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# Knowledge Networks
## A Social Network Analysis of Dissertation Subjects

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## ABSTRACT

*This paper presents a social network analysis of the subject areas of tourism dissertations in North America based on the ProQuest Dissertations and Theses-Full text database (1994-2008). This study demonstrates the openness and vibrancy of the tourism field from a network perspective. The longitudinal examinations revealed a U-shape pattern in the structural evolution of the knowledge network in tourism research. 21 key subjects were identified as the anchors of the dynamic tourism knowledge system, and their associations with each other were also examined. In addition, this article discusses the relations between the major subject areas and the faculty program distributions of doctoral tourism research at North American institutions.*

**Keywords**: *tourism knowledge, knowledge network, social network analysis, dissertations.*

## INTRODUCTION

Knowledge networks through connections of research subjects amongst knowledge domains have long been topics of interest for academics in a field. A typical and useful approach to the scrutiny of such networks is to look at subject clustering by means of social network analyses, through which knowledge traffic and connections of subjects amongst knowledge domains can be mapped and described. Notably, such a perspective sheds light on the structure and change of knowledge domains in a field, and hence contributes to a better understanding of the patterns and evolutions over time in the diffusion of a field's knowledge.

As a young and multidisciplinary field of social science, tourism studies has witnessed a high and sustained enthusiasm amongst its academics in assessing the state-of-the-art of its research and knowledge. Amongst the various perspectives on tourism knowledge, the clustering and evolution of research subjects visible over time through prominent texts such as academic journals and doctoral dissertations present a unique lens for appraising the state-of-the-art of the field's knowledge (Xiao & Smith, 2006, 2008). The purpose of this study is to examine the structure and evolution of tourism knowledge through a social network analysis of the research subjects identifiable from the tourism-focused doctoral dissertations selected from the *ProQuest Dissertations and Theses-Full Text* database during the years of 1994 to 2008. The connections among subject terms were documented based on their co-appearances in each dissertation and presented in the form of a subject correlation matrix for network analysis. Results of the study shed light on the structure of tourism dissertation subjects and on the evolution of the field as a knowledge domain.

## LITERATURE

### A social network approach to knowledge studies

Originating from the field theory in physics, graph theory in mathematics and organizational field work in anthropology in 1950s and 60s (Kilduff & Tsai, 2003), social network analysis is developed to accurately measure and represent the structure of relations among entities of interest and to explain both why these relations occur and what their consequences are (Knoke & Yang, 2008), by collecting relational data, organizing it into a matrix, and calculating various parameters such as density and centrality. Social network analysis differentiates itself from other analytical methods by focusing on the relations between rather than the attributes of the actors, and on the pattern of interactions rather than on the isolated individual actors (Scott, et al. 2008). Research suggests that knowledge networks are special types of social networks and are formed on the premises of research interests or problem areas within a scientific community charted by a discipline or field (Collins 1974). In the science communication literature, social network analysis (SNA) is documented as a useful approach to the description and interpretation of knowledge networking, and network clustering and evolutions by research subjects or problem areas in a field (Scott, 2000). Methodically, knowledge networks have been subject to social network analysis, a technique for structural interpretations of research collaborations and subject clustering, which allows scrutiny at both individual and group levels through an integration of data on individual attributes with data on interpersonal relations (Liebowitz, 2005; Schonstrom, 2005; Scott, 2000). Due to the tactic nature of knowledge, social interactions embedded in both formal and informal social networks are believed to be essential for the creation and sharing of knowledge (Cross et al., 2005; Klimkeit, 2005; Melin, 2000; Wagner & Leydesdoff, 2005). With respect to the diffusions of knowledge or information, Granovetter (1973) stresses emphasis should be laid on the cohesive power of weak ties (that is, clusters or nodes connected by fewer links over longer distances) in transmitting influences over distances and between groups.

Multidisciplinary by nature and multifaceted in problem areas, tourism research is characteristic of both strong and weak ties in its knowledge networks. The academia believes that research collaborations make significant contributions to the growth and advancement of a knowledge domain by facilitating and promoting knowledge sharing among the researchers (Melin, 2000; Wagner & Leydesdoff, 2005). This is also the rationale for the majority of social network analysis application in knowledge research, as it allows knowledge researchers to visualize the knowledge network for a rich and ecological understanding of the making of research in a given field (Hu & Racherla, 2008). While the traditional approaches dwell upon co-citation (e.g., Newman, 2001, 2004; Hu & Racherla, 2008) and/or co-authorship (e.g., Greenberg, 2009; Horn et al., 2004; Lin, 1995) aspects of knowledge networks, this analysis deals with the end product (or tourism knowledge) itself, by focusing on the research subjects and knowledge domains manifest from doctoral dissertations.

