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Structuring the Prediction Model of Export Performance of Selected Indian Industries: A Comparative Analysis

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Abstract

The study seeks empirical identification of factors underlying the successful export decision process of firms. Data from a cross-sectional field study were collected using a structured mail survey to 700 randomly selected small and medium-sized manufacturing firms in India. Particularly, the international market is affected by more complex and dynamic factors than domestic marketing; frequently being exposed to serious external uncertainties such as foreign market environment (i.e. trade barrier, political, economical, social, and cultural risks), as well as internal risks from within the organization itself. This study develops a structural equation model (SEM) to predict the export success of market entry mechanism. Through a comparative analysis of SEM with a multiple regression analysis and artificial neural network (ANN), SEM shows a more accurate prediction of performance because of its intrinsic ability to consider various risk variables in a systematic and realistic way. In addition, the use of SEM allows for visually depicting the paths of how those complicated variables are interrelated so as to promote the clear understanding of the complex system and its underpinned causes that critically affect the export performance success.

Introduction

The ability to compete in world markets by adopting successful export marketing strategies is critical to a firm's export performance. Yet, there is no uniform definition of export performance, and it is one of the least understood areas of international marketing despite a widespread literature [1]. Our aspiration is to develop and estimate an integrated empirical model of export performance. Measurement models are specified for each construct and a path model is then developed to explore interdependencies between them. Exploratory factor analysis is used to examine the dimensionality of constructs and these are confirmed by confirmatory factor analysis. Finally, a structural equation model (SEM) is specified to examine interdependencies between constructs and their measures. The SEM complements multiple regression analysis by considering various project factors in a systematic and realistic manner. This paper further provides theory explanations and research conclusions through a comparative analysis of SEM with multiple regression analysis and artificial neural network (ANN). Finally, the authors draw advantages of SEM over the other two models in this specific research domain characterized by unstable, uncertain, and dynamic export market conditions of selected Indian industries.

Literature Review

Many types of analysis methods have attempted to model complicated prediction processes in international market entry and management. These models were developed to fit each subject of interest and the research characteristics—including objectives, intention to use the model, and the scope of data required.

Typically, statistical methods can show a causality of the prediction results to ensure the result in the form of statistically reliable figures. Among those statistical methods, multiple regression analysis is one of the most widely used for modeling because it requires a relatively simple process Chan [2]. However, the modeling method using a multiple regression analysis has a significant flaw because it ignores all the potential measurement errors of the observed variable. On the other hand, SEM is superior to multiple regression methods because it recognizes the measurement error, and further offers an alternate method for measuring prime variables of interest through the inclusions of latent variables and surrogate variables. The former refers to a hypothetical concept which cannot be directly observed nor measured; the latter is a substitute variable that can be measured directly in lieu of the latent variables. Since the development of SEM, the use of this model has expanded rapidly with the aid of the development of computer science. According to Reddy [3] SEM is considered preferential as it aids in the following:

1. To identify a causal relationship between an independent variable and dependent variables by taking the measurement error of the observed variables into consideration.
2. To model a concept that is difficult to directly measure or explicitly quantify and
3. To represent indirect affects as well as the direct causal or correlation relationships between the diverse and hierarchical variables. In addition, it is possible to visualize the complex relations through a graphical representation that shows the directional paths among variables.

Further review and analysis of the relevant empirical studies and the theoretical literature on exporting revealed the correlation between four sets of firm-related constructs and export marketing activity of individual firms [4]. These constructs focus on

1. Differential firm advantages
2. Decision-maker international orientation

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3. Commitment of resources for undertaking export activities and
4. Perceived attractiveness of export marketing.

The external environment is that part of the marketing system external to the firm. Hence, the environmental context is neither directly controlling nor directly controlled by the firm. The external environment generally affects organizations by making resources available or by withholding them. Studies related to export marketing behavior stress that some characteristics external to the firm play a part equally important to internal ones in a firm's initial export decision. Firms that want to participate in exporting need to be sensitive to the following two broad types of environments: domestic market environment and foreign market environment. The environmental conditions of the domestic market and foreign market(s) can be either incentives for or obstacles in a firm's initial decision to export [5,6].

