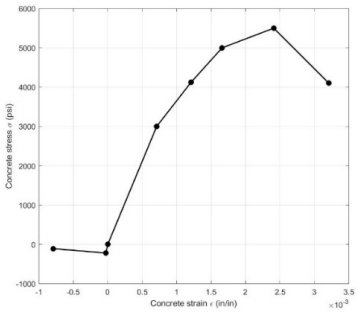


Figure 6. Stress-strain relationship of concrete (f'_c = 5500 psi)

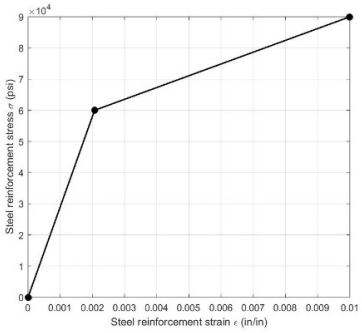


Figure 7. Stress-strain relationship of steel reinforcement (f_y = 60000 psi)

The concrete property of plastic part is defined in Table 1. In order to better simulate the effects of suddenly removing a column, use an equivalent analysis approach. First, do the static analysis of the whole building to determine the forces existing in the supporting column which will be removed in the future. For this step, only consider axial load only. For simplicity, use element type beam for both beam and column, use element type shell for slab cross section, set the rebar layer the same as the reinforcement layout shown in Figure 5. The axial load diagram of the building is shown in Figure 8. From the analysis result, the axial load of the column will be removed later is 595 kips.

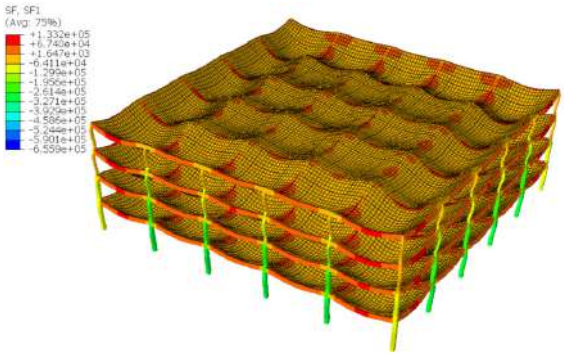


Figure 8. Axial load of structure without any column removal

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After the axial load of the column has been determined, applying an opposite direction of force which is the same as the support force of column as shown in Figure 9.[9] The moment and axial load analysis results are shown in Figure 10 and 11. Due to the first column removed, the controlled maximum moment appears at the top floor, so get the maximum moment and maximum axial load about the corresponding column to determine the experiment column's eccentricity. From the analysis result, the controlled column moment is 957.9 kips·in and the controlled axial load is 186.1 kips. The eccentricity of the moment to axial load is 5.14", because the column at the top floor is 12" x 12", so the eccentricity/column width ratio is about 0.428

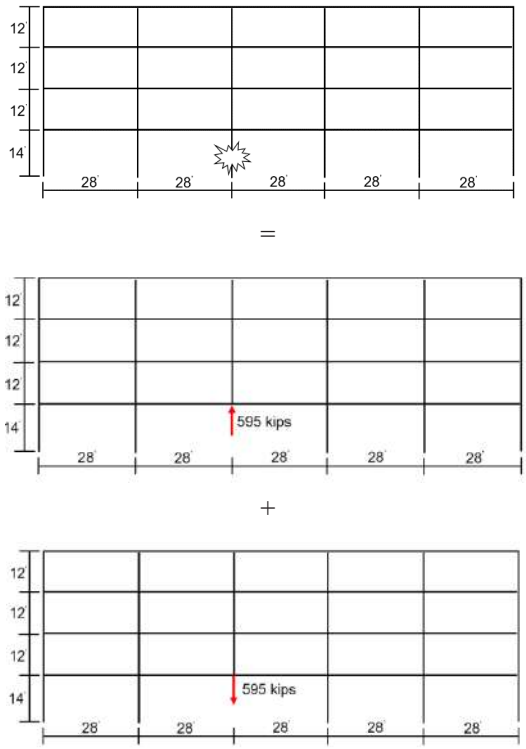
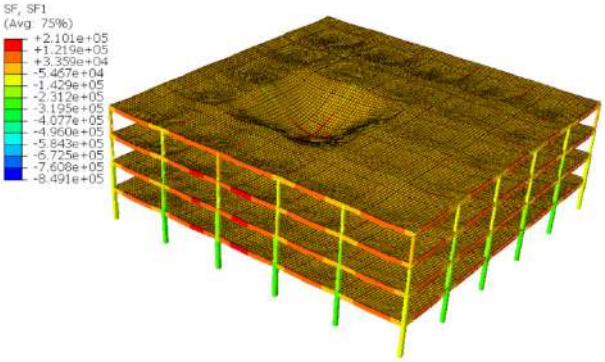
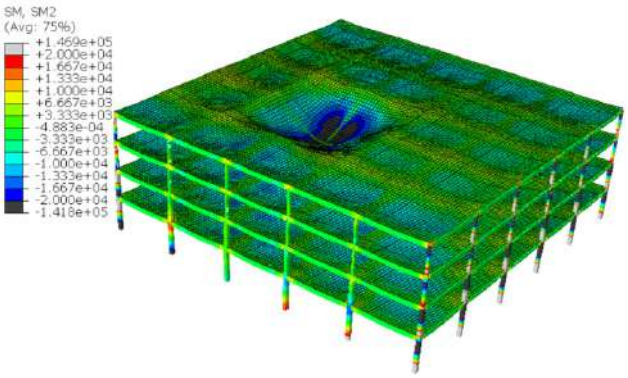


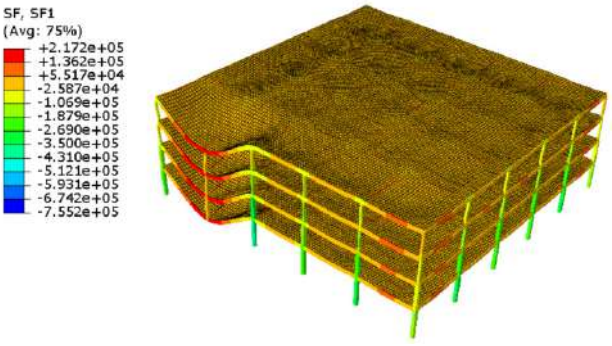
Figure 9. Analysis procedure



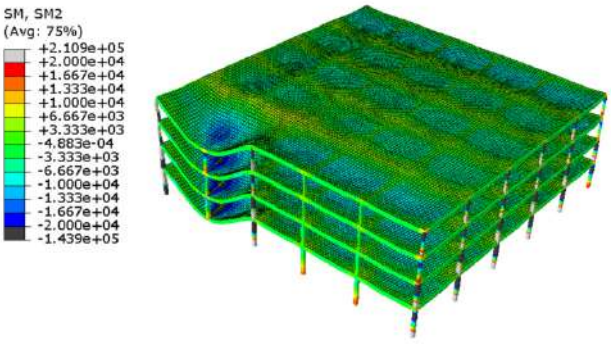
10.1 Axial diagram with interior column removal



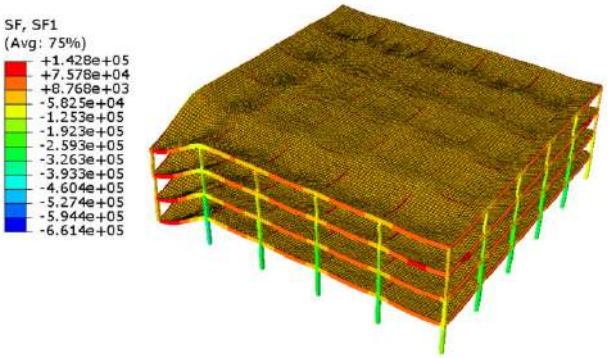
10.2 Moment diagram of with interior column removal



10.3 Axial diagram with edge column removal



10.4 Moment diagram of with edge column removal



10.5 Axial diagram with corner column removal

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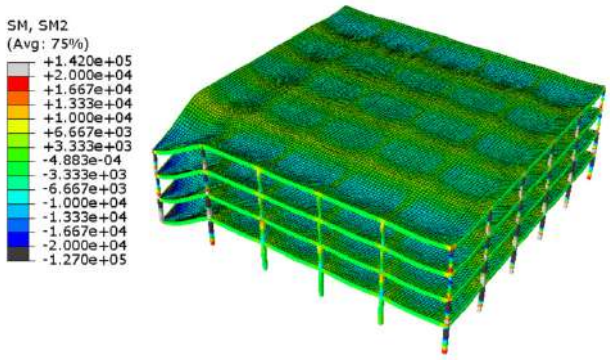

