Problematic applications of Necessary Condition Analysis (NCA) in tourism and hospitality research

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ARTICLE INFO	ABSTRACT
	The purpose of this note is to improve the application of Necessary Condition Analysis (NCA) in tourism and hospitality research by evaluating current applications. The field has rapidly adopted NCA for identifying necessary conditions in causal structures. An analysis of the 25 articles that use this emerging method reveals that most articles are problematic because they misinterpret NCA's necessity logic or do not recognize the difference between NCA's and fsQCA's necessity analyses. This situation can be easily revised by following published standards of good practice of conducting NCA.

1. Introduction

Highly ranked academic journals aim to publish innovative research for gaining new insights about topics covered in the journal. For example, this journal's aims and scope statement declares that "(i) nnovative topics and perspectives that challenge traditional paradigms are welcome to push the knowledge boundary of tourism management" and that "all papers published should contribute to theoretical and/or methodological advancement, in addition to having specific implications for tourism management/policy".

Necessary Condition Analysis (NCA, Dul 2016) is an emerging method that can serve these goals when correctly applied to tourism and hospitality topics. The method uses necessity logic for identifying single conditions that must be met in practice to enable a desired outcome. Without the necessary condition, the desired outcome will not occur. For example, applications of NCA in tourism and hospitality research show that without hedonic experience high place attachment will not be achieved (Lee & Jeong, 2021), without relational capabilities there will be no inter-firm collaboration in the tourism and hospitality industry (Della Corte et al., 2021), and without convenience tourists will not perceived utility (Tóth, Dul, & Li, 2019). The NCA method is more rapidly entering the tourism and hospitality field than many other research fields (Dul, 2021). This is an indication of the field's and its researchers' entrepreneurial spirit to advance the discipline.

Although I applaud the early and fast adoption of NCA in tourism and hospitality research, it appears that it has also a downside. When an

emerging method's standards of good practice are not yet broadly known, an early and fast adoption of the method without deep understanding of its details may result in incorrect interpretations that depart from the original ones and may result in invalid conclusions. This may hamper the development of the discipline and cause confusion in the research and practice community about what NCA is, what it can do, and what it can show. As I will illustrate below, this confusion has apparently happened in the tourism and hospitality research field. The aim of this note is to stimulate a proper and careful application of NCA in tourism and hospitality research by pointing at current problematic applications, and by showing how NCA can be properly applied.

2. NCA articles in tourism and hospitality

Table 1 shows the 25 articles that apply NCA in the tourism and hospitality field that I identified with a Google Scholar search. To safeguard journal quality, I only selected articles that are published in journals that are listed in the Web of Science (and thus have an impact factor). The articles are published in print or online between 2017, when the first NCA publication in tourism and hospitality appeared, and June 20, 2022.

The 25 articles are published in ten different journals. Most articles are published in top journals in the tourism and hospitality field (Gursoy & Sandstrom, 2016). Five top journals have published more than one NCA article: *Tourism Management* (5), *International Journal of Contemporary Hospitality Management* (7), *Journal of Travel Research* (3), *Current*

Issues in Tourism (2) and *Annals of Tourism Research* (2).

For all 25 articles, the goal of conducting NCA is to highlight the existence of necessary conditions in the causal structure of the phenomenon of interest. Two articles apply NCA as the sole method. The other articles use NCA as part of a multi-method approach: three articles apply NCA in combination with structural equation modeling (SEM), and the remainder 20 articles apply NCA in combination with fuzzy set Qualitative Comparative Analysis (fsQCA).[1]

3. Evaluation

The logic and application of the NCA method is well documented.

2019; in press Lee, Dul, & Toth). NCA has been applied in a wide variety of research fields in the social, medical and technical sciences. In general, these applications follow the published standards of good practice.[2]

An evaluation of the 25 articles that apply NCA in tourism and hospitality shows that five articles (20%) correctly apply NCA according to these standards (Della Corte et al., 2021; Lee & Jeong, 2020, 2021; Tóth, Dul, & Li, 2019; Yu, Cheah, & Liu, in press). These articles use NCA as the sole method or in combination with SEM. However, six articles (24%) apply NCA problematically due to logical misinterpretations. These articles complement NCA with fsQCA. Another fourteen articles (56%) use problematic naming and confuse what NCA actually is. These articles also focus on fsQCA.