As stated, SEM allows users to perform the substantial modeling of the variables' relationships through a path diagram; hence, it is expected that SEM is suitable for export market entry that are confounded by complex and interrelated relations of a myriad of variables. Based on the result of our earlier work, this study aims to model the relationship among various factors and the likelihood of export success through SEM application Naik [3]. This is done in order to evaluate the probable state of a given export entry determinant and to produce strategies to enhance the current conditions surrounding an export market. This model will ultimately allow the user to select promising overseas export market entry by examining the key indicators of export performance in advance.

Conceptual features of SEM

SEM is a systematic combination of confirmatory factor analysis, multiple regression analysis, and path analysis. It consists of a measurement model and a structural model. The former incorporates confirmatory factor analysis that is concerned with how well latent variables—group factors drawn from factor analysis—are represented by observed variables. The latter reflects multiple regression analysis and path analysis that models the relationship between latent variables and a final outcome of the variables of SEM are also classified into an exogenous and endogenous variable depending on whether they influence or are influenced by others. Exogenous refers to an independent variable which influences other variables while endogenous refers to a variable influenced directly or indirectly by other variables. A typical SEM is represented in the forms of an exogenous latent variable, endogenous latent variable, exogenous observed variable, and endogenous observed variable by compounding one with the others. More importantly, SEM has an error variable that capitalizes on both measurement errors and structural errors by accurately reflecting the actual phenomena.

For instance, suppose that the research hypothesis is to test how the "home background" of students has an effect on good "academic performance" in school. Figure 1 shows, since latent variables marked in an oval are difficult to directly measure, "income levels" and "education levels" of parents are instead engaged to observe "home background" that are marked in a quadrangle. The "academic performance" is also represented by other observed variables such as "language grades" and "mathematics grades." In this simple model, there are two types of errors shown as circles. The errors related to the observed variables that are encountered during the measurement process are meant to be measurement error variables. Another term related to "academic performance" is referred to as structural error variable. In a standard regression model, these errors associated with indirect measurements are not well addressed, thereby propagating the model's error [6]. This highlights the importance of SEM because it overcomes the limitation aforementioned by incorporating measurement and structural errors in the modeling process (Figure 1).

Review of relevant factors and data collection

The model used in this study was an adaptation of the model presented by Pak [5] because it includes all the relationships addressed in the literature reviewed Nguyen [6]. Also, the literature reviewed in the previous chapter suggests that the decision-makers positive attitude toward exporting is a primary determinant of a firm engaging in export market activity. Nguyen [6] found that the decision-makers perception, attitude, or expectation is considered a key variable in Pak's [5] model, which is referred by Reid [7] model. Reid also suggested that although structural and contextual characteristics influence the potential for entering foreign markets, the decision-makers experience and motivation, are important determinants in export decision-making. That is, the ongoing export decision is dependent upon management's perception of foreign markets, expectations concerning these markets, and perception of the firm's capability of entering these markets. According to Pak [5], export decision model of existing exporting firms integrated and extended the work of Wiedersheim-Paul [8] and Cavusgil and Nevin [9]. Pak [5] also found that export decision-making is conceived as a sequential process affected by internal and external determinants. The literature on export marketing behavior suggests several factors as likely determinants of the firm's ongoing export decision. He also found that each factor could be categorized under a sequential process of export decision-making. As emphasized by behavioral approaches, the major determining point, which has had an impact on the export decision-making, is the decision-makers perception about the attractiveness of exporting. Nguyen [6] found that the attractiveness of exporting is influenced by several background variables, such as decision-maker characteristics, (i.e., top management's international orientation), organizational characteristics, (i.e., differential firm advantages), domestic market environment, and foreign market environment. This affected attractiveness of export marketing influences organizational commitment to exporting in which modification of marketing strategy is considered. The organizational commitment to export marketing finally, influences the ongoing export decision Pak [5]. Nguyen [6] also found depicts the general relationship between top management, organization, environment, attractiveness of exporting organizational commitment to exporting and export dimensions, and specifies the principal components of each dimension. This model attempts to integrate internal and external factors in the export decision process of existing exporting firms. Special attention was given to external factors including external environments in domestic and foreign markets, which has been overlooked in previous studies. A total of 14 variables were specified for the seven dimensions. The constructs are assumed to be measured by indicant variables. This study is a cross sectional field study using data from a sample of India manufacturing firms. "The reasoning for the selection of cross sectional method is because