10.6 Moment diagram of with corner column removal

Figure 10. Axial and moment diagram of whole building with different column removal

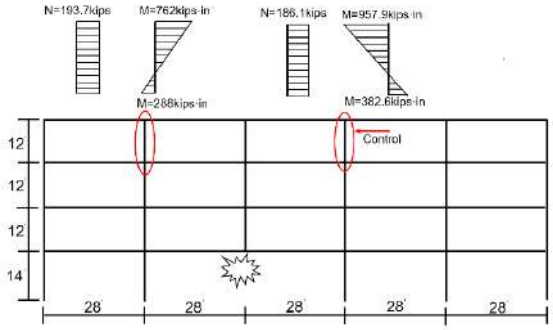

Figure 11. Top floor column's moment and axial load next to column removed

With the same method, the controlled column moment for edge column removal is 948.2kips·in and the controlled axial load is 91.7 kips. This time, the eccentricity of moment to axial load is 10.34", and the eccentricity ratio is about 0.86. On the other hand, the controlled column moment for corner column removal is 572 kips·in and the controlled axial load is 82 kips. This time, the eccentricity of moment to axial load is 6.97", and the eccentricity ratio is about 0.58.

4. Conclusion

Based on the analysis result, the column of the first floor destroyed will affects the top floor column's internal force most.

Remove the interior column of the first floor will cause the maximum axial load appears at the top floor's column. The first floor's edge column removal will cause the maximum moment to axial load ratio appears at the top floor's column.

The author recommends the eccentricity ratio of a column under sustained loading is between 0.4 to 0.9 for the future relevant concrete column experiments as the large eccentricity ratio. The value is based on the prototype structure design of the whole structural system. For the small eccentricity column test, researchers can choose 0.1 to 0.25 as the eccentricity ratio according to the former structural concrete column's test. [10]

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ARTICLE

Evaluation of Implementation Preparation for CE based on BEACON Model —Taking Construction Enterprises in Yemen as a Case of Illustration

Sabrinaji Dahmas[1] Zhongfu Li[1*] Mahmood Ahmad[2,3]

1. Department of Construction Management, Dalian University of Technology, Dalian, Liaoning, 116024, China
2. State Key Laboratory of Coastal and Offshore Engineering, Dalian University of Technology, Dalian, Liaoning, 116024, China
3. Department of Civil Engineering, University of Engineering and Technology Peshawar (Bannu Campus), Bannu 28100, Pakistan

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ABSTRACT

After decades of civil war, Yemen is in a desperate situation, and the construction industry has been suffering from low productivity and poor performance. In order to improve the productivity for the Yemeni construction industry, Construction enterprises must adopt the best and new technologies, new management concepts and philosophies such as Total Quality Management (TQM) and concurrent engineering (CE) owing to achieve improvements in the process of product development. To ensure the successful implementation of CE in the Yemeni construction industry, it is necessary to assess the readiness of those companies to implement CE. In this paper, the BEACON model is used to assess the readiness of the Yemeni companies to implement the concept of CE, that assist in overcoming the construction industry's poor productivity and performance. A study assessing CE implementation readiness will help to promote successful CE implementation in the construction industry and enhance the efficiency of construction companies. The results show that most of the construction companies in the Yemen are not ready to implement CE. The main reason is that the enterprises rely heavily on traditional management methods, and need to improve the organization and management technology. The research results can provide theoretical support for construction companies, especially Yemen companies, to establish basis in implementing an appropriate CE approach for improving performance, and also help international construction companies entering the Yemen construction market to cooperate and implement CE.

**Corresponding Author:*
Zhongfu Li,
Department of Construction Management, Dalian University of Technology, Dalian 116024, China;
Email: lizhongfu@dlut.edu.cn (Z.L.)

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1. Introduction

CE approach is a kind of integrated design for new products. Proceeding from the perspective of the whole life cycle, it puts the key issues in the downstream stage of construction projects into the design stage [1-7]. The main objective of the CE concept is to reduce or avoid conflicts between different professions that may occur during construction and enhance professional synergy and work efficiency [8-10]. It is necessary to assess the preparation of the construction enterprises before the implementation of CE owing to further improve the construction efficiency [11-13].

The real expected benefits of CE implementation in the construction industry can only be achieved through practical evaluation, planning, and improvement based on procedures. The focus is on delivering the best performance throughout the supply chain, in terms of critical success factors. BEACON allows participants in this field to evaluate and benchmark their project deliveries and identify areas that require improvement or change and work together in an active business partner to achieve real, measurable success [13].

At present, some scholars have studied the related applications of CE in the construction industry. They believe that the preparation of the CE implementation and the corporate culture significantly affect the implementation results of the CE [14-19], and the construction enterprises need to have a sufficient level of expertise to ensure that CE is effectively implemented. In this regard, the University of Loughborough, Innovation Building Engineering Center (CICE) proposed a model to evaluate the preparation of parallel projects for construction companies, namely the BEACON model, which can be used to support the assessment of the preparation work in the construction industry, and can objectively measure the readiness of CE, and performance in the construction enterprises [20]. Khalfan and Anumba used British construction companies as an example to evaluate the implementation of CE using the BEACON model. However, the research object is relatively simple, the sample type is not comprehensive, and the research needs to be further improved [11].

The construction period of Yemen's construction projects is long, mostly using backward traditional cast-in-place production methods [21-25]. Because of the improvement in the quality and efficiency of construction projects by concurrent projects, many Yemeni construction companies have begun to implement parallel projects. However, to achieve the expected benefits through the implementation of CE, it is necessary first to assess the capacity and readiness of the construction enterprise to ensure that the corresponding capabilities of the construction enterprise have reached the level required for the implementation of CE. In this paper, the Yemeni construction enterprises are taken as an example to discuss the evaluation of CE implementation in the construction industry, and the preparation of enterprises to implement CE based on the BEACON model and its questionnaire. A novel application of BEACON model approach to evaluate the implementation preparation for CE and establish basis for improving Yemeni construction enterprises performance, and also help international construction companies entering the Yemen construction market to cooperate and implement CE is presented. Therefore, this paper takes some different Yemeni construction enterprises (as contractor; subcontractor; supplier; client; and consultants) as an example to discuss assess the implementation of CE in the construction industry. In this study, using the BEACON model and its questionnaire, the preparation ability of different types of construction enterprises (clients, consultants, contractors, sub-contractors and suppliers) is evaluated, according to the five levels of maturity.

The structure of this paper is as follows: Section 2 reviews the need for CE implementation preparation; Section 3 describes the overview of the BEACON model and performance metrics; Section 4 illustrates major results findings of this study; and the last section sets out the most relevant discussion and conclusions with future work of the study.

2. Assessing the Need for CE Implementation Preparation

The use of CE by construction companies can shorten the development time and time-to-market of building products, reduce engineering changes, rework and costs, and thus improve the quality of building products and corporate profits [1-5]. The implementation of CE mainly needs to meet two essential elements: the first is personnel and management, including management system, team development, leadership, and organizational philosophy; the second is technical aspects, including design, communication, coordination, standard-setting, Technology, etc. [11-13]. At the same time, construction companies should be able to achieve a sufficient level of capability in these two aspects to better support the implementation of concurrent projects, an insufficient level of ability will make it challenging to achieve the expected results, which requires assessing the readiness to implement CE. Generally, the organizational implementation steps of CE as proposed by Karningsih et al. [13] (see Figure 1).