Table 1

Articles that apply Necessary Condition Analysis (NCA) in tourism and hospitality research (until June 20, 2022).

Reference	First online	Journal	NCA alone	NCA with SEM	NCA with QCA	Correct application	Problematic logic	Problematic naming
Cheng & Liu (2022)	2021	Tourism Management			X			X
Della Corte, Aria, Del Gaudio, Barney, Cobanoglu, & Sepe (2021)	2021	International Journal of Contemporary Hospitality Management		X		X		
Farmaki, Olya, & Taheri (2021)	2020	Journal of Business Research			X			X
Farmaki & Pappas (2022)	2021	International Journal of Contemporary Hospitality Management			X		X	
Farmaki, Pappas, Kvasova, & Stergiou (2022).	2022	Tourism Management			X		X	
Gannon, Taheri, & Olya (2019)	2019	Annals of Tourism Research			X			X
Han, Al-Ansi, Olya, & Kim (2019)	2018	Tourism Management			X			X
Lee & Jeong (2020)	2019	Current Issues in Tourism	X			X		
Lee & Jeong (2021)	2021	Journal of Hospitality and Tourism Management		X		X		
Mehran & Olya (2020)	2019	Journal of Retailing and Consumer Services			X			X
Mehran, Olya, Han, & Kapuscinski (2020)	2020	Journal of Travel & Tourism Marketing,			X			X
Mohamed, Taheri, Farmaki, Olya, & Gannon (2020)	2020	International Journal of Contemporary Hospitality Management			X			X
Olya & Al-Ansi (2018)	2017	Tourism Management			X			X
Olya & Han (2020)	2020	Journal of Travel Research			X			X
Olya, Bagheri, & Tümer (2019)	2019	International Journal of Contemporary Hospitality Management			X			X
Olya, Lee, Lee, & Reisinger (2019)	2018	Journal of Retailing and Consumer Services			X			X
Olya & Nia (2021)	2020	Journal of Travel Research			X			X
Olya, Jung, Dieck, & Ryu (2020)	2020	International Journal of Contemporary Hospitality Management			X			X
Pappas (2021)	2021	Tourism Management			X		X	
Pappas & Farmaki (in press).	2022	Current Issues in Tourism			X		X	
Pappas & Glyptou (2021a)	2020	International Journal of Hospitality Management			X		X	
Pappas & Glyptou (2021b)	2021	International Journal of Contemporary Hospitality Management			X		X	
Taheri, Olya, Ali, & Gannon (2020)	2019	Journal of Travel Research			X			X
Tóth, Dul, & Li, 2019	2019	Annals of Tourism Research	X			X		
Yu, Cheah, & Liu (in press).	2022	International Journal of Contemporary Hospitality Management		X		X		

Descriptions of the method with guidelines for applying NCA are available at the basic level (e.g., Dul, 2016b, 2020) and at the advanced level (Dul, 2021). The method is also introduced in several specific research fields, including the tourism and hospitality (Tóth, Dul, & Li,

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[1] Some articles that use NCA in combination with fsQCA also use SEM.

[2] The basic requirements for concluding with NCA that a factor is necessary are: (1) the availability of a theoretical expectation that an antecedent could be a necessary condition for the outcome (e.g., a necessity hypothesis), (2) a relevant necessity effect size, (3) a small p-value from NCA's statistical test showing that it is unlikely that the observed effect size is a random result of unrelated variables.

