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Mehmet A. Koseoglu
Metropolitan State University, koseoglu.mehmetali@gmail.com

John A. Parnell
University of North Alabama, jparnell@una.edu

Hasan E. Arici
Kastamonu University, hasanevrimarici@yahoo.com

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Authors

Corresponding Author

Mehmet Ali Koseoglu, Metropolitan State University, 1501 Hennepin Ave/Minneapolis, MN 55403

Abstract

Hospitality and tourism (H&T) researchers employ structural equation modeling (SEM) and other multivariate techniques to test their models with survey data. These approaches assess relationships among constructs and model fit, but they do not highlight the most influential survey items or links among them. Other challenges include method-specific requirements for appropriate data, the best indices to identify optimal models, minimum sample sizes, missing data, and interpreting the results from complex models. Co-occurrence network analysis (CNA) can mitigate these limitations. This study validates CNA in the H&T field with a survey dataset that assesses market strategy, nonmarket strategy (NMS), organizational values, and firm performance. CNA is proposed as a complement to existing multivariate approaches for assessing survey data. The assessment includes nine steps: (1) identify the research purpose and hypothesis, (2) determine the hypothesis-related items to measure, (3) determine the sample, (4) administer the survey, (5) determine the analysis method, (6) test the hypotheses, (7) prepare survey inputs for CNA, (8) employ CNA, and (9) visualize and interpret results. This pathway demonstrates how future research can apply and address CNA's advantages and limitations.

Keywords

co-occurrence network, multivariate analysis, methodology, sample size

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Co-Occurrence Network Analysis (CNA) as an Alternative Tool to Assess Survey-Based Research Models in Hospitality and Tourism Research

Mehmet Ali Koseoglu[1], John A. Parnell[2], and Hasan Evrim Arici[3]

College of Management
Metropolitan State University, Minneapolis, USA
[1]koseoglu.mehmetali@gmail.com

College of Business
University of North Alabama, USA
[2]jparnell@una.edu

Faculty of Tourism
Kastamonu University, Kastamonu, Turkey
[3]hasanevrimarici@yahoo.com

Abstract

Hospitality and tourism (H&T) researchers employ structural equation modeling (SEM) and other multivariate techniques to test their models with survey data. These approaches assess relationships among constructs and model fit, but they do not highlight the most influential survey items or links among them. Other challenges include method-specific requirements for appropriate data, the best indices to identify optimal models, minimum sample sizes, missing data, and interpreting the results from complex models. Co-occurrence network analysis (CNA) can mitigate these limitations. This study validates CNA in the H&T field with a survey dataset that assesses market strategy, nonmarket strategy (NMS), organizational values, and firm performance. CNA is proposed as a complement to existing multivariate approaches for assessing survey data. The assessment includes nine steps: (1) identify the research purpose and hypothesis, (2) determine the hypothesis-related items to measure, (3) determine the sample, (4) administer the survey, (5) determine the analysis method, (6) test the hypotheses, (7) prepare survey inputs for CNA, (8) employ CNA, and (9) visualize and interpret results. This pathway demonstrates how future research can apply and address CNA's advantages and limitations.

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Introduction

H&T scholars continuously seek ways to assess survey-based research models with greater precision (Assaf & Tsionas, 2019). More sophisticated statistical techniques have been recently developed or borrowed from other disciplines (Assaf & Tsionas, 2019; McCartney, 2008; Mehmetoglu, 2004; Pham & Nguyen, 2019; Tasci, et al., 2014). However, many H&T scholars are not fully aware of the applicability and limitations of these tools (Ali et al., 2018). Even advanced approaches such as SEM does not identify the most influential items in a survey or visualize the links among them (Breitsohl, 2019). Many advanced methods offer distinct advantages, such as model fit indices and hypothesis testing via path analysis. However, if a non-significant relationship has been identified, researchers must exclude certain variables from the dataset. More importantly, data collection is time-consuming, and recollection is difficult. This often presents a pertinent challenge, such as when assessing sources of carbon emissions (Liu et al., 2011). Despite its importance, there is a need for a study that proposes a new method or approach to detect some unexpected challenges or issues in quantitative analysis, such as non-significant relationships and substantial problems with validity or reliability. Thus, developing an approach that grasps and visualizes such issues before testing hypotheses would be applicable in empirical analyses.