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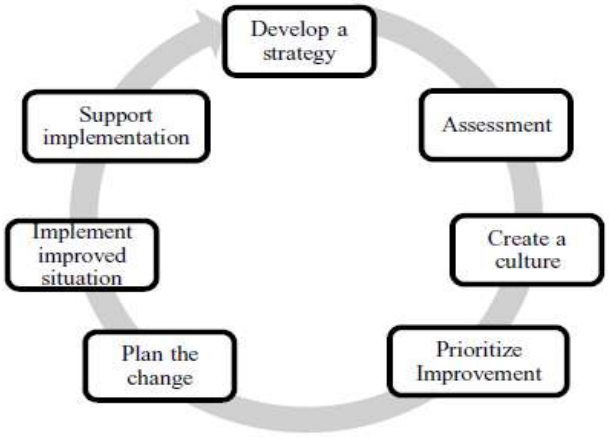

Figure 1. CE implementation steps

3. Overview of the BEACON Model

There are many tools and models, which are used to assess the readiness of enterprises in the manufacturing industry for CE. The most common are [24-27]:

(1) RACE: This tool was developed by Karandikar et al. Initially this tool was used in the US defense industry. RACE model essentially shows a snapshot of where a company is on the road to CE by asking questions about where the company presently is, as opposed to where it wants to be. The answers are mapped and a gap analysis is carried out. Now, this model often used in the fields of software engineering, automotive and electronic industries. It is possible to modify the characteristics of this model and make it reasonably suitable for use as a tool in both the construction industry and other industries. The RACE model consists in terms of two main components: organizational processes for product development, and information technology to support the product development process.

(2) PMO: the model is useful in the awareness and readiness stages of the improvement cycle of the product development process [13].

(3) PMO-RACE: PMO-RACE is the integration of both models (PMO and RACE).

Although there are many evaluation models for the implementation of CE, all these models mostly intended for manufacturing, automobile, programming, and electronic industries, where there is no special model suitable for the evaluation of CE in the construction industry. BEACON is the first model to assess the readiness of CE to implement CE [28,29].

BEACON in Construction methodology measures the readiness and subsequent performance of the participants in the infrastructure and construction supply chain. It is built on the principles of CE, used so successfully in major manufacturing and technology businesses [30]. The BEACON model icon is shown in Figure 2. The key to the BEACON model is that it includes technology and Process factors of other CE assessment tools with the extra essential elements of humans and Project present in significant infrastructure developments [31]. Measurement of those four factors targets are following (see table 1) [11, 13, 32]:

(1) Process: factors to assess the process maturity level of a construction organization - Management structures, Process Focus, Organizational Framework, Strategy Deployment, Agility.

(2) People: factors to assess the team level issues within the organization-Teams in an Organization, Discipline, Team Leadership, and Management, Team Formation, and Development.

(3) Project: factors to assess the client's requirements and design-related issues Facility Design, Quality Assurance, Client Focus.

(4) Technology: factors to characterize the introduction and utilization of advanced tools and technology within the organization - Communication Support, Coordination Support, Information Sharing, Integration Support, Task Support.

Table 1. Secondary elements of the BEACON model

Secondary Element	Description
Management system	Design the project management organization meeting the requirements of CE, establish and improve the management system.
Process Focus	Verify that the project development process has sufficient documentation and flexibility to accommodate changes in customer needs, personnel etc. Ensure that processes are regularly evaluated and improved by analyzing past decisions and reusing past processes.
Organizational Framework	Identify organized policies that help control and monitor the project development process and support teams in resource allocation, conflict resolution, and improve individual and team performance.
Strategy Deployment	Ensure that business strategies are clear and consistent, with a focus on improving the project development process. It also ensures that teams are set up to handle customer requests, and identify and prevent future problems.
Agility	Ensure that the project organization has the flexibility to respond to changes in the project development process.

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Secondary Element	Description
Team Formation and Development	Identify whether the organization has a strategy for team formation and development. Evaluate the sense of responsibility, cooperation and ability of members of the team and sub-teams.
Team Leadership and Management	Ensuring the selection and appointment of team leaders is based on technical and managerial capabilities.
Discipline	Team members can work together to achieve the team's goals, and members of different architectural disciplines can make the most of their roles and work together efficiently.
Teams in an Organization	Ensure that the team has the right to work and communicate smoothly; develop policies that measure team performance, planning, and peer review within the team.
Client Focus	Ensuring that the customer is part of the project development team. That also can prioritize all project decisions based on the customer's needs, and all members of the team understand the customer's needs.
Quality Assurance	Confirm that project standards management and quality assurance activities have been adopted and continued during the process from design to construction.
Facility Design	That verify that the preliminary design of the facility has been prepared and discussed prior to entering the final design and construction phase.
Communication Support	Ensure that team members communicate with each other over the network and use the Internet to exchange data and virtual meetings.
Coordination Support	Coordinate the work of team members to support project tracking, conflict identification and resolution, negotiation, etc.
Information Sharing	The information required for project development can be accessed electronically and managed by an appropriate database management system.
Integration Support	That confirm that all team members are integrated through a shared, integrated information model, and that all team members use a common operating system.
Task Support	Ensure that CAD, simulation tools, and past design information are effectively used for facility design and to assess the impact of management tools on the project.

For these four factors and their relevant critical elements, five different levels of performance indicators assess the level of project planning and performance within the project team and supply chain, from ad-hoc at the most basic level to optimizing at the best level. BEACON objectively measures CE readiness and performance in the construction enterprises. This research work is undertaken in five segments of the construction industry: clients, consultants, contractors, sub-contractors and suppliers as presented in Table 2.

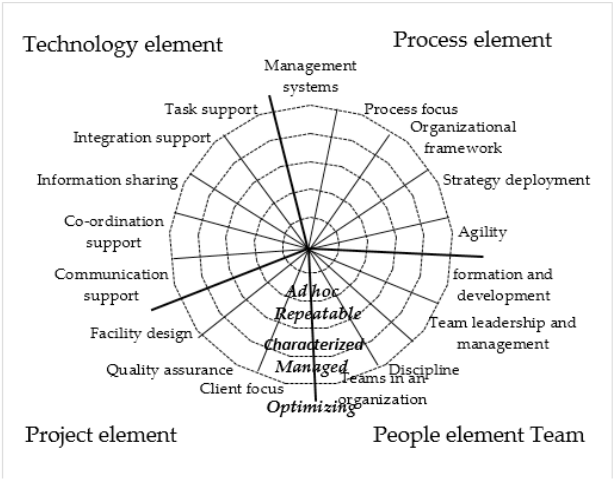

Figure 2. BEACON model icon

The BEACON model needs to evaluate the level of preparation of the various capabilities (elements) included in the model through questionnaires. Respondents need to judge the performance of the corresponding ability level in the relevant textual situation. The assessment scale has five choices and represents different scores (expressed as

Table 2. BEACON model maturity

Maturity level	Description
Ad hoc	This level is characterized by unclear procedures and controls, team confusion and disorder, team members do not understand their tasks, and do not know how to operate effectively; project management techniques are not fully applied, modern construction tools and information technology useless.
Repeatable	Standardization methods are applied in the monitoring of project development processes, the prediction of demand changes, and the estimation of costs; however, communication barriers exist within the project development team, and information technology and tools are less used.
Characterized	In the process of project development, it shows good characteristics. The company implements a part of the organization and process improvement and uses the proven technology to improve team efficiency. Most people know the customer's requirements very well, but the customer is not involved in the project construction process.
Managed	Not only does the project development process show good features, but they can also be quantified and controlled; information technology and tools are used to control and improve the project process, reducing the uncertainty of the project process; the project development team does most of the work and resolves conflicts. The customer participated in the project construction process.
Optimizing	Adopt better management techniques in the project development process, pay attention to the continuous improvement of the project; measure team performance regularly; customers become part of the project development team from the beginning, and all project decisions are prioritized according to customer needs.

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Table 3. BEACON model questionnaire example

D41: Communication support	always	most of the time	sometimes	rarely	never
1. When working in the same project, all members of the team are connected to each other in the network					
2. Everyone uses email to communicate					
3. All members and sub-teams of the project development team exchange project data over the network					
4. Team members can share project-related applications over the network					
……					

a percentage): always =4, most of the time =3, sometimes =2, rarely =1, never =0. The form of the questionnaire used in the study shown in Table 3. After summarizing the valid questionnaire results, the average of the evaluation scores of each secondary element took as the final evaluation result.

As far as aggregating all scores is concerned, in order to calculate the percentage of each critical factor and to plot it on the BEACON model chart, the actual result for each question was taken from the critical factors. For example, the results of integration support are summarized in 8 questions to receive a total score of 21 using the result for each question. If all the answers are "always" for each question or data, then the overall score will be 32. Therefore, for integration support, this will result in a 65.625% (21/32 x 100) percentage out of 100% possible. This percentage is then drawn to the model inside the "Managed Level". Most results were developed manually [11].