### Research subjects for knowledge studies in tourism

From a scientific community perspective, the growth of a field calls for periodic monitoring of its knowledge created by and/or diffused in its scientific community (Ben-David, 1964; Crane, 1972; Hagstrom, 1964, 1965). As such, the scrutiny of research topics or subjects is central to the state-of-art analysis in a field. In tourism, for example, a historical account of its research subjects based on the comprehensive subject index of *Annals of Tourism Research* (1973-2003) indicates that a number of subjects have been on the rise while a number of others have declined over the years according to their frequencies of appearance as published research (Xiao &

Smith, 2006). These patterns were also confirmed by Ballantyne, Packer, and Axelsen (2009) based on their recent study which focuses on published subjects derived from twelve tourism journals. As these authors reported, their study confirmed the increasing importance of research on tourists and tourist experiences; the decline in economic and hospitality studies; the rise in marketing and management topics; the gradual erosion of the dominance of North America; the increasing contribution of Australia, New Zealand, and Asian countries; and the emerging contribution of the interpretive paradigm in some established topic areas (Ballantyne, et al., 2009, p.151).

The growing number of doctoral dissertations focusing on tourism provides another venue for knowledge studies in tourism field. By searching volumes 36-38 of Dissertation Abstract International (DAI) with eight keywords: "airline, aviation, leisure, parks, recreation, tourism, tourist, and travel", Crichton (1978) revealed 122 travel/recreation/leisure-devoted dissertations from 1974-1977. Using keywords: "airlines, entertainment, hotel, hospitality, leisure, recreation, restaurant, resort, tourism, travel, and transportation", Pizam and Chacko (1982) located 65 dissertations in DAI from 1976 to 1987, with a high relevance to "hospitality and tourism". Criticizing the over broad scope of the previous two studies, Jafari and Aaser (1988) attempted to examine the study of tourism per se over a longer period of time from 1951-1987, by searching the Dissertation Abstracts Online with only four keywords: "travel, traveler, tourist, and tourism". The 157 tourism-focused dissertations found in this study indicated a growing recognition of tourism in the academic community, particularly in the fields of economics, anthropology, geography, and recreation (Jafari & Aaser, 1988). An updating DAI search for tourism-focused dissertation studies from 1987 to 2000 was carried out by Meyer-Arendt and justice (2002) who mainly replicated Jafari and Aaser's methodology and added a new keyword "ecotourism" into the searching procedure. With 377 dissertation entries identified, their study documented the numerical, temporal, disciplinary (topical), and institutional trends in the production of tourism-emphasized doctoral dissertations in North America Universities for the period from 1987 to 2000. With their major emphases on either the disciplinary or institutional aspects of the tourism-focused dissertations, most of the existing tourism dissertation studies acknowledged the multi-disciplinary nature of tourism research, but did not make a step further to explore the inter-disciplinary trend or the increasing knowledge collaboration in tourism field.

## METHODOLOGY

The data collection for this study followed Jafari and Aaser's (1988) as well as Mayer-Arendt and Justice's (2002) methods. The *ProQuest Dissertations and Theses-Full Text* was used as the database. Five keywords were chosen for tourism-focused dissertation search. They are "travel", "traveler", "tourism", "tourist", and "ecotourism". With the date range for data search specified for the 15 years from 1994 to 2008, 1619 results were initially returned. A complementary data search was conducted with the five aforementioned keywords re-specified as document title, and 1901 results were returned. The overlaps in these two rounds' search results were removed. Further examination in each dissertation's abstract also eliminated those that were not tourism-focused. For each dissertation, information was collected on the dissertation title, author, affiliated institution, year of completion, and subject terms.

