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Simulation Modeling of Occupational Health of Tourism and Hospitality Workers

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INTRODUCTION

The tourism and hospitality industry is a complex system with many diverse components that are connected, interdependent, and that adapt to a dynamic environment. As in other social sciences, traditional tourism and hospitality research has for the most part adopted a reductionist approach using linear analytical tools and models to explain various phenomena, with only a handful of researchers proposing a complexity science approach—primarily for destination and environmental management (Baggio, 2008; Baggio, et al., 2010; Chen, 2004; Faulkner & Russell, 1997; Georgantzas, 2003; Harrington, 2001; Harrington & Kendall, 2005; Lazzeretti & Petrillo, 2006; McDonald, 2009; Loutif, et al., 2000; Zahra & Ryan, 2007). Continuing the use of linear methods to understand the dynamic and complex nature of research problems will lead to explanations and solutions with, at best, modest results. Complexity science (Waldrop, 1992) offers great potential for studying the complex dynamical system of tourism and hospitality with greater effectiveness. In particular, the dynamic and systemic complexity of health of particular populations, in the context of tourism and hospitality, warrants the use of a systems paradigm.

LITERATURE REVIEW

Traditional Science vs. Complexity Science

The long-held belief that physical sciences represent methodological rigor has led social scientists to adopt the reductionist paradigm developed by Newton well over 300 years ago (Capra, 1983). The new wave of thought emerging from Einstein's theory of relativity, quantum mechanics, chaos theory, and growing understanding of nonlinearity has increasingly challenged the Newtonian approach (Capra, 1983, 1986; Davies & Gribbin, 2007), as scientists began to recognize the limitations of this paradigm. The accelerating pace of technological advances, destabilization of societies, and increasing levels of uncertainty have further fueled the emergence of chaos and complexity perspectives (Toffler, 1970). Social scientists are increasingly viewing the conceptual and statistical assumptions underlying the linear paradigm as being seriously flawed and limiting our ability to explain social phenomena (Resnicow & Page, 2008). The rationale behind these concerns is that the reductionist, linear approach fails to account for nonlinear, quantum influences on human behavior (Resnicow & Vaughan, 2006) and that this approach is limited by both measurement error and failure to account for behavioral variance beyond the typical 10-20% or the rare 50% (Resnicow & Page, 2008).

The recognition that "the whole is greater than the sum of its parts" and that life is dynamic and complex compels scientists to use a different paradigm—a complexity science approach and innovative tools associated with it, as described in Table 1.

Table 1. Defining complexity science and its tools.

Complexity science: the study of complex systems that have many parts that interact to produce behavior that cannot easily be explained in terms of interactions between the individual elements—as most linear approaches attempt to do (Holland, 1992). Complex systems present some of the most pressing real-world challenges for society, government, industry, the environment, health, and economics, among others. A system can be considered complex if its components meet four qualifications: *diversity, connection, interdependence*, and *adaptation* (Page, 2010). *Complex adaptive systems (CAS):* describes systems that continuously interact with and adapt to the external environment and are able to dynamically maintain their integrity and function (Page, 2010). Among the most

important properties of CAS are: *emergence, phase transitions*, *iteration*, and *resilience*.

- *Emergence (emergent phenomena)* refers to patterns of interactions among a system's components that develop from the bottom-up without any central plan or control (similar to self-organization of animals in nature, e.g., flocks of birds, schools of fish).
- *Phase transitions* (or *tipping points*) refer to when forces within a system reach a critical threshold and change the state of the system (e.g., an epidemic transitioning into a pandemic, tourism activity declining severely following a terrorist attack or economic crisis).
- *Iteration* refers to small changes in the system's initial condition with potential to impose significant effects as a result of emergence and feedback loops (that are circular or more complex chains of causation) several times, referred to as the "butterfly effect"—as when a small snowball continues to gain more snow as it rolls downward (Holbrook, 2003; Page, 2010).
- *Resilience* is the capacity of a system to absorb disturbance, undergo change and still retain its function, structure, and identity (e.g., as witnessed in the repeated recovery of the tourism industry from various economic, political, or natural adversities).