The assessment score needs to be translated into the corresponding level of maturity to determine the specific situation of the current capacity level of the construction enterprise. Generally, when the element score is in the range of 0-20%, the Ad hoc level corresponding to the maturity level, the score is in the field of 20%-40% corresponding to the repeatable level, the score is in the field of 40%-60% corresponding to the characterized level, and the score is in the 60%-80% interval corresponding to the managed level, and the score is in the 80%-100% interval corresponding to the optimizing level.

4. Results

Twenty companies in each category were randomly chosen, with at least five expected to respond. The questionnaires were sent with a cover letter to all the selected companies. Prior to submitting the questionnaires, each company was contacted and the most appropriate person was identified, either from the upper or middle management level, who have knowledge of the company and who can complete the questionnaire appropriately. A summary of the evaluation findings is compiled and presented in Table 4, which shows the average percentages of all elements within each category. Average percentages for each factor within the elements were calculated after assessing the questionnaire answers for each category. A brief narration of all case studies within each category is presented in the following sub-sections, with the results defined in the BEACON Model Diagram for each industry sector.

4.1 Questionnaire Analysis

Because of the absolute difference between the construction industry and other industries, especially the construction and construction process of construction products involves multiple participants in different parts of the supply chain. The resources required for production and construction will eventually be concentrated on the construction site, while the construction products are single-piece, The characteristics of fixedness and large volume, the implementation of CE in the construction industry requires the joint efforts of all enterprises in the supply chain to ensure that the enterprises in different links have sufficient implementation capacity, so the enterprise departments of each link should conduct a questionnaire survey together.

The typical construction supply chain includes five types of organizations: customers, consultants, contractors, subcontractors, and suppliers [32]. This paper combines relevant literature research and engineering practice to further select different types of customers, consultants, contractors, subcontractors and supplier organizations for the construction industry in Yemen. The questionnaire was issued from November 2017 to April 2018. A total of 100 questionnaires were distributed to the construction industry supply chain participants in Yemen, with an effective collection of 35. Respondents are mostly high-level or middle-level managers of organizations, who have an overall understanding and grasp of the preparations for the implementation of concurrent projects.

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Table 4. Preparation results of the CE of Yemeni construction enterprise

Elements	Serial number	Secondary element	Construction supply chain participants (%)				
			Contractor	Subcontractor	Supplier	Client	Consultants
Process element	D11	Management Systems	69.23	73.08	38.93	43	59.62
	D12	Process Focus	51.92	60.13	60	58.14	30.6
	D13	Organizational Framework	75	65	55	48.13	42.5
	D14	Strategy Deployment	57.5	52.5	58.14	60.25	85.5
	D15	Agility	40	50	67.05	56.6	45
People element Team	D21	Formation and Development	65	75	75	61.67	63
	D22	Team Leadership and Management	75	68.75	63.13	70.54	75
	D23	Discipline	75	75	82.25	60.73	87.5
	D24	Teams in an Organization	65.14	55.08	49.5	68.08	60.58
Project element	D31	Client Focus	50	61.38	86.36	45.65	31.82
	D32	Quality Assurance	36.36	75	75	35.76	50
	D33	Facility Design	90.14	61.11	85.65	75.25	35.11
Technology element	D41	Communication Support	41.67	75	95	30.15	10.5
	D42	Co-ordination Support	70	25	51.66	25	25
	D43	Information Sharing	41.67	40	77.37	25	22.73
	D44	Integration Support	54.63	70	65.75	44.8	25
	D45	Task Support	38.46	45	50	45.1	46.15

4.2 Contractor Organization

After the evaluation scores of the implementation preparations matched with the maturity, the level of readiness of contractors' organizations in the Yemeni construction industry to implement CE obtained, and the results were summarized as shown in Figure 3. The survey results of the contracting organizations show that most of the respondents considered that the preparation of people element is the most important. They also believe that team leadership, management, and professional interface are the most important elements within people's elements. At the same time, most of them ranking the people element in the construction field is the most important, and the technology element is the least important.

The survey results show that most of the critical factors (mainly processes, projects, and technical elements) are at the characterized level, and only some of the factors are at the managed level, indicating that the Yemeni contracting organizations are not ready to adopt CE. The main reason as: (1) the contracting organizations do not know much about the customer's needs. (2) The contracting organization is not involved in the design phase is likely to lead to design change or rework during the construction phase. (3) There is a lack of effective communication between the different departments. The contracting organizations should adopt a more efficient way of information communication, actively participate in the whole process of the project, open up contacts with customers and design, and strengthen the communication between different departments.

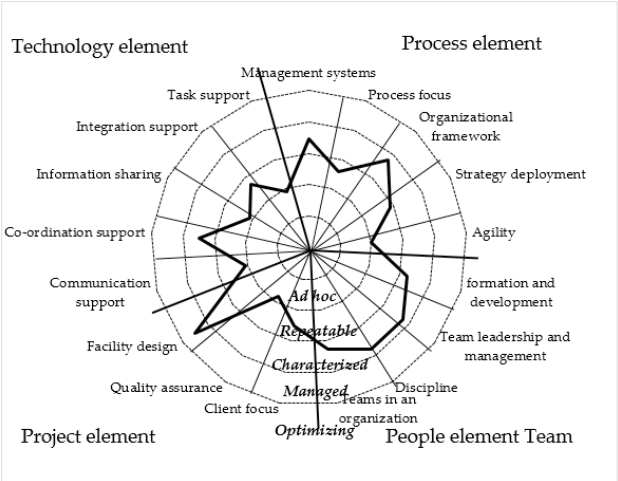

Figure 3. Evaluation of the readiness maturity of contractor's organization to implement CE

4.3 Sub-contractor Organization

After the evaluation scores of the implementation preparations matched with the maturity, the level of readiness of subcontracting organizations in the Yemeni construction industry to implement CE obtained, and the results were summarized as shown in Figure 4.

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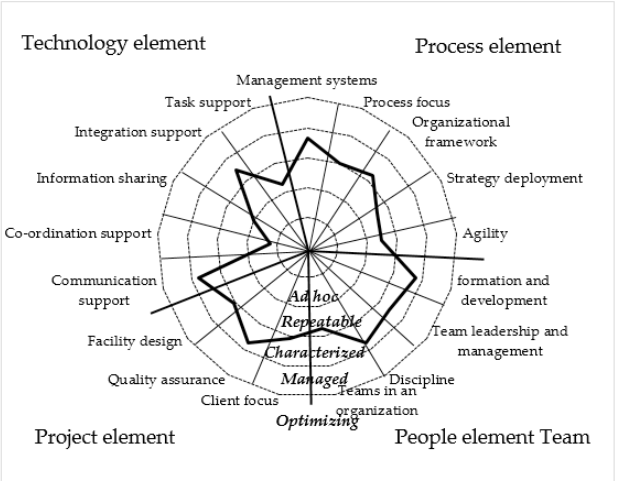

Figure 4. Evaluation of the readiness maturity of subcontractor's organization to implement CE.

The survey of subcontracting organizations in this paper shows that the majority of respondents indicated that the preparation of people element is better, and the technical elements are the worst. Also, most of the respondents commented that the people element is the most important in the construction field, and the technology element is the least important in this field. Most of the critical factors are at the managed level and do not require significant improvements. However, some of the factors (strategic deployment, flexibility, team organization, information sharing, and work support) are not at this level, but at the levels of repeatable and characterized, and these factors need to be improved. In general, Yemen's subcontracting organizations are not ready to adopt CE.

In response to the assessment of critical factors, the subcontracting organization needs to improve the workflow and content of its participation in the project process to ensure a clear business strategy. In terms of people elements, an efficient team is established to identify better and prevent future problems. At the same time, it is necessary to enhance the ability of the team to organize in different professional fields, strengthen professional coordination, and effectively deal with the contradictions between professions. Concerning technology can be summarized as follows:

1) Developing communication between different disciplines within the organization as well as with other organizations (client, supporters, etc.).

2) Integrate information, facilitate its sharing, and access by all stakeholders.