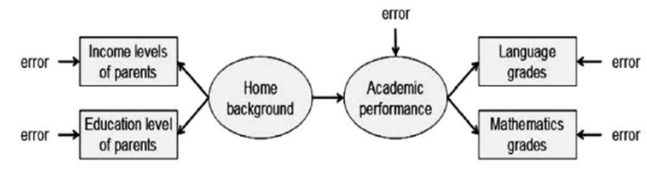


Figure 1: Example of SEM–home background and academic performance.

it involved a sample of manufacturing firms" Nguyen [6]. Nguyen [6] found a similar approach that was followed in a number of studies conducted, deals with the export behavior of firms [5,7,10-13]. The data were collected by directing questions and soliciting responses from the key person within the organization Nguyen [6]. Pak [5] found that it was methodologically sound to use a single key informant when most of the informants occupy senior executive or ownership positions within the focal organizations. In order to ensure that the industries dealt with have export potential and contain a large number of exporting firms, five India industries that represent a large share of exports were chosen. First, based on a report on India exports, mining, chemicals, industrial and electrical machinery, textiles, transport equipment, iron and sheet metal products, and foodstuffs were identified as the top exporting industries in India (World Factbook, on India, 2009). From the listing of 13,000 local India companies 700 manufacturing firms were randomly selected for this study. The selection of each manufacturing firm was not only based upon the number of employees but also of those companies that were considered part of the top exporting industries.

Export performance model

The model used in this study was an adaptation of the model presented by Pak [5] because it includes all the relationships addressed in the literature reviewed Nguyen [6]. Also, the literature reviewed in the previous chapter suggests that the decision-makers positive attitude toward exporting is a primary determinant of a firm engaging in export market activity. Nguyen [6] found that the decision-makers perception, attitude, or expectation is considered a key variable in Pak [5] model, which is referred by Reid's [7] model. Reid also suggested that although structural and contextual characteristics influence the potential for entering foreign markets, the decision-makers experience and motivation, are important determinants in export decision-making. That is, the ongoing export decision is dependent upon management's perception of foreign markets, expectations concerning these markets, and perception of the firm's capability of entering these markets. Pak [5] export decision model of existing exporting firms integrated and extended the work of Wiedersheim-Paul [8] and Cavusgil and Nevin [9]. Pak [5] found that export decision-making is conceived as a sequential process affected by internal and external determinants. The literature on export marketing behavior suggests several factors as likely determinants of the firm's ongoing export decision. He also found that each factor could be categorized under a sequential process of export decision-making. As emphasized by behavioral approaches, the major determining point, which has had an impact on the export decision-making, is the decision-makers perception about the attractiveness of exporting. Nguyen [6] found that the attractiveness of exporting is influenced by several background variables, such as decision-maker characteristics, (i.e., top management's international orientation), organizational characteristics, (i.e., differential firm advantages), domestic market environment, and foreign market environment. This affected attractiveness of export marketing influences organizational commitment to exporting in which modification of marketing strategy is considered. The organizational commitment to export marketing finally, influences the ongoing export decision Pak [5]. This export decision process is documented by Nguyen [6]. Nguyen [6] also depicts the general relationship between top management, organization, environment, attractiveness of exporting organizational commitment to exporting and export dimensions, and specifies the principal components of each dimension. This model attempts to integrate internal and external factors in the export decision process of existing exporting firms. Special attention was given to external factors including external environments in domestic and foreign markets, which has been overlooked in previous studies (Figure 2).

