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Good theories predict: Unveiling the untapped potential of "necessity" theorizing

Abstract: In this paper, we seek to introduce the concept of *necessity* logic of causality, which, despite its inherent merits in parsimony and predictive accuracy, has not received adequate attention. Our paper begins by providing a comprehensive review of various causal logic, including sufficiency, necessity, and contributory. We then critically examine the key assumptions of necessary causation (i.e., non-additivity, determinism, and asymmetry), and highlight the benefits of necessary causalities in theoretical innovation. Also, we workshop methodological protocols for necessity theory testing. Subsequently, we explore the potential of integrating necessity theories in the hospitality and tourism field by drawing on conceptual-contextual theorizing, leading to the development of "homegrown" theories; we also contend that necessary causality in transdisciplinary research can facilitate broader knowledge exchange to neighboring domains. We conclude by identifying promising research areas for necessity theorizing and testing in hospitality and tourism research.

Keywords: necessary causality, necessity theory, necessity theorizing, necessary condition analysis, causality

"A theory should be as simple as possible, but no simpler," – Albert Einstein (n.a.)

"The simplest explanation that fits the facts is the one that should be preferred." – Simberg (2002)

INTRODUCTION: BEYOND THE COMMON "CONTRIBUTORY" CAUSALITY

Scientific research has sought to identify causal relationships between concepts of interest as a part of conceptualization and theorization. Central to this endeavor is the need to explain and predict how changes in one concept will affect another (Sutton & Staw, 1995). Diverging perspectives exist on causality among scholars and philosophers, as the issues surrounding this concept are ontologically and epistemologically complex. Surprisingly, many researchers often employ a simplistic approach to defining causation, asserting that "X has an effect on Y" without due contemplation of underlying causal logic. In interpreting this introductory causal statement, often unconsciously, researchers presume that there are probabilistic uncertainties surrounding the causal relationship (i.e., "X is likely to increase/decrease Y") (Rutten, 2021). In this probabilistic logic, X is deemed as a "contributory" cause that is *neither sufficient nor necessary* because X is not able to fully guarantee the presence or absence of Y—or the increase or decrease thereof—while acknowledging the potential for Y to arise or diminish due to other factors (Riegelman, 1979).

Put differently, this conventional logic of causality assumes *additivity*, whereby a given cause (X_1) may be substituted by another cause(s) (X_2, X_3, … X_n) since each cause has a separate, independent effect on the outcome ("all X_1, X_2, … X_n can separately produce Y") (Rihoux & Ragin, 2009), thereby complicating the theoretical models. For example, in the context of home-sharing research, several studies have examined key factors that contribute to

guest booking intention such as price, location, and host attributes (e.g., profile, rating, and response rate) (Wu et al., 2017). The relationships with such causes are considered *symmetrical*, with X_n and Y likely moving in the same or opposite direction. However, due to the *probabilistic* nature of those causations, it is unlikely that any of those independent variables precisely predicts the changes in dependent variables, which in this case, refers to booking intentions. Similarly, prior research suggests multiple factors can cause job satisfaction, including work engagement, supervisory support, pay satisfaction, and organizational trust (Judge et al., 2020). Despite the existing effect of each cause, however, none of them can sufficiently explain and predict job satisfaction. For instance, in situations where supervisory support is high, job satisfaction can still stay low when there are low levels of work engagement and pay satisfaction. Considering the features and examples mentioned above, the conventional contributory-based antecedents can encounter limitations when establishing theoretical relationships. That is, studies often produce similar frameworks with different combinations of antecedents due to the substitutability of these antecedents; challenges arise in predicting the outcome using parsimonious models; and there is a wide range of uncertainties in the predictive power, reported as variances explained in models.

Beyond our common "contributory" causality, philosophical and scientific studies have recognized the notion of *necessary causality* (Dul, 2020; Goertz & Starr, 2003; Greenberg, 1955), which, this article argues, follows *non-additive*, *(quasi-)deterministic*, and *asymmetric* assumptions. The necessity logic of causality asserts that specific causes cannot be substituted by other causes, but must be present to attain the desired outcome (i.e., "X is necessary for Y") (Dul, 2020). For an outcome to occur, the presence of a necessary cause is a fundamental requirement, without which the outcome cannot come into existence. A necessary cause is free

from other causes, thereby affecting the outcome without being "confounded" ("regardless other X_2, X_3, … and X_n are present or absent, X_1 is still necessary for Y"). Acknowledging the underlying causal assumptions, these necessary causations merit parsimonious theorization and practical relevance. In essence, a *single* variable, when considered a necessary cause, can *precisely predict* the absence of an outcome that carries important weight to the researchers' and practitioners' focus of investigation (Dul, 2020). This approach to causality can add a novel perspective to the existing theoretical frameworks, as it can disentangle complex causal models and facilitate more nuanced and detailed theorizing by complementing the conventional logic of causality.

Despite its existence and profound significance, necessary causality and theoretical underpinnings under this logic have received little attention in previous literature. While the concept of necessity in causal reasoning has been a subject of philosophical contemplation since David Hume remarked on causal regularities (Greenberg, 1955; Hume, 1777; Lewis, 1973), scant efforts have been dedicated to explicitly establishing the legitimacy of necessity logic within the framework of empirical research (e.g., Dul, 2016; Dul & Hak, 2007; Goertz & Starr, 2003). These preliminary investigations serve as an introductory, logical foundation, but there remains a pressing need to transcend the existing scholarship and provide an original contribution by ontologically elucidating the assumptions and characteristics of necessary causality.

Furthermore, it is essential to propose the theoretical merits of its application in the realm of hospitality and tourism research. As Gary Goertz, a pioneering thinker of necessary causality, points out that important necessary causal factors exist in any research area (Goertz & Starr, 2003), the novelty of necessary causality will likely lead to the emergence of numerous necessity

theories flourishing within the hospitality and tourism field. In addition to that, in this article, we contend that there is ample scope for advancing theoretical insights into context-specific necessities that underline hospitality and tourism phenomena. These insights could result in enriching "homegrown" theories that are distinct from those in other fields. Furthermore, the utility of necessary causality in transdisciplinary research lies in its capacity to theorize universal necessities that go beyond conventional disciplinary boundaries. This can result in the exchange of knowledge across fields, facilitating mutually beneficial outcomes and the potential for "reversed export" of new necessity theories to neighboring domains.

Hence, the present paper seeks to introduce the concept of necessity logic of causality, which, despite its substantial significance and merits in both theoretical and practical contexts, has been given limited attention thus far. To accomplish this objective, this research undertakes a comprehensive review of various logics of causality (i.e., sufficiency, necessity, and contributory) and compares their representative assumptions (i.e., additivity vs. non-additivity, probability vs. determinism, and symmetry vs. asymmetry). Subsequently, we present a set of guidelines that facilitate necessity theorizing and elucidate the inherent advantages associated with necessary causality. Following this, we workshop methodological protocols for necessity theory testing, including the analytical technique. Last but not least, we discuss the promising application of necessity logic in theorizing and theory testing in hospitality and tourism research.