4.4 Supplier Organization

After the evaluation scores of the implementation preparations matched with the maturity, the level of readiness of supplier organizations in the Yemeni construction industry to implement CE obtained, and the results were summarized as shown in Figure 5.

A survey of supplier organizations (including material suppliers and manufacturers) in this paper shows that the respondents indicated that people and technology elements are better prepared and that the process elements are the worst. Also, most of the respondents commented that the people element is the most important in the construction field, and the technology element is the least important in this field. Process focus and agility factors in the supplier's process elements are at the managed level, organization framework and strategic deployment are at the characterized level, and management systems are only at the repeatable level. For the people element, the two factors of team leadership and management, and formation and development are at the managed level, and the remaining elements are at the level of optimizing and characterized. For project elements, the overall level is at the optimizing level, and only the quality assurance factor is at the managed level. For technical elements, most of the factors are at the managed and characterized levels, and only communication support is at the optimizing level.

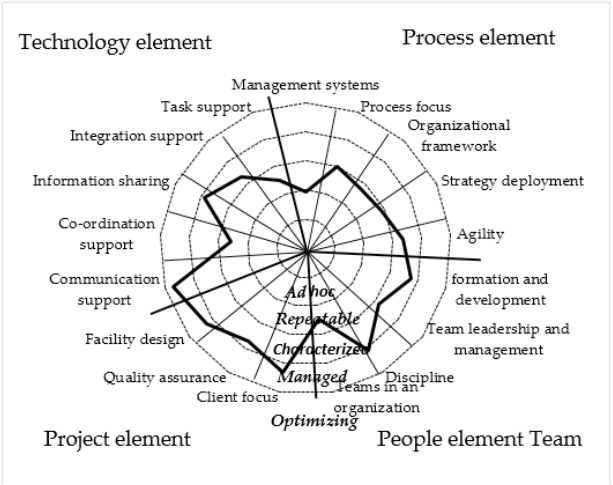

Figure 5. Evaluation of the readiness maturity of supplier organization to implement CE.

The evaluation results show that the current Yemeni supplier organizations have not adequately prepared for the implementation of concurrent projects, and needs to focus on the improvement of process and technology elements.

4.5 Customer Organization

After the evaluation scores of the implementation preparations matched with the maturity, the level of readiness of customer organizations in the Yemeni construction industry to implement CE obtained, and the results were

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summarized as shown in Figure 6.

This study received valid responses from eight different types of customer organizations (including hospitals, universities, hotels, etc.). Respondents in customer organizations indicated that the preparation of people element was the best, and the technology element was the worst. Also, most of the respondents commented that the people element is the most important in the construction field, and the technology element is the least important in this field. From the evaluation results, most of the factors except the facility design, team in an organization, and team leadership and management reach the managed level, and most of the other factors fluctuate around the characterized level. This indicates that the level of competence of Yemeni customer organizations is at the characterized level of CE preparation, and it is far from the implementation conditions of CE. Relevant enterprises should strengthen the emphasis on technology elements and other elements with lower evaluation levels and make better preparations for the adoption of CE.

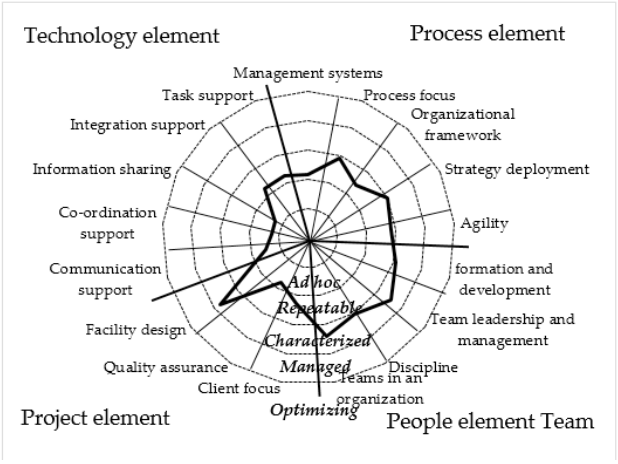

Figure 6. Evaluation of the readiness maturity of customer organization to implement CE.

4.6 Consulting Organization

After the evaluation scores of the implementation preparations matched with the maturity, the level of readiness of consulting organizations in the Yemeni construction industry to implement CE obtained, and the results were summarized as shown in Figure 7. Most of the respondents also commented that the people element is the most important in the construction field, and the technology element is the least important in this field.

The evaluation results of consulting organizations (including architects, structural designers, cost consulting, project management consulting, construction services consulting, etc.) show that most of the factors are at the repeatable level except that the communication support in the technology element is at the Ad hoc level. Also, strategic deployment and discipline factors have reached an optimizing level. Overall, Yemen's consulting organizations are not yet ready to adopt CE and need to make large-scale improvements to most of the competency factors.

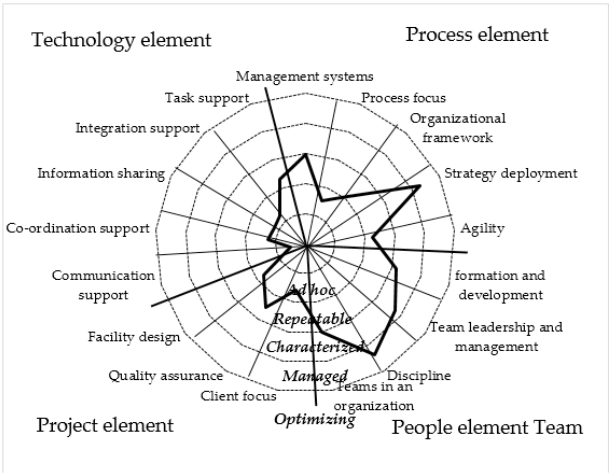

Figure 7. Evaluation of the readiness maturity of consulting organization to implement CE.

5. Discussion and Conclusions

After analyzing the results of the readiness assessment case study of the participating companies within each category, it could be seen that the people element is considered the most important element and the technology element the least important element from most of the company's point of view in all categories. Most Yemeni construction companies are not ready to implement CE and most of the critical factors in each element are within the "characterized level" of CE readiness and need improvement. The critical areas covered under the technology element need more attention and consideration by all sectors. All construction companies in Yemen are in need of major improvements in all areas under this element. The weakest determinant of all sectors is coordination support and Information Sharing.

The results interpret that the most construction enterprises in Yemen are not ready to implement CE mainly because of their dependence on traditional management methods. More improvements required in fields such as corporate culture, employee organization, and technological base. The research results can provide references for construction enterprises to implement CE and promote efficiency in the construction industry. The overall results show that the construction industry, as a whole still needs improvements in most of the critical areas in order to adopt CE effectively. Sectors, which seem to be ready for

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CE adoption, are those, which are client-focused, have a greater focus on monitoring and controlling of their project development process, and are continually improving their development processes and operations. In general, the outcomes show that the construction enterprise still wishes to supply: improvement in most of the critical areas, higher group-working and business integration. Segments that appear prepared for CE adoption are the ones which: are client-targeted, monitor and control the project development process and continual target improvement of their processes and operations. It is indicated that the better performers are likely to be major contractors and specialist sub-contractors, whereas clients, consultants, suppliers and manufacturers needed to improve their position.

This paper takes some different type of construction enterprises (as a contractor; subcontractor; supplier; client; and consultants) in Yemen as an example to discuss the implementation of CE in the construction industry, and evaluates the preparation capabilities of different links and different types of construction enterprises through the BEACON model. Based on the results of the implementation preparation assessment of different construction companies in Yemen, the level of preparation of Technology factors is generally low; most construction companies are not prepared to implement concurrent projects (CE), although some of the capacity factors have reached the level of management and optimization, but some factors also only reach the characterization level, and even some factors are below the repeatability level. The main problem lies in the fact that the management of Yemeni construction enterprises still relies on traditional management methods, and the management level lags behind. They do not understand the importance of advanced management tools and information technology in modern management. Yemeni construction companies need to pay attention to advanced management tools, introduce and apply new information technologies such as BIM technology, and strengthen information communication, sharing and collaboration.

The research results are conducive to the management improvement of Yemeni construction enterprises, and also help International construction enterprises to understand the corresponding capabilities of Yemeni construction enterprises. International construction companies entering the Yemen market usually have greater strength. They can give guidance and advice to Yemen construction companies in terms of personnel organization and management, and help local powerful cooperative enterprises to carry out training on building information management personnel, improves corporate management capabilities and help.