This study aims to validate the CNA approach as an alternative means of pretesting and visualizing links within and between scale items in a dataset. This also provides an understanding of how CNA could improve the process of empirical analysis in the field. CNA can address these challenges. This paper introduces and demonstrates the utility of this type of network analysis as a complementary methodological approach to better assess outputs from surveys and survey-based research models. As an application, CNA is employed to assess the links in a dataset that includes the emphases on market and nonmarket strategies, organizational values, and firm performance. This study demonstrates how this methodological extension can improve interpretations obtained from surveys and propose it to complement existing approaches in the literature.

This paper is organized as follows. First, the limitations and challenges associated with current survey methods are addressed, and CNA is introduced as an alternative. Second, the benefits of CNA are discussed by applying it to survey data. Finally, the pros and cons of this approach are considered by comparing the results with those obtained from multivariate analysis. The assessment includes nine steps: (1) identify the research purpose and hypothesis, (2) determine the hypothesis-related items to measure, (3) determine the sample, (4) administer the survey, (5) determine the analysis method, (6) test the hypotheses, (7) prepare survey inputs for CNA, (8) employ CNA, and (9) visualize and interpret results.

Literature Review

Limitations and Challenges When Analyzing Survey Outputs

Social scientists frequently use surveys to measure human intentions and predispositions. However, survey data is inherently challenging because of measurement errors associated with samples, item wording and interpretation, and disparate approaches to data analysis. Researchers have established methodological protocols to mitigate the effects of measurement error, but continuous improvement is warranted (Bou & Satorra, 2018; Clougherty et al., 2016). Scholars employ three types of analyses to examine survey outputs.

First, univariate analysis (e.g., frequency analysis, t-tests, measures of central tendency, z-tests) is descriptive and includes only one variable at a time. Unfortunately, one variable cannot explain minimally complex organizational phenomena. Second, bivariate analysis examines relationships between an independent and a dependent variable at a single point in time. Examples of bivariate analysis include regression analysis, crosstabulation, scattergrams, rank-order correlation, and meaningful comparisons. Although bivariate analysis represents a substantial improvement over univariate approaches, it is limited to two variables. Third, multivariate analysis examines links among more than two variables at a single point in time. Methods such as partial rank-order correlations, multiple and partial correlations, multiple and partial regression, and path analysis overcome the limitations associated with univariate and bivariate methods. Multivariate approaches represent the current standard in sophisticated organizational research, but they have shortcomings as well. First, regression models, structural equation models, configuration models, and other multivariate methods are built on unique sets of assumptions. Before using a multivariate approach, researchers should conduct a preliminary analysis to evaluate data distribution, content validity, reliability, multicollinearity, and other potential concerns. If the data does not meet the established minimum thresholds, researchers should either abandon the process or employ only simple statistical methods to capture primary findings.

Furthermore, even if the preliminary assessments meet the appropriate thresholds, the goodness-of-fit indices may not support the hypothesized model(s). When this occurs, researchers can either abort the process entirely or refine the model based on the best goodness-of-fit indices. H&T researchers (e.g., Koseoglu et al., 2019) can select the second option, although determining the amount of unreported model refinement that occurs is not possible. Nonetheless, it is difficult to interpret and explain significant links among the constructs and to identify the most influential items in the model. This challenge exists even if regression analysis, SEM, or other advanced multivariate techniques produce reasonable results.

Finally, because some multivariate analyses are highly complex, the results are difficult to interpret even under the best of circumstances. Most datasets contain extraneous or missing data that require scholarly judgment calls. Moreover, results are influenced by the size of the sample. Scholars can benefit from a tool that analyzes outputs at the item level and facilitates interpretation without limits associated with missing data and sample size. CNA meets these criteria and supplements existing methods by adding a means of visualization.