LOGICAL GENRES OF CAUSALITY

Causality is a fundamental concept in scientific inquiry. This temporally sequenced constant conjunction between cause and effect has long been a challenging topic (Kim, 1973). Despite its ontological and epistemological complexity, surprisingly, many researchers often

employ a simplistic approach to defining causation, asserting that "X has an effect on Y" without due contemplation. This practice has resulted in the widespread adoption of a "contributory" logic of causality, wherein X is not either necessary or sufficient but rather *probabilistically* linked to Y (Riegelman, 1979). Although this causal logic is clinically defined and more accessible in the social sciences, where phenomena are inherently difficult to define in terms of deterministic causation, it has led us to neglect the existence of two long-discussed Humean views of causal regularities: (1) sufficiency and (2) necessity (Greenberg, 1955; Lewis, 1973). Since Hume's (1777) remarks on the philosophy of causation, historically, discussions over the nature of causality, its explanation, and inference have been closely intertwined with discussions of sufficiency and necessity across the fields of philosophy, mathematics, and science. Our study also argues that the distinction between *necessity* and *sufficiency* plays a crucial role in the formulation and testing of causal relationships. Likewise, hospitality and tourism scholars should be cognizant of distinguishing between these two views of causality in our research endeavors.

The *sufficiency logic* posits that the presence of a cause results in the presence of an outcome. However, the *absence* of one cause (X_1) does *not* preclude the presence of an outcome that may be brought by another cause (X_2). For example, in a search for trees (Y), a person will find them by visiting a mountain (X_1) or a park (X_2). In contrast, *necessity logic* suggests that a cause is a prerequisite for an outcome. Without the cause, there is a guaranteed failure to produce an outcome. For instance, the presence of water (X) is necessary for the growth of trees (Y). Although increasing the water supply does not always increase trees' growth, regardless of other factors (e.g., fertile soil), the absence of water (absence of X) will always guarantee the death of the tree (absence of Y). In addition, a cause may be both necessary and sufficient for an outcome, meaning that the presence and absence of the cause respectively guarantee the presence and

absence of the outcome. For instance, having reached the voting age (X) is necessary and sufficient for the right to vote (Y) since one cannot vote before reaching the required age. Still, one automatically becomes eligible to vote upon reaching that age (Dul, 2022a).

Given the distinction between necessity and sufficiency logics, four types of causes may exist, which are (1) sufficient cause, (2) necessary cause, (3) necessary-and-sufficient cause, and (4) contributory cause (i.e., unnecessary-and-insufficient cause). Our research argues that it is critical to distinguish among these types of causes, as each demands different assumptions (e.g., additivity, probability, symmetry) of causality and requires distinct approaches in theory building and testing (Table 1).

Table 1. Four types of causes.

Causes	Underlying causal assumptions
Sufficient cause	Additive, (quasi-)deterministic, asymmetric
Necessary cause	Non-additive, (quasi-)deterministic, asymmetric
Necessary-and-sufficient cause	Non-additive, (quasi-)deterministic, symmetric
Contributory cause	Additive, probabilistic, symmetric

First, it should be noted that sufficient, necessary, and necessary-and-sufficient causes (vs. contributory causes) do not rely on the *probabilistic* causation assumption (Hájek & Hitchcock, 2016). In the *probabilistic* view, a cause increases the likelihood of the effect, as is the case in contributory causation (i.e., "X *is likely to* increase/decrease Y"). Conversely, the sufficiency and necessity logics rather posit the *deterministic* view by guaranteeing or promising

the change in the outcome, as opposed to relying on probability, stating "without X, there is *absolutely* no Y" (necessity) or "with X, there is *always* Y" (sufficiency) (Lewis, 1973). Notably, complex social contexts make it unlikely to identify a single cause that will suffice for a particular outcome. This highlights why it may be difficult to formulate a single sufficient cause, so scholars often attempt to identify multiple causes that are regarded sufficient to produce the desired result (e.g., multiple regression, qualitative comparative analysis).

Causal reasoning with necessity and sufficiency often requires the incorporation of *pragmatic* deterministic thinking, which involves the consideration of potential outlier scenarios, within its deterministic causations (Dul & Hak, 2007). In social realities, deterministic relationships are usually proposed under the assumption of some outliers, although they may not always be explicitly stated. For example, in the tourism context, perceived physical safety is regarded as a necessary factor for travelers to consider a destination to be suitable, although potential outlier cases may exist such as space tourism or war tourism (Lee et al., 2023). As such, both absolute and pragmatic views on necessity are legitimate, yet the latter view may be more realistic and useful in theorizing social realities – it focuses on the majority of the cases and suggests that the condition must be put and kept in place to avoid a guaranteed failure in nearly all cases (i.e., acknowledging outliers). This *quasi*-view on necessary causality takes into account the realistic relationship between the necessary factor and the outcome, suggesting that the condition must be maintained to avoid failure in nearly all possible scenarios.

In addition, necessary and sufficient causes (vs. necessary-and-sufficient and contributory causes) are based on causal *asymmetry*, such that changes in the cause and the outcome do not necessarily occur correlational in the same or opposite direction (Glaesser, 2023; Ragin, 2014; Rasoolimanesh et al., 2023). In specific, the presence of a sufficient cause produces an outcome,

but the absence of that cause does not guarantee the absence of the outcome ("X is sufficient but *not necessary* for Y"). Similarly, the absence of a necessary cause can certainly prevent the occurrence of an outcome, but the presence of that cause does not mean that it alone produces the outcome ("X is necessary but *not sufficient* for Y"). However, necessary-and-sufficient and contributory causes hold symmetrical effects as their changes—always or likely, respectively—make subsequent changes in outcomes as well.

Lastly, in contrast to sufficient and contributory causes, necessary and necessary-and-sufficient causes do not assume *additivity*—the notion that each substitutable cause has a separate effect on the outcome. The sufficiency or contributory approach posits that a cause will (always or likely) result in an outcome, which can be substituted by the presence of other causes. Thus, this can be expressed in an additive model (i.e., "$Y = a + b_1X_1 + b_2X_2 + \ldots + b_nX_n$"), as is common in multiple regression. Conversely, in necessity logic, each cause must be present regardless of the other causes because necessity, by definition, implies unsubstitutability. Figure 1 demonstrates the visual representation of four distinct types of causes and their outcomes, whereby X denotes the cause along the horizontal axis, and Y denotes the outcome along the vertical axis. It is noteworthy that no occurrences must be expected in the lower-right quadrant, where the presence of *sufficient* X is evident, but Y is absent. Similarly, in the upper-level quadrant, where the *necessary* X is absent, but Y is present, no events are anticipated. However, in the case of *contributory* X, observations may occur in all quadrants (Figure 1).