System dynamics (SD): methodology and computer-aided modeling techniques used to understand nonlinear behaviors of dynamic complex systems (Forrester, 1971, 1994; Radzicki & Taylor, 2008; Sterman, 2000, 2001). SD modeling is based on the premise that the complex behavior of a system results from the interplay of stocks, flows, feedbacks, and time delays occurring within this bounded endogenous system:

- *Stocks:* variable measured at one specific time and represents a quantity existing at that point in time, which may have accumulated in the past (e.g., number of hotel workers injured on the job)
- *Flows:* variable measured over an interval of time (e.g., a year)
- Feedbacks: output of a system that is routed back as an input as part of a chain of cause-and-effect, forming a loop
- *Time delays*: shows time it takes for things to happen
- *Causal-loop diagram*: problem presented in a type of nonlinear influence diagram (which variables influence which other variables)
- *Stock-and-flow diagram*: problem presented in a way to reveal that all dynamic behavior in the world occurs when flows accumulate in stocks

Computer software programs (e.g., Vensim, DYNAMO, STELLA) are used to simulate a SD model of the situation being studied to run "what if" simulations to test the effectiveness of certain policies or interventions to understand how the system changes over time (Homer & Hirsch, 2006). A SD model can illustrate structure causing a problem, how problem is created, identify high-leverage policies to alter behavior, reveal reasons for failure of low-leverage policies, and help argue for better alternatives.

Examining Health in the Context of Tourism and Hospitality

Health in the context of tourism and hospitality represents a complex system involving various populations and policies (Apostolopoulos & Sönmez, 2007; Chalmers, 2013; Krause, et al., 2005, 2010). Three particular populations of interest that exemplify complex systems are: (a) those employed in the industry (Hsieh, et al., 2013, 2014, 2015; Krause, et al., 2005, 2010), (b) travelers and host communities (Apostolopoulos & Sönmez, 2002, 2007; Apostolopoulos, et al., 2002; Sönmez, et al., 2006, 2007; Wickens & Sönmez, 2007), and (c) the working population in the U.S. impacted by a "vacation deficit" (Chalmers, 2013; Sönmez & Apostolopoulos, 2009).

More specifically, the occupational health of pink/blue collar (low-skill/low-pay) tourism and hospitality sector workers (lodging, foodservice, attractions, transportation) who are exposed to disproportionately high levels of occupational stress and exposures to a multitude of risks leading to overlapping health conditions (Chalmers, 2013; Sönmez & Apostolopoulos, 2009). The traveling public and members of tourist receiving and generating communities are vulnerable to infectious diseases or (in the case of travelers) may engage in risk-taking behaviors, with travelers bridging communities of varying disease prevalence (e.g., recent Ebola spread from Africa to the U.S.) (Apostolopoulos & Sönmez, 2007). Finally, the working population in the U.S. suffers from overwork and burnout due to lack of sufficient time off. Global health indicators suggest clear links between declining time off, absence of mandated vacations, U.S. social, health, labor, and corporate policies, and increasing public health problems, skyrocketing health-care costs, and impacts on productivity—despite U.S. health expenditures, which are the highest in the world as a share of GDP (OECD, 2011, 2013, 2015; WHO, 2012, 2015).

Occupational Hazards of Low-Skill/Low-Pay Hospitality Sector Jobs

In the services sector, hospitality jobs (in lodging and food service) are among the most demanding and too frequently characterized by unfavorable conditions that lead to adverse effects on employees' physical and psychosocial health (Brownell, 2008; Hsieh, et al, 2013, 2015; Karatepe & Tizabi, 2011; Ross, 2005). For *hotel workers*, these include: (a) long/irregular work hours/shiftwork (Pienaar & Willemse, 2008; Wial & Ricker, 2002; Willemse, 2006); (b) low-pay (Gautie, 2010); (c) job insecurity (Bothma & Thomas, 2001), lack of promotion prospects (Krause, et al, 2002; Lo & Lamm, 2005); (d) time pressures (Krause, et al., 2002; WorkCover, 2003; EASHW, 2010); (e) repetitive/boring work (Murray & Gibbons, 2007); (f) work overload (Lo & Lamm, 2005; Murray & Gibbons, 2007; O'Neill & Davis, 2011); (g) low decision latitude (Chiang, et al., 2010; Shani & Pizam, 2009); (h) emotional labor (Kim, 2008); (i) sexualized workplaces (WorkCover NSW, 2003; Worsfold & McCann, 2000); (j) unpredictability (Shani & Pizam, 2009); (k) interpersonal tension/conflict (Lo & Lamm, 2005; O'Neill& Davis, 2011; Zohar, 1994); (l) work-home conflict (Hsieh, et al., 2008; Wong & Ko, 2009); and (m) threats of violence, bullying, mistreatment, and discrimination (Murray & Gibbons, 2007).

For *restaurant workers*, these include: (a) physical hazards causing burns (e.g., hot oils/water/steam, fryers, grills, flame); (b) chemical hazards (e.g., cleaning solutions, gases, fumes from heated oils and cooking of meat/fat, harmful byproducts including carcinogens/mutagens found in fumes when preparing foods under high temperatures); (c) biological hazards (e.g., foodborne organisms); (d) environmental hazards linked to poor equipment, slippery floors, environmental tobacco smoke, repetitive motions leading to falls, sprains, strains, cuts, contusions, or burns; and (e) psychosocial hazards (e.g., work stress, emotional strain) (Tsai 2009; Tsai & Bruck 2009; Tsai & Salazar 2007; Ward, et al., 2010).