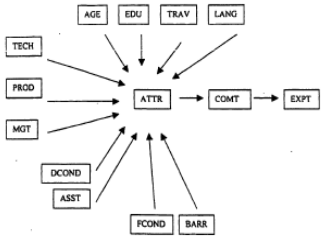
The operational measures used to reflect each of the constructs in Pak's research model were divided into seven dimensions with multiple items representing some of the dimensions. "A total of 14 variables were specified for the seven dimensions. The constructs are assumed to be measured by indicant variables. The observable indicators for each construct should be operationalized into multi-item scales as recommended by [3,6]. Further, the seven dimensions of Pak's research model were based upon the following hypothesized dimensions:

Nguyen [6] found that the construct Export decision (EXPT) was measured using the four-item scale developed by Reid [7] and was modified to suit the purpose of this study. "The items were developed to tap the firm's desire to enter new foreign markets, to continue export activities, to introduce new products, and to increase export sales Nguyen [6].

Analysis of SEM results

The authors developed a comprehensive SEM model (Figure 2) throughout numerous iterations to achieve the most suitable model with the support of knowledge gained from literature review, feed-back from our previous work, and the input of several international construction experts. To quantify the relationship levels between project performance and performance-influencing variables, this study uses the LISREL (Linear Structural Relation), which is widely used as the representative program of SEM.

As seen in figure 2 two endogenous variables of attractiveness of exporting (TI 1) and export decision (713) are measured by a single indicator (Y1 and Y4), respectively. However, the endogenous variable of organizational commitment to export marketing (12) is measured by two indicators (Y2 and Y3). For the exogenous constructs, each of the latent (or unobserved) variables (E1 to E5 and E-7) is measured with one of the single indicators (X1 to X5 and X8). Whereas, E6 was measured with two indicators (X6 and X7). In the proposed structural model of Nguyen's study of Germany and Pak's [5] study of U.S., each of the three endogenous variables (111 to 113) is measured by a single indicator (Y1 to Also, there were eleven latent (or unobserved) variables (E1 to ell) and each variable was measured with a single indicator from (X1 to X11), respectively.



ATTR Attractiveness of exporting
COMT Organizational commitment to export marketing
EXPT Export decision
Decision-Maker Characteristics
AGE Age
EDU Level of education
TRAY Frequency of foreign travel
LANG Foreign language competence
Unique Firm Advantages
TECH Technology intensiveness
PROD Product uniqueness
MGT Management expertise
Domestic Market Environment
DCOND Domestic market conditions
ASST Government export assistance
Foreign Market Environment
FCOND Foreign market conditions
BARR Market barriers

Figure 2: Path diagram for the proposed model of export decision.

As in the prior studies, the estimates of the structural equation model were assessed. The chi-square index is regarded as a goodness of fit (or badness of fit) measure in the sense that small ×2 values correspond to good fit and large ×2 to bad fit. The chi-square index for both the data in this study (×2=334.59, p=0.00 (p<05) and the study in Germany (×2=78.56, p=000 (p<05) is significant, suggesting discrepancies between the data and the model. The results from this study are presented in figure 3.

The goodness of fit (GFI) indices generated by the LISREL program suggest that a substantial amount of variance is accounted for by the model (GFI=0.90) and the AGFI, which is the GFI adjusted for degrees of freedom, is 0.69. Both the GFI and AGFI are between zero and one. Joreskog and Sorbom [13] suggest that a value approaching one is an indication that the data fit the whole model well. The root mean square residual (RMR) is relatively small (0.84). In comparison, Nguyen [6] study of Germany found that the GFI=932, the AGFI=840, and the RMR=059.

The relationship between differential advantage in technology intensiveness and attractiveness of exporting is positive; and the relationship between differential advantage in product uniqueness and attractiveness of exporting is positive. With regard to differential firm advantages, product advantage has a strong significant effect on attractiveness of exporting [PROC (71.3=2.37, t=18.39)]. Therefore, hypotheses H1 and H2 were strongly supported. These results were not all that surprising when it is recognized that if a manager is able to set the company's product apart from that of the competition in the foreign market, export marketing will more than likely be more attractive.