3.1. Logical misinterpretations

The six articles with logical misinterpretations use NCA for checking whether the elements that are part of fsQCA's sufficient configurations, are necessary. When NCA is applied it is checked whether the element is a necessary *for the outcome*. If the condition is *not* necessary for the outcome (necessity effect size = 0), the six articles conclude that the corresponding fsQCA's sufficient configuration cannot produce the outcome. The configuration is then removed from further analysis. For example, Pappas (2021) finds three possible configurations with fsQCA each consisting of five or six elements that are sufficient for purchase intentions of holidaymakers. These configurations are called 'price-quality nexus (micro)', 'generated experience (meso)' and 'perceived destination image (macro)'. After performing NCA on all elements of the three configurations, the article excludes the first configuration because, according to NCA, one of its elements ('high scores in price risks') is not a necessary condition for the outcome 'purchase intention'. Pappas et al. (2021, p. 2942) state: "Combined with the fsQCA results, the only solution that includes high scores in price risks is the first one …, meaning that this complex configuration should be excluded from further analysis". Although a factor that is a necessary condition for the outcome must be part of each sufficient configuration, the opposite is not true: a factor that is part of the sufficient configuration must not automatically be a necessary condition for the outcome. Thus, when an element is not a necessary condition for the *outcome*, its absence in the configuration is not a requirement for the configuration being sufficient for the outcome.[3] Following necessity logic and NCA, if an element of a configuration is not necessary for the outcome, the configuration can still produce the outcome. It is incorrect to conclude that the configuration cannot produce the outcome because there is no necessary condition for the outcome in it. Therefore, the configuration should not be excluded from further analysis. A second problem in these articles is that the necessity effect sizes of most elements are often very small and none was tested for randomness (p-value) using NCA's statistical test (Dul, van der Laan, & Kuik, 2020). According to NCA, when the effect size is small (e.g., < 0.10) or the p-value is large (e.g., > 0.05), it cannot be concluded that the condition is necessary.

This problematic application of NCA can be simply corrected by following the standards of good practice (Dul, 2021). First, also NCA's statistical test should be applied. Second, threshold values for effect size (e.g., > 0.10) and p-value (e.g., p < 0.05) should be set before considering an element being necessary for the outcome. If one of these thresholds is not achieved, the necessity of the element for the outcome should be rejected. Additionally, if the researcher does not have a theoretical justification why the element can be necessary for the outcome, the element cannot be considered a necessary condition for the outcome. Third, after an element is considered to be necessary for the outcome, by logic it must be *present* in all configurations that can produce the outcome, also in the sufficient configurations that are identified by fsQCA.[4]

3.2. Confusion between necessity analyses of NCA and fsQCA

The problem with the second group of problematic articles that apply NCA is that they actually do not apply NCA. These articles use the name 'NCA' for the necessity analysis of fsQCA. For example, Olya and Al-ansi (2018, p. 283) claim to identify "the risk antecedents necessary to achieve the desired outcomes by using NCA (Dul, 2016a)", Gannon, Taheri, and Olya (2019, p. 245) state that "Necessary Condition Analysis (NCA) was also conducted", Olya, Jung, Dieck, and Ryu (2020, p. 775) report that "(t)his study applies fsQCA and NCA to identify adequate recipes and necessary predictors", and Cheng and Liu (in press, p. 8) write that "(t)he results of the NCA, PLS-SEM and fsQCA mutually confirm and supplement each other". However, none of the articles apply NCA. Instead, the necessity analysis that is part of fsQCA was applied. The necessity analysis of NCA and the necessity analysis of fsQCA are completely different. The main difference is that QCA defines necessity only 'in kind' using Boolean algebra (X is necessary for Y) and NCA defines necessity 'in kind' and 'in degree' using linear algebra (level X is necessary for level Y). NCA usually identifies more necessary conditions than QCA. The differences between NCA and fsQCA have been discussed in Dul (2016a) and Vis and Dul (2018) and the NCA and QCA communities consider NCA and QCA two separate but complementary research approaches. Although nearly all articles in the second group refer to the publication that discusses the difference between NCA and fsQCA (Dul, 2016a), they ignore this difference and use the name NCA for fsQCA's necessity analysis. Furthermore, the articles of the second problematic group suggest that fsQCA is only about conducting a sufficiency analysis, whereas actually the fsQCA's necessity analysis is an integral part of fsQCA (Ragin, 2000; Schneider & Wagemann, 2012). The QCA community does not use the name 'NCA' for the necessity analysis of fsQCA.

