MODELLING OF THE RISKS FACED BY INDIAN CONSTRUCTION COMPANIES ASSESSING INTERNATIONAL OPPORTUNITIES

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Abstract

Indian construction companies have only 0.05% market share in the 3-4 trillion dollar global construction business and only two Indian construction companies figure in the ENR "Top 225 Global Contractors 2006" list. Hence, while enormous scope for growth exists, international construction experience is limited. This study explores the risks as perceived by Indian companies venturing abroad since risks in international construction differ from home market risks. Literature survey identified a number of risk factors that were evaluated by the experts, highlighting fourteen important risk factors. Interpretive Structural Modelling (ISM) was used to develop a hierarchical model showing the relationships between the different risk factors, thus helping to focus on the key risks for effective risk management. The study shows that *poor project management* is a key risk forming the hub of the system, while *political instability* has maximum influence. The results of the study can be used by managers to visualise the risks in perspective and prioritise the mitigation effort.

Keywords: International construction, Indian construction, construction risks, Interpretive Structural Modelling.

1. Introduction

The construction industry is a high risk and low profit margin industry. In the area of international construction, the risks are much more, due to the political, legal, financial and cultural complexities involved. The Indian construction industry has only two companies that figure in the list of "Top 225 International Contractors-2006", published by Engineering News Record in the Aug 21/28, 2006 issue. There is a lack of international experience as far as international construction is concerned. The Indian industry is more labour intensive and the application of latest technologies is also limited. These factors would have an influence and hence the Indian companies seeking to venture into the international construction scenario would view the risks differently. This research views the risks from the India perspective.

The three major processes of risk management include:

- Risk Identification - determining which risks are likely to affect a project and documenting the scope of each element.

- Risk Quantification - evaluating risks and risk interactions to assess the range of possible project impacts.
- Risk Response Development and Control - defining opportunities for enhancements and managing changes in risk across the project life cycle. [1].

This study is an attempt to help the managers in the construction industry to identify and organise the risk factors in a hierarchy showing the inter-relationships. Once this has been done, further decisions can be taken on the responses to risks, which maybe mitigation/avoidance or a decision to accept the risk by accepting a possibility of a lower profit or by developing a contingency plan to be implemented on the risk materialising. Generally companies plan to protect against recurrent, low-impact risks, but ignore high-impact, low-likelihood risks. This is more relevant in the international context since disasters like SARS outbreak and Tsunami had a big impact on the economy of the regions where they occurred, as also terrorist acts like 9/11.

2. Research Methodology

In this research, the first step has been to carry out literature survey and have interactions with Indian construction professionals to identify the risks and group them into fourteen risk factors that became the variables of the research. The views of two experts were sought and their responses used to apply the ISM technique to the variables, in order to place them in a hierarchy based on their dependence or influence on other risks, and show their relationships.

It must be kept in mind that ISM does not give exact results that would be interpreted in a similar manner by all readers. The outputs are not to be taken literally, but are to be seen as a platform to promote thinking. The analysis throws up counter-intuitive aspects of the system. The usefulness is in that eighty percent of the results obtained are self-evident and conform to the participants' initial intuition. They therefore provide confirmation of the common. Above all, they lend weight to the remaining 20% of counter-intuitive results.

The main objectives of the paper are:-

- To identify the risks in international construction.
- To develop a hierarchy of the risks and find out the inter-relationships between the risks from the Indian construction professionals point of view, using ISM.

Finally, in order to validate the findings, interviews were conducted with industry professionals and academics. The results were also compared with other published works on the subject.

3. Risks in International Construction

Literature survey and discussions with professionals has been done to identify the risks in international construction. The literature survey includes works of Ashley and Bonner, 1987 [2]; Bing and Tiong, 1999 [3]; Han and Diekman, 2001 [4]; Han, Diekman and Ock, 2005 [5]; Turnbaugh, 2005 [1]; Wang, 2004[6]. Previous researchers have grouped risks

into categories based on different criteria, for example Wang [6] has grouped risks into Country Level, Market Level and Project Level risks; Han and Diekman [4] have classified risks as Political, Economic, Cultural/Legal, Technical/Construction and Other risks. In this research, grouping of risks ab-initio has been avoided, since the aim of the paper is to present a grouping based on importance of the risk. Fourteen risk factors have been identified for further analysis and these risks are briefly described in Table 1 : Summary of Risk Factors.