As hypothesized, H3 has not been supported since management expertise has a significant negative effect on the attractiveness of exporting (MGT (71.4=-0.82, t=-3.60)).

The LISREL estimate and the t-value provided no support for this hypothesis. The negative finding is contrary to the finding of Nguyen [6]. This result is perplexing especially because the simple correlation between MGT experience and attractiveness of exporting is positive. The result may be due to other intervening variables or it may be that more experience managers are more conservative and less likely to take risks.

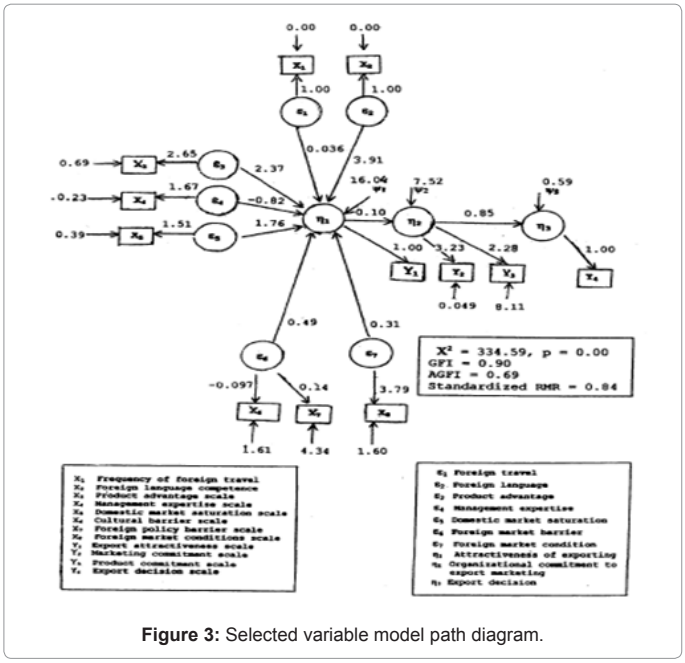


Figure 3: Selected variable model path diagram.

Two of the top management international orientation constructs; age and level of education are not primary determinants of the attractiveness of exporting. As determined from the correlation matrix, age is .006 and level of education is -0.032, which indicates that the two constructs have almost no relationship with the attractiveness of exporting. Foreign travel has an insignificant effect on the attractiveness of exporting. This means that top management's frequency of foreign travel is a less significant determinant of the attractiveness of exporting for India.

However, language competence has a significantly positive effect [LANG (71, 2=3.91, t=18.39)] on the attractiveness of exporting. Thus, hypothesis H4 is partially supported. This suggests that age, educational level, and frequency of travel do not affect the manager's determination to export. But being able to speak a foreign language is a very important determinant for managers to explore foreign markets.

The domestic market environment was analyzed utilizing domestic government obstacles (GVOB), domestic market unfriendly (DBAD), and domestic market saturation (SATU). Domestic market obstacles and domestic market unfriendly did not affect the attractiveness of exporting. But domestic saturation [SATU, y1.5=1, 7.6, t=7.11)], as an indication of domestic market condition, significantly contributes to the attractiveness of exporting, thus H5 is partially supported. It is expected that the cause of poor opportunities and saturated home market might be overcome by increasing current export sales or exporting to new foreign markets. This expectation leads to at least one positive relationship between a factor of adverse domestic market conditions and the attractiveness of exporting.

It is believed that government can stimulate export activity by providing export programs Reid [7]. However, in this study, India government export assistance did not enter the regression, therefore, H6 was not supported.

There is a positive relationship between favorable foreign market conditions and attractiveness of exporting. In this study, favorable foreign market conditions are only significant at a10% level (FCOND (71_7=31, t=1.73)), thus H7 is only marginally supported.

