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DEVELOPMENT OF LOOP DESTRUCTIVE NETWORK ANALYSIS

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ABSTRACT

Background: *Research on risk network analysis has not developed a simple method that is based on the destructive network function of nodes.* ***Objective:*** *Hence, we propose loop destructive network analysis (LDNA), a method of identifying the most influential relation and node to break (destruct) a major number of loops. For this purpose, general connectivity is reduced with minimal effort.* ***Case study:*** *LDNA is applied in the connective network of construction corporate social responsibility (CSR) implementation risks. The process and result are showcased and discussed to deliver a clear understanding on LDNA.* ***Significance:*** *This method will aid the success of resource planning in systematic risk reduction.*

KEY WORDS
Risk analysis
Dynamic modelling
Network of risks

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INTRODUCTION: MODEL DEVELOPMENT

Risk analysis [1–7] and dynamic modeling [8–11] have been studied to show construction stakeholders the best identification and analysis approaches for risk networks. These networks contain negative loops, and possible issues resulted from negative loops in a continuous and stronger risk effect. Studies have focused on identifying and rectifying risk of nodes and reducing the effect of one node of risk to another. However, research on risk network analysis has not developed a simple method that is based on the destructive network function of nodes and relationships in loops of negative effects. In general, two perspectives that are based and depend on the nature of phenomena are used to destroy major loops in networks, namely, node- and relation-based loop destruction. A simplified model proposal framework for both perspectives is described below.

Step 1. Identifying loops: The loops are mapped and are classified on the basis of the number of nodes involved. For example, we should seek “n−1” type loops in the network of “n” node (e.g., 2-node type, 3-node type, ….“n”-node type of loops).

Step 2. Identifying the most loop-destructive-single node(s) and/or relationship(s): The destructive factor (DF) of each node and/or relation considered dividing the number of loops that the node involved in the total number of loops.

Step 3. Identifying the best sequential partner(s) nodes and/or relations most loop-destructive-single node(s): The highest DF that combines the minimum number of nodes and /or relations that ensures the maximum number of alternative solutions is reached. The result is introducing optimum node and/or relation combinations to destroy all the loops in the networks and to reach a full DF of 1.

CASE STUDY

[Fig. 1] shows an observed conceptual network of issues in implementing construction corporate social responsibility (CSR). The network is adopted from Keyvanfar et al. (2018) [12]. Every node in [Fig.1] influences and is influenced by another set of nodes. The network possesses several negative infinitives loops. We must eliminate effective nodes in the network to optimize the reduction of the negative effect of the loops. The target problem is eliminating the minimum number of nodes to destroy the loops only. The proposed step-by-step node-based LDNA is discussed below.

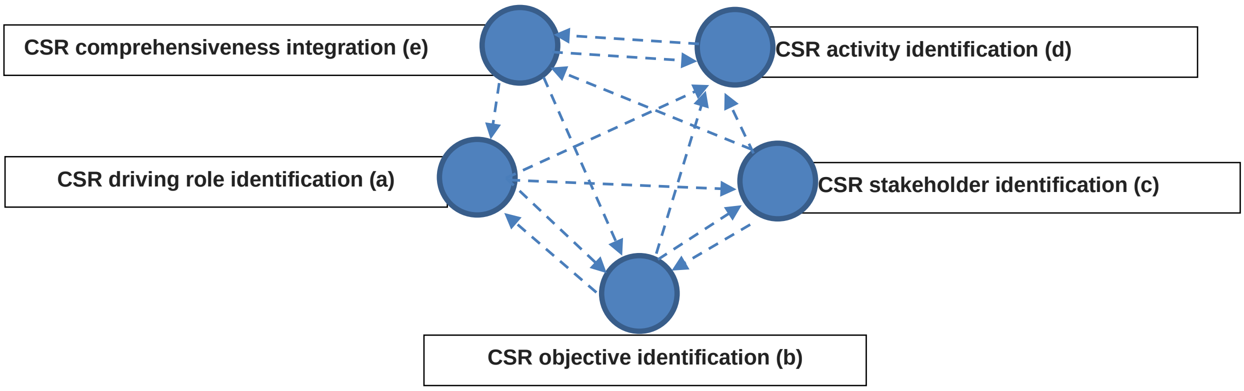

Fig. 1: Connective network of CSR implementation risks

Step 1: The loops are identified. Two-, three-, four-, and five-node loops are present. In [Fig.2], we classify the loops to introduce the investigated loop in the studied network. Fifteen loops are investigated, of which three, four, five, and three loops are two-, three-, four-, and five-node types, respectively.