Author Contributions

Conceptualization, S.D. and Z.L.; Formal analysis, S.D. and M.A.; Funding acquisition, Z.L.; Investigation, S.D. Z.L, and M.A.; Methodology, S.D.; Software, S.D.; Validation, S.D. and M.A.; Writing – original draft, S.D.; Writing – review & editing, M.A.

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ARTICLE

Factors Affecting Road Rating

Fei Wang* **Bokuan Zhang** **Ruishu Gong**

College of Electrical Engineering, North China University of Technology, Tangshan, Hebei, 063210, China

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ABSTRACT

The decision of traffic congestion degree is an important research topic today. In severe traffic jams, the speed of the car is slow, and the speed estimate is very inaccurate.

This paper first uses the data collected by Google Maps to reclassify road levels by using analytic hierarchy process. The vehicle speed, road length, normal travel time, traffic volume, and road level are selected as the input features of the limit learning machine, and the delay coefficient is selected. As the limit learning machine as the output value, 10-fold cross-validation is used. Compared with the traditional neural network, it is found that the training speed of the limit learning machine is 10 times that of the traditional neural network, and the mean square error is 0.8 times that of the traditional neural network. The stability of the model Significantly higher than traditional neural networks.

Finally, the delay coefficient predicted by the extreme learning machine and the normal travel time are combined with the knowledge of queuing theory to finally predict the delay time.

1. Background

In recent years, with the rapid economic growth and the acceleration of urbanization, urban population and vehicles have continued to increase, urban traffic issues have received widespread attention, traffic congestion has become increasingly serious, and urban traffic space has become increasingly saturated. Existing navigation software often obtains real-time GPS data through software installed in the vehicle to determine the current road congestion situation. However, under severe traffic jams, the speed of the car is slow, and the speed estimation is very inaccurate. As a result, the final predicted time is often much shorter than the actual time, or even one tenth of the actual time. Therefore, every driver hopes to be able to more accurately predict the time of vehicles passing through a congested road section, so as to avoid them entering the congested road section and reduce the waste of time.

Analysis of the model: Because the length and scale of the road sections and the location of the service target machine sections themselves are different, it is not easy to analyze traffic congestion.

2. Analysis of Road Congestion

The road congestion is related to the traffic condition of the road section, and the traffic condition of the road section is also related to the weather conditions of the day, the position and traffic status of the road section, the traffic volume during the road section time, and the road section. The overall length is related to many factors.

**Corresponding Author:*
Fei Wang,
College of Electrical Engineering, North China University of Technology, Tangshan, Hebei, 063210, China;
Email: 1643360071@qq.com

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Even the traffic conditions on different roads in the same section of the road are very different.

In order to simplify the model, distinguish between different sections, and explain the above definitions separately, these indicators have added relative reference data, taking into account relevant factors such as traffic flow, section length, geography, climate, and environment, making the evaluation indicators comparable. At the same time, the comparison between road indicators makes it practical.

Divide the road section. According to experience, the length of the road section should generally be (0.16km_16km), and different values can be taken according to different road conditions and speed conditions. Due to the good road conditions and high vehicle speed, the length of the road section can be appropriately extended; The traffic speeds of downtown and commercial areas are relatively low, and there is a large flow of people, and the road conditions are more complicated, so shorter lengths are preferable. And the road section can be set according to the location of the road. In this question, directly select the road section divided by Google Maps. Characteristic parameters of traffic flow:

According to experience, the traffic flow parameters are applied to quantify the traffic flow changes, indicating that the characteristics reflect the state of traffic congestion. In practical applications, traffic flow, speed, and traffic density are the three most widely used traffic parameters.

2.1 Traffic Flow

The number of vehicles passing a place on a road per unit time is called traffic flow.

$$Q = \frac{N}{T}$$

Among them: Q is the traffic flow;T is the length of the observation period; N is the number of vehicles passing through the observation point during the period.

Traffic flow will change with time and space. It is a dynamic parameter. Traffic flow can be used as a characteristic to measure urban traffic congestion, and its changing law can reflect road congestion to a certain extent. However, because different road congestion states may occur under the same traffic flow conditions, there is often a large error in judging road congestion traffic conditions only by applying traffic flow. In practical applications, we should even characterize with other traffic flows Parameters in combination.

2.2 Speed

The distance a vehicle travels per unit time is called speed. Microscopically, the instantaneous speed of each vehicle is the speed at a certain moment. However, because traffic flow is a complex system composed of multiple vehicles, there are different concepts of speed. Common definitions include time average speed and space average speed through the length of a road segment over a period of time. The formula is as follows:

$$\overline{v}_i = \frac{1}{N}\sum_{i=1}^{N} v_i$$

$$\overline{v}_s = \frac{D}{\frac{1}{N}\sum_{i=1}^{N} t_i} = \frac{1}{\frac{1}{N}\sum_{i=1}^{N} \frac{1}{\overline{v}_i}}$$

The number of vehicles N is used to indicate the speed of the i-th vehicle passing through the observation point. In the following formula: is the time it takes for the first vehicle to pass the length of the road section, and the average speed of the first car to pass the road section.

$$\overline{v}_i = \frac{D}{t_i}$$

2.3 Traffic Density

The definition of traffic density is the number of vehicles appearing on a road unit length at a certain moment. The calculation formula is as follows:

$$\rho = \frac{N}{D}$$

ρ represents the traffic density; N the number of vehicles; D the length of the observation section.

Under normal circumstances, the traffic density is directly proportional to the traffic flow, that is, the greater the traffic flow, the greater the traffic density. However, when there is severe traffic congestion on the road, the vehicle will be in a stagnant state. At this time, the road traffic flow is very close to zero, but the traffic density is close to the maximum.

In practical applications, the above data is difficult to obtain, and the lane time occupancy can be directly obtained through detection, so in general, time occupancy is often used instead of traffic density. Occupancy is defined as the ratio between the sum of the time it takes a vehicle to pass an observation point and the observation time within a certain period, as shown in the formula:

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$$oc = \frac{1}{T}\sum_{i=1}^{N} t_i$$

Among them: T is the observation time; t_i is the time when the first car passes.

When the traffic flow is small, the vehicle speed will be relatively high, and the road time occupancy will be low; when the traffic flow increases, the vehicle speed will decrease, and the road availability rate will increase significantly; when the traffic congestion occurs on the road, the traffic The flow will be reduced to a certain extent, and the number of vehicles passing through the observation point will be reduced. However, due to road congestion, the speed will decrease significantly. At this time, we worry that the road time will be at a higher value. Therefore, road time occupancy can better reflect road traffic conditions.

2.4 Road Grade

Classification of road grades using AHP:

Roads can be divided into multiple levels, with different levels of traffic capacity and ease of congestion. According to national standards, divided by the width of the main road and road restrictions, the speedway levels are mainly divided into four levels, respectively as shown in the following table:

The division of the road is too one-sided. In order to consider that the location of the road and the actual transportation capacity do not meet the requirements of this question, we re-select the indicators in this question and classify the roads:

Item level	Design Speed (km / h)	Number of one-way lanes	Road width (m)	Total road width (m)	Divider settings
First level	60~80	No less than 4	3.75	40~70	(Required)
Secondary	40~60	No less than 4	3.5	30~60	(Should be set)
Third grade	30~40	No less than 2	3.5	20~40	(Can be set)
Fourth grade	Below 30 km	No less than 2	3.5	16~30	(Not set)

After consulting the literature, the following four indicators were selected:

The location of the road C1 (in the core business area, transportation hub area, and general area). The road functions are different according to the location of the road. To simplify the model, the road location is selected.

Traffic density C2 (relatively large, medium and small)

Road width C3 (number of one-way lanes)

The number of densely-concentrated areas in the road section C4 (such as large and medium-sized hospitals, schools with a lot of people, shopping malls, and entertainment venues)

Quantify the small indicators corresponding to each indicator to get the scores of each road segment, sort them separately, and define them hierarchically. We define the road segments as six indicators.