Generally, being faced with market barriers tends to discourage the continuance and expansion of exporting, thus it would have a negative effect on attractiveness of exporting. However, since the respondents were queried about how important are market barriers rather than what market barrier are your company facing, knowing the importance of market barriers in international markets (BARR (71.6 =0.49, t=5.02)) would tend to be a positive or an insignificant effect on attractiveness of exporting and, in fact, that is what was found. In Nguyen [6] study of Germany, knowing the importance of market barriers in international markets also resulted in having an insignificant effect on attractiveness of exporting [BARR (71.11=0.042, t=0.876)]. Obviously, being faced with market barriers and knowing the importance of market barriers in international markets does not have the same effect on the attractiveness of exporting.

Attractiveness of exporting is related positively to organizational commitment to export marketing. Attractiveness of exporting has an insignificant effect on increasing organizational commitment to export marketing activities (ATTR) (132.1=0.10, t=1.55)), thus H9 is not supported. This suggests perceived attractive of exporting is not an indicator of organizational commitment.

Organizational commitment to export marketing has a significant positive impact on the export decision [COMT (132.2=0.85, t=12.61)]. Although organizational commitment (COMT) in this study was divided into marketing commitment and product commitment, both of these latent variables loaded on the variable COMT. This indicates that if a firm has both a strong marketing and product commitment to export marketing, it will also be more likely to make the decision to export or the decision to increase export activities. Nguyen [6], on the other hand, found only one level of commitment for organizational commitment (COMT) and also found that organizational commitment has a significant positive impact on the export decision [COMT((32,2=0.442, t=6.043)].

As for the accuracy of the model, the goodness of fit index (GFI) is an opposite indicator to test how well data fits. It generally ranges from 0 (no fit) to 1 (perfect fit). GFI is interpreted similarly with R-squares of the regression analysis, and is rarely affected by a change in sample sizes or violation of multivariate normality—thereby being considered an acceptable index for investigating the goodness of the proposed model. Considering the fact that the universally recommended level is above 0.8, Naik [3] the model reflects the data properly with a GFI of 0.851, as shown in table 1. In addition, the root-mean-square error of approximation (RMSEA) is estimated at 0.051, proving that the acceptable limit at a high level of confidence is obtained. Plainly put, the SEM satisfies the goodness of fit measures, which indicates a statistically well-fitted model in predicting a probable performance for export marketing performance.

Implications and applications of SEM

The SEM model shows how the project performance is influenced by the various hierarchical factors with a consideration of the particular project conditions. The "path diagram" is based on causal or co-relational relationships and graphically depicts how a variety of latent and observed variables may interact with others to influence export performance. Once firms are actively engaged in export activities, differential advantages in product advantages were found to be an important determinant of the attractiveness of exporting.

Firms need to have products that are superior to their competitors.

Results indicated that a firm's attractiveness of exporting was found to be significantly related to technology intensiveness and product uniqueness. There is a large body of empirical evidence that has consistently found a significant relationship between the intensity of technological effort

exerted by an industry and the proportion of its output that is exported Naik [3]. He also reported that unique product qualities are cited as key motivators in firms that began exporting. Once firms began to export, based upon these differential advantages, international competitive forces will demand that firm managers become more effective and efficient. However, despite the manager's level of efficiency, with new foreign market opportunities are new and difficult challenges. To take full advantage of these

differential advantages in the foreign market, the firm's manager should also consider formalizing the internal structure, developing better administrative procedures and techniques, and rationalizing the decision-making process. Resource constraints and limited capabilities common to small and medium-sized firms may very well make the implementation of these challenges relatively more difficult. However, implementation would not only enhance the effectiveness of the manager but would also offer the following advantages to the small and medium-sized firms:

1. Greater viability and
2. Increased growth and expansion.

The basic challenge for public policy-makers is to understand the needs of the firm relative to export expansion and to meet them effectively with assistance programs. This understanding means providing the right information to the right firms at the right time. Additionally, what is needed is a better understanding of firm's awareness of public assistance services and, perhaps more critically, their actual or perceived impact on firm's export marketing activities. This increased understanding would assist public policy-makers in matching programs to specific firm needs. Showing that external resources can positively contribute to export expansion would also establish pragmatic credibility with management.

