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ORIGINAL ARTICLE

Interpreting the Interpretive Structural Model

Sushil

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Abstract *Interpretive structural modeling (ISM) is a process that transforms unclear and poorly articulated mental models of systems into visible, well-defined models useful for many purposes. The interpretation of links is comparatively weak in ISM; the interpretation of the directed link in terms of how it operates is lacking. This paper is an attempt to interpret the links in the interpretive structural models using the tool of Interpretive Matrix and leads to evolve the framework and methodology of total interpretive structural modeling (TISM). First, an overview of ISM is provided. This is taken-up further by highlighting the need of interpretation of interpretive structural models. In order to evolve the framework of TISM, the tool of Interpretive Matrix is briefly introduced, which is integrated into the methodology of TISM. The basic process of TISM is presented in a step-by-step manner with indicative directions for scaling-up this process. Some tests for validating total interpretive structural models are also proposed. Finally, the basic process of TISM is illustrated with the help of an example in the context of organizational change. This process can be used for conceptualization and theory building in organizational research.*

Keywords Interpretive Matrix · Interpretive structural modeling · Organizational change · Theory building · Total interpretive structural modeling

Sushil (✉)
Department of Management Studies, Indian Institute of Technology, Delhi, Delhi, India
e-mail: profsushil@gmail.com

Introduction

In any organizational research, conceptualization or theory building phase is crucial as the essence of research depends on it. In the process of developing a conceptual framework or theory, that is to be tested later, some basic questions need to be answered. The six fundamental questions are *what*, *how*, *why*, *who*, *where*, and *when* as outlined by Whetten (1989), in the path breaking paper on "What constitutes a theoretical contribution?". Out of these, the most fundamental ones are *what*, *how* and *why* those form the basis of this paper. Any theory is supposed to define the basic constructs, dimensions or elements constituting the framework (*what*). For example, in organizational research, it is imperative to identify the performance dimensions and the antecedents influencing the performance. The next question to be delineated in the conceptualization phase is the hypothesized relationships among the research variables (*how*). Further, the causal thinking (*why*) need to be deliberated in order to interpret the linkages that are envisaged as hypotheses.

The above questions in theory building may either be derived from existing literature (using past theories or models already validated by other researchers), or may be explored using grounded theory (Corbin and Strauss 1990) (in areas where adequate literature in research domain in a given context is not available). The grounded theory seeks the inputs from field in terms of qualitative views from working professionals/experts based on their experience in the problem domain under investigation, or by using case experiences in an inductive manner.

Usually, organizational researchers find it convenient to answer *'what'* either from literature or field, or both so as to identify key research variables as the starting point in any research query. They may use past theories to back *'how'* and *'why'*, e.g. Maslow's need hierarchy theory links 'motivation' with fulfillment of needs at different levels of hierarchy.

However, in the context of grounded theory applications, though explicit procedure of content analysis methodology is provided to identify elements/variables, the methodological framework is comparatively weak to answer *'how'* and *'why'* in terms of relationships. Such inter-linkages of research elements are usually portrayed by organizational researchers using some possible logic as they seem to be working on a case to case basis. For example, while developing a theory of organizational change, field experiences may point out important change forces as globalization, changing customer needs, new technology, changes in government policy, and so on. In order to answer how these change forces are related and why they are expected to be related in that manner, adequate step by step methodology is lacking in the grounded theory in order to generate a transparent and well organized logic.

Systems theory and systems engineering based methods may provide a helping hand to organizational researchers on this front. Identification of structure within a system is of great value in dealing effectively with the system and better decision-making. Structural models may include interaction matrices and graphs (Warfield 1973a, b, 1974b); Delta charts; signal flow graphs, etc., which lack an interpretation of the embedded object or representation system. This paper is an attempt to enhance interpretive logic of systems engineering tools in delineating not only a hierarchical structure of the intended organizational theory, but also to interpret the links in order to explain the causality of the conceptual model by using strengths of paired comparison methodology. It takes interpretive structural modeling (ISM) (Warfield 1973a) as the starting point for conceptualization of organizational research and further develops it into total interpretive structural modeling (TISM).

An interpretive structural model (ISM) deals with the interpretation of the embedded object or representation system by systematic iterative application of graph theory resulting in a directed graph for the complex system for a given contextual relationship amongst a set of elements. Interpretive structural modeling, can, therefore, be defined as a process that transforms unclear and poorly articulated mental models of systems into visible, well-defined models useful for many purposes.

In any interpretive structural model, the interpretation of the diagraph can be done at two levels, i.e. nodes and links. An ISM interprets the nodes in terms of the definition of elements. But the interpretation of links is comparatively weak in ISM; this is limited to interpreting the contextual relationship between the elements and the direction of relationship in a paired comparison. But the interpretation of the directed link in terms of how it operates is lacking. For example, two objectives A and B are related by the contextual relationship 'will help achieve'. If there is a directed relationship in an ISM from objective A to objective B, thereby implying that objective A will help achieve objective B, it does not interpret that in what way objective A will help achieve objective B.

This paper, thus, is an attempt to interpret the links in the interpretive structural models using the tool of Interpretive Matrix (Sushil 2005a) and leads to evolve the framework and methodology of total interpretive structural modeling (TISM) for conceptualizing poorly articulated mental models and theory building. First, an overview of ISM is provided in terms of its methodology and various matrices with its possible limitations in organizational research. This is taken-up further by highlighting the need of interpretation of interpretive structural models. In order to evolve the framework of TISM, the tool of Interpretive Matrix is briefly introduced, which is integrated into the methodology of TISM. Finally, the basic process of TISM is illustrated with the help of an example in the context of organizational change. In the concluding section, its possible applications in organizational research and future directions are outlined.

Interpretive Structural Modeling—An Overview

The mathematical foundations of the methodology of ISM can be found in various reference works (Harary et al. 1965; Waller 1980; Warfield 2003). The applications of philosophical basis for the development of the ISM approach (Warfield 1973c) and the conceptual and analytical details of the ISM process (Warfield 1974a, 1976, 1994, 1999) are dealt with by many authors. Malone (1975) discussed the application of ISM in structuring personal values and focusing on barriers to investment in a central city. Hawthorne and Sage (1975) used ISM for higher education program planning. Jedlicka and Meyer (1980) used ISM for cross-cultural studies. Saxena et al. (2006) have applied it in conjunction with other modeling methodologies in the context of energy conservation policy. There are multiple other applications of ISM in many areas; some representative ones are: decision support systems (Hansen et al. 1979), waste management (Sharma and Sushil 1995), vendor selection (Mandal and Deshmukh 1994), product design (Lin et al. 2006), supply chain management (Agarwal et al. 2007), decision making (Lee 2008), value chain management (Mohammed et al. 2008), world-class manufacturing (Haleem et al. 2012), and so on.

ISM is a computer assisted interactive learning process whereby structural models are produced and studied. Structural models so produced portray the structure of a complex issue, a system or a field of study in carefully designed patterns employing graphics and words. It is a means by which a modeling group can impose order on the complexity of relationships among elements. The method is interpretive in that the group's judgment decides whether and how elements are related, structural in that an overall structure is extracted from the complex set of elements on the basis of relationships, and modeling in that the specific relationships and overall structure are portrayed in a digraph (directed graph) model. ISM is primarily intended as a group learning process but it can also be used by individuals working alone. In a nutshell, ISM is a process that is based on relational mathematics, which clarifies and transforms ill-structured mental models about the system under study into a clear interrelated structured set of system elements (Warfield and Cárdenas 1994).

At the outset, an element set, that is composed of elements relevant to the problem or issue, is generated. Any suitable group process can be used for this, e.g. brainstorming, nominal group technique (NGT) etc. Next a contextually relevant subordinate relation is chosen. It should be subordinate in the sense that a direction should be attached to it. It should be so phrased as to lead to paired comparisons, e.g. 'is objective *A* more important than objective *B*?'.

