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Developing a weighted model to measure knowledge diffusion in a tourism destination network

Hossein Raisi [a], Llandis Barratt-Pugh [b], Rodolfo Baggio [c], Gregory Willson [a], Sam Huang [a] and Kourosh Esfandiar [a]

[a]School of Business & Law, Edith Cowan University, Joondalup, Australia; [b]Business School, University of Western Australia (PhD) Honorary Research Fellow, Claremont, Australia; [c]Dondena Center for Research on Social Dynamics and Public Policy, Bocconi University, Milan, Italy

ABSTRACT

Efficient knowledge transfer enhances tourism destination competitiveness. Multiple factors, however, affect knowledge transfer, making it a complex process to quantify. To address this complexity, we developed a quantitative tool by integrating a diffusion model with the major antecedents of knowledge transfer identified in the knowledge management literature. We applied this model in the Western Australian tourism industry and demonstrated its practicality. The proposed model provides a quantitative tool for destination management organizations to monitor, assess and improve the efficiency of knowledge diffusion within their tourism destinations. Such improved knowledge diffusion is critical in strengthening a destination's innovative capabilities and competitiveness.

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Knowledge diffusion; tourism destination; network; knowledge transfer; knowledge management

Introduction

Knowledge has been widely recognized as a crucial resource for sustainable competitive advantages and innovative ability (Abdollahi et al., 2023; Argote & Ingram, 2000; Valeri & Baggio, 2022; Yiu & Law, 2014). However, knowledge creation is increasingly becoming a cooperative networking process beyond the boundaries of individual firms (Chuang et al., 2016; Loebbecke et al., 2016; Zhao et al., 2023). Organizations can strengthen their knowledge reservoir by engaging in knowledge diffusion networks and transferring knowledge within networks (Argote et al., 2021; Argote & Ingram, 2000 Li et al., 2015).

Inter-firm knowledge transfer networks play a crucial role in enhancing the competitiveness of the tourism industry (Cooper, 2018; Ubeda-Garcia et al., 2021), which is predominantly comprised of Small and Medium Enterprises (SMEs) that often rely on external knowledge sources (Brandão et al., 2018; Williams & Shaw, 2011). However, SMEs in the tourism sector frequently face challenges related to limited internal Research and Development (R&D) capabilities and difficulties in creating externalities within their clusters (Durst & Runar Edvardsson, 2012; Perles-Ribes et al., 2017). This challenge becomes more pronounced at the destination level, as destinations serve as the primary competitive units in tourism (McTiernan et al., 2023). Tourism destinations encompass a variety of organizations and businesses that work together to create tourism products (Scott et al., 2008). Facilitating effective knowledge transfer within these tourism destinations and among associated organizations can enhance the overall innovative capacity of the destination and elevate its competitiveness (Baggio & Cooper, 2010; McLeod, 2020; Yiu & Law, 2014). Thus, by leveraging inter-firm knowledge transfer networks, SMEs in the tourism industry can tap into external expertise, foster innovation, and strengthen their competitive position within the destination.

CONTACT Kourosh Esfandiar K.esfandiar@ecu.edu.au School of Business & Law, Edith Cowan University, Joondalup, WA 6027, Australia

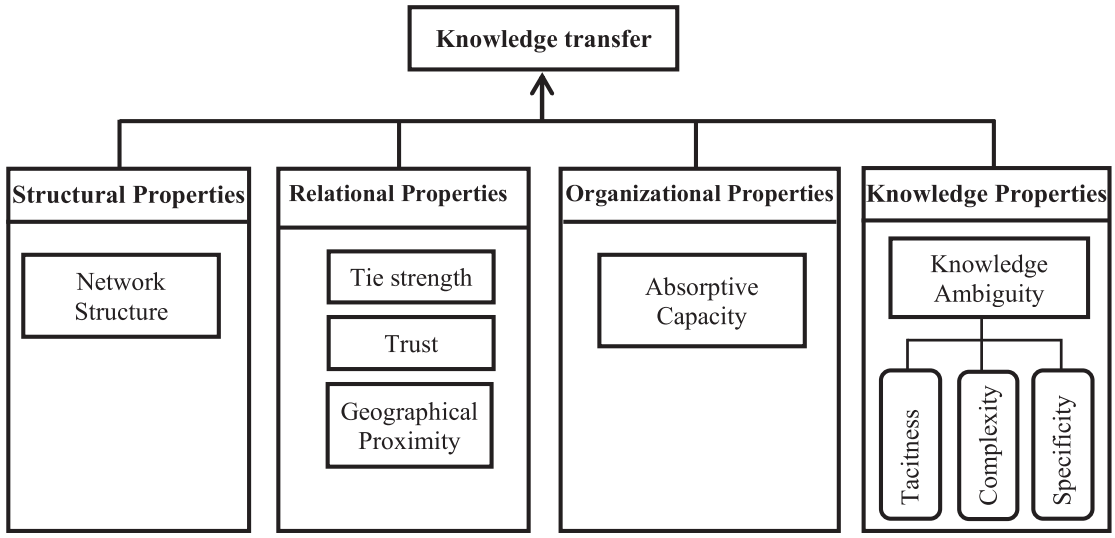

Figure 1. Antecedents of knowledge transfer used as weights in the diffusion model.

Knowledge management (KM) has been identified fundamental for the operation of the tourism and hospitality industries (Cooper, 2015; McLeod, 2020) and its application in tourism organizations presents opportunities for development and improvement (Anand et al., 2022; Zehrer, 2011). Further, knowledge management is a crucial aspect for tourism entrepreneurs, with a growing interest from practitioners, consultants, and researchers in the tourism and hospitality industry (Kharel et al., 2020). Thus, the pivotal role of knowledge in enhancing destination competitiveness has been acknowledged, yet the tourism sector has been slow in embracing knowledge management practices (Cooper, 2006, 2018; Higuchi & Yamanaka, 2019; Novotny et al., 2024; Odunga et al., 2020; Shaw & Williams, 2009). This means there is a need for greater integration of KM concepts into tourism research and practice.

This paper aims to ameliorate this deficiency by developing a refined *weighted diffusion model* that measures knowledge transfer efficiency in tourism destinations. This model generates data that can guide local actions to improve efficiency. While knowledge diffusion has received increasing scholarly attention recently (Jiafu et al., 2018a; Qiao et al., 2019), research on the 'efficiency' of such diffusion is lacking (Jiafu et al., 2018b). Previous studies mainly used simulations of model-generated networks in which knowledge transfer was considered a process of barter and exchange (Zhang et al., 2017).

In tourism research, with the exception of two studies conducted by Baggio and Cooper (2010) and Del Chiappa and Baggio (2015) employing epidemiological simulation models to measure knowledge transfer efficiency in tourism networks, no other attempts have quantified the *efficiency* of knowledge flow in a tourism destination. This distinctive approach not only contributes to our understanding of knowledge transfer within tourism destinations but also provides the tourism industry with a valuable instrument for competitive development.