Comparative analyses with other models

To simplify the comparisons, the comparative models are limited to identify the causal relationships between xx variables and the level of profit which is one of the key dependent variables involved in SEM. Regression model and ANN method has been widely used in prediction perspectives. This study compares the modeling features of SEM method to those of multiple regression and ANN model—particularly in terms of capturing variables' complex relations and first, the authors developed the following regression equation through exploratory factor analysis and a multiple regression analysis. Refer to Naik [3] for detailed procedures and an explanation of the model.

Eight factors are selected in this multiple regression model out of all fourteen latent variables that appeared in SEM. From the multiple regression results, practitioners can recognize important factors influencing project performance based on the coefficient value of each factor. However, most factors are difficult to measure because they are to some extent qualitative or unobservable; therefore these factors are measured through Likert scale with 1–7 scores that transform human cognition into a numerical scale. It implies a high potential of error in the measurement of independent variables. Moreover, in international construction projects, project performance cannot be adequately explained just through linear relations because they might have more complex problems such as interrelations between risk factors and observed errors. That explains why SEM is more accurate and realistic than the regression model. Consequently, using SEM is more helpful for understanding 'performance algorithms' because users can recognize the complex relationships visually and systematically.

Next, the authors developed an ANN-based prediction model

Parameter	Variable	AMOS estimate	T-Value
$\gamma_{1.1}$	TRAV	0.36	.24
$\gamma_{1.2}$	LANG	3.91	18.39**
$\gamma_{1.3}$	PROC	2.37	8.39**
$\gamma_{1.4}$	MGT	-0.82	-3.60**
$\gamma_{1.5}$	SATU	1.76	7.11**
$\gamma_{1.6}$	BARR	0.49	5.02**
$\gamma_{1.7}$	FCOND	0.31	1.73*
$\beta_{2.1}$	ATTR	0.10	1.55
$\beta_{2.2}$	COMT	0.85	12.61**

* Significant at p<0.10
** Significant at p<0.05

Table 1: AMOS estimates and T-values.

to compare with SEM. A network employs the same questionnaire answers as the network's inputs (exposure level to 64 risk variables) and the level of profit as its single output figure. To build an ANN, the number of hidden layers, the number of neurons in each layer, the transfer function of each neuron, and the training function to adjust the weights should be decided in advance. Based on the sensitivity analysis for the structures of layers and neurons, the network was designed to have three layers with 5, 2, and 1 neuron, respectively. Accordingly, the input layer was made of 64 neurons corresponding to the 64 risk variables. Back-propagation algorithm was used to train the ANN model with 126 case projects, and to test the model with additional 15 projects. T-test was used to find the differences between the previous 126 sample projects and the additional 15 test projects. As a result of the T-test, the level of significance of the two-tailed test is 0.962, which means that there are few differences between the two distributions of the project groups.

ANN adopts non-parametric regression estimates made up of a number of interconnected, processing elements between input and output data. As such, the mechanism of performance prediction between the ANN method and SEM is fundamentally different. Whereas SEM assesses the final outcome through a path diagram and underlined statistical models, the ANN adopts the learning algorithm drawn from the field of artificial intelligence. Therefore, SEM allows the decision maker to mathematically analyze the result for every possible component of the complex phenomenon, while the ANN model does now show the concrete mechanism to produce the final results.

The authors then compared the deviations between output from each model and actual performance levels. The accuracy of each model was expressed by means of a percentage (Table 2). The average deviance of profit level in the case of a multiple regression model is 0.82. The overall accuracy is also estimated at 86.3%. Similarly, those from the ANN forecasting model are 0.67% and 88.8%, respectively. These numbers reveal that the SEM shows a moderately higher accuracy by showing a better performance–0.56 of average deviance and 90.7% of overall accuracy. Although all three models can predict profitability for overseas projects with reasonable accuracy, the SEM is more accurate and powerful in recognizing the complex structures of variables and their underpinning cause-and-effect relationships. The following is a summary of discussions of how the SEM outperforms the regression model and ANN in its capacity to predict project success in the dynamic and floating international construction projects.