One could argue that a researcher is free to introduce the names 'NCA' and 'Necessary Condition Analysis' also for the necessity analysis of fsQCA. However, methodological experts and users of NCA and QCA alike will not appreciate mixing of the terms as the necessity analyses of NCA and fsQCA are different. Mixing the terms will confuse researchers and practitioners. The confusion has already been exported to other research fields where researchers have followed articles from the second problematic group to conduct their necessity analysis (e.g., in press-Mostafiz, Sambasivan, Goh, & Ahmad).

This problematic use of the terms 'Necessary Condition Analysis' and NCA' can be simply corrected. I recommend that researchers, editors and reviewers value and maintain the distinction between the necessity analysis of NCA and that of fsQCA, and only use the words 'NCA' and 'Necessary Condition Analysis' in their originally meaning, as in done in other research fields.

4. Conclusion

Examples show that NCA can be successfully applied in tourism and hospitality research. However, these good examples represent only a small part of the articles that have applied NCA. The problematic articles make logical misinterpretations or confuse the necessity analyses of NCA and fsQCA. They have appeared in 9 out of 10 journals that have published about NCA. All problematic articles are multi-method articles that attempt to combine fsQCA with NCA. Successfully combining NCA with fsQCA has been demonstrated in other research fields where top journals have published articles that apply NCA in combination with fsQCA. For example, in small business research Torres and Godinho (2022) identify necessary conditions both with NCA and with fsQCA. In information management Mazumder and Garg (2021) apply NCA and fsQCA in combination and propose to replace fsQCA's necessity analysis with

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[3] Instead, for a configuration being sufficient for the outcome an element that *is* a necessary condition for the outcome must be part of it. A 'necessary condition for the *outcome'* is not the same as 'an element of a configuration that is a necessary condition for the *configuration* being sufficient'. The latter is a INUS condition: an Insufficient but Necessary element of Unnecessary but Sufficient configuration. NCA captures necessary conditions for the outcome, not INUS conditions (see also Dul, Vis, & Goertz, 2021).

[4] A simple way of combining NCA and fsQCA is to do both analyses separately and discuss the consequences of the findings. Surprisingly, several articles do not discuss the logical impossibility of finding an element to be a necessary condition for the outcome, and yet accept configurations without the necessary elements as being sufficient for the outcome according to fsQCA. For example, Farmaki, Olya, and Taheri (2021) consider 'brand masculinity' a necessary condition for 'brand love', but this necessary condition was not part of the sufficient configuration Recipe 4-C1.

NCA's necessity analysis to maximally exploit the benefits of NCA. When NCA is properly conducted, NCA can be successfully applied in single-method research or in multi-method research in combination with fsQCA, SEM, or Multiple Linear Regression (MLR).[5]

For successfully applying NCA in single-method or multi-method research in the tourism and hospitality field, I recommend that researchers follow NCA's standards of good practice and learn from good examples within and outside the field. This can turn problematic practices into successful ones. I hope that this note helps the tourism and hospitality field with this development.

Impact statement

When applied correctly, NCA identifies necessary but not sufficient conditions for an outcome (e.g., good performance). The practical relevance of knowing these 'critical success factors' or 'must have' factors is that they must be satisfied for achieving the outcome. Although the presence of 'must haves' does not guarantee the outcome, their absence guarantees failure. If the right level of the necessary conditions is absent, the condition will be a bottleneck for the outcome. For achieving a desired outcome, practitioners must act on bottlenecks. If bottlenecks exist, acting on 'nice to have' factors is a waste, because the absence of 'must have' factors cannot be compensated other factors.

Declaration of competing interest

None.

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[5] In single-method research, NCA tests theoretical necessity statements (necessity hypothesis). In multi-method research with SEM, NCA tests the necessity of latent concepts that are part of the SEM model (see for example Richter, Schubring, Hauff, Ringle, & Sarstedt, 2020 for guidelines). This is done by analysing the latent variable scores produced by the measurement model. This means that NCA should be conducted after SEM. When NCA is combined with MLR, NCA can test the variables that are part of the MLR model for necessity (e.g., combined scores from Likert scales or factor scores from a separate factor analysis). In this case the order of conducting NCA and MLR is not relevant (see Dul, 2021 for more details).

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