The model developed, presented, and subsequently trialed in this paper integrates a wide range of knowledge transfer antecedents based on the KM literature (Becker & Knudsen, 2006; Cooper, 2015; Easterby-Smith et al., 2008; Fang et al., 2013; Pook et al., 2017; Shaw & Williams, 2009; Shekhar, 2016; Zehrer, 2011). It acknowledges three fundamental components in knowledge transfer: sender and receiver, network context, and knowledge content (Argote et al., 2003). This paper explored and tailored the key antecedents of knowledge transfer for application within tourism destinations and determined that four broad dimensions are required to examine the knowledge flow between tourism organizations: "structural properties' of the network, "relational properties' of the interactions within the network, "organizational properties' of the tourism companies involved and "knowledge properties' of the data and know-how being exchanged (see Figure 1).

While these antecedents are often explored separately in KM literature (van Wijk et al., 2008), no empirical study has incorporated these four groups of antecedents into a diffusion model to measure the

efficiency of knowledge transfer within a tourism destination network which is the unique feature of this paper. Additionally, recognizing the complexity involved in the diffusion of knowledge and the varied impact of multiple factors, weighted models offer superior precision compared to conventional un-weighted models (Cannatelli et al., 2017; Li et al., 2019). For example, each organization has its unique absorptive capacity (the ability to locate, digest and apply knowledge (Cohen & Levinthal, 1990; Song et al., 2018)), and every organization has different network relationships within a destination that impact diversely upon the efficiency of knowledge transfer. In our model, these factors are appropriately weighted, tailored for the tourism industry, as detailed in the method section of this paper.

The paper's structure is as follows: The subsequent section offers a review of literature, delving into relevant studies on knowledge transfer within the tourism sector. This is followed with a description of the key four groups of antecedent factors that underpin our model. Following this, the weighted model that was constructed from this exploration is explained. Finally, a description is provided about how this model was trialed within an Australian tourism destination.

Literature review and conceptual model development

The interpretation of knowledge and knowledge transfer can be ambiguous, and their definitions significantly influence how they are measured. In the subsequent sections, we aim to elucidate our definitions of knowledge and knowledge transfer, particularly within the context of this study. Also, we discuss the main dimensions of knowledge transfer antecedents, proposed by previous studies.

Knowledge transfer in tourism

The multifaceted nature of knowledge concept has led to diverse perspectives and a lack of consensus in its definition (Abdollahi et al., 2023; Fochler, 2016). Birch and Cumbers (2010) emphasize its evolution into an economic commodity, driving global competitiveness. Cooper (2018) echoes this, acknowledging knowledge as pivotal across disciplines. Current definitions of knowledge debate its independence from the knower, as an object, or its inseparability from the knower (Edwards, 2015). The first perspective sees knowledge as an external 'object' leading to managing things, supported by the first generation of KM (Spender, 2015). The second perspective emphasizes the human knower, posing the challenge of managing people (Edwards, 2015).

Blackler (1995) outlines five forms of organizational knowledge, including its embodiment in staff, embedding in routines, enculturation among staff, and encoding in manuals, guidelines, and procedures. This aligns with the embedded perspective of knowledge adopted by social network researchers, where knowledge is understood and assessed in relation to the social context and social actors producing and receiving the knowledge (Abdollahi et al., 2023; Alavi & Kane, 2008). In the context of the tourism industry, characterized by complex networks, a perspective akin to that of social network researchers is pertinent. This viewpoint regards knowledge as embedded within organizations and their network of relationships, aligning with the tourism industry's complex interdependent networks and continual knowledge transfer (Abdollahi et al., 2023; Fauzi, 2023; Scott et al., 2008). Thus, emphasizing knowledge as a process or flow is an appropriate focus for knowledge transfer in the tourism industry.

Various theoretical frameworks have been applied to study inter-organizational knowledge transfer (Martinkenaite, 2011). Previous studies can be broadly categorized into studies focused on either 'antecedents' or 'consequences' of knowledge transfer (van Wijk et al., 2008). A variety of antecedents of knowledge transfer have been investigated by prior studies and have been formally structured and categorized in different ways. Generally, at the most basic level, elements of every knowledge transfer process include the sender and the receiver (e.g. an individual, a group or an organization), the knowledge and the environment in which this process occurs (Argote et al., 2003; Becker & Knudsen, 2006).

Most of the previous studies (e.g. Cavallari, 2013; Cummings & Teng, 2003; Fritsch & Kauffeld-Monz, 2010; Lawson & Potter, 2012; Levin & Cross, 2004; Li et al., 2015; Martinkenaite, 2011; Pook et al., 2017; Shekhar, 2016; Valeri & Baggio, 2022; Xu & Ma, 2008) are developed around these central elements. However, they had their own limitations. For example, Cummings and Teng (2003) used dimensions of knowledge context, relational context, activity context, and recipient context but did not consider the structural properties. Levin and Cross (2004) used dimensions of structural, relational, and knowledge

but focused on tie strength and trust, omitting consideration of structural properties and several other antecedents. Fritsch and Kauffeld-Monz (2010) investigated knowledge transfer at the inter-organizational level but did not consider knowledge and organizational properties. Li et al. (2015) did not consider structural properties, absorptive capacity, and proximities. In more recent studies, Shekhar (2016) investigated knowledge transfer at both inter-organizational and intra-organizational levels but overlooked structural properties and antecedents such as absorptive capacity, knowledge ambiguity, and tie strength. Pook et al. (2017) explored knowledge transfer at the cross-border level with dimensions of knowledge characteristics, knowledge context, and network characteristics but overlooked structural properties from a network analysis perspective and antecedents such as proximities, absorptive capacity, knowledge ambiguity, and tie strength. Further, Zehrer (2011) examined the status of KM in Austrian tourism organizations, finding that they mainly applied Grant's (2005) model of KM. The study also showed that intra-organizational transfer of knowledge was more common than inter-organizational transfer in that destination. Thus, by reviewing previous research on knowledge transfer antecedents and aiming to construct a comprehensive and measurable framework for a tourism destination, we developed our framework based on four key dimensions: 'structural properties,' 'organizational properties,' 'relational properties,' and 'knowledge properties.'

Theoretically, this framework is derived from social capital theory, which encompasses the two dimensions of structural and relational properties. Nahapiet and Ghoshal (1998) discussed the "structural" and "relational" dimensions of social capital and included the third dimension of "cognitive" properties. However, in this paper, we decided not to include the cognitive dimension and instead add two dimensions of "organizational" and "knowledge" properties. The reasons for this decision are, first, at the inter-organizational level of a tourism destination comprising hundreds of organizations, it is impractical to measure the cognitive properties, which would require a deep examination of several factors inside organizations that would be difficult to measure. An important aim of this framework is to provide a practical structure for users where components can be measured. Each dimension and the constructing components will be described in the next sections.