Work/Nonwork Stressors of Hispanic Immigrant Hospitality Sector Workers

Particularly low-skill/low-pay jobs in the tourism and hospitality sector tend to attract vulnerable workers such as immigrants and minorities. Minorities account for more than 60% of hotel and restaurant workers in the U.S. (BLS, 2014); among them, 22% are Hispanic (NCLR, 2011), as compared to 14.6% of the general workforce (NCLR, 2011). Hispanics are found more often than other ethnic groups in hotel housekeeping and food service jobs (NCLR, 2011). Immigrant hospitality workers' socioeconomic backgrounds, immigration status, lack of English proficiency, and limited or no access to either private or publicly funded healthcare place them at an elevated risk for poor health. This vulnerable and underserved immigrant population is also prone to various forms of mistreatment or abuse, including wage theft (i.e., minimum wage violations, withholding of overtime pay), job insecurity, no access to healthcare (Chang, et al., 2013; Gaydos, et al., 2011), racial discrimination (Krause, et al., 2002; Lundberg & Karlsson, 2011), and sexual and verbal abuse (Liladrie, 2010; Poulston, 2008).

Focusing on hotel housekeepers reveals their exposure to a plethora of disproportionately high stressors and work-induced hazards that can lead to adverse health consequences (Hsieh, et al., 2013, 2014, 2015). Compared to other occupations, an increase in occupational stress has been seen in the hospitality industry over the past 15-20 years (Murray & Gibbons, 2007). Hotel workers have reported being stressed on 40-60% of their workdays, compared with a national sample that reported being stressed 25-44% of their workdays (O'Neill & Davis, 2011).

Hispanic hotel housekeepers are rendered particularly vulnerable to elevated occupational hazards and resulting health strains due to their socioeconomic status, immigration status, language barriers, and lack of access to healthcare services (Hsieh, et al., 2013, 2014, 2015). Ethnographic fieldwork with Hispanic hotel housekeepers exploring issues of psychosocial and physical occupational health revealed exposure to physical, chemical, and social hazards in the workplace as well as musculoskeletal injuries and work-related stress from constantly experiencing time pressures at work, feeling rushed to finish assigned rooms, and workplace mistreatment, including interpersonal (e.g., supervisor favoritism, unfair work assignments, biased allocation of cleaning supplies, disrespect, and verbal abuse due to ethnicity) and policy-related factors (e.g., low pay, lack of paid sick leave or overtime, and absence of appropriate cleaning tools or protective equipment) (Hsieh, et al., 2013, 2014, 2015, n.d). Nonwork sources of stress included financial hardships and ongoing worries about bills (Hsieh, et al., 2015).

METHODOLOGY

The determinants and distribution of health and disease outcomes in each of the foregoing populations (i.e., tourism/hospitality sector workers; travelers/host communities; general vacation-deprived working population) represent interacting, complex, evolving, interdependent, adaptive, and spatially and temporally distinct components with unpredictable and nonlinear trajectories. The health of any of these populations is a complex and adaptive dynamical system with nonlinear and emergent properties. Understanding and predicting the activity, trajectory, behavior of health of these populations has potential to help devise and strengthen disease prevention efforts at local, national, and international levels.

We aim to initiate a dialogue on using complexity science and its tools to bring innovation to tourism and hospitality research, by using the specific example of the occupational health of Hispanic immigrant hospitality sector workers.

Occupational Health of Hispanic Immigrant Hotel Workers as a Complex Adaptive System

Complex adaptive systems (e.g., immigrant health) are comprised of interacting heterogeneous elements with emergent properties, persist over time, and adapt to changing circumstances (Diez Roux, 2011). As a result of varied disturbances (e.g., declining healthcare access), population health can move from a “steady” state into transitions (e.g., increasing health risks) with adverse effects (e.g., chronic disease) when surpassing certain thresholds (e.g., disease onset) (Galea, et al., 2009). Threshold conditions are vital for systems because, when crossed, they shift the dominance of feedback loops that control the process and irrevocably affect its “capacity to absorb disturbances and reorganize while undergoing changes so as to still retain the same function, structure, identity, and feedbacks” (Galea, et al., 2010). Understanding how such transitions can be leveraged as areas of intervention remains a top priority for prevention programs (Jones, et al., 2006).