CNA

Co-occurrence is a relationship between a pair of actors or items that appear together in any context (Lancho-Barrantes & Cantú-Ortiz, 2019; Xu et al., 2018). Scientists have used this term for decades primarily to analyze the intellectual structure (co-citation analysis), contextual structure (co-word analysis), and social structure (co-authorship analysis) of a discipline by using publications' bibliographies (i.e., citations, keywords, and authors/institutions) (Ciano et al., 2019; Pestana et al., 2019). Scholars have also employed CNA to analyze relationships among terms in a text as a part of qualitative analysis (Chen et al., 2018; Sulis et al., 2022). Factor analysis and multidimensional scaling can be used to assess these co-occurrences. Still, these approaches do not identify the (in)connections among actors and the (non)influential actor(s) in these co-occurrences. Researchers have sought to overcome these limitations with social network analysis (Koseoglu et al., 2015; Tang et al., 2014).

CNA is a type of social network analysis that helps researchers elucidate actors or items' positions in the network (Kumari et al., 2021; Tang et al., 2016). This study refers to the social network approach as CNA. Previous research proposed CNA as a legitimate approach to visualize potential links within and across various constructs (Freilich et al., 2010). In doing so, quantitative researchers could benefit from the outputs of this approach by initially detecting distribution and interconnections of items as well as potential ties between variables studied. In other words, CNA can help identify hypothesized relations before conducting multivariate analysis, which inherently requires further effort and patience. When employing CNA, researchers can discern (non)influential actors or items in the network and visualize interactions among them (Otte & Rousseau, 2002). Based on the findings, they can enhance the performance of related issues by refining innovation and learning strategies. For example, in a co-citation analysis through CNA, researchers can identify the most influential citations as central, peripheral, or bridging in the network. More importantly, CNA enables researchers to modify (if necessary) their study models before submitting hypothesis testing. The following example illustrates this type of application to survey data.

Step by Step Tutorial With an Example

This example applies CNA to Koseoglu et al.'s (2019) analysis of NMS and performance among hotels in Hong Kong. It provides context by providing a brief overview of the constructs addressed in the study. Readers interested in a more detailed discussion should consult the initial study. Koseoglu et al. (2019) examined how a firm's emphasis on market and nonmarket strategies, and organizational values impact performance. Market strategies seek to enhance organizational performance by dealing with competitors, customers, and suppliers (Altinay & Arici, 2021; Morgan & Vorhies, 2018; Zollo et al., 2018). In contrast, NMS includes organizational actions that seek to improve firm performance outside of the market dimension (Frynas et al., 2017; Liedong et al., 2017; Parnell, 2018). Some scholars view NMS as a necessary strategic complement, while others see it as an alternative to market orientation (Doh et al., 2012; Henisz & Zelner, 2012; Kingsley et al., 2012; Meyer & Peng, 2016; Rodgers et al., 2021).

Theoretical viewpoints have also endorsed the positive association of NMS and organization performance (e.g., Liu & Chen, 2015; Parnell, 2015). To illustrate, the resource-based view of Barney (1991) addresses the importance of external facilities in the saturation of strategic resources (Koseoglu et al., 2019). Stakeholder theory emphasizes the necessity for planners to view a comprehensive range of units that affect and are influenced by their activities (Hillman & Keim, 2001). Institutional theory addresses the role of a business in affecting its structure and strategic decisions (Hadani, 2012). Finally, public choice theory highlights the reciprocal exchange firms seek from public organizations (Wood & Frynas, 2006). From these theoretical perspectives, NMS can be viewed positively because it can contribute to corporate social responsibility and enhance relationships with stakeholders (Morsing & Roepstorff, 2015; Scherer et al., 2016; Wickert, 2016) or negatively because it embodies cronyism and corruption through lobbying and political engagement (Iriyama et al., 2016; Néron, 2016; Unsal et al., 2016). Values are enduring beliefs that transcend specific situations and guide the selection or evaluation of behavior (Bourne & Jenkins, 2013). Organizational values play important roles in the strategic decision-making process (Badovick, & Beatty, 1987; Dunn et al., 1994; Gehman et al., 2013; Williams, 2002; Zheng et al., 2010). Scholars have identified links between combinations of values and firm performance (Büschgens et al., 2013; Garcia & Archer, 2012; Parker et al., 2003; Parnell, 2021; Voss & Voss, 2000). Koseoglu et al. (2019) assessed the links among market and nonmarket strategies, organizational values, and firm performance. This study illustrates CNA by investigating the links among market strategies (cost leadership and differentiation strategies), nonmarket strategies, organizational values, and firm performance within market and competition, customer, and financial dimensions, as depicted in the research model in Figure 1.