Despite the growing attention to KM concepts in tourism research, this field remains relatively young and underdeveloped in the tourism domain (Cooper, 2018; Czernek, 2014; Shaw & Williams, 2009). While considerable focus has been directed towards KM in hospitality research (e.g. García-Almeida & Yu, 2015; Hallin & Marnburg, 2008; Nieves & Diaz-Meneses, 2018), researchers have also extensively examined knowledge transfer between research (academic) and practice (industry) in tourism (Scott et al., 2017; Thomas, 2012). However, tourism is often described as a "knowledge and research averse industry" (Baggio & Cooper, 2010; Cooper, 2018), and the link between research findings about tourism and industry action remains a shaky bridge.

Cooper (2018) and Czernek (2017) have enumerated some characteristics of the tourism industry that impede the effective integration of KM within the industry. These include the dominance of SMEs and family-owned businesses, the lack of trust and collaboration between tourism operators, poor adoption, and coordination of knowledge transfer due to a plethora of fragmented tourism products, poor staff human resource practices, and the lack of attempts to audit or measure intangible knowledge resources.

Our study addresses the issues of auditing and measurement of knowledge assets within tourism destinations. Few previous efforts have been made to conceptualize and measure knowledge resources within the tourism context. The two studies by Thomas and Wood (2014, 2015) are examples that attempted to conceptualize absorptive capacity within the industry. Absorptive capacity is a critical factor in knowledge transfer. However, on its own, it fails to provide a complete knowledge flow picture within a tourism destination.

In recent times, several studies have investigated knowledge transfer within tourism contexts. Kim and Shim (2019) explored the personal factors that impact inter-organizational knowledge sharing in a tourism district. In another study by the same authors, they highlighted the pivotal role of social capital in knowledge sharing and competitiveness within a tourism destination (Kim & Shim, 2018). Binder (2020) examined the effect of network relationships on the absorptive capacity of firms in the hotel industry, revealing that the quality of relationships facilitates access and availability of valuable knowledge to firms. Raisi et al. (2020) examined the knowledge transfer network of a destination, focusing on its

structural properties. However, their study lacked integration of non-network KM antecedents of knowledge transfer. Despite their contribution to this emerging domain, none of these studies have attempted to produce an overall efficiency measurement of the network and have only focused on specific issues of knowledge transfer.

Our paper, in terms of context, extends previous studies in this area by first focusing on knowledge transfer among tourism actors, second by integrating network and KM factors within the criteria for measurement, and in weighting the impact of those factors. In the next section, we will explore why particular KM factors are intrinsically important to our model.

Antecedents of knowledge transfer

Knowledge transfer is a complex process involving nebulous substances and opaque interactions. Many factors have been introduced and discussed within the KM literature, including knowledge stickiness (Szulanski, 2002), causal ambiguity (Reed & DeFillippi, 1990), tacitness (Polanyi, 1967), trust (Lane et al., 2001), proximity (Boschma, 2005), absorptive capacity (Cohen & Levinthal, 1990; Zahra & George, 2002), network structure (Inkpen & Tsang, 2005), and tie strength (Granovetter, 1973). Knowledge transfer depends on the relational networks of companies within the destination.

Social capital theory indicates how the structure and relationships within a knowledge network play a mediating role in facilitating knowledge flow within the system. In addition, characteristics of knowledge and individual organizations involved in the network mediate what and how knowledge is consumed and utilized within the destination. In summary, four broad categories of antecedents of knowledge transfer have been identified within the literature, namely structural, relational, organizational, and knowledge properties (Argote et al., 2003; Becker & Knudsen, 2006; Easterby-Smith et al., 2008; Martinkenaite, 2011; Nahapiet & Ghoshal, 1998). The structural and relational properties within the knowledge network originate from social capital theory (Nahapiet & Ghoshal, 1998), whereas the organizational and knowledge properties are derived from absorptive capacity and knowledge management theory. These four dimensions and their constructing factors are used as the weights in our diffusion model.

The **structure of the network** can have a direct impact on the efficiency of knowledge flow among organizations (Fritsch & Kauffeld-Monz, 2010). Network analysis is instrumental in revealing the underlying structure of relationships, diagnosing weaknesses and limitations in knowledge flow, and pinpointing key actors within the network. For instance, prior research has demonstrated that a "small-world" structure is optimal for knowledge diffusion (Cowan & Jonard, 2004; Watts & Strogatz, 1998). Network analysis has garnered increasing attention in tourism research in recent years (Baggio, 2017; Czernek-Marszałek, 2018; Li et al., 2015).

Su et al. (2017) recommended the use of the two most relevant network properties of knowledge diffusion, which are “path length” and “clustering coefficient”. In a network, a path is the sequence of nodes (enterprises) and ties (relational interactions) where all nodes and ties are distinct. Short path length implies that knowledge can spread more rapidly and widely in the network and with lower costs. Research shows that knowledge diffusion increases as path length decreases (Cowan & Jonard, 2004; Singh, 2005). The clustering coefficient quantifies the density of interconnectedness among nodes’ neighborhoods. Dense clustering can improve knowledge diffusion and the speed of spread of knowledge (Reagans & McEvily, 2003; Schilling & Phelps, 2007). Clustering also can help develop trust and willingness to share knowledge (Coleman, 1988; Schilling & Phelps, 2007).

The measurement of path length and clustering coefficient is based on two factors associated with nodes and ties. In unweighted networks, these parameters are typically homogeneous. To address homogeneity in the measurement, Su et al. (2017) proposed employing weighted path length and clustering coefficient, which we have adopted in this study. These measures consider variations in the parameters of nodes and ties in weighted networks, ensuring a more accurate assessment.

Relational properties describe the quality of the relationships within a network (Tsai & Ghoshal, 1998). One of the most used properties to describe the quality of a tie is *tie strength* (Granovetter, 1973). This reflects the closeness and frequency of interaction within the relationship. Theories have been developed on advantages of both weak and strong ties (Levin & Cross, 2004). While weak ties can help expand networks to find more new ideas (Alavi &

Leidner, 2001), several studies have indicated the significance of strong ties for effective knowledge transfer and enhancing absorptive capacity (Levin & Cross, 2004; van Wijk et al., 2008).

Another critical factor impacting on knowledge transfer in a network is *trust*. While trust can increase the willingness to transfer knowledge, lack of trust leads to competitive confusion; for example, partners might be concerned about opportunistic behaviors (Inkpen & Tsang, 2005). Additionally, trust reduces the costs associated with knowledge transfer by minimizing conflicts and the need for information verification (Levin & Cross, 2004).