Table 1: Summary of Risk Factors

Code	Risk Factor	Description of Risk Factor
R1	Poor Government Responsiveness	Delay in approvals; inconsistent approach towards tax laws, foreign firms, environmental laws, expatriate laws, finance laws etc.; corruption levels.
R2	Weak Legal System	Not universally understood; not effective and efficient; prone to be influenced; weak protection of intellectual property.
R3	Political Instability	Unstable government; inconsistency in approach of central and state/provincial governments, probability of nationalisation of projects.
R4	Cultural Differences	Inability to reconcile differences in work culture, language values, racial prejudices between foreign and local partners. Attitude of public towards foreign firms.
R5	Force Majeure	Natural and man-made disasters that are beyond the company's control eg. flood, earthquake, war etc.
R6	Poor Financial Capability of Local Partner	Financial soundness of the local partner.
R7	Foreign Exchange Risk (Forex)	Exchange rate and interest rate fluctuations; unexpected inflation.
R8	Inaccurate Assessment of Market Demand	Inaccurate assessment of market demand made by owner or local partner
R9	Low Project Team Cohesion	Poor interpersonal relations between multinational team members.
R10	Ambiguous Project Scope Definition	Ambiguous scope definition due to different systems and standards in foreign countries and unfamiliar contract conditions; inadequate design detailing.
R11	Poor Cost Management and Control	Delay or default in payments by owner; inadequate cash flow
R12	Poor Project Management	Inadequate or poor planning and control due to lack of organisation structure or incompetence of project team, due to difficulty in assessing capabilities in foreign countries.
R13	Poor Productivity and Quality	Low productivity and quality standards of the local workforce due to outdated technology, inadequate training and supervision.
R14	Weak Safety Ethos	Inadequate emphasis on safety leading to high accident rate

4. ISM methodology and Model Development

4.1 Introduction to ISM

ISM methodology helps to impose order and direction on the complex relationships among elements of a system [7]. ISM is an interactive learning process whereby a set of different directly and indirectly related elements are structured into a comprehensive systemic model. The model so formed portrays the structure of a complex issue, a system of a field of study, in a carefully designed pattern employing graphics as well as words. For complex problems, like the one under consideration, a number of risk factors will come into play. The direct and indirect relationships between the risk factors describe the situation far more accurately than the individual factors taken in isolation. Therefore, ISM develops insights into collective understanding of these relationships.

The ISM methodology is interpretive from the fact that the judgment of the group decides whether and how the variables are related. It is structural too, as on the basis of relationship, an overall structure is extracted from the complex set of variables. It is a modeling technique in which the specific relationships of the variables and the overall structure of the system under consideration are portrayed in a model. ISM is primarily intended as a group learning process, but it can also be used individually.

4.2 Steps Involved in ISM

The various steps involved in the ISM methodology are as follows:

- Variables affecting the system under consideration are listed, which can be objectives, actions, risks or individuals, etc.
- From the variables identified in the first step, a contextual relationship is established among variables with respect to which pairs of variables would be examined.
- A structural self-interaction matrix (SSIM) is developed for variables, which indicates pair wise relationships among variables of the system under consideration.
- Reachability matrix is developed from the SSIM and the matrix is checked for transitivity. The transitivity of the contextual relation is a basic assumption made in ISM. It states that if a variable A is related to B and B is related to C, then A is necessarily related to C.
- The reachability matrix obtained in fourth step is partitioned into different levels.
- Based on the relationships given above in the reachability matrix, and the levels identified, the ISM model is drawn.
- The ISM model developed in the sixth step is reviewed to check for conceptual inconsistency and necessary modifications are made.