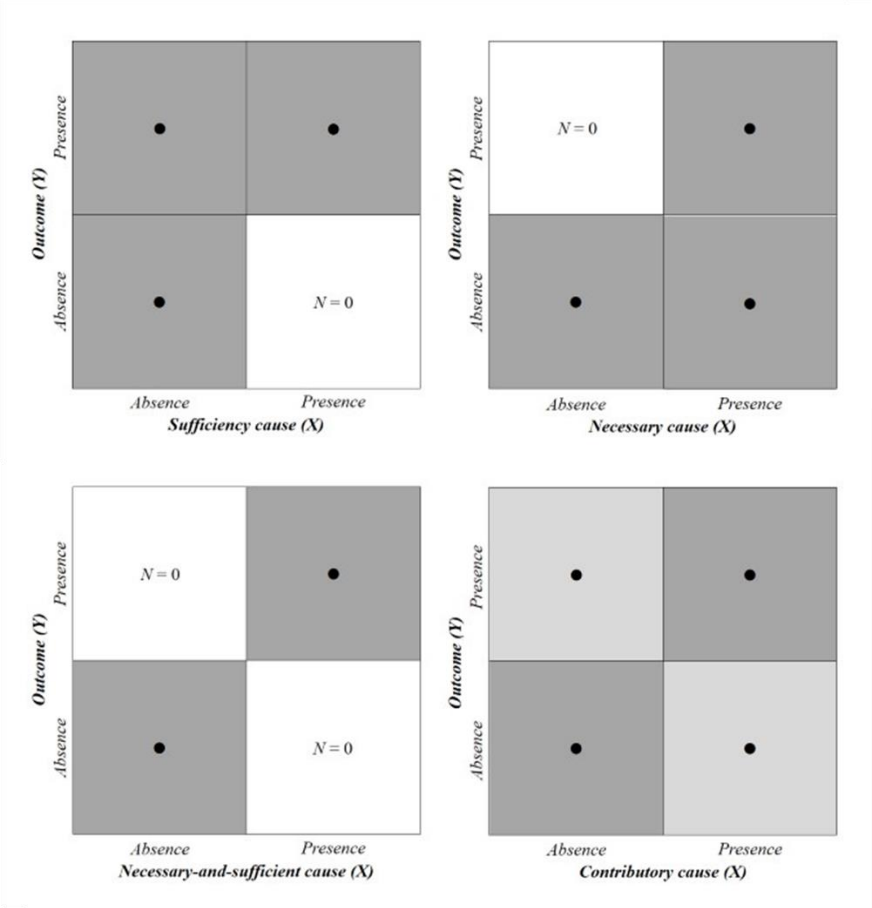

Figure 1. Illustration of four types of causes (dichotomous).

One common myth regarding sufficient and necessary causes is that they are limited to dichotomous logic, wherein the relationships between causes and outcomes are expressed solely in terms of presence or absence. Similar to conventional causal reasoning, however, both sufficiency and necessity logic can also be formulated in continuous manners (Dul, 2016; Lee et al., 2023). In this regard, continuous sufficiency logic refers to the minimum numeric value of the cause (X_c) within the lowest and highest limits that ensure a certain value of the outcome (Y_c) (i.e., "$X \geq X_c$ is sufficient for $Y = Y_c$"). On the other hand, continuous *necessity* logic specifies a minimum X_c required to enable Y_c (i.e., "$X \geq X_c$ is necessary for $Y = Y_c$"). In Figure 2, we depict a visual representation of how the four types of causes (presented in Figure 1) can be

reexpressed continuously with XY scatterplots, wherein both the X and Y variables are continuous. Note that, similar to Figure 1, the plot with the necessary X exhibits an empty space in the upper-left corner, where X_c is relatively low while Y_c is relatively high. In contrast, the plot with sufficient X shows an empty space in the lower-right corner, where X_c is relatively high while Y_c is relatively low. However, in the case of *contributory* X, observations may occur all over the plot (Figure 2).

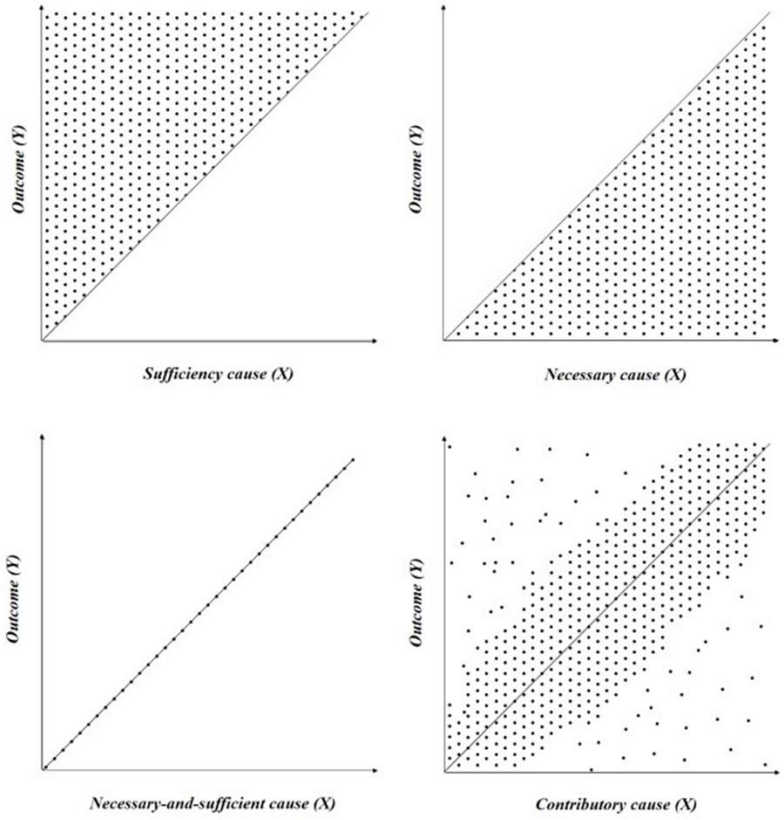

Figure 2. Illustration of four types of causal (continuous).

THE NECESSARY CAUSALITY AND NECESSITY THEORIES

In theory building and testing, historically, extant research has predominantly focused on "contributory" causations. Recently, sufficiency logic with a conjunctural approach is receiving increasing attention as research has emerged that seeks to identify a combinatory set of causes sufficient to produce the desired outcome, such as qualitative comparative analysis (QCA) (Geremew et al., 2023; Rihoux & Ragin, 2009). However, the concept of necessary causality alone has received scant attention, despite its existence, significance, and various merits in theory and practice. The previous section addressed this gap by exploring the non-additive, deterministic, and asymmetric assumptions that underpin necessary causations. In addition, the current section further discusses what necessity theories are, how to theorize them, and what theoretical and practical benefits necessity theories offer.