https://digitalcommons.usf.edu/globe/vol7/iss1/5
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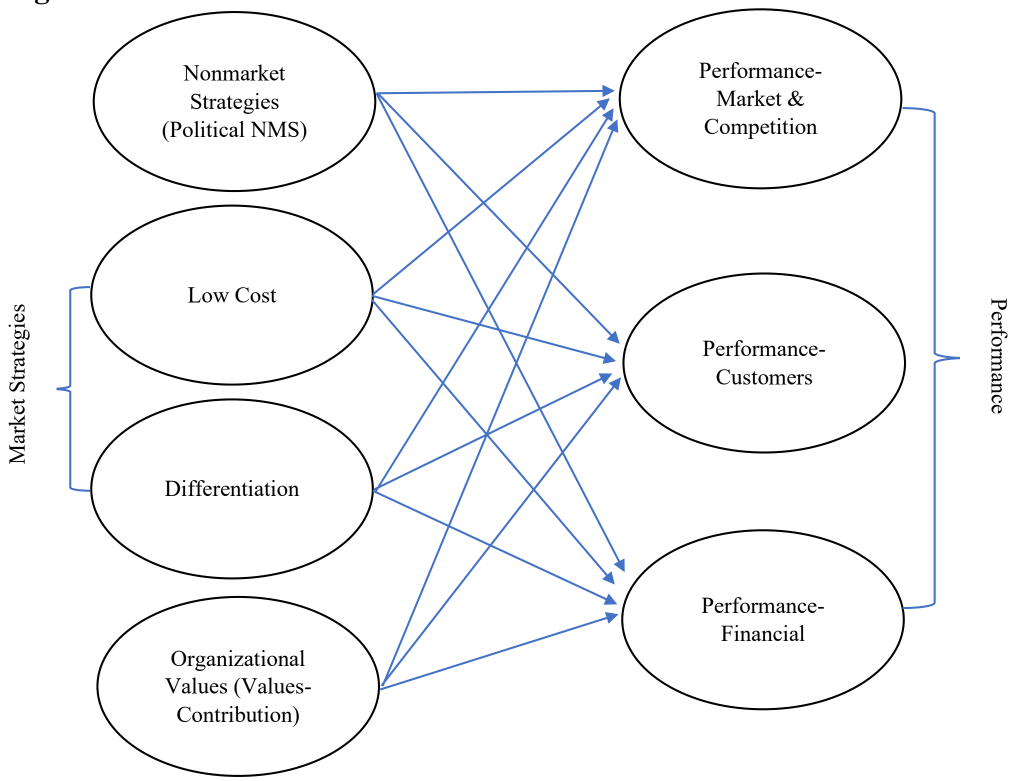
Figure 1. Research Model



Koseoglu et al., (2019) developed twelve hypotheses to test the model and employed a multi-step approach.

- Step 1. Identify the Research Purpose and Hypothesis
- Step 2. Determine the Hypothesis-related Items to Measure
- Step 3. Determine the Sample
- Step 4. Administer the Survey
- Step 5. Determine the Analysis Method

Step 6. Test the Hypotheses

Koseoglu et al. (2019) assessed each scale for reliability and validity (see Koseoglu et al., 2019). Results from the saturated model supported H1c, H3b, H4a, H4b, and H4c (see Koseoglu et al., 2019). Overall, these results did not support the proposed model. At this point, we could (1) abort the project, (2) utilize CNA with the existing model, or refine a new model and follow the CNA steps to acquire a deeper understanding of the relationships among the items. We chose the second option. Therefore, we developed a CNA model.

Step 7. Prepare Survey Inputs for CNA

The data for the survey items were coded by combining the item code provided in Table 2 (e.g., cost1, cost2, etc.) with Likert responses. Each participant's response was coded as well. The Bibexcel software package program was used to generate the appropriate data for CNA.