4.3 Structural Self-interaction Matrix (SSIM)

ISM methodology suggests the use of the expert opinions based on various management techniques such as brainstorming, group discussion, etc. in developing the contextual relationship among the variables. Thus, in this research for identifying the contextual relationship among the risk factors in international construction projects, two professionals from the industry and academia were consulted for the same. For analyzing the risk factors

a contextual relationship of "aggravates" type is chosen. This means that one variable or factor aggravates another variable or factor. Based on this, contextual relationship between the variables is developed. Keeping in mind the contextual relationship for each variable, the existence of a relation between any two enablers (i and j) and the associated direction of the relation is questioned. Four symbols are used to denote the direction of relationship between the enablers (i and j):
V: risk factor i will aggravate risk factor j;
A: risk factor i will be aggravated by risk factor j ;
X: risk factor i and j will aggravate each other; and
O: risk factors i and j are unrelated.

The following examples explain the use of the symbols V, A, X, and O in SSIM (Table 2):

- Risk Factor R1 (Poor Government Responsiveness) would aggravate Risk Factor R11 (Poor Cost Management and Control) since an unresponsive government could lead to delayed payments which would result in Poor Cost Management and Control, hence the relationship is "V".
- R1 would be aggravated by R3 (Political Instability), hence the relationship is "A".
- R1 and R2 (Weak Legal System) would aggravate each other, hence "X".
- R1 and R14 (Weak Safety Ethos) are unrelated, hence the relationship is "O".

Similarly, all the relationships in the SSIM are examined and filled.

4.4 Reachability Matrix

The SSIM is transformed into a binary matrix, called the Reachability Matrix by substituting V, A, X, O by 1 or 0 as per the case. The rules for the substitution of 1's and 0's are the following:

- if the (i, j) entry in the SSIM is V, then the (i, j) entry in the reachability matrix becomes 1 and the (j, i) entry becomes 0;
- if the (i, j) entry in the SSIM is A, then the (i, j) entry in the reachability matrix becomes 0 and the (j, i) entry becomes 1;
- if the (i, j) entry in the SSIM is X, then the (i, j) entry in the reachability matrix becomes 1 and the (j, i) entry also becomes 1; and
- if the (i, j) entry in the SSIM is O, then the (i, j) entry in the reachability matrix becomes 0 and the (j, i) entry also becomes 0.

Following these rules the reachability matrix is made as shown in Table 3 : Reachability Matrix.

The transitivities are removed to get the Final Reachability Matrix, shown in Table 4 : Final Reachability Matrix.

4.5 Level Partitions

From the final reachability matrix, the reachability and antecedent set for each enabler are found. The reachability set consists of the element itself and the other elements which it may impact, whereas the antecedent set consists of the element itself

Table 2: Structural Self Interaction Matrix

		Risk Factor (*j*) →												
Code	**Risk Factor (*i*)**	R 14	R 13	R 12	R 11	R 10	R 9	R 8	R 7	R 6	R 5	R 4	R 3	R 2
R1	Poor Government Responsiveness	O	O	O	V	O	O	V	O	O	O	O	A	X
R2	Weak Legal System	V	O	O	V	O	O	O	O	O	O	O	A	
R3	Political Instability	O	O	O	V	O	O	O	V	O	O	O		
R4	Cultural Differences	V	O	O	O	O	X	O	O	O	O			
R5	Force Majeure	O	O	O	O	O	O	O	O	V				
R6	Poor Financial Capability of Local Partner	O	V	V	X	O	O	O	O					
R7	Foreign Exchange Risk (Forex)	O	O	O	O	O	O	O						
R8	Inaccurate Assessment of Market Demand	O	A	A	V	O	O							
R9	Low Project Team Cohesion	V	V	X	O	O								
R10	Ambiguous Project Scope Definition	V	V	O	V									
R11	Poor Cost Management and Control	A	X	A										
R12	Poor Project Management	V	V											
R13	Poor Productivity and Quality	A												
R14	Weak Safety Ethos													