Having decided on an element set and the contextual relation, the modeling group carries out all paired comparisons. Two elements are picked and pair-wise comparison of the same is made. Group judgment on the paired comparison is determined by consensus majority vote after the discussion. On the basis of the replies of the pair-wise comparisons, it infers certain replies due to transitivity of the contextual relation and calls for replies to certain other paired comparisons. Transitivity of the contextual relation is a basic assumption in ISM, which states that if element A is related to B and B is related to C, then A is necessarily related to C. When the necessary input information is available, a structural model is generated in the form of a digraph in which the collective features of the group's thinking are assumed to be reflected. Depending upon the needs of the modeling group and requirements of the problem at hand, many kinds of structural models can be generated in ISM.

Development of an Interpretive Structural Model

The elements are to be defined first; the contextual relations of the elements are then determined. Based on the contextual relationship under consideration, the structural self-interaction matrix (SSIM), reachability matrix, the lower triangular format of reachability matrix, digraph for interpretive structural model, and the interpretive structural model are developed (Saxena et al. 2006). The development of ISM along with TISM is illustrated with various matrix and graphical tools in the modeling of organizational change forces in the last section.

Structural Self-Interaction Matrix

Keeping in view the contextual relationships in each element, the existence of a relation between any two elements (i and j) and the associated direction of relation R is questioned by a group of experts concerned with the program. Four symbols are used for the type of relation that exists between the two elements under consideration. The symbols are:

i. V for the relation from element i to element j and not in both directions;
ii. A for the relation from element j to element i but not in both directions;
iii. X for both the direction relations from element i to j and j to i;
iv. 0 (zero), if the relation between the elements does not appear valid.

The structural self-interaction matrix (SSIM) for the element under consideration is then prepared by filling in the responses of the group on each pair-wise interaction between the elements.

Reachability Matrix

The SSIM format is transformed into the reachability matrix format by transforming the information in each entry of the SSIM into 1's and 0's in the reachability matrix.

The four situations are:

i. If the (i, j) entry in the SSIM is a V, the (i, j) entry in the reachability matrix becomes 1 and the (j, i) entry becomes 0.
ii. If the (i, j) entry in the SSIM is an A, the (i, j) entry in the reachability matrix becomes 0 and the (j, i) entry becomes 1.
iii. If the (i, j) entry in the SSIM is an X, both the (i, j) entry and the (j, i) entry of the reachability matrix become 1.
iv. If the (i, j) entry of the SSIM is a 0, then both the (i, j) and (j, i) entries of the reachability matrix become 0.

Following these rules, the reachability matrix for the elements is prepared. The reachability matrix as obtained from the SSIM is checked for the transitivity rule, i.e. for any elements A, B, and C and set S, given that A *R* B and B *R* C, it necessarily follows that A *R* C. If the transitivity rule is found not to be satisfied, the SSIM is reviewed and modified by giving specific feedback about transitive relationship to the experts in the group. From the revised SSIM, the reachability matrix is again worked out and tested for the transitivity rule. This process is repeated till the reachability matrix meets the requirements of the transitivity rule.

Partitions on the Reachability Matrix

Once the reachability matrix has been prepared, it must be processed to extract the digraph and associate structural models. Warfield (1974c) suggests the use of a series of partitions which are induced by the reachability matrix on the sets and sub-sets of the elements, i.e. relation partition and level partition.

Lower-Triangular Format Reachability Matrix

The reachability matrix is further transformed into a lower triangular format by identifying the highest level elements and inserting them as the first elements in the new reachability matrix. Interactively, the next highest level elements are identified and transformed until the elements are arranged into a lower triangular format. The rows having the maximum number of 0's are the rows relating to the highest level elements and the rows having the maximum number of 1's relate to the lowest level elements.

Lower triangular reachability matrix can be easily prepared with the help of computers (Warfield 1973d). However, when the number of elements is small and the intention is to develop ISM through manual operations, the preparation of the lower triangular reachability matrix is optional; the digraph can be developed directly from the reachability matrix.

Digraph for Interpretive Structural Model

Having identified the levels of the elements, the relationship between the elements is drawn indicating the serial number of the elements and the direction of relation with the help of an arrow. The digraphs thus drawn are quite complex and are examined interactively to eliminate transitive relationships. After eliminating the transitive relationships, the digraph is finalized for the interpretive structural model. The digraphs give information about hierarchy among the elements.

The digraph thus developed may have cycles at a particular level and feedbacks across the levels between elements. In normal circumstances, the feedbacks and cycles should be eliminated to arrive at a digraph with minimum edges; but the same should be retained in the matrix if the intention is to further study the influence of indirect relationships between the elements.

Interpretive Structural Model

The structural model is derived from the connective information contained in the digraph. The details of elements are indicated in the respective boxes with indicated relations as worked out in the digraph, thus obtaining the interpretive structural model for the element. The interpretive structural model depicts the elements and their reachability to the higher level elements and provides a clear picture with an understanding of the inter-relationships among the elements. The strongly connected elements at the same level may be represented in the same box as separate bullets for a simplified presentation.

Strengths and Limitations of ISM for Organizational Research

Strengths

i. Helps in presenting a complex system in a simplified way.
ii. Provides interpretation of the embedded object.
iii. Transforms unclear and poorly articulated mental models of systems into visible, well-defined models thereby help in answering *what* and *how* in theory building.
iv. Facilitates the identification of the structure within a system.

Limitations

i. Technique of ISM can be used only by persons who are knowledgeable about it and are trained to interpret the data.
ii. Use of computers is necessary and the technique may be difficult to apply if computer facilities are not available.
iii. The interpretation of links is partial thereby exposing the model to multiple interpretations by the user.
iv. It remains silent on the causality of links and thus pose limitations in answering *why* in theory building.

Interpretation in ISM

Interpretive structural modeling was a major milestone in incorporating interpretation in the structural modeling.

A structural model in the form of a diagraph has nodes as well as links. Interpretive structural modeling interprets the links in terms of the contextual relationship and the direction of the relationship for each pair of elements. This becomes the starting point of articulating the structure of any ill-defined system. At the final stage, it interprets the nodes of the diagraph in terms of the definition of respective elements so that a clear picture can be portrayed in terms of the relationships among the elements. However, interpretation of the links is limited to the contextual relationship and the direction of the relationship. There is a need to interpret it further in terms of clarifying the way in which the directed relationship is materialized. This can be achieved by making use of Interpretive Matrix as a tool to convert binary relationships in the final diagraph in the form of interpretive relationships. An overview of the Interpretive Matrix is provided in the next section. It has been applied in pair-wise relationships in the context of SAP-LAP linkages (Sushil 2009a) and decision-making as interpretive ranking process (Sushil 2009b).

The interpretive ranking process (IRP) takes advantage of the analytical logic of the rational choice process and couples it with the strengths of the intuitive process at the elemental level. It is rooted into the strengths of the paired comparison approach to minimize the cognitive overload (Warfield 1974c; Saaty 1977). At the same time, it overcomes the weakness of the paired comparison approach the way it is applied in rational choice models, such as Analytic Hierarchy Process (AHP) (Saaty 1977). In AHP, an expert gives the judgment about the importance of one element over the other in the pair along with its intensity, but the interpretation of the same is left in a tacit manner with the expert, thereby making the interpretive logic of the decision opaque to the implementer. In IRP, the expert is supposed to spell out the interpretive logic for dominance of one element over the other for each paired comparison. In a similar manner, the paired relationships in ISM can be interpreted using Interpretive Matrix and structural model with total interpretation of nodes as well as links can be developed.

Interpretive Matrix to Interpret Links

The Need

The structural modeling is used to portray the system structure in terms of relationships of elements. These relationships may or may not have a direction. The undirected relationships are used, for example, in Program Planning Linkages (Hill and Warfield 1972) in terms of 'self-interaction matrices' and 'cross-interaction matrices' which are binary in character. It uses paired comparison methodology to compare two elements for a relationship. If there is a relationship, an entry of '1' is made in the relevant cell of the matrix, or else a '0' entry is made. The manipulation of matrices is done using binary arithmetic. The directed relationships are used in directed graph theory (Harary et al. 1965) and ISM (Warfield 1994). In this case, the entries in the cells incorporate direction of relationships as well using some symbols and then converted into binary matrices.