The situation of different roads at the same moment is collected here, as shown in the following table:

Table 1. situation of different roads at the same moment

Road name	position	Number of concentration areas	Section width
P1	Core business district	4	4
P2	Transportation hub area	6	4
P3	Ordinary area	3	2
P4	Ordinary area	9	3

Pick the first four roads and analyze them hierarchically

Compare the four elements of the base layer pair by pair to establish a judgment matrix (also called a pairwise comparison matrix), as shown below:

$$\begin{pmatrix} 0 & C1 & C2 & C3 & C4 \\ C1 & 1 & 1 & 1/2 & 1/2 \\ C2 & 1 & 1 & 1/3 & 1/2 \\ C3 & 2 & 3 & 1 & 3 \\ C4 & 2 & 2 & 1/3 & 1 \end{pmatrix}$$

Similarly, we can construct a judgment matrix as follows:

Road position C1-P1

$$\begin{pmatrix} C1 & P1 & P2 & P3 & P4 \\ P1 & 1 & 2 & 6 & 6 \\ P2 & 1/2 & 1 & 3 & 3 \\ P3 & 1/6 & 1/3 & 1 & 1 \\ P4 & 1/6 & 1/3 & 1 & 1 \end{pmatrix}$$

$$\begin{pmatrix} C2 & P1 & P2 & P3 & P4 \\ P1 & 1 & 2 & 7 & 7 \\ P2 & 1/2 & 1 & 5 & 5 \\ P3 & 1/7 & 1/5 & 1 & 1 \\ P4 & 1/7 & 1/5 & 1 & 1 \end{pmatrix}$$

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$$\begin{pmatrix} C3 & P1 & P2 & P3 & P4 \\ P1 & 1 & 1/2 & 2 & 1/5 \\ P2 & 2 & 1 & 3 & 1/2 \\ P3 & 1/2 & 1/3 & 1 & 1/4 \\ P4 & 5 & 2 & 4 & 1 \end{pmatrix}$$

$$\begin{pmatrix} C4 & P1 & P2 & P3 & P4 \\ P1 & 1 & 1 & 3 & 2 \\ P2 & 1 & 1 & 3 & 2 \\ P3 & 1/3 & 1/3 & 1 & 1/2 \\ P4 & 1/2 & 1/2 & 2 & 1 \end{pmatrix}$$

Similarly, we can construct the following judgment matrix: road position C1-P1, where CI is the consistency index, and its calculation formula is as follows:

$$CI = \frac{\lambda_{\max} - n}{n-1},$$

RI is the average fixed consistency index, which is a fixed parameter, which can be obtained by checking the table.*CI*<1.0, The consistency of the judgment matrix is considered acceptable.

The consistency indicators of the above four judgment matrices are shown in the following table.

Table 2. consistency indicators

Target layer	Pairwise comparison	C1	C2	C3	C4
Consistency ratio *CR*	0.0039	1.66	0.006	0.027	0.0039

The consistency ratios all meet the requirements, and the weights are calculated by the arithmetic average method as shown in the following table.

Table 3

	Index Weight	1	2	3	4
position	0.15	0.54	0.27	0.09	0.09
density	0.13	0.53	0.32	0.07	0.07
Number of zones	0.46	0.13	0.26	0.09	0.57
width	0.23	0.35	0.35	0.10	0.18

Therefore, the influencing factors of the evaluation levels of the four roads are:

In this way, the collected data is scored, and it is hierarchically selected and defined to obtain five levels.

3. Analysis of the Relationship Between Traffic Flow Parameters and Traffic Congestion

Road traffic conditions are complex, mixed, and random, while neural networks have the characteristics of learning complex non-linear systems.

Therefore, neural networks are highly matched to road traffic conditions and are applicable to the field of traffic prediction. Although at present, many neural network-based computer sciences have been used for traffic prediction and have achieved fruitful results. The neural network models currently applied in the field of traffic prediction are: multilayer feedback neural network [9], radial basis RBF neural network [10], BP neural network [11], recurrent neural network [12-13], time delay neural Network model [14] and so on. However, when using traditional neural networks to solve complex non-linear problems such as traffic prediction, there are disadvantages such as large amount of input data, slow training speed, complex model, easy to fall into local optimum, and difficult to converge. There are shortcomings, so that neural networks have not been applied on a large scale in traffic prediction, and their role in solving traffic congestion and congestion is very limited. In order to solve this problem more accurately, this paper uses Extreme Learning Machine (ELM) to solve this problem more accurately.

Extreme learning machine (ELM) is a single hidden layer feedforward neural network proposed by Huang et al. [5] for the problems of slow training of traditional neural networks and easy to fall into local minima.The connection weights between the hidden layer and the hidden layer and the hidden layer neuron threshold are randomly generated networks. During the training process, only the number of hidden layer neurons can be set to obtain the unique optimal solution and traditional nerves.Compared with the network, it has the advantages of fast learning speed and good generalization performance.Therefore, it is widely used in regression fitting and classification recognition.

Therefore, the over-limit learning machine algorithm is very suitable for use in complex and variable traffic prediction models with large amounts of data.

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REVIEW

Analysis of Moral Hazard in Engineering Agent Construction System

Lihua Wang* **Shuguang Zhou** **Yuetong Hui**

Logistics University of People's Armed Police Force, Tianjin, 300300, China

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ABSTRACT

Analyze the moral hazard issues in the construction agency system, and enumerate the performance of moral hazard. Deeply analyze the causes, start with strengthening supervision and perfecting incentive measures, eliminate the impact of moral hazard, and give play to the advantages of agent construction.

1. Introduction

According to the "Decision on the Reform of the Investment System" issued by the State Council, the agent construction system refers to the system in which the government selects professional project management units through bidding, is responsible for project investment management and construction organization implementation, and is delivered to the unit after the project is completed. The engineering agent construction system is a unique engineering management system in China, born from the CM model in the United States. At present, most of the agent construction projects are non-operating projects invested by the government, such as public buildings such as schools and hospitals. The corresponding government authorities are the Education Bureau and the Health Planning Bureau [1]. The original intention of implementing the engineering agent construction system is to solve the problems of non-professionalization, low efficiency, and low quality brought by the traditional government investment project management model under the four-in-one model of "investment, construction, management, and use", and use the system Means to eliminate corruption. Once the system was introduced, it achieved great results in the trials in various places.

With the continuous development of society and economy, municipal engineering has received widespread attention." Engineering agent construction system" is a new type of management system that can improve the efficiency of investment and achieve efficient management of project engineering[2].The government has transformed from a production unit and a supply unit of an investment project into a partner and a supervision and management organization, which fully reflects the fair relationship in the market economy. It is beneficial for the market to play its fundamental role in economic operation and resource allocation. The implementation of the Engineering agent construction system can regulate the government's management of non-operating projects,

**Corresponding Author:*
Lihua Wang,
Logistics University of People's Armed Police Force, Tianjin, 300300, China;
Email: 3170939995@qq.com

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promote the continuous improvement of the professional level of project management, and improve investment efficiency [3]. However, in the process of implementing the engineering agent construction system, some difficulties have hindered the exertion of the advantages. Among them, the problem of moral hazard is the most obvious.

2. Performance of Moral Hazard Issues

Moral hazard means that the agent harms the interests of the client or other agents while maximizing their own interests. It is manifested that in the agent construction project, due to the inconsistency of the interests and the asymmetry of information, the agent has used its information advantage to damage the government's interests for the purpose of maximizing its own interests. As a result, there is a moral hazard that adversely affects the results of project construction.

2.1 The Problem of Rent Seeking by Government Officials

At present, most construction contract is a whole-process management contract. The construction agency has been involved in project construction since the feasibility report was prepared. Therefore, the construction agency has great information advantages. As the project budget has some flexibility in preparation and approval, there is room for adjustment. Compared with the government department, the agent construction company has more understanding of the specific situation of the project. Then, the construction agency may conspire with the budget approving department, causing the problem of official power rent-seeking and causing property damage to the country.