Table 3: Reachability Matrix

Code	**Risk Factor**	R 1	R 2	R 3	R 4	R 5	R 6	R 7	R 8	R 9	R 10	R 11	R 12	R 13	R 14
R1	Poor Government Responsiveness	1	1	0	0	0	0	0	1	0	0	1	0	0	0
R2	Weak Legal System	1	1	0	0	0	0	0	0	0	0	1	0	0	1
R3	Political Instability	1	1	1	0	0	0	1	0	0	0	1	0	0	0
R4	Cultural Differences	0	0	0	1	0	0	0	0	1	0	0	0	0	1
R5	Force Majeure	0	0	0	0	1	1	0	0	0	0	0	0	0	0
R6	Poor Financial Capability of Local Partner	0	0	0	0	0	1	0	0	0	0	1	1	1	0
R7	Foreign Exchange Risk (Forex)	0	0	0	0	0	0	1	0	0	0	0	0	0	0
R8	Inaccurate Assessment of Market Demand	0	0	0	0	0	0	0	1	0	0	1	0	0	0
R9	Low Project Team Cohesion	0	0	0	1	0	0	0	0	1	0	0	1	1	1
R10	Ambiguous Project Scope Definition	0	0	0	0	0	0	0	0	0	1	1	0	1	1
R11	Poor Cost Management and Control	0	0	0	0	0	1	0	0	0	0	1	0	1	0
R12	Poor Project Management	0	0	0	0	0	0	0	1	1	0	1	1	1	1
R13	Poor Productivity and Quality	0	0	0	0	0	0	0	1	0	0	1	0	1	0
R14	Weak Safety Ethos	0	0	0	0	0	0	0	0	0	0	1	0	1	1

Table 4: Final Reachability Matrix

Code	Risk Factor	R 1	R 2	R 3	R 4	R 5	R 6	R 7	R 8	R 9	R 10	R 11	R 12	R 13	R 14
R1	Poor Government Responsiveness	1	1	0	0	0	1	0	1	0	0	1	0	1	1
R2	Weak Legal System	1	1	0	0	0	1	0	1	0	0	1	0	1	1
R3	Political Instability	1	1	1	0	0	1	1	1	0	0	1	0	1	1
R4	Cultural Differences	0	0	0	1	0	0	0	0	1	0	1	1	1	1
R5	Force Majeure	0	0	0	0	1	1	0	0	0	0	1	1	1	0
R6	Poor Financial Capability of Local Partner	0	0	0	0	0	1	0	1	1	0	1	1	1	1
R7	Foreign Exchange Risk (Forex)	0	0	0	0	0	0	1	0	0	0	0	0	0	0
R8	Inaccurate Assessment of Market Demand	0	0	0	0	0	1	0	1	0	0	1	0	1	0
R9	Low Project Team Cohesion	0	0	0	1	0	0	0	1	1	0	1	1	1	1
R10	Ambiguous Project Scope Definition	0	0	0	0	0	1	0	1	0	1	1	0	1	1
R11	Poor Cost Management and Control	0	0	0	0	0	1	0	1	0	0	1	1	1	0
R12	Poor Project Management	0	0	0	1	0	1	0	1	1	0	1	1	1	1
R13	Poor Productivity and Quality	0	0	0	0	0	1	0	1	0	0	1	0	1	0
R14	Weak Safety Ethos	0	0	0	0	0	1	0	1	0	0	1	0	1	1

Table 5: Identification of Levels

Barrier	Reachability	Antecedent	Intersection	Level
R1	1,2,6,8,11,13,14	1,2,3	1,2	
R2	1,2,6,8,11,13,14	1,2,3	1,2	
R3	1,2,3,6,7,8,11,13,14	3	3	
R4	4,9,11,12,13,14	4,9,12	4,9,12	
R5	5,6,11,12,13	5	5	
R6	6,8,9,11,12,13,14	1,2,3,5,6,8,10,11, 12,13,14	6,8,11,12 13,14	
R7	7	3,7	7	I
R8	6,8,11,13	1,2,3,6,8,9,10,11, 12,13,14	6,8,11,13,	I
R9	4,8,9, 11,12,13,14	4,6,9,12	4,9,12	
R10	6,8,10,11,13,14	10	10	
R11	6,8,11,12,13	1,2,3,4,5,6,8,9,10,11, 12,13,14	6,8,11,12,13,	I
R12	4,6,8,9,11,12,13,14	4,5,6,9, 11,12	4,6,9,11, 12	
R13	6,8,11, 13	1,2,3,4,5,6,8,9,10,11, 12,13,14	6,8,11,13	I
R14	6,8,11,13,14	1,2,3,4,6,9,10,12,14	6,14	