Thus, though the structural models depict relationships between elements/variables, these relationships need to be properly interpreted. The 'interpretive matrix' (Sushil 2005a) is a step in this direction to aid the interpretation of relationships in structural models in a given context.

The Principle

The Interpretive Matrix represents interpretation of relationships on pairs of elements in cells which are binary, fuzzy or statistically significant. The main question answered in interpreting an undirected relationship is 'why' the relationship exists in between the two elements. In case of directed relationships the interpretation is done in terms of 'how' the relationship works, in a given context. The interpretation may change for different contextual relationships, which may be for example, influences, enhances, precedes, will help achieve, more important than, and so on.

The Tool

The Interpretive Matrix represents a set of relationships in a matrix form, giving interpretation for each paired relationship in the relevant cell. There could be three basic types of interpretive matrices, viz. triangular, square, and rectangular. The square Interpretive Matrix is used to interpret the relation in the final diagraph in TISM.

A square Interpretive Matrix shows directed relationships among a set of elements/variables. For relationship between a pair of elements i and j, there are two entries in the matrix; one depicting the directed relation from i to j; and the other one from j to i.

Total Interpretive Structural Modeling

The Interpretive Matrix can be directly applied in case of structural modeling to interpret directed and undirected binary or fuzzy relations. In case of a graphical model, the interpretation of the relation can be shown by the side of the link connecting the pair of elements having the relation. By interpreting both the nodes and links in the structural

Table 1 Structures made in TISM

Type	Explanation
Intent	*Elements:* objectives
	Relation: A should/will help achieve B
	Interpretation: in what way A should/will help achieve B?
Priority	*Element:* projects, goals, etc.
	Relation: A is of equal or higher priority than B (The relationship must allow for the possibility of cycles)
	Interpretation: on what basis priority is decided?
Attribute enhancement	*Elements:* problems, opportunities, causes
	Relation: A would cause/enhance B
	Interpretation: how would A cause/enhance B?
Structure of process	*Elements:* activities, events, etc.
	Relation: A should precede B
	Interpretation: why should A precede B?
Mathematical dependence	*Elements:* quantifiable parameters or factors
	Relation: A is a function of B
	Interpretation: what is the nature of function

model, an interpretive structural model can be upgraded as a total interpretive structural model (TISM), which may have higher applicability in real life situations. The explanation of some of the structures that can be made using TISM in terms of elements, relationships and possible interpretation are summarized in Table 1.

The basic process of TISM is presented in a step-by-step manner with indicative directions for scaling-up this process. Some tests for validating the total interpretive structural models are also proposed.

Steps of the Basic Process

The steps of the basic process of TISM are diagrammatically portrayed in Fig. 1 and are briefly outlined as follows. These steps along with the matrices and other tools are illustrated in the example of TISM of organizational change. The central tool of ISM, i.e. reachability matrix and its partitions is adopted as it is in the process of TISM.

Step I: Identify and Define Elements

The first step in any structural modeling would obviously be to identify and define the elements whose relationships are to be modeled. This can be done by using any idea generation method as a small group exercise or using grounded theory. The identified elements may also be related with past studies if such information is available.

Step II: Define Contextual Relationship

In order to develop the model of the structure relating the elements, it is crucial to state the contextual relationship between the elements. The contextual relationship is dependent on the type of structure we are dealing with such as intent, priority, attribute enhancement, process or mathematical dependence, as illustrated in Table 1. For example, in case of intent structure, which is widely used in management, the contextual relationship between different objectives as elements could be: 'A should help achieve B' or 'A will help achieve B'.

Step III: Interpretation of Relationship

This is the first step forward over the traditional ISM. Though the contextual relationship interprets the nature of relationship as per the type of structure, it remains almost silent to interpret how that relationship really works. In order to interpret the ISM further to make it TISM, it is advisable to clarify the interpretation of the relationship, as illustrated in Table 1 for different types of structures. For example, in case of intent structures, we should bring out the deeper understanding by interpreting the relationship as: 'In what way A should/will help achieve B?'. The interpretation of the relationship would be specific for each pair of objectives by answering the above interpretive query so as to make the deep rooted knowledge explicit.

Step IV: Interpretive Logic of Pair-wise Comparison

In ISM, the elements are compared to develop SSIM, as described previously. The only interpretation that is made here relate about the direction of the relationship. In order to upgrade it to TISM, it is proposed to make use of the concept of Interpretive Matrix so as to fully interpret each paired comparison in terms of how that directional relationship operates in the system under consideration by answering the interpretive query as mentioned in step III. For paired comparison, the ith element is compared individually to all the elements from $(i + 1)th$ to the nth element. If there are n elements, there will be in all $n(n - 1)/2$ paired comparisons. Since each pair of elements (i, j) may have two possible directional links i–j or j–i, there will be in all $n(n - 1)$ rows in the Knowledge Base. For each i–j link the entry could be 'Yes(Y)' or 'No(N)' and if it is 'Yes', then it is to be further interpreted. This will unearth the interpretive logic of the paired relationships in the form of 'Interpretive Logic—Knowledge Base'. This is illustrated as Exhibit 1 in Appendix for the example of organizational change forces.