Proximity is yet another important precondition for knowledge transfer (Knoben & Oerlemans, 2006). Various forms of proximity have been suggested (Boschma, 2005); nevertheless, the majority of research primarily concentrates on geographical proximity (Blasi et al., 2024; Knoben & Oerlemans, 2006). Geographical or physical proximity facilitates face-to-face interactions and, thus, fosters the transfer of knowledge, particularly tacit knowledge, due to its personal and non-codifiable nature (Cooper, 2015; Knoben & Oerlemans, 2006). Tacit knowledge, crucial in sectors like tourism, is often embodied in experts and stakeholders, playing a vital role in creating sustainable competitive advantages, especially in small and medium-sized enterprises where this type of knowledge is more prevalent than explicit knowledge (McTiernan et al., 2023; Were et al., 2021; Yachin, 2021).

The **organizational** dimension of antecedents examine how characteristics of each organization can impact the knowledge transfer process. Acquiring external knowledge is not a straightforward process and organizations have very diverse capabilities when identifying, absorbing, and using knowledge. This ability is called *absorptive capacity,* and each enterprise in the network will have a very different profile (Cohen & Levinthal, 1990). For example, while two organizations may have similar network connections and gain access to similar knowledge sources, their abilities to process and use such knowledge may vary considerably.

The last dimension of knowledge transfer antecedents in the model is **knowledge properties**. Owing to the complex and nebulous nature of knowledge, the characteristics of any particular knowledge sources significantly mediate subsequent transfer processes. Therefore, any model aiming to measure knowledge transfer effectiveness must consider the *type* of knowledge being transferred. Several extensively studied characteristics of knowledge include ambiguity, stickiness, complexity, tacitness, explicitness, context dependence, and specificity (Chen & Lee, 2017; Fang et al., 2013). In this paper, we employ the concept of *knowledge ambiguity*, which denotes the intrinsic and unalterable uncertainty concerning the precise nature of underlying knowledge components and their interactions. Three specific factors have been determined to explore knowledge ambiguity, namely "tacitness", "complexity", and "specificity" (Fauzi, 2023; Reed & DeFillippi, 1990), and these are incorporated into our model.

The knowledge transfer antecedents that have been described under these four dimensions are used as criteria to apply weights in the diffusion model. Our model is specifically produced for use within tourism destinations. Tourism destinations comprise of multiple interactions between public and private bodies, ranging from multinational corporations to micro family businesses and display diverse organizational characteristics, capabilities, and objectives that range from sophisticated business strategies to naive personal ventures. Our model is designed to capture both the broad pattern of network interactions within the destination and the unique position of each organization within the network (Figure 1).

The weighted knowledge transfer model

Our weighted model produces an output index within the range of 0–1. Higher values near to 1 signify greater knowledge transfer efficiency. However, the four components of the model and the multiple factors within them do not have equivalent weights within the analysis process. The various nodes and ties within a network are given different weights based on the knowledge transfer antecedents and their different impacts upon knowledge transfer. When data is collected, the transfer efficiency between each pair of nodes is calculated according to factors assessed and the weight ascribed to each of those factors. The efficiency of every pair of nodes is then computed into a single value to indicate the efficiency of the whole network (Figure 2).

Further elaboration on the weighting of the model components is provided in subsequent sections. For further understanding of how these weights for specific factors are calculated, see Su et al. (2017).

The basic knowledge network is defined as $G = (P, E)$ where $P = \{p_1, p_2, [\ldots], p_n\}$ denotes the

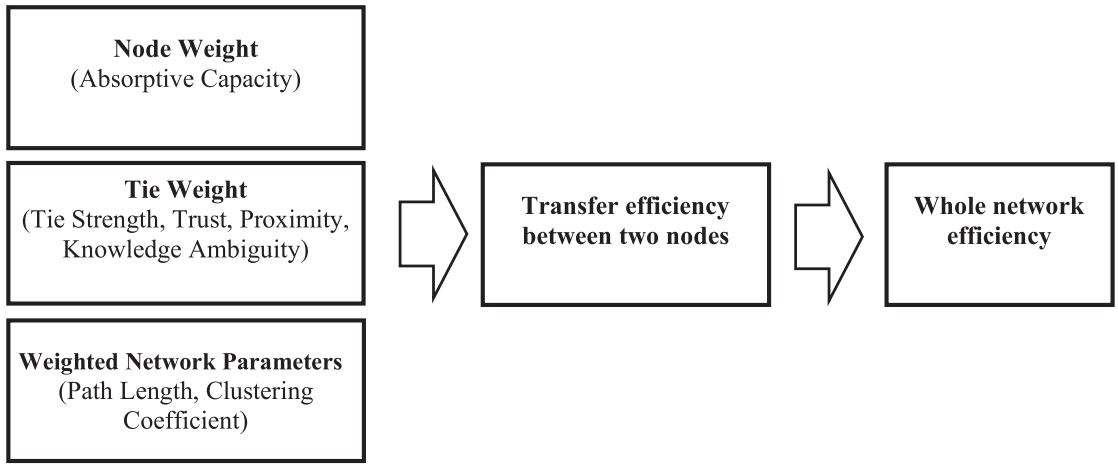

Figure 2. Process of efficiency measurement.

node set of the network, and $E = \{e_{ij} = (p_i, p_j) | \theta(p_i, p_j) = 1; p_i, p_j \in P\}, i, j = 1, 2, [\ldots], n$ denotes the edge set of the knowledge transfer network.

The node weight shows the capability of the organization to transfer knowledge. In this paper, absorptive capacity (AC) is used as the criterion for the node weight. A decision matrix is made $T = [t_{ig}]_{n\times 3}$ where t_{ig} is the consequence with a numerical value of member p_i with respect to criterion R_g, $g = 1$ in our case, which is AC. Next, each element in the matrix T is normalized and a sum of weights is calculated regarding each criterion. In this paper, we have only one criterion.

The tie weight indicates the strength of ties to transfer the information and knowledge. We use the relational properties as the criterion for the tie weight: C_1 tie strength, C_2 trust, C_3 geographical proximity, and C_4 knowledge ambiguity. Like the node weight, a decision matrix is considered- $A^k = [a_{ij}^k]_{n\times n}$, where $a_{ij}^k (i \neq j)$ is a consequence that indicates transfer level between members p_i and p_j in regards to criterion C_k, $k = 1, 2, 3, 4$. Every element in A^kmatrix is normalized to the $A'^k = [a_{ij}'^k]_{n\times n}$. Next, each criterion is given weight w_k, $\Sigma_{k=1}^3 \; w_k = 1$, $k = 1, 2, 3, 4$. Then S_{ij}, the edge weight, can be calculated by $S_{ij} = w(p_i p_j) = \sum_{k=1}^{3} w_k \; .a_{ij}'^k k = 1, 2, 3, 4.$

The weighted network parameters were previously used by Su et al. (2017) in order to avoid the problem of homogeneity. Path length and clustering coefficient are two important metrics in structural analysis of a network. The calculated weights for nodes and ties are applied in measuring the weighted path length and clustering coefficient (see Su et al. (2017) for further details).