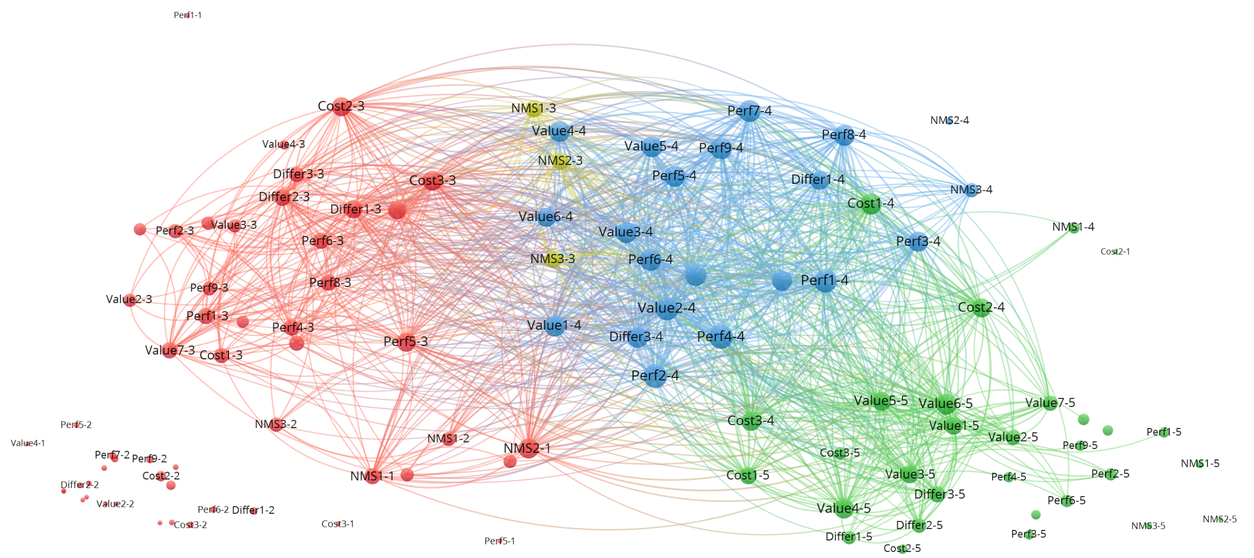
Step 8. Employ CNA

UCINET, Pajek, Gephi, VOSviewer, and other software packages can employ CNA. Each package takes a different approach to identifying network attributes at the macro level and an actor's position in the network at the micro level. This example used VOSviewer.

Step 9. Visualize and Interpret Results

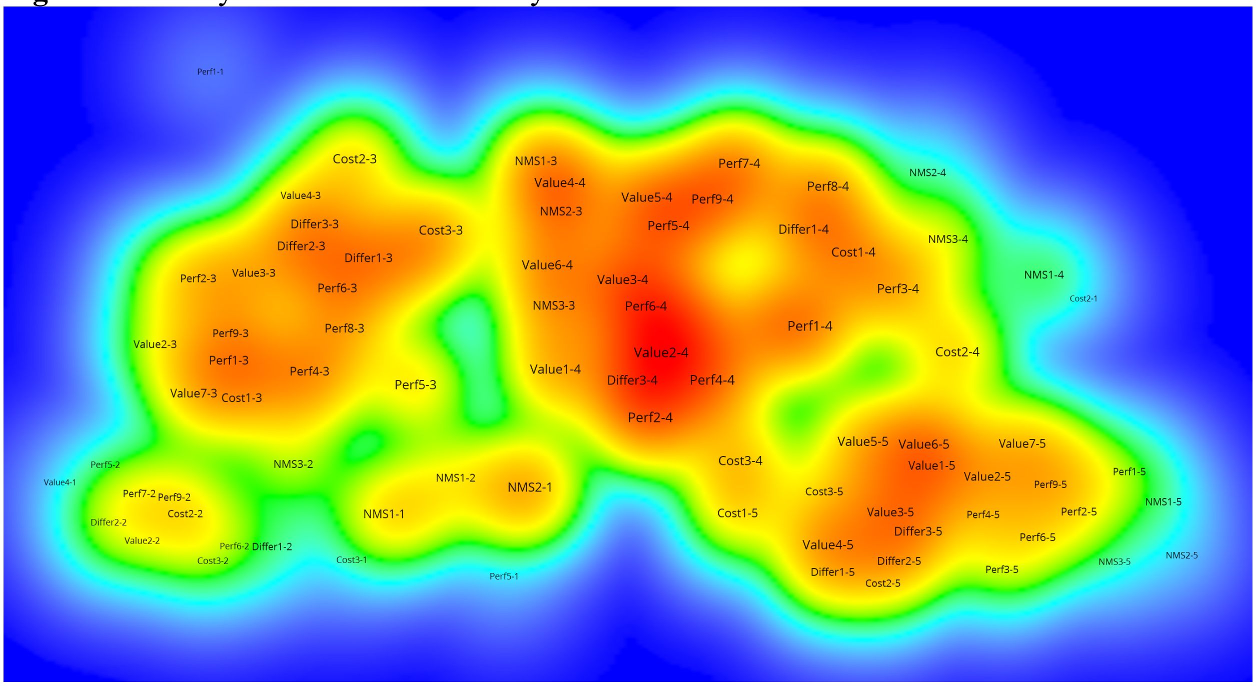
VOSviewer provides two map options. Network visualization (see Figure 2) is a cluster view of the intellectual structure and the links for each item, while density visualization (see Figure 3) provides a density view of survey items. Figure 2 is a network visualization that depicts four clusters. The nodes represent participant responses for related items. The color of the nodes depicts those that are assigned to each cluster, while the lines connecting the nodes illustrate the relationships among them. Participant responses with assigned clusters and their weights are provided in the Appendix.