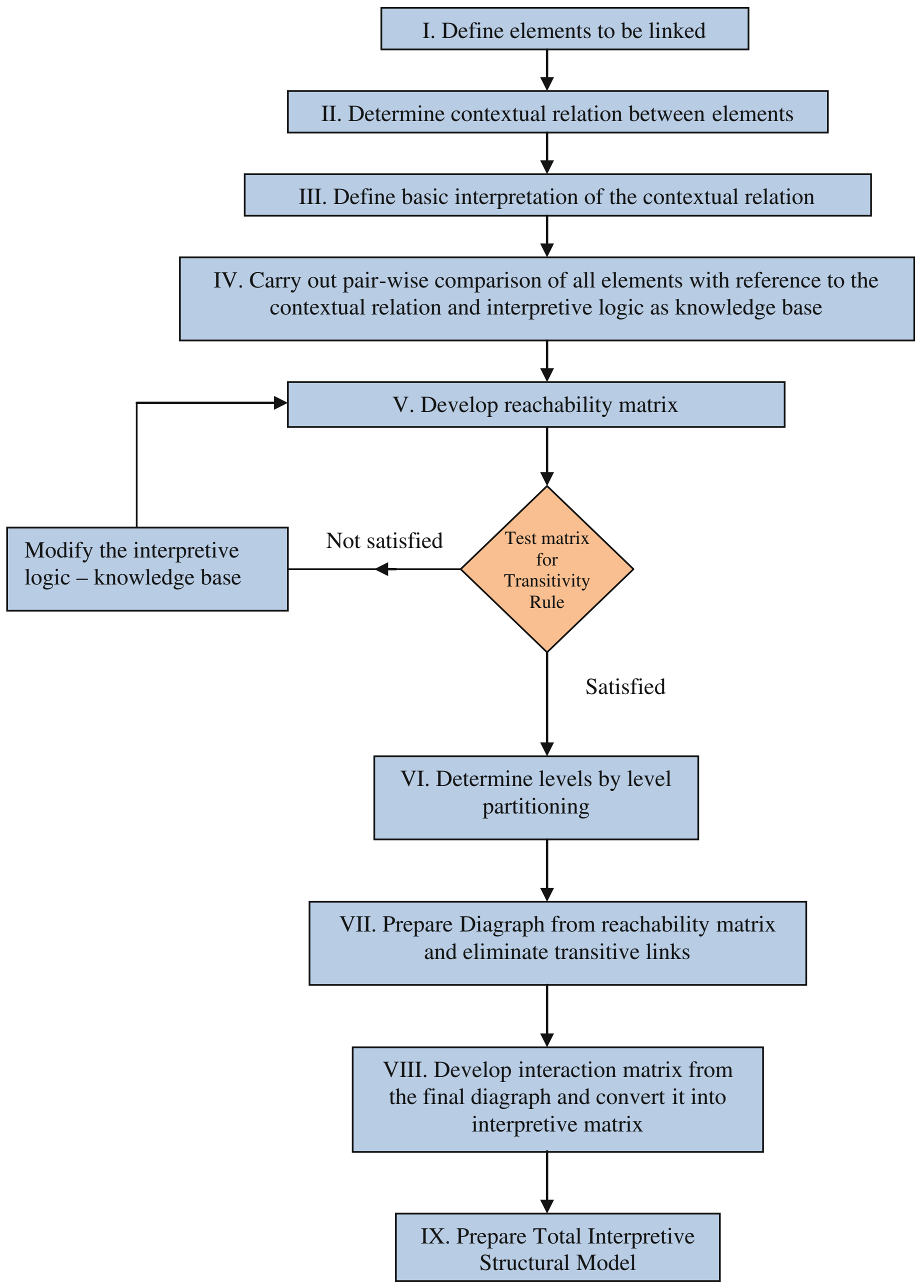

Fig. 1 Basic process of total interpretive structural modeling

Step V: Reachability Matrix and Transitivity Check

The paired comparisons in the interpretive logic—knowledge base are translated in the form of reachability matrix by making entry 1 in $i - j$ cell, if the corresponding entry in knowledge base is 'Y', or else it should be entered as 0 for the corresponding entry 'N' in knowledge base. This matrix is checked for the transitivity rule and updated till full transitivity is established, as shown in Exhibit 2 in Appendix for the illustrative example. For each new transitive link, the Knowledge Base is also updated. The 'No' entry is to be changed to 'Yes' and in the interpretation column 'Transitive' is entered. If the transitive relationship can be meaningfully explained, then the logic is written along with the 'Transitive' entry or else it is left as it is.

Step VI: Level Partition on Reachability Matrix

The level partition is carried out, similar to ISM, to know the placement of elements level-wise (Warfield 1974c; Saxena et al. 2006). Determine the reachability and antecedent sets for all the elements. The elements in the top level of the hierarchy will not reach any elements above their own level. As a result, the reachability set for a top level element will consist of the element itself and any other elements within the same level which the element may reach, such as components of a strongly connected sub-set. The antecedent set for a top level element will consist of the element itself, elements which reach it from lower levels, and any element of a strongly connected sub-set at the top level. As a result, intersection of the reachability set and the antecedent set will be the same as the reachability set if the element is at the top level. The top level elements satisfying the above condition should be removed from the element set and the exercise is to be repeated iteratively till all the levels are determined.

Step VII: Developing Diagraph

The elements are arranged graphically in levels and the directed links are drawn as per the relationships shown in the reachability matrix. A simpler version of the initial diagraph is obtained by eliminating the transitive relationships step-by-step by examining their interpretation from the knowledge base. Only those transitive relationships may be retained whose interpretation is crucial.

Step VIII: Interaction Matrix

The final diagraph is translated into a binary interaction matrix form depicting all the interactions by 1 entries. The cells with 1 entry are interpreted by picking the relevant interpretation from the knowledge base in the form of Interpretive Matrix (Exhibit 5).

Step IX: Total Interpretive Structural Model

The connective and interpretive information contained in the interpretive direct interaction matrix and diagraph is used to derive the TISM. The nodes in the diagraph are replaced by the interpretation of elements placed in boxes. The interpretation in the cells of interpretive direct interaction matrix is depicted by the side of the respective links in the structural model. This leads to total interpretation of the structural model in terms of the interpretation of its nodes as well as links, as depicted in Fig. 2 for the illustrative example.

Scaling-up the Process

The basic process presented in the previous section can be scaled-up to cater to the complex requirements of a variety of modeling situations. Some possible directions for scaling-up the process are enumerated as follows:

Using Multiple Interest Groups/Experts

In case of complex systems such as policy structures, the bias can be minimized by extracting the knowledge base of interpretation of paired comparisons separately for each interest group or expert. The multiple interpretive logics can be synthesized to get an overall model either based on consensus building or as an aggregation of the relationships for various experts.

Use of Content Analysis Tools

The interpretive logic obtained from various experts can be subject to content analysis tools so as to synthesize the content of interpretation for each paired comparison.

Up-gradation of Knowledge Base

The knowledge base can be upgraded with dynamic application of the structural modeling. In order to enhance the model for an additional element, only related paired comparisons and their interpretations are to be carried out to get the updated knowledge base and TISM. This would require process and tools for up-gradation of the knowledge base in a systematic manner.

Fuzzy TISM

Fuzzy interpretive structural modeling is a step ahead of ISM (Saxena et al. 2006). In a similar manner, the TISM can also be upgraded to be Fuzzy TISM. While TISM considers only the existence of an interaction between elements, the possibility of interaction is also considered as an extension in fuzzy total interpretive structural modeling. The possibility of interaction can be defined by qualitative considerations on a 0–1 scale as follows:

Possibility of interaction	No N	Very low VL	Low L	Medium M	High H	Very high VH	Full F
Value on the scale	0	.1	.3	.5	.7	.9	1

The possibility of interaction can be superimposed in the reachability matrix for further processing. The Fuzzy TISM is presented with different notations indicating the possibility of interaction among the sub-elements. The utility of TISM is greatly enhanced by incorporating the possibility