Transfer efficiency between two nodes is mostly influenced by the individual transfer capacity of organizations, strength of relationships between them and network characteristics such as path length and local clustering coefficient. The knowledge transfer effect between two organizations is calculated using the following equation: $T_{ij} = \frac{(A_i A_j)^{\alpha} . S_{ij}^{\beta}}{[d^w(i.j)]^{\varepsilon}} e^{(c_i^w(i) c_i^w(j))^{\emptyset} - 1}$, where, T_{ij} represents the knowledge transfer effect coefficient between p_i and p_j, and $\alpha, \beta, \varepsilon, \emptyset \in [0, 1]$ are, respectively, the adjustment coefficient of each factor.

Whole network efficiency

Having obtained the transfer efficiency between all pairs of nodes (T_{ij}), the efficiency of knowledge diffusion for the whole network can be calculated as:

$$KE = \frac{\sum_{i\neq j\in G} e_{ij}}{N(N-1)} = \frac{\sum_{i\neq j\in G} T_{ij}}{N(N-1)}.$$

Importance Ranking

Following Su et al. (2017) and applying the node deletion method as outlined by Nagurney and Qiang (2008), it is possible to create an importance ranking of network members based on their contributions to

knowledge flow. The importance rank of node p_i is measured by the relative decrease in the efficiency of the entire network when the node p_i is removed.

Application of the weighted diffusion model in an Australian destination

This section discusses the application of the weighted diffusion model in an Australian destination, focusing on the study area, data collection methods, and the development of the questionnaire.

Study area and data collection

The model was empirically trialled in Western Australia (WA), Australia. WA is the largest geographical state in Australia, situated in the western region of the continent near the Indian Ocean with a wealth of tourist attractions (Gładyk & Podhorodecka, 2021) and a growing tourism visitor economy, contributing significantly to the state's economy and job market. According to Tourism Research Australia, (TRA, 2023), the WA state achieved its highest ever annual visitor spend, with $16.8 billion in 2022–2023, filling 89,100 jobs and contributing $8.7 billion to WA's economy in 2021–2022. Despite its potentials and current growth, WA has not yet achieved an ideal position in Australian tourism, mainly because of the adverse effects of long distances. WA needs to increase its competitive advantages to compensate for the negative impacts of distances (Smith et al. 2014). This necessitates the importance of research on effective knowledge transfer which can aid destination management organizations in gaining insights into network dynamics, identifying strengths and weaknesses, and devising strategies for improvement.

Regarding the sampling procedure, it is first essential to clarify the level of analysis before addressing population and sampling. In this research, the level of analysis encompassed two key aspects. Firstly, it pertained to an inter-organizational study, thereby necessitating the consideration of organizations as the units of analysis rather than individuals. Secondly, the level of analysis was associated with network analysis (NA). Network studies generally conduct at either the ego-centric or complete network level. The ego-centric level focuses on individual actors (ego), actors (alters) directly connected to the ego, and the direct relations between those alters. On the other hand, the complete network level concentrates on a set of actors and their relations within a bounded sample or population, requiring complete network data on actors and their interrelations. Complete network data enable the researcher to analyse individual actors, clusters, or the whole network (Carolan, 2014).

In this research, since the purpose was to provide a comprehensive view of knowledge transfer in the whole network of the destination, the complete network approach was taken. For both ego-centric and complete network levels of study, researchers face boundary specification (Marsden, 1990). Two general approaches to boundary specification in network studies are the realist and nominalist perspectives. In the realist approach, respondents identify themselves as members of the network, and the boundary is perceived as actual, representing limits that are knowingly encountered by the majority or all participants within the entity such as a family, corporation, or social movement (Knoke & Yang, 2008). Conversely, the nominalist approach involves setting boundaries based on the theoretical concerns of the researcher, which may not necessarily align with recognized or organized groups. The realist approach is more appropriate for small, more explicit groups and activities, while the nominalist approach is more appropriate for larger, more formal groups (Alhajj & Rokne, 2014; Scott, 2017).

Given that the tourism organizations in the study were formally distinguishable, the realist approach to boundary specification was employed, thereby defining the study population as all tourism organizations operating in WA. Tourism sectors and related businesses and organisations were defined according to the classification used by the Australian Tourism Data Warehouse (ATDW) with minor modifications. These organizations were classified into 12 distinct tourism sectors, as outlined in Table 1.

A roster comprising 1000 Western Australian tourism companies and organizations was compiled based on the ATDW. It should be noted that WA, as a tourism destination, shares similarities with other destinations. That is, a knowledge network dominated by public servants with ministerial agendas, significant staffing, and global branding, while the majority of operators within the network are small entrepreneurs, with lifestyle aspirations providing discrete local services such as accommodation, food and hire services (Musu, 2020).

This study involved the distribution of a questionnaire to organizations via email, with non-responders being sent two reminders after a two-week period. At

Table 1. Tourism sectors and organisations included in this study.

Sector	Description
Accommodation	Accommodation establishments allowing short-term stay, such as apartments, backpackers and hotels, bed and breakfasts, caravan and camping sites, farm stays, holiday houses, motels, and resorts
Restaurant	Restaurants that are of high quality or particular interest to visitors
Attraction	Places of interest open to visitors, cultural resources such as museums, theme parks
Tour	Organised excursions usually with a guide and commentary
Event	Includes activities which are scheduled events, may be once only, annual, biennial, biannual, weekly, fortnightly, etc. events can be local, minor, or major events
Information services	Visitor information centres
Intermediary	Travel agencies
Regional public body	Bodies primarily targeted towards local residents; some supporting tourist information provided; these bodies also manage infrastructure for tourism
Tourism association	Tourism industry associations and organisations
Public tourism body	Bodies that develop policy and regulations for tourism industry
Transport	Transfer services and air, coach, ferry, and rail point-to-point services
Hire	Hire services including vehicle, boat, equipment and houseboat hire, and yacht and boat charters
Other services	Bodies that do not fit in any other sector, for example, advisory or educational services

destination level, organizations are the units of analysis; thus, it was emphasized in the survey that the responding individual should possess substantial knowledge about their organization's knowledge network. Specifically, the "information letter" of the questionnaire clarified that "tourism organizations" encompassed businesses in various tourism sectors, including attractions, hotels, restaurants, intermediaries, tourism associations, and public tourism bodies. The research defined a tourism organization as any public or private entity, regardless of size, operating in at least one tourism sector, such as accommodation, transportation, attractions, and intermediaries. Therefore, the term "organization" was inclusive of all types and sizes of tourism-related companies, firms, or enterprises.