and the other elements that may impact it. Thereafter, the intersection of these sets is derived for all the enablers. The enablers for whom the reachability and the intersection sets are the same occupy the top level in the ISM hierarchy. The top-level element in the hierarchy would not aggravate any other element above its own level. Once the top-level element is identified, it is separated out from the other elements. Then, the same process is repeated to find out the elements in the next level. This process is continued until the level of each element is found. The first step is shown in Table 5 : Identification of Levels. These levels help in building the ISM model.

4.6 Building the ISM Model and its Analysis

The Levels of the Factors identified above, along with the Final Reachability Matrix are used to draw up the ISM Model shown in Figure 1 : ISM Model of Risk Factors.

The ISM sets out the variables in a hierarchical manner, with factors having least influence at the top. It also shows the relationships between the variables. In this research, the ISM shows that Political Instability is at the bottom, implying that this factor can influence other factors like Foreign exchange risk, Government responsiveness and the legal system directly and most other factors indirectly, while it cannot be influenced by any other factor. Hence we can conclude that the Political Stability risk factor is an important factor that merits attention right at the beginning, during the Idea/Feasibility Stage of the project. We could also infer that investing in a politically unstable country is fraught with risks and we have no means to manage or mitigate the risks. The next level risk factors are Ambiguous Project Scope Definition, Force Majeure, Weak Legal System and Poor Government Responsiveness. These too exert influence on other factors and aggravate them, while they themselves cannot be influenced by any factor within the control of the company intending to undertake the project. Hence a country where these risks are perceived to be high, needs to be approached with caution. These risks could be broadly classified as ‘Environmental Risks’.

Poor Financial Capability of the Local Partners is the next level risk. It can be influenced by the previously discussed factors, at the same time it directly affects Project Management and other factors indirectly.

Project Management clearly forms the hub of the system. It directly influences a large number of risks and is amenable to be influenced by risk factors within the control of the company. Hence, we can conclude that project management is an extremely important risk factor requiring major management involvement.

Safety Ethos is the next level risk. Finally, we have the top level risk factors which are amenable to be influenced and hence controlled by other factors ie. the company can influence and reduce the risk posed by these factors. They influence each other, and the outcome of their mitigation or management directly reflects on the project success.

Intuitively, Foreign Exchange Risk is thought of as a major risk in international construction, the ISM shows that is it only aggravated by one risk factor, Political Instability, and it does not aggravate any other risk factor. It directly affects project success. Hence, it is largely disconnected from the system and needs to be treated separately by using foreign exchange risk management techniques.