2.2 Conspiracy Issues between Agent Construction Companies and Engineering Participating Units

Acting as the agent within the scope of project management stipulated in the construction contract, the agent plays a leading role in project management. Except for major project decisions, general management and project decisions are made by the agent. The government only sends a small number of personnel to collect construction information at the project site, and track and supervise the implementation of the project [4]. Against this background, some agencies have the idea of power rent-seeking. They conspired privately with the construction unit, the material supply unit, and the supervision unit to jointly conduct misconduct. The agency unit allows the participating units to cut corners, change the construction period, and change the procedures to obtain undeserved benefits. They partnered to deceive the government, making the government mistakenly believe that the project is in good condition. In the early years, some agency construction units and contractor units conspired to artificially increase the cost of the project, forcing the government to invest more, thereby increasing the revenue of the agency construction unit. Recently, the government eliminated the problem by issuing documents requesting that the losses caused by additional investment be borne by the construction agency. However, in a recent survey, it was found that some agency construction companies have found other ways to obtain benefits. For example, on the premise of ensuring that the final account of the project does not exceed the estimated budget of the project, the construction unit accepts bribes and allows the participating units to use inferior materials and equipment. Such acts are countless and have seriously harmed national interests. Relying on their own professional advantages, the agent construction unit can ensure that the project does not have problems in the short term and pass the acceptance. However, this kind of project has many defects and low durability. It will gradually expose various problems during long-term use, which will reduce the credibility of the government.

2.3 The Laziness Problem of Agent Construction Companies

After the project starts, the agency construction company is responsible for the organization and coordination of the entire project. It plays the role of a central brain. The final result of a project is excellent or passing, which has a lot to do with the effort level of the agency construction company. Since the government only sees the results of the acts of the agent construction company, it pays little attention to its behavior itself, so that the agent construction company has a lot of room for maneuver. At present, some agency construction companies are reluctant to perform their duties, and their efforts are not worth the remuneration paid by the government. The project management is extensive and inefficient. Although the project can still be delivered on time, there are many hidden dangers in the project, which affects the safety of the building. For example, the curing of cement has strict time requirements at all stages. If the agent construction company does not strictly supervise the construction unit, some units will end the maintenance in advance in order to shorten the construction period, thereby laying hidden safety hazards, shortening the life of the building, and causing waste of government investment.

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3. Analysis of the Causes of Moral Hazard

3.1 Regulatory System is Difficult to Implement

In order to ensure that the agent construction companies perform their duties, the government has established strict supervision measures, but many problems have occurred in the implementation of the supervision system. Some government personnel lack a sense of responsibility, fail to implement the inspection system, and even collude with the agent construction companies. As a result, the role of government supervision cannot be exerted. Some government personnel are not professional and are easily cheated when facing professional agency construction companies. Although the government can rely on the supervision unit for supervision, the supervision industry has low profits and bad morals, and conspiracy between the agent construction unit and the supervision unit often occurs. The government cannot fully trust the supervision unit. In the absence of supervision, it is difficult for the government to detect the unethical behavior of the agent.

3.2 The Risks and Costs of Unethical Behavior are Low

In the context of market competition, many unethical behaviors can be explained from the perspective of interests. China's construction market has been in a state of "High investment, low yield" for a long time. If the construction unit completes a project strictly according to standards, it will require a lot of capital and time, but the benefit conversion rate is very low. Agent construction units are mostly risk-averse, and their income from unethical behavior is equal to the expected return minus the cost of risk. Due to the lack of supervision and light punishment, the risk of unethical behavior is low, but the expected benefits are high, which has attracted the attention of some people. Interests drive them to abandon the bottom line and take immoral behavior to obtain undeserved benefits.

3.3 Incentives are not Enough

In order to motivate the agent construction companies to perform their duties seriously, the government has set up incentive measures. But from the application results, the effect is not significant. Because under current market conditions, the benefits of unethical behavior far outweigh the benefits of incentives. In addition, some local governments have set caps on rewards privately, which has dampened the enthusiasm of the agent construction companies. Therefore, some agent construction companies have voluntarily given up rewards, reduced investment, perfunctory matters, and even engaged in speculative behaviors to obtain undeserved benefits.

4. Measures to Address Moral Hazard

To eliminate the effects of moral hazard, we need to start with both internal and external aspects. It is necessary not only to reduce the constraints of external objective conditions, but also to enhance internal management capabilities. A two-pronged approach can minimize risk.

4.1 Strengthen Supervision

From the perspective of external factors, the prerequisite for the generation of moral hazard is that the agent construction unit cannot be effectively monitored, and its immoral behavior is difficult to be found. Therefore, the government must reasonably arrange various tasks, ensure a certain amount of regular inspections and surprise inspections, and cannot fully trust the report of the agent construction unit, and conduct field inspections. At the same time, it is necessary to increase inspections of participating units to avoid collusion. The government should strengthen market investigations and increase the approval of project estimates to prevent material suppliers and agent construction companies from conspiring to misrepresent prices. Supervise all aspects and urge all participating units to perform their duties.

4.2 Increase Punishment

Benefits are one of the main reasons for unethical behavior. To curb defeats, it is necessary to reduce expected returns or increase risk costs. At present, it is difficult to reduce the expected benefits, so we mainly start with increasing the cost of risks. Within the scope allowed by the rules and regulations, the competent government department raises the rent-seeking threshold of the agent, and sets up a punishment mechanism, thereby increasing the rent-seeking cost of the agent[5].Strengthen the government's own Integrity building and increase the bribery cost of the agent construction unit. As the cost of risk increases, the benefits of agency construction companies decrease, and the tendency to adopt unethical behavior decreases.

4.3 Improve the Professional Ethics of Agent Construction Personnel

The above measures are to solve the problem from the outside. To solve the problem from the inside, we must solve the problem of people. As China's agent construction model is still in its infancy, most of the talents in

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China's agent construction units are transformed from traditional construction management. The quality of personnel is not high, the organizational structure of personnel is unreasonable, the evaluation methods are not perfect, and there are many problems in management, operation and innovation[6].Therefore, the government should promulgate relevant policies to strengthen the professional ethics of agents and cultivate employees' correct sense of justice and self-discipline. Municipal engineering involve huge amounts of money. To resist immoral behavior, it is necessary to strengthen the construction of psychological defense. The government and enterprises must work together to establish a reasonable evaluation mechanism. Credit lost employees are not allowed to participate in the construction of the project.

4.4 Increase Motivation

Incentive measures are divided into explicit incentives and implicit incentives. Explicit incentives are the sum of the substantial compensation that the parties expect to obtain within a certain period of time [7]. Implicit incentives are compensation for explicit incentives, most of which are the reputational effects of spiritual rewards. In today's society, just propagating the "communist style" is difficult to produce sufficient incentive effects, and excessive demands for "material rewards" are not feasible. The two need to be combined. In other words, we need to consider both explicit and implicit incentives. When conducting explicit rewards, the government should pay attention to the amount of rewards. Too little will not be enough to motivate the agent construction enterprises, and too much will lead to excessive government investment. The implicit rewards provided by the government must also be well-founded. False praise cannot be given, otherwise the agent construction unit cannot afford the evaluation given by the government, which will damage the public's trust in the government and affect the government's credibility. In terms of specific measures, on the one hand, according to the local price level and the actual operation of the project, the agency construction fee rate is dynamically adjusted to adapt to market changes, and to avoid rigidity and loss of labor enthusiasm caused by invariability. On the other hand, the investment balance is graded and rewarded. The more the balance, the higher the reward ratio, which increases the enthusiasm of the agent.

4.5 Cultivate the Government's Own Agency Talent

To solve the problem of moral hazard, a powerful measure is to strengthen the government's own talent team building. As long as government officials have excellent professional standards, high professional ethics, can perform their duties seriously, and timely detect and identify unethical behavior of participating enterprises, the incidence of moral hazard can be further reduced. The government should encourage departmental personnel to strengthen professional learning, increase the enthusiasm of departmental personnel for learning by means of monetary rewards. Enhance the professional conduct and professionalism of departmental personnel. Ensure that the personnel of the department are of high professional quality and strong sense of responsibility, and can effectively find problems, solve problems, and protect national interests.

5. Conclusion

We should make clear that in view of China's current construction industry situation, the moral hazard problem in agent construction projects is an objective and unavoidable hidden danger, and there is no effective solution in the short term. Although the agency construction system has various problems and difficulties, advantages outweigh disadvantages. In general, the engineering agent construction system is still a policy management reform in line with China's national conditions. It is a basic strategy to standardize and organize the order of the economic market. It is a major measure to ensure the quality of construction projects and improve the efficiency of project investment[8].Therefore, the government and enterprises must work together to build a defense system through various means such as education and restraint. We will work together in various fields, taking into account the current and future, and gradually eliminate the impact of moral hazard, and promote the development of the national economy.

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