In the participant information letter, it was explicitly stated that the term "knowledge" encompassed all forms of data, information, or expertise pertinent to their professional activities, including areas such as marketing, management, technology, products, and strategic planning. We emphasized that the transfer or learning process could be formal or informal. Thus, knowledge was broadly defined in this research to include both explicit and tacit knowledge, without distinguishing between knowledge, information, and data. Additionally, we specified that the questionnaires are best answered by individuals with a good knowledge of their organization's external contacts and relationships. We outlined that the questionnaire comprised two parts: the first part focused on the organization's external relationships, while the second part requested specific details about these relationships. This approach aimed to ensure that participants had a thorough understanding of "knowledge," thereby enhancing the validity of the research findings. The study utilized a developed questionnaire for data collection, with details on its structure and measurements provided in the subsequent section. After passing validation and ethics stages, the questionnaire was adapted into an online version using Qualtrics. Before distributing the questionnaire, the researchers sought assistance from major gatekeepers in the destination for data collection, with three organizations agreeing to help. One advertised the survey in their newsletter twice, two others distributed the survey in their network.

During the data collection phase, relationship data were concurrently imported to facilitate the creation of the network. This approach aided in identifying both new and significant organizations throughout the data gathering process. New organizations referred to those mentioned by survey respondents but were not initially included in the original email list, while important organizations were those frequently cited or central within the network. For the highly central organizations that had not responded to the survey, an additional reminder was sent, whereas new companies received two reminders. This iterative process continued until all companies had been reminded, ensuring that every organization in Western Australia had been contacted.

After screening and cleaning the data, a network of 490 nodes with 994 ties was created from 164 usable questionnaires. The network was structured from the relational data collected by a name generator question in the survey. A name generator is used to collect information to identify the actors with which the organization has relationships. The respondents are asked to identify (a designated quantity of) entities/actors (organizations) with which they maintain a specific form of relation (Marsden, 1990). All organizations in the network were then categorized into

Table 2. Weight criteria and measurement.

Weight type	Criteria	Measurement items	Cronbach's α
Node weight	Absorptive capacity	Please indicate to what extent your organization: • effectively identifies, selects, and imports new knowledge. • has effective practices to analyses new knowledge. • successfully adds new knowledge to existing knowledge. • successfully applies new knowledge for business benefits.	0.916
Tie weight	Tie strength	*Tie strength* • How long has your organization been working with this organization? • How frequently do you interact with this organization? • You have a close friendly relationship with this organization.*Type of relationship* • Is this organization your … supplier/customer/competitor/partner/collaborator/other … *Type of knowledge transferred* • What kind of information and knowledge do you receive from this organization? marketing/product design/management practices/technology/government policy/ destination infrastructure planning/destination management/ destination marketing/ other *Type of channel used* • Which channels do you usually use to receive the information and knowledge from this organization? (Several options can be selected.)Face to face/workshops/training/ conferences/video/telephone/online chat/ SMS/mobile communication apps (e.g. WhatsApp)/email/fax/newsletters/ social media (e.g. Facebook, Twitter)/websites/ print documents	0.923
	Trust	• Your organization relies on the information and knowledge from this organization. • You trust this organization not to act opportunistically against you. • This organization is predictable and consistent in providing you with the information and knowledge.	0.672
	Knowledge ambiguity	• The knowledge received from this organization is complex. • Interdependent activities are required to apply the knowledge you receive from this organization. • Mastery of diverse activities and tasks is required to apply the knowledge you receive from this organization. • Your staff are required to work side by side with this organization to learn the new knowledge. • Personal trainings were needed to learn the new knowledge from this organization. • The learning from this organization needs significant investment in human resources.	0.739

5-point Likert scale was used for measuring non-categorical items.

tourism sectors, as originally defined by the ATDW and used by Raisi et al. (2018) with minor modifications (see Table 1).

Questionnaire development

We developed a questionnaire for data collection based on the model. We sourced measurement items from previous studies. Antecedents of knowledge transfer were used as the key criteria to give weights to nodes and ties. The measurement of antecedents is explained in the following paragraphs, and the items used in the questionnaire are presented in Table 2.

The **relational data** were used to construct the network; then the network parameters were measured. The relational data were gathered through a name generator question, which asked respondents enumerate up to 10 tourism entities (or firms) that provide their organization with information and knowledge pertaining to their operations. Our pilot survey returns indicted that respondents listed three to six contacts and rarely responded with 10 or more contacts. To ensure having a practical length of the survey, and to focus on face validity for the potential respondents, the number of organizations were limited to ten. Results validated this restrictive measure, since the average number of organizations listed by respondents ranged five to six. Furthermore, only 3% of respondents supplied more than eight contacts. Also, a short explanation was added to the questionnaire preamble to clarify the meaning of "knowledge" in this context: It stated: "By knowledge, we mean any data, information, or knowledge regarding your work, such as marketing, management, technology, products, planning, etc."

*Absorptive capacity w*as measured using four items adopted from Pavlou and El Sawy (2006). An average of absorptive capacity for each tourism sector was used for the nodes with missing absorptive capacity values.

Tie strength was measured based on three most common variables of closeness, frequency, and

duration of relationships. In addition, following the idea that stronger ties use more means of communication (Haythornthwaite, 2005), multiplexity of ties was applied to the measurement of tie strength. Three types of multiplexity were measured: number of transfer channels used, number of types of relationships (e.g. partner, supplier, customer) and number of types of knowledge content transferred (e.g. marketing, technology, destination management). Strength of a tie was measured as: *average (No. of layers × closeness, No. of layers × frequency, No. of layers × duration)*.

Trust was measured with three components introduced by Young-Ybarra and Wiersema (1999): dependability, predictability, and faith.

Physical proximity was measured by asking the distance of the respondent from the knowledge partner. Distances were divided into local, regional (in WA), national (outside WA) and international.

Knowledge ambiguity was measured with 3 dimensions of causal ambiguity proposed by Reed and DeFillippi (1990): tacitness, complexity and specificity of knowledge. Eight items were used, but through an exploratory factor analysis, two items were dropped.

The resulting model is therefore based on a range of criteria that dynamically combine together to produce a holistic assessment of the destination network because they incorporate a wide range of factors that that have been previously utilized independently in related research on knowledge transfer.

Results

Summary of network properties

As network properties are fundamental in this weighted model, an overview of network structure properties is provided herein. However, it is important to note that a thorough analysis of the structural properties of the network falls outside the scope of this paper and is addressed in a separate study. The data collected from the responding tourism actors about their network interactions and knowledge flow resulted in the construction of network map that has 490 nodes with 994 ties (Table 3). That is, it comprises of nearly 500 organizational contacts and about a thousand relational interactions between organizations. While there are many organizations with single contacts, key actors have deep and wide connections. It is a *weighed* network forming one giant network component. Figure 3 and Table 3 show the visualization and structural properties of the network in its undirected mode. We have considered transfer of knowledge an exchange of information or knowledge, which the undirected network is a better representation.

Table 3. Network properties.