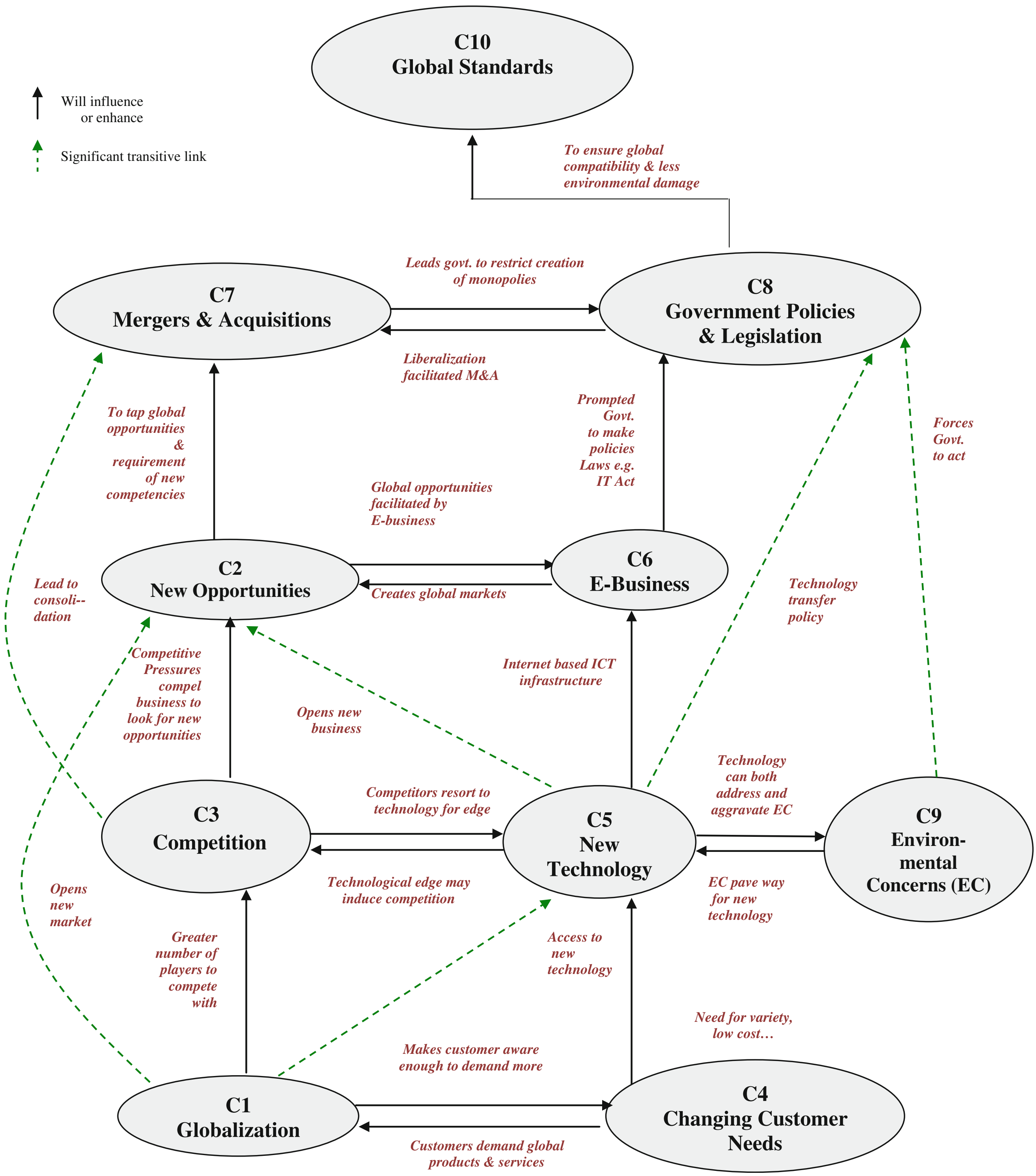

Fig. 2 Total interpretive structural model (TISM) of organizational change forces

of interaction along with the graphical presentation. An added advantage of Fuzzy TISM is that it can provide the interpretive structure of elements with one possibility of interaction at a time and ignoring all other possibilities of interactions. For example, if the analyst is keen to study high possibility of interactions only, he/she focuses on all entries of .7 only and replaces all other entries by 0's in the reachability matrix.

Developing Models with Multiple Types of Elements

In the basic process, the structures modeled are simple considering only one type of elements and contextual relationship. The process of TISM can be scaled-up to model complex structures with multiple types of elements with one or multiple types of contextual relationships. For example, a model can be developed with both information and decision elements. Another example is to model the relationships of situation, actor and process elements. In this case, the contextual relationships could be multiple, e.g. between situation and actor elements—'how a situation element influences an actor?' and between actor and process elements—'what role an actor plays in a process?'.

Analysis of TISM

The total interpretive structural model can be further analyzed to derive meaningful conclusions about the model. Some possible types of analysis could be:

- *Relationship analysis*: TISM can be analyzed for both driver power and dependence of various elements in the model. The analysis can be done for direct relationships as well as indirect relationships as is done in case of ISM (Saxena et al. 2006).
- *Analysis and interpretation of paths:* TISM can be analyzed to identify major paths in the model and their overall interpretation.
- *Application of IRP:* The elements or paths in TISM can be ranked using interpretive ranking process (Sushil 2009b).

Plural and Dynamic Models

In the basic process, only a single consensus model is prepared. There can be plural models with multiple perspectives and interpretations. If the plurality is taken on the time dimension, i.e. separate models are developed for different phases, then these can be treated as dynamic models, e.g. models for pre-implementation and post-implementation of e-business.

Integration with other Methodologies

The total interpretive structural modeling can be suitably integrated with other modeling methodologies, such as system dynamics, soft system methodology and so on to generate integrative models overcoming the limitations of TISM.

Validation

Since the TISM process is rooted in interpretive logic, the process of validation would also be predominantly interpretive in nature. The validation of Total Interpretive Structural Models will have multiple points of contact for validation to generate confidence in these models; some important ones are highlighted as follows:

Validating Model Structure

The model structure is to be validated in terms of elements and relationships. The critical questions that need to be answered for validating model structure are:

- *Whether all relevant elements are included?*
  The elements should be reviewed to examine that all relevant elements are included. This would require a structured walkthrough the list of elements.
- *Whether the interpretation of relations is correct?*
  A structured walkthrough is to be made through the interpretive logic of paired comparisons to examine the correctness of the interpretations.

Sensitivity Analysis

The sensitivity analysis of the structure can be carried out by changing relations one by one in the reachability matrix and redrawing the model each time. The relations that lead to significant change in the model structure are treated as sensitive relations and need to be reinterpreted with care.

Interpreting Paths

Important paths in TISM can be identified from the driver to dependent elements. The interpretation of elements as well as links on the path is to interpreted in totality and discussed for its relevance in the real life setting.

Validating Implications

The ultimate validation of the model would be by way of real life implementation and answering the question:

- *What are the real life implications of the interpretation in the model?*

Illustrative Example

The process of TISM is illustrated with an example of interactions of organizational change forces. The major forces that push the organization towards change are:

globalization, new opportunities, competition, changing customer needs, new technology, e-business, mergers and acquisitions, government policies and legislation, environmental concerns, and global standards (Sushil 2005b; Sushil 2012; Nasim and Sushil 2010, 2011). The basic process of TISM is followed to develop an 'attribute enhancement structure' for the change forces. The basic elements, contextual relationship and interpretation of the relationship are shown in Table 2.

All the organizational change forces are subject to paired comparison with suitable interpretation by the group to evolve the interpretive logic—knowledge base, which is converted into reachability matrix. The reachability matrix is tested for the transitivity rule and updated iteratively. The final knowledge base and reachability matrix satisfying the transitivity rule are shown in Exhibits 1 and 2 respectively in the Appendix. The level partitioning is carried out on the reachability matrix and the first iteration of identifying the elements at level I and the elements arranged as per levels after all the iterations are indicated in Exhibit 3. The elements arranged as per levels are portrayed graphically and the links are mapped from the reachability matrix to develop the diagraph. The transitive links not having any meaningful interpretation are removed and the final diagraph with select transitive links is shown in Exhibit 4. The final diagraph is translated into interaction matrix, which is converted into Interpretive Matrix by using the interpretation given in the knowledge base for the respective relations, as shown in Exhibit 5. The diagraph is translated into ISM by interpreting the nodes, in box-bullet representation, is shown in Exhibit 6. The interpretation of the links is mapped on the ISM from the Interpretive Matrix and the TISM of organizational change forces is obtained as shown in Fig. 2.

The major driving change forces are 'globalization' and 'changing customer needs', that on the one hand, through increasing competition and creation of new opportunities result into 'Mergers & Acquisitions' and on the other, influence the demand as well as access for new technology. This further influences the 'government policies and legislation' on technology, environment and business and end up in evolution of 'global standards' for global compatibility and environmental control.

Conclusions and Future Directions

The process of interpretive structural modeling is revisited and upgraded to TISM by incorporating the interpretation of each relation. This not only would be useful in making the structural model fully interpretive, but will also contribute in creating a knowledge base of the interpretive logic of all the relations. The total interpretive structural models are expected to be supported by deeper knowledge about the system by involving the experts in the group to make the interpretive logic of the directional relation expressed for each paired comparison. The process of TISM, as proposed in this paper, is a first attempt in this direction and thus kept simple in the illustration. The scaling-up of the process relating to multiple interest groups, use of content analysis tools etc. are introduced briefly so as to keep the concept in manageable limits. It may act as a stepping stone in enhancing the interpretiveness in the structural modeling thereby making the logic of the model more transparent rather than leaving it open to multiple interpretations by various users. This will also be helpful in linking structural modeling with knowledge management and making it dynamic to be upgraded further. The application of TISM,

Table 2 Elements, contextual relationship and interpretation for the illustrative example

Element no.	Elements	Contextual relation	Interpretation
	Organizational change forces:	Organizational change force A will influence/enhance organizational change force B	How or in what way organizational change force A will influence/ enhance organizational change force B?
C1	Globalization		
C2	New opportunities		
C3	Competition		
C4	Changing customer needs		
C5	New technology		
C6	E-business		
C7	Mergers and acquisitions		
C8	Government policies and legislation		
C9	Environmental concerns		
C10	Global standards		

as illustrated in the context of organizational change, can be extended to articulate and interpret many more complex and ill-defined issues such as decision-making, culture, policy formulation, and so on.