1. The regression method does not identify all the relations necessary to reflect realistic situations and cannot cope with a complex problem such as hierarchical structures of dependencies between each factor. Accordingly, it is better under simple conditions because it can develop a quantitative form with addition or subtraction that can be readily interpreted. In contrast, the SEM can be used where the final outcome is best represented as a sequence and relation of interrelated variables. The SEM is also used to recast a complex problem into several smaller related "path diagrams".

2. The SEM can measure direct as well as indirect effects among the various latent and observed variables. It also enables representing these multi-layered causal or co-relational relationships and their degree of impacts toward the output variables by providing the structural coefficients. Thus, the SEM allows for intuitive apprehending of the interrelationships of the variables that are not visible in both regression and ANN model.

3. The SEM performs better in supporting the process of strategic decision making. Many of the risks inherent in international construction can be mitigated or avoided by the adoption of appropriate project execution strategies. The firm can choose to negotiate a favorable resolution process based on the SEM feedback, as previously demonstrated in Section 7. Through this feedback system, the firm can choose well-fitted strategies designed to improve the firm's capacity to perform or to improve a project's particular conditions.

Conclusion

This study produced a model to predict the key performances of overseas construction projects, using an SEM approach. SEM is a way to systematically combine confirmatory factor analysis, multiple regression analysis, and path analysis in order to have a holistic view of a complex interdependent phenomenon. The authors used data extracted from 126 construction projects to develop the SEM, and an additional 15 sample projects were used to test the model. The comparison analysis between SEM and other models indicated that

Project number	Actual level of profits (1-7)	Regression model		ANN model (1-7)		SEM (1-7)	
		Predicted	Deviation	Predicted	Deviation	Predicted	Deviation
1	7	6.71	0.29	6.48	0.52	6.89	0.11
2	5	4.18	0.82	4.91	0.09	4.87	0.13
3	5	3.28	1.72	4.28	0.72	5.21	0.21
4	5	7.00	2.00	6.89	1.89	6.01	1.01
5	7	6.15	0.85	6.91	0.09	6.09	0.91
6	7	7.00	0.00	6.49	0.51	6.82	0.18
7	1	1.00	0.00	0.98	0.02	1.67	0.67
8	5	2.96	2.04	4.79	0.21	5.67	0.67
9	5	4.83	0.17	4.63	0.37	4.51	0.49
10	6	6.28	0.28	6.95	0.95	5.74	0.26
11	4	5.98	1.98	5.36	1.36	3.67	0.33
12	6	7.00	1.00	6.08	0.08	5.12	0.88
13	1	1.00	0.00	1.25	0.25	2.08	1.08
14	1	1.37	0.37	1.15	0.15	1.54	0.54
15	2	2.83	0.83	2.10	0.10	1.12	0.88
Average			0.82		0.67		0.56
Overall accuracy			86.3%		88.8%		90.7%

Table 2: Accuracy comparison of three models.

SEM has strong potential to accurately and reliably predict the probable performance of international construction projects.

This work contributes to the identification of key variables based on the structural coefficients that significantly determine the success of an overseas project. The primary variables drawn from our study are: "attitude and ability of owner and A/E," "commitment of organization," "project information in early stage," and "appropriateness of cost management."

Despite its successful application, this study developed a generic model for general types of overseas projects due to the limited sample data. The comparison of accuracy of the models was drawn from limited test samples. Future research is required to develop a more refined SEM to better explain the causal relationships of diverse performance-influencing factors. This will lead to more accurate performance prediction of international construction projects. Further, the SEM tool will also be extended to other related fields—for example, modeling for international design-build projects, international build–operate–transfer projects, and other projects with country specific environments. When upgraded with more valuable project samples to identify comprehensive risk variables and performance criteria, the proposed model is expected to significantly improve performances of various types of projects in diverse regional locations.

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