Network properties	Value
Type of network	undirected
Nodes	490
Edges	994
Connected components	1
Average degree	4.057
Density	0.008
Average path length	3.809
Average clustering coefficient	0.245
Modularity	0.57
Number of communities	16

The network has a *very low density* of 0.008, indicating significant lack of connections within the network. The *density measurement* ranges from 0 to 1 and in this case demonstrates the very low ratio of existing links in the network compared to the maximum possible links that could be achieved within the network. The *clustering coefficient* indicates the prevalence of forming links among the immediate neighbors of a node. In other words, clustering coefficient shows the density of a node (or enterprise) neighborhood. In this undirected network, the average clustering coefficient is calculated to be 0.25. This value is relatively high when compared to an equivalent

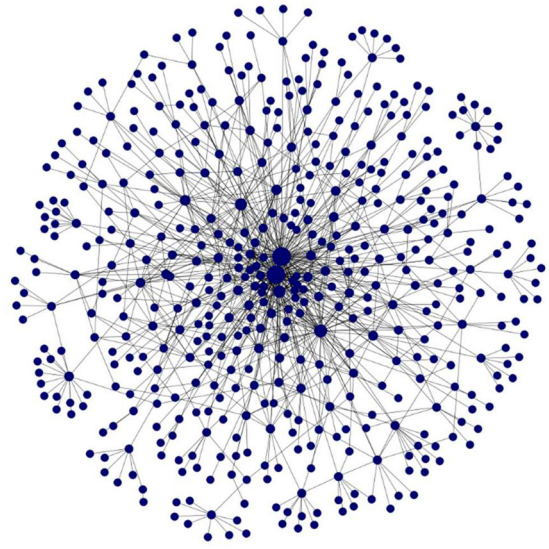

Figure 3. WA tourism knowledge diffusion network – Node size: degree.

random graph. This implies that network tourism actors in this destination tend to *create clusters* and have knowledge exchange within those clusters rather than across the whole network. This result is supported with modularity value (0.57), which is another community detection method, and is relatively high for this network. Indeed, industry sources confirmed these results indicating that most of the tourism business tended to operate in isolation, and that where interactions occurred, they tended to be between enterprises in the same sub-locality.

Tie strength results showed that most organizations in the network have *long established relationships*. Only 3.2 percent of ties are less than a year old. About 70 percent of the organizations have more than 5 years old relationships and 42.5 percent more than 10 years. Regarding the frequency of interactions, organizations have monthly (37.4%), weekly (24.4%) and quarterly (19.4%) interactions subsequently. In addition, 67 percent of relationships between the organizations were reported to be close and friendly. Results on geographical proximity showed that the majority of connections are local (54.5%) and regional (33%). Only 10 and 2 percent of connections are national and international. This highlights the tendency of tourism actors *for local and regional knowledge exchange* and establishing local industry clusters. Once again, subsequent industry discussions at state level confirmed that this pattern of results reflected the state of the industry where members have limited but long-term inter-relations bounded within the state territory.

Diffusion model results

The main goal of the proposed model was to quantify the efficiency of the knowledge flow within this destination network. The efficiency score for a network ranges from 0 to 1, with 1 indicating complete efficiency. The efficiency result for WA tourism is very close to zero: 0.0019. The efficiency result was calculated by taking the figures from data collection and using the weights as described above. This indicates an *extremely low efficiency* of knowledge transfer between tourism organizations in WA. It should be noted that this is the first application of this model in a tourism destination context, and as such, there are no previous studies available for comparison. The validity of our analysis and results was confirmed by comments from state tourism managers who indicated that the results reflected their own perceptions of the WA tourism market.

Table 4. Importance ranking.

Ranks of tourism sectors	Average rank of nodes in each sector	Tourism sector
1	89.5	Regional tourism organizations
2	154.9	Public tourism body
3	186.2	Tourism association
4	193.5	Tour
5	200.4	Intermediary
6	209.3	Accommodation
7	237.2	Transport
8	245.6	Information services
9	251.5	Hire
10	262.2	Event
11	276.6	Regional public body
12	283.4	Attraction
13	293.0	Other tourism Services
14	327.9	Restaurant
15	332.4	Others non-tourism

An importance ranking method was also used within the analysis to locate specific destination actors who had significant and an overriding impact on the efficiency of the network. Importance of each node was measured based on the node deletion method (Nagurney & Qiang, 2008). This method involves measuring the efficiency of the network both with and without the node in question, and the difference in network efficiency reveals the importance of that organization or node. Table 4 shows the average importance ranking of organizations in each tourism sector.

The ranking shows which tourism sectors are dominant and important for the efficiency of the network. Column two in the table indicates the average rank of nodes in each sector. Unsurprisingly, regional tourism organizations (RTOs), public tourism bodies and tourism associations have the highest influence on the efficiency of knowledge transfer within the network, as it is their designated role to collate and distribute knowledge to accelerate tourism enterprise growth.

Discussion and implications

This paper introduced a weighted diffusion model to measure the efficiency of knowledge transfer between tourism organizations in a destination. The rationale for constructing, developing, and trialing a weighted diffusion model to measure the efficiency of knowledge transfer among tourism organizations within a destination was outlined. Our model

leveraged previous research in this field and extended it to build a new and unique industry resource, contributing to academic knowledge in this domain. Subsequently, the model was put to the test within the Western Australian (WA) tourism industry and the results indicated an extremely low efficiency of knowledge flow in the destination. An importance ranking method was also used, which can identify the destination actors that have critical impacts on the efficiency of the tourism network. Previous tourism studies in this area (Baggio & Cooper, 2010; Del Chiappa & Baggio, 2015) took advantage of simulation methods to measure knowledge diffusion; however, the focus of those studies was mainly on the structure of the network, and KM-related antecedents of knowledge transfer were not considered.

The study revealed a very low efficiency of knowledge transfer within Western Australia's tourism sector, indicating that the WA network of knowledge transfer is not efficient and needs considerable improvement. Efficient transfer of knowledge builds the basis for the innovative capabilities of a tourism destination and its competitiveness (Baggio & Cooper, 2010; Czernek, 2014). Among the first steps to improve the efficiency of knowledge transfer are those to measure it, understand the current situation and diagnose the issues and problems. Thus, WA tourism was examined in this respect. Quantification of knowledge transfer efficiency can help the destination management to understand better the functionality of the destination regarding diffusion and transfer of knowledge and information. The results, if valued and utilized by industry actors, could at least raise some concerns and awareness regarding knowledge management and transfer and help increase the significance of the issue within the destination. Moreover, WA DMOs can expand and use the approach used in this research to initiate and establish a procedure to continuously measure and monitor the efficiency of WA tourism. Regional DMOs can also use this approach for smaller regional destinations.

Both theoretical and practical implications of this study regarding the efficiency of knowledge transfer among tourism organizations within a destination are presented below.