The TISM method, as proposed in this paper, has already been experimented in a variety of organizational research contexts to derive meaningful insights. It has been applied by Nasim (2011) to conceptualize hierarchical relationships of continuity and change forces in the context of e-government. Other application areas where successful implementation of TISM is made *inter alia*, include: strategic intents of Mergers and Acquisitions; knowledge management and organizational vitalization, strategy execution (Srivastava and Sushil 2011); higher education; telecom policy; technological competitiveness at national level; sustainable enterprise; and strategic performance management.

The panorama of applications of TISM, as mentioned above, has used a variety of innovative ways at different stages of modeling. The elements considered (*what*) in the above applications have used literature as well as grounded theory as the base. The elements identified from either of these approaches have further been validated through expert surveys in order to establish the relevance in a contextual setting. For example, Nasim and Sushil (2010) used literature to generate the elements in e-government context and validated them using expert survey. From the point of view of grounded theory the elements are generated by expert interviews or caselet research in different applications.

The expert opinion on relationships in the form of interpretive logic knowledge base have been obtained through a variety of mechanisms such as expert workshops (Nasim 2011), opinion surveys, and caselet research (Bishwas and Sushil 2011). The relationships and their respective interpretations have further been validated in some of the researches through expert surveys. The discussion of the interpretation of the model has also been enriched through anecdotic evidences (Srivastava and Sushil 2011) in order to enhance the practical understanding of the conceptual model.

The proposed TISM method seems to have a vast untapped potential in answering the fundamental questions in theory building and conceptualization of organizational research incorporating interpretation both from existing theories and grounded theory.

Appendix: Illustration of TISM Process for Organizational Change Forces

Please indicate your response to the relationship between the pair of 'Change Forces' affecting businesses in general, as given below, by writing 'Y' for 'Yes' and 'N' for 'No' and also cite the reason for the same, in brief (See Exhibits 1, 2, 3a–e, 4, 5a, b and 6).

Exhibit 1 Interpretive logic—knowledge base

S. no	Element no	Paired comparison of change forces	Y/N	In what way a change force will influence/enhance other change force? Give reason in brief
C1-Globalization				
1	**C1–C2**	**Globalization will influence or enhance new opportunities**	**Y**	**New markets open up**
2	C2–C1	New opportunities will influence or enhance globalization	N	
3	C1–C3	Globalization will influence or enhance Competition	Y	Greater no. of players to compete with
4	C3–C1	Competition will influence or enhance globalization	N	
5	C1–C4	Globalization will influence or enhance changing customer needs	Y	Customer becomes aware enough to dd more
6	C4–C1	Changing customer needs will influence or enhance globalization	Y	Consumers demand global product & services
7	**C1–C5**	**Globalization will influence or enhance new technology**	**Y**	**Access to new technology**
8	C5–C1	New technology will influence or enhance globalization	N	
9	C1–C6	Globalization will influence or enhance E-business	Y	Transitive
10	C6–C1	E-business will influence or enhance globalization	N	
11	C1–C7	Globalization will influence or enhance mergers and acquisitions	Y	Transitive
12	C7–C1	Mergers and acquisitions will influence or enhance globalization	N	

Exhibit 1 continued

S. no	Element no	Paired comparison of change forces	Y/N	In what way a change force will influence/ enhance other change force? Give reason in brief
13	C1–C8	Globalization will influence or enhance government policies and legislation	Y	Transitive
14	C8–C1	Government policies and legislation will influence or enhance globalization	N	
15	C1–C9	Globalization will influence or enhance environmental concerns	Y	Transitive
16	C9–C1	Environmental concerns will influence or enhance globalization	N	
17	C1–C10	Globalization will influence or enhance global standards	Y	Transitive
18	C10–C1	Global standards will influence or enhance globalization	N	
C2-New opportunities				
19	C2–C3	New opportunities will influence or enhance competition	N	
20	C3–C2	Competition will influence or enhance new opportunities	Y	Competitive pressures compel businesses to look for new opportunities
21	C2–C4	New opportunities will influence or enhance changing customer needs	N	
22	C4–C2	Changing customer needs will influence or enhance new opportunities	Y	Transitive
23	C2–C5	New opportunities will influence or enhance new technology	N	
24	**C5–C2**	**New technology will influence or enhance new opportunities**	**Y**	**New technology may create new business or market….**
25	C2–C6	New opportunities will influence or enhance E-business	Y	Global opportunities facilitated by E-business
26	C6–C2	E-business will influence or enhance new opportunities	Y	Creates global markets
27	C2–C7	New opportunities will influence or enhance mergers and acquisitions	Y	To tap global opportunities and to counter competitive threats
28	C7–C2	Mergers and acquisitions will influence or enhance new opportunities	N	
29	C2–C8	New opportunities will influence or enhance government policies and legislation	Y	Transitive
30	C8–C2	Government policies and legislation will influence or enhance new opportunities	N	
31	C2–C9	New opportunities will influence or enhance environmental concerns	N	
32	C9–C2	Environmental concerns will influence or enhance new opportunities	N	
33	C2–C10	New opportunities will influence or enhance global standards	Y	Transitive
34	C10–C2	Global standards will influence or enhance new opportunities	N	
C3-Competition				
35	C3–C4	Competition will influence or enhance changing customer needs	N	
36	C4–C3	Changing customer needs will influence or enhance competition	Y	Transitive
37	C3–C5	Competition will influence or enhance new technology	Y	Competitors resort to technology for edge
38	C5–C3	New technology will influence or enhance competition	Y	Technological edge may reduce competition.
39	C3–C6	Competition will influence or enhance E-business	Y	Transitive
40	C6–C3	E-business will influence or enhance competition	N	

Exhibit 1 continued

S. no	Element no	Paired comparison of change forces	Y/N	In what way a change force will influence/enhance other change force? Give reason in brief
41	**C3–C7**	**Competition will influence or enhance mergers and acquisitions**	**Y**	**Greater competition leads to consolidation**
42	C7–C3	Mergers and acquisitions will influence or enhance competition	N	
43	C3–C8	Competition will influence or enhance government policies and legislation	Y	Transitive
44	C8–C3	Government policies and legislation will influence or enhance competition	N	
45	C3–C9	Competition will influence or enhance environmental concerns	N	
46	C9–C3	Environmental concerns will influence or enhance competition	N	
47	C3–C10	Competition will influence or enhance global standards	Y	Transitive
48	C10–C3	Global standards will influence or enhance competition	N	
C4-Changing customer needs				
49	C4–C5	Changing customer needs will influence or enhance new technology	Y	Need for variety, lesser cost…
50	C5–C4	New technology will influence or enhance changing customer needs	N	
51	C4–C6	Changing customer needs will influence or enhance E-business	Y	Transitive
52	C6–C4	E-business will influence or enhance changing customer needs	N	
53	C4–C7	Changing customer needs will influence or enhance mergers and acquisitions	Y	Transitive
54	C7–C4	Mergers and acquisitions will influence or enhance changing customer needs	N	
55	C4–C8	Changing customer needs will influence or enhance government policies and legislation	Y	Transitive
56	C8–C4	Government policies and legislation will influence or enhance changing customer needs	N	
57	C4–C9	Changing customer needs will influence or enhance environmental concerns	Y	Transitive
58	C9–C4	Environmental concerns will influence or enhance changing customer needs	N	
59	C4–C10	Changing customer needs will influence or enhance global standards	Y	Transitive
60	C10–C4	Global standards will influence or enhance changing customer needs	N	
C5-New technology				
61	C5–C6	New technology will influence or enhance E-business	Y	Internet based ICT Infrastructure
62	C6–C5	E-business will influence or enhance new technology	N	
63	C5–C7	New technology will influence or enhance mergers and acquisitions	Y	Transitive
64	C7–C5	Mergers and acquisitions will influence or enhance new technology	N	
65	**C5–C8**	**New technology will influence or enhance government policies and legislation**	**Y**	**Prompts new policies & laws**
66	C8–C5	Government policies and legislation will influence or enhance new technology	N	
67	C5–C9	New technology will influence or enhance environmental concerns	Y	Environmental friendly technologies developed address Env. concerns