Necessity theories and theorizing

A theory employing *necessity* logic to explain causal relationships between concepts is known as a *necessity theory* (Bokrantz & Dul, 2023). Inherent to theories, including necessity theories, are constructs, propositions, mechanisms, and boundaries (Bacharach, 1989). Propositions serve to elucidate the causal relationship between the constructs. Mechanisms explain the underlying dynamics that justify the selection of constructs and the proposed causal relationship. The boundaries serve to demarcate the set of circumstances where the theory is expected to hold, thus limiting the propositions. During theorization under the *necessity* logic, "defining the theoretical domain – where the theory is supposed to hold – is important for all theories because theories do rarely hold universally" (Dul, 2021, sec. 2.2.). Hence, necessity theorizing also involves establishing theoretical boundaries that define the scope of applicability of the theory and delimit its propositions.

While necessity theories share these components in theory development based on other causal logics, they are unique in their assertion that constructs have necessary causal effects per the necessity logic of causality. This "necessitarian" stance shapes how the causal relationships among concepts are explicated, as well as the selection of mechanisms and boundaries that support these relationships. Necessity logic stands in stark contrast to conventional logic where a cause is viewed as neither necessary nor sufficient, but instead "contributory" on average (Riegelman, 1979). Therefore, rather than inquiring whether a cause is likely to correlate with an outcome, researchers may instead ask whether that factor is a necessary component or requirement for the outcome to occur. As previously discussed, necessary causes are based on non-additive, deterministic, and asymmetric assumptions to causation; hence, in their logical reasoning, researchers ought to speculate causal relationships by searching for a potential necessary-but-not-sufficient cause that cannot be substituted (i.e., non-additivity) and that accurately explains/predicts the absence of the outcome (i.e., determinism) but cannot do so for the presence of the outcome (i.e., asymmetry).

Further, we advise that necessity theorizing be done based on robust theoretical frameworks and existing empirical insights around them. Theories provide well-reasoned and logical arguments concerning the nature of causal relationships between causes and outcomes. Researchers typically commence with assumptions when constructing theories or theoretical frameworks, drawing from established theories, fundamental principles, or informed speculations (e.g., Ehrenberg, 1988). They then proceed to deduce specific explanations or predictions through a process of logical inference. In theory-driven research, the validity of a theory and its core propositions are assessed by applying it to a specific context of interest (Rivera, 2020; Schmitt et al., 2021). This approach can likewise be employed in the development of *necessity*

theories and hypotheses. The inadequacy observed in the realm of theorizing predominantly stems from problematic assumptions that often lean towards probabilistic and statistical interpretations. Therefore, it is crucial that necessity theorists incorporate robust assumptions and clearly recognize theoretical boundaries and uncertainties. This approach will improve the precision of predictions and enhance control.

Although the identification of necessary antecedents relies on theoretical support, there is a scarcity of existing frameworks that explicitly articulate *necessary* causations. One such instance is the "threshold hypothesis" from psychology literature, presenting that creativity requires a certain level of intelligence (Jauk et al., 2013; Karwowski et al., 2016). In marketing literature, the three-factor theory of customer satisfaction posits "hygiene factors" that are formulated based on necessity logic; hygiene factors, if unfulfilled, can guarantee the absence of satisfaction but do not necessarily lead to customer satisfaction although fulfilled (Matzler & Sauerwein, 2002). Although explicit necessity-based causal statements are rare in the literature, there are several theoretical statements that imply their existence. In the hospitality and tourism field, studies mentioned that "community capacity building is a necessary ingredient for the success of community development" (Aref & Redzuan, 2009, p. 21) and that "successful service brand enactments are a necessary (if not sufficient) antecedent for achieving a differentiated competitive advantage" (Xie et al., 2014, p. 1). Lee et al. (2023) have also recently provided a compilation of necessity-oriented statements from existing works, underscoring the prevalence of necessity reasoning within our domain (see Table 9.1., p. 157). Hence, there is great potential for researchers to contribute to the field with dedicated efforts in concretizing these necessary causations, along with further logical and theoretical reasoning. Ultimately, this *necessity theorizing* will generate valuable insights by shedding light on the factors and mechanisms that

drive necessity-based causal relationships beyond conventional probability-based hypothesis testing.

Benefits of necessary causality: parsimony and precise prediction

The necessity logic of causality offers notable advantages, particularly in its ability to make parsimonious theories that make precise predictions. Social sciences often possess an unlimited number of variables that could be considered to predict any outcome. To provide a comprehensive explanation for the presence or increase of an outcome, researchers resort to incorporating multiple—mostly probabilistic—causal factors into their frameworks or models—mostly in an additive manner. This approach can be easily observed in systematic meta-analytic reviews that consider numerous independent/moderating variables to explain an outcome variable, resulting in a complex model. Similarly, qualitative comparative analysis (QCA) studies aim to identify sufficient combinations of causes for an outcome, thereby leading to complexity in their discussions. On the other hand, the theoretical statements derived from necessity logic do not focus on numerous factors that account for causality to explain or predict the presence of an outcome. Instead, it prioritizes one factor that can account for the *absence* of the outcome when such a cause is not present; by this non-additive assumption, one single factor suffices. Therefore, necessary causality is best suited for developing succinct theories or models that identify a few key necessary factors for the research phenomenon under investigation.

Conventional causal theories, which follow the probabilistic approach, are often criticized for lacking predictive abilities. That is, while causal factors are conceptualized to either increase or decrease the outcome, the actual consequences are determined by probability, resulting in a lack of certainty (Rutten, 2021). In “hard” scientific fields, such as medicine, engineering, and

physics, researchers and practitioners have access to a plethora of "proven" theories that they can confidently apply in their industrial practices or daily lives. However, in social sciences, including hospitality and tourism, which involve much more complex, multi-causal structures, it is challenging to identify a dependable theory that can be heavily relied upon for practical applications due to its unpredictability (Verhagen, 2022). Even if predictive power can be tested through statistical metrics, such as R^2 and CV(RMSE), achieving sufficient predictive power for a single linear cause to accurately predict outcomes in complex social contexts is usually improbable. Additive or configurational models may then introduce additional variables to improve predictions, but this comes at the cost of sacrificing theoretical and empirical parsimony. In contrast, necessary causality holds a pragmatic deterministic view of causality, and thus, its unique feature is the near perfect prediction of the outcomes. Consequently, the characteristics of parsimony and predictive accuracy are representative of necessary causality and provide significant benefits to theories and practices. As Lewin (1952) famously stated, "there is nothing as practical as a good theory," the concise and predictable theoretical statements offer practical relevance and utility.