Traditional mental and theoretical models, research designs, and analytical tools are not well equipped to investigate processes rooted in systems that are exemplified by dynamic interactions among diverse actors, feedbacks, transitions, and adaptation (Luke & Stamatakis, 2012). Embedded in the “general linear model” (Waldrop, 1992), correlation-based methods, even when relaxing some of their assumptions, are unable to capture feedbacks that can increase the resistance of problems to change (e.g., adverse health outcomes triggered by chronic and acute stress) (Diez Roux, 2011; Galea, et al., 2009, 2010). The scale, multidirectionality, and complexity of immigrant health have been examined using methods unable to reveal the multilayered causal gamut of chronic syndemicity (a “syndemic” is a set of linked health problems involving two or more afflictions, e.g., discrimination, poverty, stress, and cardiovascular disease) (Apostolopoulos, 2012; Milstein, et al., 2009). Regression models assess links between variables while controlling for confounders; however, regression is neither able to account for interrelationships, reciprocity, and the discontinuous nature of underlying risks, nor can it fully recognize pathways linking levels of those factors (Galea, et al., 2009; Homer, et al. 2007). Most importantly, regression models cannot handle feedback loops, as even the most sophisticated techniques can break down in the presence of nonlinearity (Galea, et al., 2010; Luke & Stamatakis, 2012).

In light of inherent limitations of these methodologies (Diez Roux, 2011), compared with the dynamic complexity of—in this case—Hispanic immigrant health (Apostolopoulos, 2012), different theories and analytical tools are needed. Complex systems theory and methodologies provide an alternative by permitting the simultaneous examination of dynamic interrelationships of factors at multiple levels of analysis, while enabling investigation of their impact on the system's behavior over time (Midgley, 2003). These methodologies supersede traditional approaches to immigrant health by conceptualizing disease causation within complex systems with positive and negative feedbacks (Homer & Hirsch, 2006). Systems methodologies are also useful for explaining assumptions about complex population health situations by predicting empirical observations and providing a framework to identify knowledge gaps, thus specifying outcomes even when detailed knowledge is lacking and clarifying types of new data that are needed (NCI, 2007; Sterman, 2000).

Chronic disease research (Abdel-Hamid, 2002, 2003; Hirsch & Wils, 1984; Homer, et al., 2004, 2010; Jones, et al., 2006; Milstein, et al., 2007) has used system dynamics (SD) modeling to improve prediction of potential intervention effects in complex situations in which pathways from interventions to outcomes may be indirect, delayed, or affected by nonlinearities. SD modeling is guided by nonlinear dynamics and feedback control theory using the feedback loop mechanism to describe graphically and mathematically endogenous system changes (Sterman, 2001). SD modeling is based on the premise that the complex behavior of a system results from the interplay of stocks, flows, feedbacks, and time delays occurring within this bounded endogenous system (Sterman, 2000). Simulation is used to track stock accumulations (e.g., injured hotel workers), determined by flows (e.g., injury rate), feedbacks (causal loops with balancing and reinforcing effects), and time delays (e.g., lag time between starting work and injury) (Sterman, 2000). System behavior is influenced by its internal structure (number and types of feedbacks and associated strengths), as positive and negative loops can be seen as fighting for system control, with dominant loops determining system outcomes over time (Sterman, 2001). Our goal is to leverage a reinforcing loop to move us to an improved, but stable state of Hispanic immigrant hospitality worker health. SD modeling provides the tools to assemble information about a problematic complex health situation into a single and visible dynamic hypothesis and, via computer simulations, to compare scenarios to aid in navigating the landscape of change (Sterman, 2000). It is a way of mapping and modeling potential forces of change within a dynamical system to better understand mutual influences and to govern the system's overall direction (Hirsch & Homer 2004; Sterman, 2000).

SD modeling differs from conventional approaches by (Milstein, et al., 2009; van Vliet, et al., 2011): (a) starting from theory, experiences of stakeholders (i.e., hospitality sector, Hispanic community organizations), and available data to develop dynamic hypotheses in the form of diagrams and models; (b) building mathematical models based on differential equations that manifest processes hypothesized as leading to disease, rather than statistical models correlating risk factors to disease; (c) analyzing mathematical models via computer simulations to gain insights into system behavior and to formulate ideas on gathering additional data to test dynamic hypotheses (the model, with different assumptions); and (d) using models to design the most informative studies possible and to gather data with the purpose of pursuing realistic explanations of models.

CONCLUSION AND DISCUSSION

Innovative complex-systems approaches grounded in complex adaptive systems (CAS) theoretical, methodological, and analytical perspectives have potential to lead to greater understanding of health problems as well as appropriate interventions. In addition, these innovative methods can advance tourism and hospitality research beyond the traditional methods for a variety of research issues beyond the hospitality worker occupational segment in particular or health in general. The foregoing methods and tools will be discussed in the context of this particular population and research problem, and using causal-loop and stock-and-flow diagrams to illustrate our use of these methods.

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