Exhibit 1 continued

S. no	Element no	Paired comparison of change forces	Y/N	In what way a change force will influence/enhance other change force? Give reason in brief
68	C9–C5	Environmental concerns will influence or enhance new technology	Y	EC pave way for new technology
69	C5–C10	New technology will influence or enhance global standards	Y	Transitive
70	C10–C5	Global standards will influence or enhance new technology	N	
C6-E-business				
71	C6–C7	E-business will influence or enhance mergers and acquisitions	Y	Transitive
72	C7–C6	Mergers and acquisitions will influence or enhance E-business	N	
73	C6–C8	E-business will influence or enhance government policies and legislation	Y	Prompts govt. policies & laws e.g. IT Act,…
74	C8–C6	Government policies and legislation will influence or enhance E-business	N	
75	C6–C9	E-business will influence or enhance environmental concerns	N	
76	C9–C6	Environmental concerns will influence or enhance E-business	Y	
77	C6–C10	E-business will influence or enhance global standards	Y	Transitive
78	C10–C6	Global standards will influence or enhance E-business	N	
C7-Mergers and acquisitions				
79	C7–C8	Mergers and acquisitions will influence or enhance government policies and legislation	Y	Leads govt. to restrict creation of monopolies
80	C8–C7	Government policies and legislation will influence or enhance mergers and acquisitions	Y	Liberalization facilitated M& A
81	C7–C9	Mergers and acquisitions will influence or enhance environmental concerns	N	
82	C9–C7	Environmental concerns will influence or enhance mergers and acquisitions	N	
83	C7–C10	Mergers and acquisitions will influence or enhance global standards	Y	Transitive
84	C10–C7	Global standards will influence or enhance mergers and acquisitions	N	
C8-Government policies and legislation				
85	C8–C9	Government policies and legislation will influence or enhance environmental concerns	N	
86	**C9–C8**	**Environmental concerns will influence or enhance government policies and legislation**	**Y**	**Forces government to act**
87	C8–C10	Government policies and legislation will influence or enhance global standards	Y	To ensure global competitiveness & to reduce environmental damage
88	C10–C8	Global standards will influence or enhance government policies and legislation	N	
C9-Environmental concerns				
89	C9–C10	Environmental concerns will influence or enhance global standards	Y	Transitive
90	C10–C9	Global standards will influence or enhance environmental concerns	N	

Bold Significant transitive

Exhibit 2 Reachability matrix

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
C1	1	1	1	1	1	1	1	1	1	1
C2	0	1	0	0	0	1	1	1	0	1
C3	0	1	1	0	1	1	1	1	1	1
C4	1	1	1	1	1	1	1	1	1	1
C5	0	1	1	0	1	1	1	1	1	1
C6	0	1	0	0	0	1	1	1	0	1
C7	0	0	0	0	0	0	1	1	0	1
C8	0	0	0	0	0	0	1	1	0	1
C9	0	1	1	0	1	1	1	1	1	1
C10	0	0	0	0	0	0	0	0	0	1

Exhibit 3 Partitioning the Reachability matrix into different levels

Variables	Reachability set	Antecedent set	Intersection set	Level
(a): Iteration-1				
C1	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	1, 4	1, 4	
C2	2, 6, 7, 8, 10	1, 2, 3, 4, 5, 6, 9	2, 6	
C3	2, 3, 5, 6, 7, 8, 9, 10	1, 3, 4, 5, 9	3, 5, 9	
C4	1, 2, 3, 4, 5, 6, 7, 8, 9, 10	1, 4	1, 4	
C5	2, 3, 5, 6, 7, 8, 9, 10	1, 3, 4, 5, 9	3, 5, 9	
C6	2, 6, 7, 8, 10	1, 2, 3, 4, 5, 6, 9	2, 6	
C7	7, 8, 10	1, 2, 3, 4, 5, 6, 7, 8, 9	7, 8	
C8	7, 8, 10	1, 2, 3, 4, 5, 6, 7, 8, 9	7, 8	
C9	2, 3, 5, 6, 7, 8, 9, 10	1, 3, 4, 5, 9	3, 5, 9	
C10	**10**	**1, 2, 3, 4, 5, 6, 7, 8, 9, 10**	**10**	**I**
(b): Iteration-2				
C1	1, 2, 3, 4, 5, 6, 7, 8, 9	1, 4	1, 4	
C2	2, 6, 7, 8	1, 2, 3, 4, 5, 6, 9	2, 6	
C3	2, 3, 5, 6, 7, 8, 9	1, 3, 4, 5, 9	3, 5, 9	
C4	1, 2, 3, 4, 5, 6, 7, 8, 9	1, 4	1, 4	
C5	2, 3, 5, 6, 7, 8, 9	1, 3, 4, 5, 9	3, 5, 9	
C6	2, 6, 7, 8	1, 2, 3, 4, 5, 6, 9	2, 6	
C7	**7, 8**	**1, 2, 3, 4, 5, 6, 7, 8, 9**	**7, 8**	**II**
C8	**7, 8**	**1, 2, 3, 4, 5, 6, 7, 8, 9**	**7, 8**	**II**
C9	2, 3, 5, 6, 7, 8, 9	1, 3, 4, 5, 9	3, 5, 9	
(c): Iteration-3				
C1	1, 2, 3, 4, 5, 6, 9	1, 4	1, 4	
C2	**2, 6**	**1, 2, 3, 4, 5, 6, 9**	**2, 6**	**III**
C3	2, 3, 5, 6, 9	1, 3, 4, 5, 9	3, 5, 9	
C4	1, 2, 3, 4, 5, 6, 9	1, 4	1, 4	
C5	2, 3, 5, 6, 9	1, 3, 4, 5, 9	3, 5, 9	
C6	**2, 6**	**1, 2, 3, 4, 5, 6, 9**	**2, 6**	**III**
C9	2, 3, 5, 6, 9	1, 3, 4, 5, 9	3, 5, 9	
(d): Iteration-4				
C1	1, 3, 4, 5, 9	1, 4	1, 4	
C3	**3, 5, 9**	**1, 3, 4, 5, 9**	**3, 5, 9**	**IV**
C4	1, 3, 4, 5, 9	1, 4	1, 4	
C5	**3, 5, 9**	**1, 3, 4, 5, 9**	**3, 5, 9**	**IV**

Exhibit 3 continued

Variables	Reachability set	Antecedent set	Intersection set	Level
C9	**3, 5, 9**	**1, 3, 4, 5, 9**	**3, 5, 9**	**IV**
(e): Iteration-5				
C1	**1, 4**	**1, 4**	**1, 4**	**V**
C4	**1, 4**	**1, 4**	**1, 4**	**V**

S. no	Variable code	Variables	Level in the TISM
f: List of variables and their levels in TISM			
1.	C10	Global standards	I
2.	C7	Mergers & acquisitions	II
3.	C8	Govt. policy & legislations	II
4.	C2	New opportunities	III
5.	C6	E-business	III
6.	C3	Competition	IV
7.	C5	New technology	IV
8.	C9	Environmental concerns	IV
9.	C1	Globalization	V
10.	C4	Changing customer needs	V