One caveat of the concept of necessary causality is that while the absence of a necessary cause precludes the occurrence of a given outcome, the presence of said cause does *not* exclusively produce the outcome. Such a notion diverges from that of contributory and sufficient causality, whereby the causes usually serve to account for and predict the presence of the outcomes, or their increased level. In both industry and academia, the objective is to ensure the desired outcome occurs, increases, or reaches a high level. In this regard, necessity theories alone, which solely emphasize the absence or decrease of the outcome, are insufficient.

However, despite the fundamental departure of its causal approach from prevalent practices, which typically involve predicting the "presence" or "high levels" of outcomes, necessary causality still holds significant implications in guaranteeing the manifestation of the desired outcome. In the realm of prediction, mere contributory-based causal factors often encounter limitations, such as 1) substitutability of antecedents, which often result in studies examining similar frameworks but with various combinations of antecedents; 2) challenges in accurately predicting the presence of the outcome, leading to complex models that incorporate numerous antecedents; 3) a wide range and uncertainties of predictive power, requiring models to report the extent of variances explained (e.g., R^2) which are often modest.

Complementing conventional causal logic, necessary causality furnishes indispensable knowledge to avert the absence of a desired outcome. Although research objectives typically revolve around ensuring the presence of outcomes, achieving such goals demands not only factors that contribute to the rise of the outcomes but also those that are irreplaceable and must be present to prevent complete failure. Hence, the application of the necessity logic assumes a pivotal role in fostering a more comprehensive understanding of research phenomena, despite being underutilized in existing research. Beyond the realm of theoretical framework development, it is noteworthy that practitioners have already resorted to the identification of crucial prerequisites as a means of preventing the failure of desired outcomes (Dul, 2020). This is exemplified by techniques such as the MoSCoW technique, where the focus lies not only on "should-have" and "could-have" but also on "must-have" factors that cannot be achieved or substituted by fostering conditions that contribute to the success (Clegg & Barker, 1994). In practical scenarios, the ability to identify necessary key factors is often paramount and used to supplement contributory factors. The endeavor to exhaustively consider contributory factors

related to goal attainment without addressing the *necessary* conditions is not only considered impractical but also ineffective in achieving the desired outcome.

In consequence, although pure necessity models do not suffice in providing a comprehensive account of causality, identifying necessary causality can be a critical addition to conventional theoretical frameworks. *Necessity* logic can be instrumental in refining and disentangling complex causal models by removing extraneous factors that are not deemed necessary. Furthermore, certain causal factors can be depicted as contributory while simultaneously being deemed necessary (i.e., "X likely increases, and is necessary for, Y"). Such a combined form of causal effect warrants more nuanced and elaborate theorizing, as it encompasses distinct causal logics simultaneously. Richter et al. (2021) provide an example of this dual causal nature. Their research proposes the theoretical conjecture that in the context of global virtual teamwork, team members who exhibit higher levels of cultural intelligence are likely to enhance team performance; meanwhile, it is also a necessary factor to avoid unsatisfactory outcomes. Thus, investigating both causality logic may help in deepening the existing literature in a respective field by identifying the theoretical uniqueness of certain factors (Richter et al., 2020).

CAN WE TEST "NECESSITY THEORY" AND HOW?

In conducting studies, researchers typically start with a theoretical framework that helps them formulate hypotheses and then select appropriate methods for data collection and analysis. The "theory-method fit" is paramount to ensuring the rigor of scientific findings according to the research questions. Therefore, careful consideration of the theory-method fit is imperative to successful research practice.

Causal logic-method fit: previous attempts at analytical methods

We suggest that the causal logic that underlines the proposed relationship should be specified, which includes the concepts of sufficiency and necessity as well as the underlying assumptions of (non-)additivity, probability/determinism, and/or (a)symmetry. In the context of typical "contributory"—unnecessary-and-insufficient—hypotheses (i.e., "X likely increases/decreases Y"), mean-based methods are valid options as they align with probabilistic and symmetric assumptions (e.g., t-tests, ANOVA, regression, SEM). In instances where hypotheses explicitly propose the sufficiency logic of causality (i.e., "X *always* produces Y"), the conventional additive model does not provide valid insights because, normally, each independent variable is not capable of sufficiently producing the outcome variable, particularly in complex social contexts. Instead, there exists an alternative stream of causal thought that regards sufficiency causality as a combination of causally relevant factors that generate the outcome, known as "conjunctural causation" (Fainshmidt et al., 2020). In this regard, a combination of factors (X_1, X_2, X_3, … X_n) concurrently lead to the outcome (Y), thereby abandoning the additive view while allowing the combinatory roles of causes that influence the outcome (i.e., "a set of X_1, X_2, X_3, … X_n together produces Y"). To test causal relationships based on conjunctural sufficiency logic, we recommend the use of comparative configurational methods such as qualitative comparative analysis (QCA).

Necessity hypotheses that assume a non-additive, (quasi-)deterministic, and asymmetrical view of causality require techniques that accurately capture this function. A few methodological attempts have been made using quantitative techniques, such as linear regression (e.g., OLS regression, SEM), curvilinear, and threshold-based models (e.g., segmented, polynomial

regressions), as well as qualitative evaluations and descriptive and visual inspections. Qualitative evaluations can be a valid option for establishing necessity-based causal relationships by comparing cases in which a variable is present or absent, possibly through the triangulation of data sources (e.g., Decrop, 1999; Dul & Hak, 2007). However, they are limited by the lack of control, small sample size, and subjective interpretation. Similarly, descriptive and visual inspections may help researchers identify situations in which there are zero cases of the outcome occurring without the cause (e.g., Pan, 2015; Waterman, 1993), but they are also not immune to personal biases and do not provide statistical significance. As such, these methods may be used in conjunction with other quantitative approaches to strengthen the validity of the findings.

Meanwhile, Dul (2016) notices some studies introduce theoretical necessity statements but recast them as traditional causal hypotheses, such as "X increases/decreases Y," for testing conventional variants of general linear models (e.g., correlation, OLS, SEM). These analytical methods are, however, invalid for testing *necessity* hypotheses as they aim to identify average lines that explain symmetrical relationships between causes and outcomes. T-tests and ANOVAs exhibit the same issues, along with the limitations of using curvilinear models and segmented regression analysis (e.g., Füller et al., 2006; Karwowski & Gralewski, 2013). All these methods are still "mean-based," as the linear or non-linear lines span across and between cases; hence, they do not provide robustness to the necessity effects discovered. In consequence, existing studies have encountered difficulties in identifying and applying an appropriate research method that aligns with the underlying assumptions of necessary causality, leading to ambiguous and invalid conclusions.