Figure 2. Network Visualization of Survey Items



In Figure 2, cluster 1 (red) includes mainly response of 3 or below for items related to cost (Cost3-3; Cost2-3), nonmarket strategies (NMS2-1), differentiation (Differ1-3), and performance (Perf5-3; Perf3-3) with high weights. Several value items (Value3-3; Value7-3) are also included, but their weights are not high. Cluster 2 (green) includes items responses of 4 and 5 and are mainly related to cost and value. Differentiation and performance items are not very influential. Custer 3 (blue) primarily includes items with responses of 4 related to value and performance. Whereas Differ3 and Differ 4 are influential in this cluster, NMS3 and NMS2 have little influence. Interestingly, this cluster contains no items related to cost. Cluster 4 (yellow) includes only three items related to NMS, all with responses as 3. The heat map (Zupic & Čater, 2015) in Figure 2 provides a density view of participant responses. It consists of warmer colors and bold characters to show the density of the nodes in the network. As seen in Figure 3, there are several islands. Perf6-4, Value2-4, Differ3-4, Perf4-5, and Perf2-4 appear very warm (dark red). Differentiation, value, and performance responses of 3 or above appear warmer (light red) in other islands.

Figure 3. Density Visualization of Survey Items



Three individual centrality scores were used to investigate the position of responses. Degree centrality shows the number of connections a response has in the network. Closeness centrality indicates a node's closeness to all other nodes and identifies nodes at the heart of the network. Betweenness centrality points out a node's role as a broker or gatekeeper in the network (Golbeck, 2015). Table 1 lists 20 responses with the highest centrality scores.

Table 1. Top 20 Responses With Highest Centrality Scores

No	Label	Degree	Label	Closeness Centrality	Label	Betweenness Centrality
1	NMS2-1	100	Perf4-4	1	Value7-3	58.64008
2	Value1-4	96	Perf8-4	1	NMS2-1	47.70574
3	Value2-4	96	Perf6-4	1	Value2-4	46.34492
4	NMS1-1	96	Perf5-4	1	Perf4-3	33.98464
5	Perf5-3	96	Perf7-3	1	Value1-4	33.52290
6	Perf4-3	94	Perf8-3	1	Value3-3	32.25709
7	Perf2-4	93	Perf5-3	1	Differ3-4	31.00366
8	Value7-4	93	Perf6-3	1	NMS3-2	30.48116
9	Differ3-4	93	Perf7-5	1	NMS1-1	29.93160
10	Value7-3	93	Perf8-5	1	NMS2-2	29.88273
11	NMS1-2	93	Perf7-2	1	Perf2-3	28.13745
12	Perf4-4	92	Perf8-2	1	Value3-5	26.66495
13	Value5-4	92	Perf6-2	1	Value2-3	25.87512
14	Cost3-3	92	Value7-4	0.973684	NMS1-2	25.13339
15	Perf8-3	92	NMS2-1	0.972603	Perf2-4	24.87990
16	Cost3-4	92	Perf2-4	0.966667	Value1-3	23.50986
17	Cost1-5	92	NMS1-1	0.961039	Perf3-2	23.24816
18	Perf6-4	90	Value5-4	0.956522	Cost3-3	22.95146
19	Value4-4	90	Perf4-3	0.952381	Perf3-3	22.94792
20	Value6-4	90	NMS1-2	0.948718	Value7-4	22.64173
21	Value4-5	90				