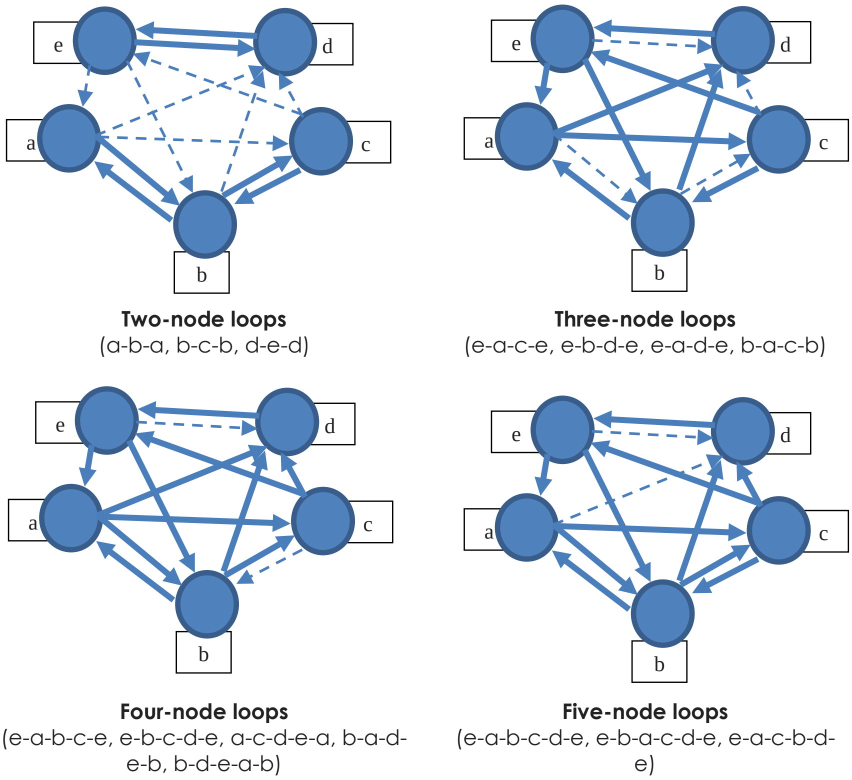

Fig. 2: Loop mapping of the connective network of CSR implementation risks

Step 2: The most involved nodes in the different loops are investigated. The DF for each node is calculated [Table 1]. The DF of each node considers dividing the number of loops that the node involved in the total number of loops. The DFs of nodes (e) and (c) of 0.8 and 0.6 are the highest and lowest, respectively.

Table 1: DF calculation based on investigating most repeated node in network loops of CSR issues

Node		Frequency	DF
a	CSR driving role identification issues	11	0.733
b	CSR objective identification issues	11	0.733
c	CSR stakeholder identification issues	9	0.6
d	CSR activity identification issues	10	0.667
e	CSR comprehensiveness integration issues	12	0.8

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Step 3: The best partners of the node (e) are investigated.
First, the DFs of every combination of the node (e) with other nodes are calculated [Table 2]. Alternative nodes (a), (b), (c), and (d) are available for possible partnership with (e) (For example, the partnership of (e) and (a) is accumulation of DF of (e) and (a) without double-counting the shared loops in which (e) and (a) both exist.). Within these alternatives, combinations of (e) with (a), (b), or (c) produce the maximum DF. (d) cannot be an effective partner because the DF of its combination with (e) is low and is even the same as that of (e) alone. Given that the DF of two-node combinations is not satisfactory (i.e., 1), we identify possible three-node combinations.

The DF of every combination of other nodes with (e-a) is listed in [Table 3]. The DF of the combination of (e-a) with (b) or (c) results in a satisfactory level of 1. The same result is obtained for the combination of (e-c), and (a) or (b) and for that of (e-b) and (a), or (c), or (d). The combination of (e-b) presents three alternatives to find the best third partner, whose partnership is preferred for destructive efforts to those of other alternatives introduced in step 2.

This will guide us to introduce the combination of node (e), and (b), and (a), or (c), or (d) as the result of the current LDNA case study, where (e) is the most loop-destructive node.

Table 2: DF calculation to establish the best two-node partnerships with most loop-destructive node

Node combination	Frequency	DF	Node combination	Frequency	DF
a and b	14	0.933	b and d	14	0.933
a and c	13	0.867	b and e	14	0.933
a and d	14	0.933	c and d	14	0.933
a and e	14	0.933	c and e	14	0.933
b and c	13	0.867	d and e	12	0.8

Table 3: DF calculation to establish best three-node partnership with most loop-destructive node

Node combination	Frequency	DF	Node combination	Frequency	DF
a and b and c	14	0.933	a and d and e	14	0.933
a and b and d	15	1	b and c and d	15	1
a and b and e	15	1	b and c and e	15	1
a and c and d	15	1	b and d and e	15	1
a and c and e	15	1	c and d and e	14	0.933

Addressing comprehensive CSR integration risks [node (e)] will help address network of risks and is the most efficient target to consider. Such findings are important because researchers can reconsider the future direction of this body of knowledge and effectively eliminate the problems of CSR implementation.

SIGNIFICANCE

LDNA is partially showcased in this case study to introduce its steps and logic of approach to readers. The proposed method is only for small human-based decision-making group discussions. The method can significantly support relevant decision-making in reducing the negative loops of a network of risk. Although we use construction risk as the impetus for this research, the method is appropriate for general applications, and it will be introduced in upcoming manuscripts.

CONFLICT OF INTEREST
The authors do not have any conflict of interest.

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