We propose the application of *necessary condition analysis* (NCA) to test causal relationships based on necessity logic. NCA is an analytical method that endeavors to scrutinize

hypotheses pertaining to the necessary causal factors that contribute to outcomes (Dul, 2016). Since its introduction in 2016, NCA has gained recognition as a valid analytical option in various fields, including psychology (Karwowski et al., 2016), medicine (Kerwin et al., 2018), computer science (Loh et al., 2022), and management subfields, such as HRM (Hauff et al., 2019), supply chain management (Bokrantz & Dul, 2023), international business (Richter & Hauff, 2022), and marketing (Dul et al., 2021). While some recent studies have employed QCA to examine *necessary* causality, QCA is part of a well-established methodology that primarily focuses on sufficiency logic, particularly in exploring how different combinations of causal factors can produce the desired outcome (Rasoolimanesh et al., 2023). NCA is on the other hand a designated method for testing *necessary* causations; unlike QCA, which relies on Boolean algebra and thus, handles dichotomous logic only, NCA employs principles from linear algebra to establish a framework for continuous logic, specifically stating the necessity of one level (X) for another level (Y). (Table 2).

Table 2. Analytical methods that fit causal logic and assumptions.

Analytical methods	Causal logic	Underlying causal assumptions
Mean-based techniques (ANOVA, regression)	Contributory logic	Additive, probabilistic, symmetric
Qualitative comparative analysis	Sufficiency, conjunctural logic	Non-additive, (quasi-)deterministic, asymmetric
Necessary condition analysis	Necessity logic	Non-additive, (quasi-)deterministic, asymmetric

Note: none of the techniques introduced can infer causality definitively, as the veracity of causal inference is heavily reliant on research design (e.g., experiments, observations). The issue of research design is beyond the purview of this paper.

The necessary condition analysis technique

While conventional statistical techniques (e.g., ANOVA, regression) are typically aimed at finding regression line across data, NCA draws a "ceiling line" to ascertain the unachievable space in which a cause X is absent, but an outcome Y is present, as evident from the unoccupied region in the upper-left corner of the scatterplot displayed in Figure 3. Note that when a high level or the presence of X is necessary for a high level or the presence of Y, cases with low X and high Y will not exist. Therefore, the core of NCA lies in the formulation of a "ceiling line" to detect the region where no cases are possible. There exist multiple techniques for depicting ceiling lines. However, two common approaches utilized in NCA are (1) ceiling envelopment (CE) and (2) ceiling regression (CR) with free disposal hull (FDH) (see Figure 3). The former method, CE-FDH, produces a piecewise straight line that is suitable for dichotomous and discrete necessary conditions, while the latter technique, CR-FDH, generates a trend line that connects the edge points of the CE-FDH line and is suitable for continuous necessary causes. Consequently, the relative size of empty space above the ceiling line compared to the total potential area indicates a necessary causal effect.[12] From a pragmatic deterministic perspective regarding necessary causality, the space above the ceiling line may contain a few exceptional observations that may be outliers or measurement errors. In NCA, the accuracy rate of a ceiling zone is defined as the ratio of observations below the ceiling line to the total number of

[1] To determine the necessity effect size measure, NCA employs the formula $d = C/S$, where d represents the effect size, C indicates the size of the empty space, and S is the size of the potential area containing observations given the observed minimum/maximum values X and Y. As such, S can be calculated as $(X_{max} - X_{min}) \times (Y_{max} - Y_{min})$.

[2] The effect size (d) is bounded between 0 and 1 and is categorized as a "small effect" for $0 \leq d \leq 0.1$, a "medium effect" for $0.1 \leq d \leq 0.3$, a "large effect" for $0.3 \leq d \leq 0.5$, and a "very large effect" for $d \geq 0.5$ (Dul, 2016b, p. 30). Additionally, the statistical significance of the effect size (p) can be determined by an approximate permutation test.

observations. To gauge predictive accuracy, a benchmark of 95% has been proposed. That is, NCA considers X as a necessary cause only if more than 95% of the sample cases predict the (absence of) Y. This parameter has statistical implications for "predictive power." Recent NCA studies have also used "accuracy" parameters to support their necessary conditions, as seen in the work of Della Corte et al. (2021), Lee & Jeong (2019), and Tóth et al. (2019). Nevertheless, researchers must exercise caution and diligently scrutinize cases along the ceiling line in order to make a thoughtful "trade-off decision" that balances the effect size and accuracy rate, thereby redrawing the most appropriate and valid ceiling line (Dul, 2016).[3]

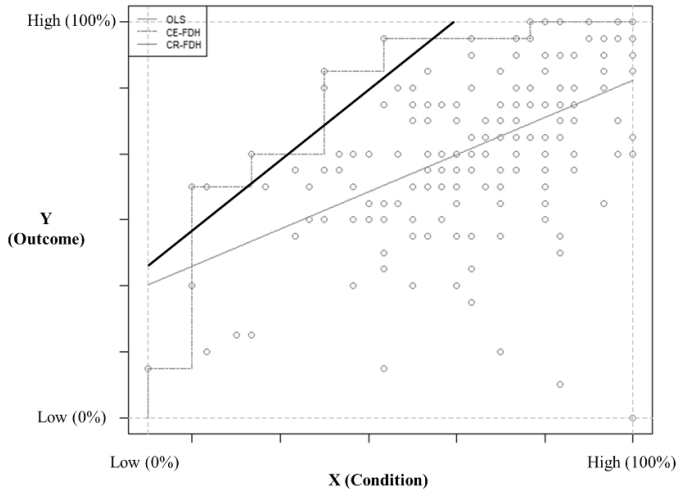

Figure 3. A scatterplot with regression and ceiling lines; the bold straight line is drawn with CR-FDH, the piecewise line with CE-FDH, and the light straight line with regression.

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[3] All analytical procedures related to NCA can be carried out using a freely available software package within the R programming language (https://cran.r-project.org/web/packges/NCA/index.html). Interested readers are encouraged to consult Dul (2018) for a quick start guide to the latest version of the NCA R software.

Conceptual-contextual theorizing using necessary causality

In the effort to develop field-specific necessity theories, we echo the contextualizing-conceptualizing approach as it effectively accounts for the unique characteristics of this applied field (Hong et al., 2014; Miao, 2021). For hospitality and tourism, existing concepts and theories can be decomposed into their constituent contextual components and redefined to be more relevant to this field of application (Hong et al., 2014). To further enhance the development of distinctive "homegrown" theories, particular attention must be given to the misaligned gaps between the hospitality and tourism context and existing theories (Miao, 2021; Miao et al., 2022). *Necessity* logic can be integrated into conceptual-contextual theorizing in tourism and hospitality research for a couple of reasons.