Discussion

This present work seeks to validate the CNA approach in pretesting and visualizing scale items and study variables in multivariate analysis in hospitality research. By employing a nine-step approach that spans the purpose of the research through visualization and interpretation, the example illustrates how CNA can be utilized to reveal relations within and across constructs in a study model. This study is among the first papers to develop a new approach that enables researchers to foresee some unexpected non-significant relationships contrary to their hypotheses or other problems with validity and reliability. This approach provides an important advantage to scholars who have to recollect data to address such problems. Hence, the CNA approach proposed could improve research efficiency and effectiveness for scholars in the social sciences, especially those adopting SEM, by pretesting the data and detecting potential challenges before hypothesis testing.

Conclusions

This paper first proposed CNA as a means of addressing methodological limitations for assessing survey data. It is recommended as a complement -not a substitute- for existing multivariate approaches. CNA offers a unique and valuable means of visualizing relationships among survey items. It also contributes to scholars' productivity by pretesting and visualizing the links among variables, thereby expediting analysis. The extent of the value CNA provides organizational scholars remains largely untested. Still, it appears to be especially applicable to exploratory studies that employ small or large samples with a considerable amount of missing data. Nonetheless, additional analyses of relatively small and large datasets and those with a high percentage of missing data and outliers are warranted.

Theoretical Implications

This study contributes to the scholarly debate about quantitative analysis in the H&T field. It makes two primary scientific contributions. First, CNA can provide a better pathway for researchers who aim to test causal relationships, thereby encouraging additional academic effort in the realm of SEM and multivariate analysis. Second, CNA facilitates the visualization of potential interrelated links within and between constructs in a study model. Visualization can enhance academic knowledge about the proposed links between variables and scale items and ultimately foster the pretesting of measurement scales developed by previous scholars. Therefore, it can support the pre-test (pilot) analysis, which is essential for achieving the construct and face validity of the survey items (Arasli et al., 2020; Testa, 2007). It remains unclear if CNA provides better outcomes than the pilot test for ensuring the validity of the survey questionnaires in H&T studies or its applicability in hospitality. Additional work is required in this arena. Methodological scholars could expand the present understanding of CNA by employing it in future empirical studies.

Practical Implications

As the previous example illustrates, CNA complements multivariate techniques in several important ways. First, even when other methods provide meaningful findings, CNA provides additional insight by clarifying the links among the survey items. CNA enables scholars to present influential survey items in the given response through centrality scores in the network. Scholars can also employ CNA with a dataset that includes gender, education, management position, and other categorical variables.

CNA's ability to provide visualization at the item level cannot be replicated by other approaches. Second, researchers and scholars can employ CNA to obtain insight from survey results when the data is not readily analyzable by other bivariate or multivariate methods. This insight is also available when the model is partially or not supported by other means. CNA results are also relatively easy to interpret. Third, scholars can apply CNA to datasets with any sample size, even if it is below the recommended size for other approaches. A large sample size is always preferable but is not a prerequisite for CNA. The example presented herein demonstrates CNA's usefulness with relatively small samples. Fourth, with CNA, scholars can either ignore the missing data or code it for every item and response. The latter option can help researchers understand how missing data might influence the purported links among survey items.

