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Incorporating polarity of relationships in ISM and TISM for theory building in information and organization management

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ABSTRACT

Some mapping methods are used for the conceptualization of theories in information and organization management which may help in modeling both feedback and hierarchical structures. Total Interpretive Structural Modelling (TISM) is an enhancement of interpretive structural modeling (ISM) to explore hierarchical models that aid in theory building in information and organization management. It is based on pair comparison method to generate a hierarchical digraph, which is then translated into the interpretive model by interpreting both nodes and links in the digraph. The relationships in both ISM and TISM could be binary or fuzzy. However, a missing dimension of these structural models is the polarity or direction of relationships. A relationship between a pair of elements could be having positive or negative polarity. This aspect has been widely used in the feedback structures as causal influence diagrams (CIDs) in system dynamics methodology. This paper is using the learning from CIDs to introduce polarity of relationships in ISM and TISM. The polarity of relationships will further refine ISM/TISM as a more explanatory model for theory building. This enhanced model not only provides hypothesis formulation simply as a driver-dependence relationship but also addresses whether the driving variable(s) will influence the dependent variable positively or negatively. The paper illustrates modified TISM process incorporating polarity with an example in the context of information and organizational change management and discusses the nuances of such an enhanced model.

1. Introduction

Theory building in information and organization management requires mapping of mental models and hypothesized relationships. This mapping has been aided by a range of methods such as cognitive mapping (Eden, 1988), system dynamics (Forrester, 1968), and ISM/TISM. Both Interpretive Structural modeling (ISM) (Warfield, 1974) and Total Interpretive Structural Modelling (TISM) (Sushil, 2012, 2016) are interpretive methods to crystallize ill-structured mental models into well-articulated hierarchically structured conceptual models. Both researchers and practitioners have used these as enabling aids in conceptualization and theory building. The fundamental questions in theory building such as 'what', 'how' and 'why', as given by Whetten (1989), are addressed by these interpretive methods. ISM effectively addresses the first two questions, i.e. 'what' and 'how' regarding elements and their hierarchical (driver-dependence) relationships, whereas TISM further addresses the question 'why' and brings more explanatory power in the context of theory building. There is yet another dimension in theory building and formulation of a hypothesis, i.e., the polarity of relationships. This dimension explains the direction of the relationship between independent and dependent variables, i.e., whether the independent variable(s) is/are influencing the dependent variable positively or negatively (Eisenhardt, 1989). Such positive and negative relationships are extensively used in theory building in the context of information and organization management.

Even though the application of both ISM and TISM is in vogue, the literature on these modeling methods is almost silent on the concept of polarity in relationships, which is integral to the process of conceptualization and theory building. This concept of polarity is extensively used in the context of System Dynamics (SD) methodology that portrays feedback structures in the form of causal influence diagrams (Forrester, 1975; Sterman, 2000). The learning and significance of polarity in system dynamics are reflected to examine and define the polarity of relationships in ISM and TISM to make them far more powerful by portraying the direction of relationships in a more explanatory manner. Hypotheses conceptualizing positive and negative relationships have been developed by some researchers in information and organizational management. For example, Lane, Salk, and Lyles (2001) hypothesized that absorptive capacity and learning relate positively to joint venture performance. Whereas Morris and Cadogan (2001) related partners conflict with quality of joint venture marketing strategy both positively (functional) and negatively (dysfunctional).

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Dhir and Sushil (2017) related constructs from transaction cost and social exchange paradigms with modification and termination flexibilities of cross-border joint ventures both positively and negatively.

The main objectives of this paper are:

(i) To propose an enhanced methodology of ISM/TISM incorporating polarity of relationships to aid theory building in information and organization management.
(ii) To refine the classification of variables in the conceptual framework as driver, linkage, autonomous and dependent variables with a positive or negative orientation.
(iii) To identify the positive and negative paths from driver variables to dependent variables, via linkage or intermediate variables in the management of information and organizational change.

The paper first gives a selective review of evolution and application of ISM/TISM methodology. It also briefly reviews system dynamics methodology to bring out the significance of polarity of relationships. The methodology of incorporating polarity of relationships in modified ISM/TISM process with simultaneous transitivity checks (Sushil, 2017a) is elaborated. It then gives an illustrative example in the context of information and organizational change management to develop a TISM model of criteria for evaluating change propositions with the polarity of their relationships. Finally, it provides a discussion of its implications and concludes with limitations and directions for further research.

2. Literature review

A selective review of evolution and application of ISM/TISM is first provided, which is supported by an overview of SD methodology to highlight the significance of polarity of relationships. This review has led to the identification of a gap area of the polarity of relationships which has not yet been effectively addressed in the ISM/TISM process.