First, the hospitality and tourism industry takes pride in its distinctiveness in creating experiential value for consumers (Gursoy, 2018; Hwang & Seo, 2016). The industry's value proposition centers on the recognition that consumers seek not merely a place to visit/stay or a meal to consume, but experiences that cater to functional, social, and emotional needs and well-being. Achieving these goals demands mindful designs of the service product across touchpoints of the customer journey, which can emphasize novelty, memorability, hospitableness, and personal touch (Crompton, 1979; Lu et al., 2020; Mody et al., 2019). Unlike other industries where experiential values may be considered optional elements that can attract customers but are not essential, the hospitality and tourism industry recognizes the indispensability of offering such values. Neglecting to deliver unique service experiences inherent to the hospitality and tourism industry can result in immediate failure. Hence, necessity logic can offer ample opportunities to advance theoretical insights into the *context-specific* essentialities of experiential values within this field. Such phenomena defy sole probabilistic causality logic but can be complemented with

the lens of necessary causality to enable optimal theorizing practices. Consequently, this perspective can enrich our comprehension of the necessary nature of providing exceptional hospitality and tourism services and aid in the development of effective strategies for achieving this goal.

Second, the hospitality and tourism industry is largely influenced by other economic sectors as well as its external environment. Such an interdependent relationship with other factors makes the field highly susceptible to external risks and threats, including economic fluctuations, political instability, and natural disasters (Chew & Jahari, 2014; Li et al., 2018; Sönmez & Graefe, 1998). Any of these risk factors impact our industry's operation and stakeholder engagement more seriously than most other sectors. The prolonged COVID-19 pandemic has demonstrated the industry's vulnerability to public health risks such as infectious diseases (Fotiadis et al., 2021). Despite being forced to reimagine travel and hospitality in a post-pandemic era, this disaster also urges scholars to enlighten the field to prevent the subsequent halt of travel and hospitality consumption. The existence of most external risks poses an immediate threat to the industry. Therefore, the necessity logic of causality should be encouraged for future scholarship in the field of tourism and hospitality. This theorizing approach not only contributes resilience to the industry and prevention of future disruptions in pragmatic worth but also consummates theory building that plants the seeds for inspiring homegrown theory in the field.

Transdisciplinary theorizing using necessary causality

We encourage transdisciplinary theorizing that incorporates *necessary* causality in hospitality and tourism research. The industry's interaction with diverse fields of knowledge and

stakeholders makes it a fertile ground for transdisciplinary inquiry, where disciplinary boundaries are blurred and various perspectives are brought to bear upon the research (McPhee et al., 2018; Miao et al., 2022). Transdisciplinary research has the potential to foster synergies in theoretical development beyond disciplinary boundaries by integrating diverse disciplines and unconventional perspectives and assumptions. This approach can facilitate the identification of solutions to issues that are relevant not only to the hospitality and tourism industry but also to broader societal challenges (McPhee et al., 2018). Despite its potential benefits, transdisciplinary research can present challenges due to the achievement of multiple goals from different fields' perspectives, leading to intertwined problems that are difficult to solve. For example, in the context of gentrification, touristifying a regional town may have the potential to foster the local economy and encourage new employment in the tourism and hospitality sectors. However, it could also result in the depletion of natural and cultural resources and threaten the lives of original residents as the land price rises (Aref & Redzuan, 2009). These varying effects of gentrification on different subjects, including economics, psychology, sociology, public policy, and geography, make it challenging to resolve related issues.

To this end, we propose the approach of transdisciplinary necessity theorizing, which entails identifying key necessary factors that are critical for achieving all goals at acceptable levels. By doing so, we can gain a more concise understanding of the interdependence between different disciplinary aspects of the targeted issues and effectively manage them. While seeking a simple solution to solve all intertwined goals may seem almost improbable, identifying at least certain conditions that, if not met, would disrupt all of these goals is relatively achievable. Let us bring back the issue of gentrification; one could possibly conceptualize "local community support" as a necessary condition that must be preserved for regional town development towards

tourism not to backfire in any way. With that, “local community support” serves as a universal attribute across disciplinary boundaries, which is necessary for achieving each of the main goals related to each discipline. We anticipate that the necessary causality will give rise to numerous transdisciplinary necessity theories within the hospitality and tourism fields. These theories can offer insights and solutions to issues that transcend traditional disciplinary boundaries, resulting in a mutually beneficial exchange of knowledge.

Necessity theory testing in hospitality and tourism research

Notably, there has been an early adoption of the concept of necessary causality, accompanied by the utilization of its analytical technique known as NCA. Within the context of hospitality and tourism research, NCA was initially introduced by Lee and Jeong (2019) to examine the necessity effect of tourists’ hedonic experience on the eudaimonic experience. Several other studies have adopted this approach and utilized NCA when examining necessary causalities (e.g., Della Corte et al., 2021; Lee et al., 2022; Tóth et al., 2019; Yu et al., 2022). For example, Della Corte et al. (2021) identified individual capability in interfirm collaboration as a necessary cause of the likelihood of cooperation.

However, two issues have emerged that may hinder the development of *necessity* theories and create confusion in the literature concerning what constitutes *necessity* theory testing and how it should be conducted. Firstly, a majority of studies lack independently developed hypotheses for testing necessary causal relationships. While labeling research as “exploratory” as a pretext for avoiding a thorough literature review is not desirable, this also could be attributed to researchers’ unfamiliarity with theorizing or formulating hypotheses based on necessary causality and expressing them in necessary language. Indeed, while these studies are early

adopters of necessary causations and methodological technique (i.e., NCA), they did not articulate what *necessity* logic means in their assumptions and the differences from the dominant contributory (and sufficiency) logic. However, this is no fault or weakness of these studies because authors need to prioritize discussion within the scope of their research questions. The lack of conceptual awareness of such logical reasoning, albeit the emergence of empirical attempts that utilize such a theorization approach, has propelled this research to fill this gap. We aspire to provide a clear articulation of the concept of necessary causality, highlighting its distinctive attributes in relation to existing causal logic. By doing so, we hope to facilitate future studies in the hospitality and tourism domain in their ability to develop hypothesis statements that incorporate necessity logic.

Secondly, given the lack of methodological expertise, the NCA technique has not been correctly applied. Some studies contain logical misinterpretations, while others confuse NCA with other methods (Dul, 2022b). The logic and application of this technique are well-documented (Dul, 2016, 2020, 2022a); in recent years, scholars also introduced guidelines and applications of NCA in hospitality and tourism research (Lee et al., 2023; Tóth et al., 2019). In this article, we hope the conceptual and methodological guide will advocate good practices for the application of necessity logic and encourage scholars to continue to break boundaries in knowledge advancement.