Bold indicates variables selected at respective levels

Exhibit 4 Diagraph with significant transitive links

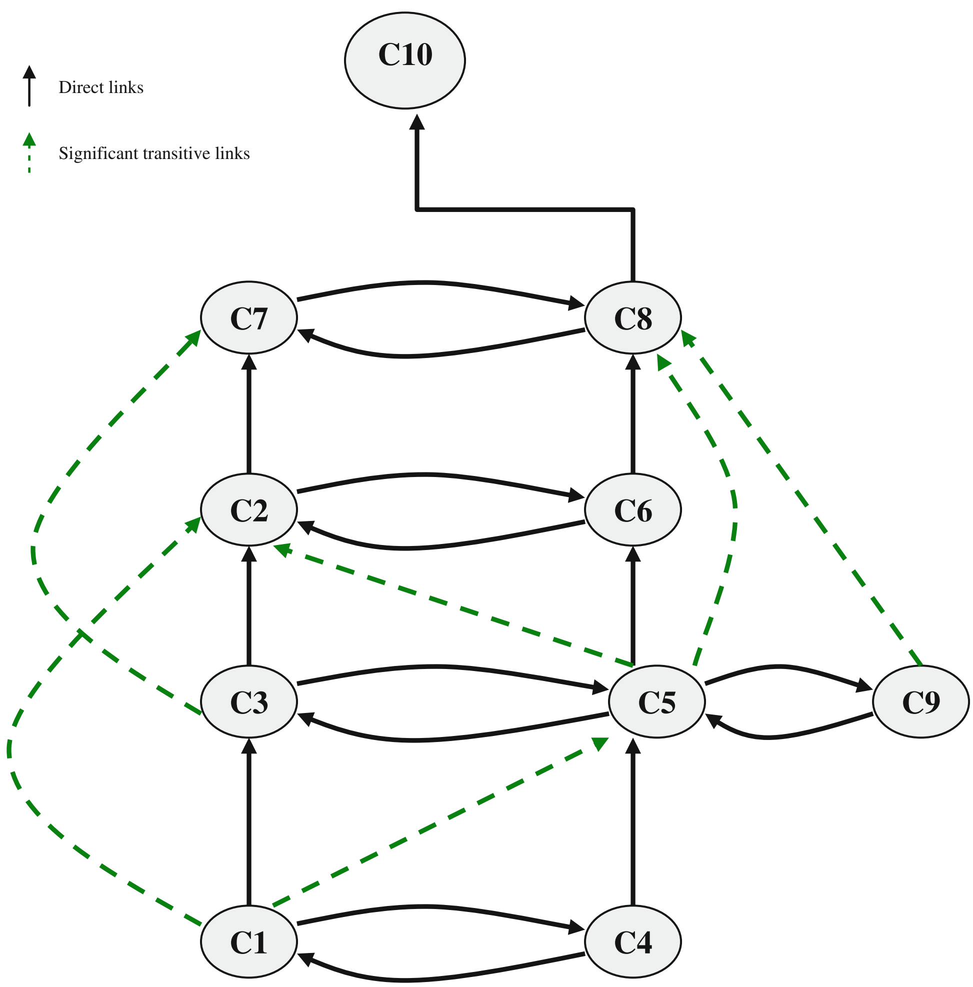

Exhibit 5 Interaction matrix

	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10
(a): binary matrix										
C1	–	*1*	**1**	**1**	*1*	0	0	0	0	0
C2	0	–	0	0	0	**1**	**1**	1	0	0
C3	0	**1**	–	0	**1**	0	*1*	0	0	0
C4	**1**	0	0	–	**1**	0	0	0	0	0
C5	0	1	*1*	0	–	**1**	0	*1*	**1**	0
C6	0	**1**	0	0	0	–	0	**1**	0	0
C7	0	0	0	0	0	0	–	**1**	0	0
C8	0	0	0	0	0	0	**1**	–	0	**1**
C9	0	0	0	0	**1**	0	0	*1*	–	0
C10	0	0	0	0	0	0	0	0	0	–
(b): interpretive matrix										
C1	–	Opens new markets	Greater no. of players to compete with	Customer becomes aware enough to demand more	Access to new technology	–	–	–	–	–
C2	–	–	–	–	–	Global opportunities facilitated by E-business	To tap global opportunities and requirement of new competencies	–	–	–
C3	–	Competitive pressures compel businesses to look for new opportunities	–	–	Competitors resort to technology for edge	–	Lead to consolidation	–	–	–
C4	Customers demand global products & services	–	–	–	Need for variety, lesser cost…	–	–	–	–	–
C5	–	Opens new area of business or market	Technologic-al edge may reduce competition	–	–	Internet based ICT Infrastructure	–	Techno-logy transfer policy	Technology can both address & aggravate EC	–
C6	–	Creates global markets	–	–	–	–	–	Prompts govt. policies & laws e.g. IT Act…	–	–
C7	–	–	–	–	–	–	–	Leads govt. to restrict creation of monopolies	–	–
C8	–	–	–	–	–	–	Liberalization-on facilitated M & A	–		To ensure global compatibility& less environmental damage
C9	–	–	–	–	EC pave way for new technology	–	–	Forces Govt. to act		
C10	–	–	–	–	–	–	–	–	–	–

Bold direct link

Italic Significant transitive link

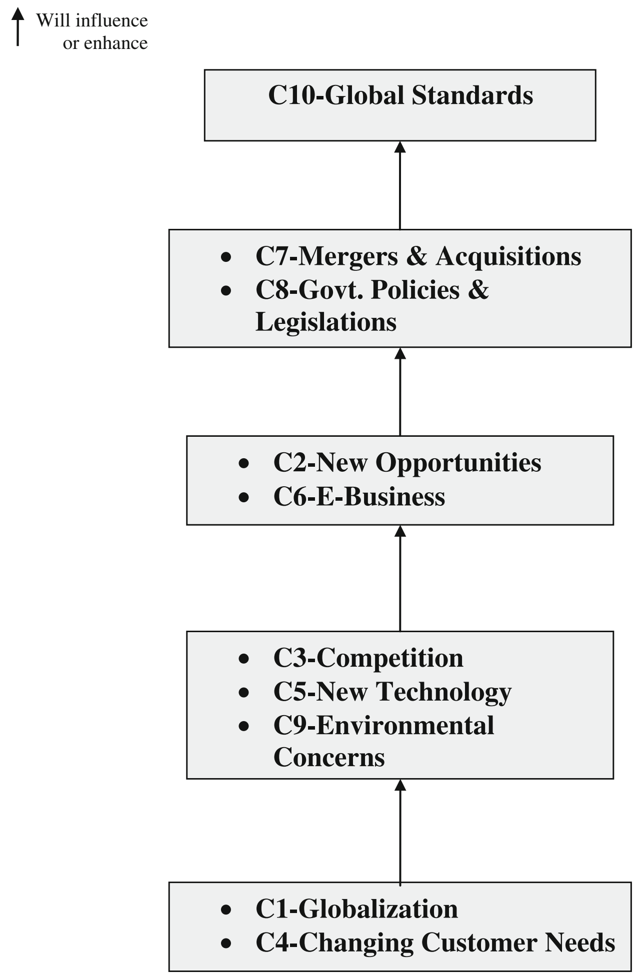

Exhibit 6 Interpretive structural model (ISM) of organizational change forces

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Key Questions Reflecting Applicability in Real Life

1. In what way, Total Interpretive Structural Modeling (TISM) will be helpful in conceptualization of research framework?
2. What are the dominant application areas of TISM in modern business organizations?
3. At which level applicability of TISM is higher: strategic or operational?

Author Biography

Sushil is Professor of Strategic, Flexible Systems and Technology Management, and Chair, Strategic Management Group at the Department of Management Studies, Indian Institute of Technology Delhi. He has served as Visiting Professor and delivered seminars in many leading universities; some representative ones are University of Minnesota, Minneapolis, MN, Stevens Institute of Technology, NJ, University of Lethbridge, Alberta, Université Paris 1 Panthéon-Sorbonne, Paris, among others. He is an active researcher and supervised more than 50 doctoral dissertations. He is having eighteen books to his credit in the areas of Flexibility, Strategy, Systems Thinking, and Technology Management. He has over 250 papers in various refereed journals and conferences.

He has pioneered the area of 'Flexible Systems Management' and made original contributions to the field of knowledge in the form of interpretive approaches in management such as SAP-LAP models/linkages, Total Interpretive Structural Modeling, and Interpretive Ranking Process. He has evolved the concept and framework of 'Flowing Stream Strategy' as strategic flexibility to manage continuity and change. He has also provided mantras for continuous organizational vitalization (LIFE), and models for strategic performance management (Flexible Strategy Game-card), sustainable enterprise (Star Model) and strategy execution (4A's Model).