2.1. Evolution and application of ISM/TISM

The paired comparison method for unearthing the hierarchical structure among a set of elements/variables was introduced by Warfield (1974). He effectively utilized the paired relationships in a directional frame of reference using a contextual relationship to portray the hierarchical structure among them in the form of a digraph. This abstract digraph is interpreted regarding elements and their directional relationships as Interpretive Structural Model. The paired comparisons are used to minimize cognitive overload but require a system engineering approach to synthesize them in the form of a reachability matrix with transitivity checks. The reachability matrix indicates the reachability of one element to the other elements in the set. The transitivity implies that if element *i* reaches element *j* and element *j* reaches element *k*, then element *i* transitively reaches element *k*. The algorithms for transitivity checks and hierarchical partitioning have been presented in Warfield (1990). Some early applications of ISM are reported by Jedlicka and Meyer (1980), Malone (1975), Mandal and Deshmukh (1994), Saxena, Sushil, and Vrat (1990, 1992), and Sharma, Gupta, and Sushil (1995). The indirect relationships have been analyzed by using MICMAC method by Saxena et al. (1990). A large number of applications of ISM and MICMAC have been made in the extant literature. The applications of ISM have largely been made in the context of operations and information management. Some recent applications of ISM are related to IT enablers (Thakkar, Kanda, & Deshmukh, 2008), world-class manufacturing (Haleem, Sushil, Qadri, & Kumar, 2012), supply chain risk (Venkatesh, Rathi, & Patwa, 2015), and supply chain resilience (Jain, Kumar, Soni, & Chandra, 2017). In the context of information management, it has been applied to study factors of information systems project failure (Hughes, Dwivedi, Rana, & Simintiras, 2016; Hughes, Dwivedi, & NP, 2017); hierarchy of factors related to innovation using big open linked data (Dwivedi et al., 2017), and digital government trustworthiness (Janssen, Rana, Slade, & Dwivedi, 2018), among other applications. It has also been applied to supplier development enablers (Dalvi & Kant, 2017), lean, green and resilient supply chain management (Cherrafi, Elfezazi, Garza-Reyes, Benhida, & Mokhlis, 2017; Ruiz-Benitez, López, & Real, 2017), and so on.

However, it was observed that despite extensive application of ISM in a variety of areas these models (developed by ISM) are partly interpreted. ISM is a graph-based method (a graph consists of nodes as well as links), but it has been interpreting only nodes and partly interpreting links by defining the contextual relationship. The total interpretation of both nodes and links has been attempted in the form of Total Interpretive Structural Modelling (TISM) by Sushil (2012). After the advent of this enhancement of ISM, it has been applied in some areas such as drug selling (Wasuja, Sagar, & Sushil, 2012), sustainable manufacturing (Dubey, Gunasekaran, Sushil, & Singh, 2015), organizational excellence (Agarwal & Vrat, 2015), and strategic performance management (Yadav, Sushil, & Sagar, 2015). Some other areas of application of TISM are green supply chain management (Shibin et al., 2016), workplace flexibility (Yadav, Rangnekar, & Bamel, 2016), inland waterborne transport (Kumar, Haleem, Qamar, & Khan, 2017), agile performance in healthcare (Patri & Suresh, 2017), sustainable supply chain performance (Sandeepa & Chand, 2018; Shibin, Gunasekaran, & Dubey, 2017), and so on.

Further, it is noted that a good number of applications of both ISM and TISM that have been published had technical errors. The correctness of these models can be checked by following the guidelines provided by Sushil (2016). It has also been realized that the key challenges in the application of both ISM and TISM are a large number of pair-comparisons to be made by experts and cumbersome multi-order transitivity checks are to be carried out. These challenges can be obviated by a modified ISM/TISM method that has been developed to carry out transitivity checks along with the direct pair comparisons (Sushil, 2017a). This modified method provides a substantial reduction in direct pair-comparisons by eliminating redundant comparisons that can be easily derived by the transitivity logic.

Apart from the development of TISM and other recent improvements in the ISM/TISM method, attempts had been made to obtain the strength of each pair relationship using fuzzy set theory (Zadeh, 1965). An early initiative in this direction was taken by Saxena et al. (1992) to provide a framework of fuzzy ISM. Recently, Khatwani, Singh, Trivedi, and Chauhan (2015) provided the methodology of fuzzy TISM, which has been applied in some cases (Mohanty & Shankar, 2017). In addition to methodological advancements, innovations in implementation of ISM and TISM have been made in terms of empirical validation (Anbarasan & Sushil, 2018; Bishwas & Sushil, 2016; Srivastava & Sushil, 2015), factor analysis to derive the elements for ISM/TISM (Chatterjee, Kar, & Gupta, 2017), anecdotal evidence in verifying the model in real life (Singh & Sushil, 2017), and so on. One recent advancement has been made to use TISM as a basis for deriving weights of criteria in MCDM methods by taking their driving power as the basis and used it in conjunction with Interpretive Ranking Process (Sushil, 2009) in the form of the TISM-IRP process by Sushil (2017b, 2018). Despite these developments, it is noticed that almost none of the past works on ISM/TISM has taken into consideration the polarity of relationships, which has been used in developing causal influence diagrams (CIDs) as a conceptualization tool in system dynamics methodology. A brief review of the same is given in the next section to provide a basis and inspiration for considering the issue of the polarity of relationships in the ISM/TISM process.

2.2. Polarity of relationships in system dynamics

System Dynamics (SD) methodology is a dynamic simulation method to test the dynamic hypothesis in any system. The dynamic hypothesis is portrayed in the form of causal influence diagrams (CIDs) to present the feedback structure logically. The SD methodology was

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