As discussed, the field of hospitality and tourism can be fertile ground to test *necessity* theories or use *necessity* logic to complement conventional causal logic. As the tourism and hospitality field continues to evolve and flourish, there are endless opportunities for theory testing using necessity logic with the proper analytical technique. This approach provides a new angle for hypothesizing important research questions when the *necessary* conditions become

critical aspects. For example, issues related to ethics and security in technology-enabled services could benefit from necessity theorizing—What are the "must-have" factors for the practice/company to be considered ethical? What are the "must-have" factors for the practices to gain consumer trust? In recent years, the tourism and hospitality industry has undergone significant transformations as a result of advancements in information and communication technologies (Erdem & Firpo-Cappiello, 2021). The use of artificial intelligence systems, including those embodied in large language models (e.g., GPT, BERT, XLNet), has opened up new possibilities for customer services such as AI-guided information search (e.g., ChatGPT, Bard) (Wawro, 2023), algorithmic recommendations on travel platforms (e.g., TripAdvisor) (Kamal & Chatzigiannakis, 2021), technology-enabled personalized services (e.g., smart hotels) (Phillips, 2020), and machinery or robotic services (e.g., serving robots, barista machines, and self-service kiosks) to perform functions that are physically or mentally taxing for human employees (Robot newspaper, 2020).

The rise of service technologies in the industry also prompted serious ethical and security concerns among consumers. For example, the amount and levels of transparency of the personal data collected (Munchbach, 2022), and the potential consequences of consumer data being hacked or obtained by other malicious actors (Ibraimova & Wilde-Detmering, 2023). Another debatable issue that has surfaced with the proliferation of AI is whether it is ethical for algorithms to control customer behaviors and decision-making processes (e.g., algorithmic dynamic pricing and automated transportation). In the hospitality and tourism industry, the power balance is often tilted towards the consumer side as a result of fierce competition among analogous products/services. This dynamic further underscores the importance of upholding ethical and moral standards, as any failure to do so can render companies vulnerable to severe

damage (Wolff et al., 2019). Such damage could manifest as consumer distrust, which may result in direct complaints, public criticism, or even legal action, depending on the severity of the ethical breach. Hence, companies must understand the gravity of ethical considerations and take proactive steps to ensure that their technology-enabled services are delivered in an ethical and trustworthy manner. Moving forward, future research may benefit from utilizing necessity logic to identify conditions that can prevent consumers from losing trust and switching to other companies due to moral and ethical breaches.

Meanwhile, the hospitality and tourism industry has come to recognize sustainability as a critical imperative, owing to a set of several societal and environmental factors. The industry heavily relies on natural and regional resources for its operations and customer experience, necessitating the implementation of responsible and sustainable practices to prevent severe environmental impacts (Holden, 2016). The economic viability of the industry is also contingent on sustainable practices, as unsustainable practices may result in reputational damage, regulatory penalties, or losing competitive edges (Khatter et al., 2019). As sustainability concerns continue to escalate, consumers are increasingly prioritizing environmentally responsible and socially conscious consumption in daily life, prompting the hospitality and tourism industry to integrate sustainability into its practices (Pratt, 2022). Therefore, this integration is not merely an ethical obligation but also a strategic necessity for long-term success and growth. Accomplishing this objective requires the pursuit of a sustainable business while achieving goals in environmental regulations, social responsibilities, and economic sustainability concurrently (Barbier, 1987). The interdependence of these objectives presents a multifaceted managerial challenge, requiring businesses to carefully navigate conflicting outcomes and trade-offs.

In addressing the multifaceted and complex nature of sustainability issues, the adoption of the *necessary* causality approach may prove beneficial. This approach involves identifying a few key factors that are essential for the achievement of sustainable goals at acceptable levels. By doing so, the interdependence between the environmental, social, and economic aspects of sustainability can be more concisely understood and managed, thereby attaining "win-win" solutions while avoiding "green-washing" (Tounta, 2022) or "sustainability paradox" (Luo et al., 2020) scenarios. For example, the use of sustainable products and materials in the core operations and service delivery of businesses (e.g., locally sourced food, environmentally friendly products, and recycled papers) can be considered essential in achieving sustainability goals and meeting the demands of customers seeking sustainable consumption options. Further, given the resource-intensive nature of the industry, particularly concerning energy consumption for heating/cooling, lighting, and other operational activities (Ioannidis et al., 2021), having actionable energy conservation initiatives are likely critical in reducing the industry's environmental impact and mitigating negative consequences on the environment.

CONCLUSION

Good theories can be those that are pithy—i.e., simple yet comprehensive. The principle of simplicity, known as Ockham's Razor, resonates with *necessity* theorizing where a simple model can yield nearly perfect predictions (i.e., determinism). However, the *necessity* logic of causality has received limited attention and is not well understood in the literature. In this article, we review various causality logics and introduce the key assumptions of *necessary* causation. We highlight the benefits of *necessary* causalities, such as parsimony and precision in predictions, and discuss opportunities for theoretical innovation. For example, we suggest

opportunities to integrate *necessity* theories in the hospitality and tourism field, drawing on conceptual-contextual theorizing, leading to "homegrown" theories. We additionally discuss that *necessary* causality in transdisciplinary research can facilitate knowledge exchange and "reversed export" to neighboring domains. In the end, we suggest promising research areas for *necessity* theorizing in hospitality and tourism research.

This research has several limitations that can be addressed in future endeavors. Our study centered on a philosophical discussion of the necessity logic, rather than delving into the veracity of causal inference. In addition to theoretical support, the rigor and accuracy of causal inference are significantly reliant on research design (e.g., experiments and observations), which can require implementing certain data collection/analysis strategies to allow causality testing (e.g., time variance in measurement/manipulation, randomization in sampling/treatment assignments, collecting variables from different sources). Future research could explore and compare different research designs in their roles in establishing causal inference based on necessity logic. Second, scholars have attempted to combine asymmetrical analysis (e.g., QCA) with symmetrical techniques such as SEM (e.g., CB-SEM, PLS-SEM) to provide more comprehensive answers to research questions (Geremew et al., 2023; Richter et al., 2020). Although this article focuses on *necessity* logic and its techniques, we encourage future studies to attempt to combine sufficiency/contributory logic with *necessity* logic, including integration with qualitative research to create more opportunities and conceptual lenses for knowledge advancement. Third, although we include references for readers to review how necessity logic can be operationalized via empirical examples (e.g., Della Corte et al., 2021; Lee et al., 2022; Lee & Jeong, 2019; Tóth et al., 2019; Yu et al., 2022), this research is not an empirical application of *necessity* logic within defined research questions. It is noteworthy that necessity logic is not limited to certain research

questions or topical areas, but instead, a new philosophical perspective to understand a research phenomenon. While sufficiency or contributory logic, commonly employed in previous research, focuses on identifying relationships that have a positive or negative impact on an outcome, *necessity* logic possesses the unique ability to predict the absence of an outcome with strong predictive capability. Consequently, future studies are encouraged to integrate this theoretical perspective when investigating research questions and hypotheses that cannot be adequately addressed using conventional logic, yet hold significant value for scholarship advancement.

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