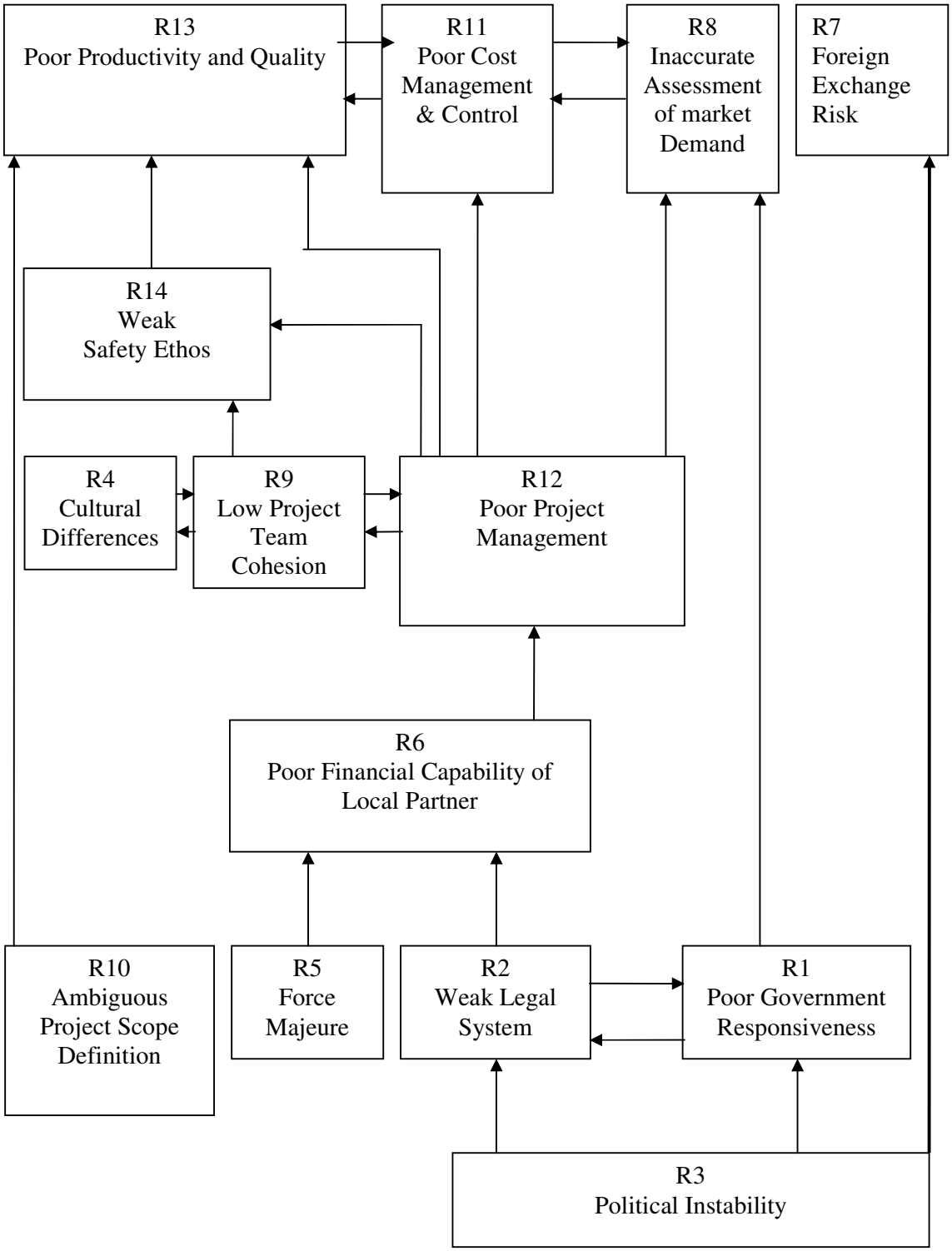

Figure 1: ISM Model of Risk Factors

5. Conclusion

The research has identified fourteen risk factors likely to be faced by companies undertaking construction projects outside their home country, by means of literature survey and by unstructured interviews with Indian construction industry professionals. These risk factors were subjected to structural analysis using the ISM method.

The ISM method has resulted in arranging the risk factors in a structured hierarchical model showing their inter-relationships. Poor Project Management emerges as a key risk factor forming the hub of the system and thus requiring maximum management attention. Financial Capability of Local Partner, Project Team Cohesion, Cultural Differences and Safety Ethos are the next level of factors requiring management attention. The Environmental factors emerge as the ones least amenable to mitigation. Foreign Exchange Risk is largely disconnected from the system and requires to be addressed separately.

The research needs to be validated by carrying out survey and statistical analysis along with correlation with case studies. This can be taken up for future research work. ISM has the capability to develop and present a model of the system under study without spending too much time on data collection, and hence is very useful in many situations when there may not be adequate time to conduct a survey.

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