Theoretical implications

First, despite the complexity in quantifying knowledge transfer, it appears that this proposed model can provide an effective estimation of knowledge transfer efficiency in a tourism network. That is mainly because the model embodies the major antecedents of knowledge transfer: structural properties (path length, clustering coefficient), relational properties (tie strength, trust, proximity), organizational properties (absorptive capacity) and knowledge properties (knowledge ambiguity). Encompassing such a comprehensive list of knowledge transfer factors has been lacking in previous empirical studies, and quantifying and weighting these factors within this model appears to provide an effective way of measuring the knowledge flow within a tourism destination. Thus, this study presents the first application of a weighted diffusion model to quantify knowledge transfer in a tourism destination. In this regard, by introducing a weighted diffusion model tailored to quantify knowledge transfer within tourism destinations, this study addressed a critical gap in empirical studies in this domain.

Second, the quantification of knowledge transfer efficiency within the industry is itself a significant contribution made by this paper to the tourism literature. Efficient knowledge transfer serves as the basis for enhancing the innovative capabilities and competitiveness of a tourism destination (Baggio & Cooper, 2010; Czernek, 2014). Measuring the flow of knowledge, as undertaken in this study, represents one of the initial steps toward enhancing knowledge transfer efficiency and understanding the current situation and diagnosing the issues and problems. Quantification of knowledge transfer efficiency can help the destination management to better understand the functionality of the destination regarding diffusion and transfer of knowledge and information.

And third, in terms of learning and knowledge theory, this paper makes a significant contribution. Organizational learning theory (Argyris & Schön, 1997), learning network theory (Poell et al., 2000), and activity theory (Engeström, 1999), while emerging from different yet related theoretical disciplines, all focus on the internal mechanisms and interactions of organizations: how they learn, change, and extend identity. In contrast, absorptive capacity theory (Griffith et al., 2003) focuses on the capability of an organization to locate, draw in, and then use new knowledge. All four theories map critical processes that determine the ability of organizations within tourism destinations to learn and grow. However, all four theories assume an environment where information and knowledge flow and are available for harvesting. What this study indicates is that

such external knowledge flows may vary considerably in their quality and quantity, and that local networks may include or exclude such organizational actions to gain and use knowledge for subsequent learning and growth. This paper establishes the exploration of the diffusion and transfer of knowledge in a tourism destination as a prerequisite for subsequent absorption, knowledge work, organizational learning, and business extension. The study adds to theory in this area by providing empirical evidence from the pilot investigation demonstrating that where there is a lack of connectivity in the network, knowledge flow will be restricted.

Practical implications

The empirical WA example makes several contributions. First and primarily, it provides a real-life example to indicate how the model can be applied and, using sample cross-sectional data, offers detailed empirical data and results about how the model can indicate the efficiency of knowledge transfer in this specific tourism destination. Second, it provides an analysis of this specific tourism destination and gives an example of how such data can be used by the industry to effect change. Results indicated that the WA network of knowledge transfer is not efficient and needs considerable improvement. Third, the developed model presents a practical toolkit that can be used by DMOs. They can benefit from this model by applying it to monitor the knowledge flow and its efficiency in their destination, focusing on managing actors on relevant issues for intervention and improvement. Thus, by applying the model, DMOs of WA tourism can identify areas of inefficiency and intervene to improve destination competitiveness and innovation capabilities. Fourth, the subsequent use of this model and the possible resulting increase of more efficient knowledge flows within tourism destinations provide the opportunity for a wide range of tourism businesses and coordinating bodies to expand local tourism businesses and provide improved experiences for social actors, especially as the stringent restrictions of the COVID era are lifted. Continuous monitoring of knowledge transfer efficiency enables DMOs to adapt strategies and foster a culture of knowledge management within destination management discourse, driving positive change and strengthening tourism destinations worldwide. And finally, regional DMOs can also leverage the approach outlined in this study to benefit smaller regional destinations. Regional DMOs play a crucial role in promoting and managing tourism activities within specific geographic areas. By adopting the strategies and insights presented in this research, smaller regional destinations in WA can enhance their competitiveness and resilience, attract more visitors, and stimulate economic growth.

Conclusions

This study addresses a critical gap in understanding the significance of KM within the tourism industry, an area that has historically lagged behind other sectors in this aspect. Knowledge and knowledge transfer, though intangible and challenging to measure, play a pivotal role in determining the competitiveness of a tourism destination. By proposing a method to assess the efficiency of knowledge transfer within a tourism destination and developing a model to quantify and estimate this efficiency, this paper addresses a significant knowledge gap in the tourism sector.

The model introduced in this study offers a valuable tool for examining knowledge transfer efficiency within tourism destinations, providing a foundation for informed discussions and strategic actions. Leveraging the integrated Hawthorne effect (Mayo, 1949), which emphasizes the impact of social interactions on individual behavior, this model highlights the importance of knowledge management concepts in enhancing the performance and competitiveness of tourism destinations. This paper has generated a tool to support research and industry actors' movement in this direction. While the results of our limited empirical trial are only relevant to WA tourism operators, the significant contribution of this paper is a weighted and trialed model that can be used globally in any tourism destination to explore how they can develop the efficiency of their knowledge flow and thereby expand their industry.

While this study presents valuable insights, it is important to acknowledge its limitations for future research opportunities. The model introduced does not consider the dynamic nature of tourism networks and knowledge transfer, providing only a static snapshot of the current state. Conducting follow-up analyses over time could reveal the evolving dynamics of knowledge flow within destinations. As the initial application of such a model in tourism, there is room for further development and refinement to address the underdeveloped nature of KM concepts in the industry. Future studies can enhance the

model by adapting and redefining knowledge transfer concepts, enabling comparisons across different destinations to establish benchmarks and drive continuous improvement within the tourism sector. Additionally, adding a qualitative section to the quantitative approach of this study would be very useful. While the study aimed to quantify intangible assets, the inherent limitations of quantitative approaches in capturing subjective aspects warrant a qualitative expansion for deeper insights. Moreover, the study focused on the antecedents of knowledge transfer; thus, the consequences of knowledge transfer – mainly innovation and competitiveness – were not included. Future studies could investigate the influence of 'network structure', 'efficient knowledge transfer', or 'position of organizations in the network' on knowledge transfer outcomes such as performance, innovative capabilities, or competitiveness. Additionally, the study's constraint of a small sample size underscores the need for larger samples to ensure the reliability of findings.

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ORCID

Hossein Raisi http://orcid.org/0000-0001-9068-2073
Llandis Barratt-Pugh http://orcid.org/0000-0003-0464-7103
Rodolfo Baggio http://orcid.org/0000-0001-9207-9665
Gregory Willson http://orcid.org/0000-0001-9300-6361
Sam Huang http://orcid.org/0000-0003-4990-2788
Kourosh Esfandiar http://orcid.org/0000-0001-6242-2899

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