Limitations and Future Research

Several important limitations should be noted. First, although CNA provides powerful tools for visualizing links among data, it does not preclude the application of appropriate multivariate methods. Second, CNA is an informative tool, but it does not infer or establish causality. Third, scholars should avoid the temptation to modify construct measures to enhance the visualization (see Figures 2 and 3). Scale items should not be eliminated solely to improve factor loadings, coefficient alpha scores, or goodness-of-fit measures. Any decisions to modify items and constructs in a model, whether based on CNA or another statistical tool, should be supported by theory. Finally, the example analyzed herein utilized data from another published paper (Koseoglu et al., 2019) that examines relationships between NMS and firm performance in the hospitality industry in Hong Kong. Validation of the CNA approach can be further assessed by developing a novel study model and collecting data from different cultures, destinations, and industries. Doing so will enable a better understanding of the generalizability and restricting conditions of the proposed approach.

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Appendix. Clusters in the Network (1-Red, 2-Green, 3-Blue, 4-Yellow).

No.	Label	Cluster	Wgt.
1	Cost3-3	1	34
2	NMS2-1	1	34
3	Cost2-3	1	31
4	Perf5-3	1	31
5	Differ1-3	1	30
6	Perf3-3	1	30
7	Differ2-3	1	27
8	Perf8-3	1	24
9	NMS1-1	1	24
10	Value7-3	1	24
11	Perf6-3	1	24
12	Perf4-3	1	23
13	Perf1-3	1	23
14	Perf7-3	1	21
15	Differ3-3	1	21
16	Cost1-3	1	20
17	NMS1-2	1	18
18	Perf2-3	1	18
19	Perf9-3	1	17
20	NMS3-2	1	17
21	NMS3-1	1	16
22	Value3-3	1	16
23	NMS2-2	1	15
24	Value2-3	1	15
25	Value1-3	1	15
26	Value6-3	1	13
27	Value5-3	1	13
28	Cost2-2	1	10
29	Value4-3	1	9
30	Perf3-2	1	8
31	Differ1-2	1	6
32	Perf7-2	1	5
33	Perf8-2	1	5
34	Perf9-2	1	5
35	Cost3-2	1	4
36	Perf6-2	1	4
37	Differ2-2	1	3
38	Perf5-2	1	3
39	Perf4-2	1	3
40	Value5-2	1	3

No.	Label	Cluster	Wgt.
41	Value3-2	1	3
42	Perf1-2	1	3
43	Value2-2	1	2
44	Cost3-1	1	2
45	Value4-2	1	2
46	Value1-2	1	2
47	Perf5-1	1	2
48	Value6-2	1	2
49	Differ3-2	1	2
50	Cost1-2	1	2
51	Perf2-2	1	2
52	Value4-1	1	1
53	Perf1-1	1	1
54	Cost1-4	2	37
55	Value6-5	2	37
56	Value4-5	2	34
57	Cost2-4	2	33
58	Value5-5	2	31
59	Cost3-4	2	31
60	Value3-5	2	28
61	Value1-5	2	28
62	Cost1-5	2	25
63	Differ3-5	2	24
64	Value2-5	2	21
65	Value7-5	2	21
66	Differ2-5	2	19
67	Differ1-5	2	16
68	Perf2-5	2	14
69	Perf6-5	2	13
70	Cost3-5	2	13
71	NMS1-4	2	12
72	Perf7-5	2	11
73	Perf9-5	2	10
74	Perf1-5	2	10
75	Perf8-5	2	10
76	Perf4-5	2	10
77	Perf5-5	2	9
78	Cost2-5	2	9
79	Perf3-5	2	8
80	NMS1-5	2	5

No.	Label	Cluster	Wgt.
81	NMS3-5	2	4
82	NMS2-5	2	2
83	Cost2-1	2	1
84	Perf2-4	3	50
85	Perf4-4	3	48
86	Value2-4	3	46
87	Perf1-4	3	45
88	Perf7-4	3	42
89	Perf9-4	3	42
90	Perf6-4	3	42
91	Value1-4	3	39
92	Value7-4	3	39
93	Value4-4	3	38
94	Perf8-4	3	37
95	Perf5-4	3	37
96	Value5-4	3	37
97	Value3-4	3	37
98	Differ3-4	3	37
99	Perf3-4	3	36
100	Differ2-4	3	35
101	Value6-4	3	32
102	Differ1-4	3	32
103	NMS3-4	3	19
104	NMS2-4	3	6
105	NMS3-3	4	27
106	NMS2-3	4	26
107	NMS1-3	4	25

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