A series of data matrix constructions and transformations were carried out for data analysis. First, a binary dissertation-by-subject table matrix was constructed with dissertation in rows and subject in columns. This table matrix was then transposed into a new subject-by-dissertation matrix where the original rows were turned in the columns while the original columns became the rows. As the third step, a new subject-by-subject data matrix was built through multiplying the transposed data matrix X' by the original data matrix X. The value in the $ij^{th}$ (when $i \neq j$) cell of this

new subject-by-subject matrix indicates how many times the $i^{th}$ and the $j^{th}$ subjects co-appeared in the collected tourism-focused dissertations. In addition, five 3-year periodical subject-by-subject data matrices (i.e. data matrices for 1994-96, 1997-99, 2000-02, 2003-05, 2006-08) were also constructed using the same procedure.

Data analysis of this study consisted of six major phases. First, descriptive overviews were made on the production of tourism-focused dissertations and the use of subjects from 1994 to 2008. Second, the associations among the subjects were visualized into a network using *Netdraw,* and a series of mathematical network measures were conducted using UCINET (Borgatti, et al., 2002) for a structural understanding of the subject network. Third, the overall subject network was broken down into five 3-year periodical networks and the longitudinal structural change of the subject network was examined. Fourth, a set of key players in the subject networks were identified for investigating their ego-network structures and their roles in the entire tourism knowledge network. Five, a reduced network was also constructed to examine how these key subjects were connected to each other over time in the making of tourism research. At last, the time and institutional factors were introduced into the analysis via correspondence analysis.

## RESULTS AND DISCUSSIONS

### Descriptive overview

The annual production of tourism dissertations in North America experienced a nearly 300% increase from 1994 (n=31) to 2008 (n=90). 304 subjects were used for indexing these dissertations. The number of subjects for each dissertation ranged from 1 to 10, with an average of 3.17. In these dissertations, about 15% had one subject, 26% had two and another 26% contained three. Over 80% of the dissertations had at most 4 subjects. Gradually increasing from 2.3 subjects in 1994, the average number of subjects used for one dissertation reached its peak in 2002 with over 4 subjects for one dissertation. Despite the exceptionally high figure for 2005 (n=4), the average number of subjects had actually been dropping back to the late 1990's level ever since 2002 and reached its lowest point (n=2.2) in 2008.

### Subject network construction and visualization

Using *Netdraw* (Borgatti, 2002), the overall subject-by-subject data matrix was visualized into a subject network (see figure 1), in which each node stood for a subject and the ties referred to the connections among them. The down left part of figure 1 is an overview of the entire subject network. *Recreation*, as the most connected node, sits at the center of the network. The isolated node lying in the left upper corner of the network represents the subject of *Physical anthropology*. With 304 nodes (subjects), this network had a pretty low density of 3.96%, denoting a potentially poor state of connection among the subject areas documented in these tourism dissertation studies.

### Longitudinal network analysis

Five 3-year periodical subject networks (i.e. subject networks for 1994-96, 1997-99, 2000-02, 2003-05, and 2006-08) were constructed (see figure 2) for a series of longitudinal network measures (see results in table 1). The periodical production of tourism-focused dissertations has been growing since the first time of measurement, and the periodical increment has been relatively steady ranging from low twenty to high thirty.

Indexed by counting the number of nodes of a given network, network size is a basic demographic measure for networks. Compared to the stable increment in periodical production of tourism dissertations, a nearly twofold increase in the size of periodical subject networks was observed at the turning of centuries, which indicated that a substantial number of new subjects had

emerged in tourism research since 2000. However, it didn't last long, as the subject network size began to drop after the 2000-02 period, despite the ever-growing dissertation production.

Network density measures the extent to which all possible relations in a network are actually present (Mitchell, 1969). In this study, a higher network density indicates a greater degree of associations among the subjects for tourism-focused dissertations. The densities of all the five periodical networks remained pretty low (under 0.1), which suggest the diversity in the subject areas of tourism research and also imply the large potential to link different knowledge domains for future tourism research. Network density is supposed to be very sensitive to network size in a negative way (Borgatti, et al., 2002). Even with fewer subjects than the 2000-02 and 2003-05 networks, the 2006-08 network was found having the lowest density. Along with the declining subject network size, the low densities of connection could be an indication of the health of tourism studies in terms of relatively stable problem areas and a level of openness of its research community to be potentially linked to other sub-domains of knowledge for tourism research.

**Figure 1 Structure of Overall Subject Network     Figure 2 Five 3-Year Periodical Subject Networks**



Overview of the subject network for tourism-related dissertations 1994-2008
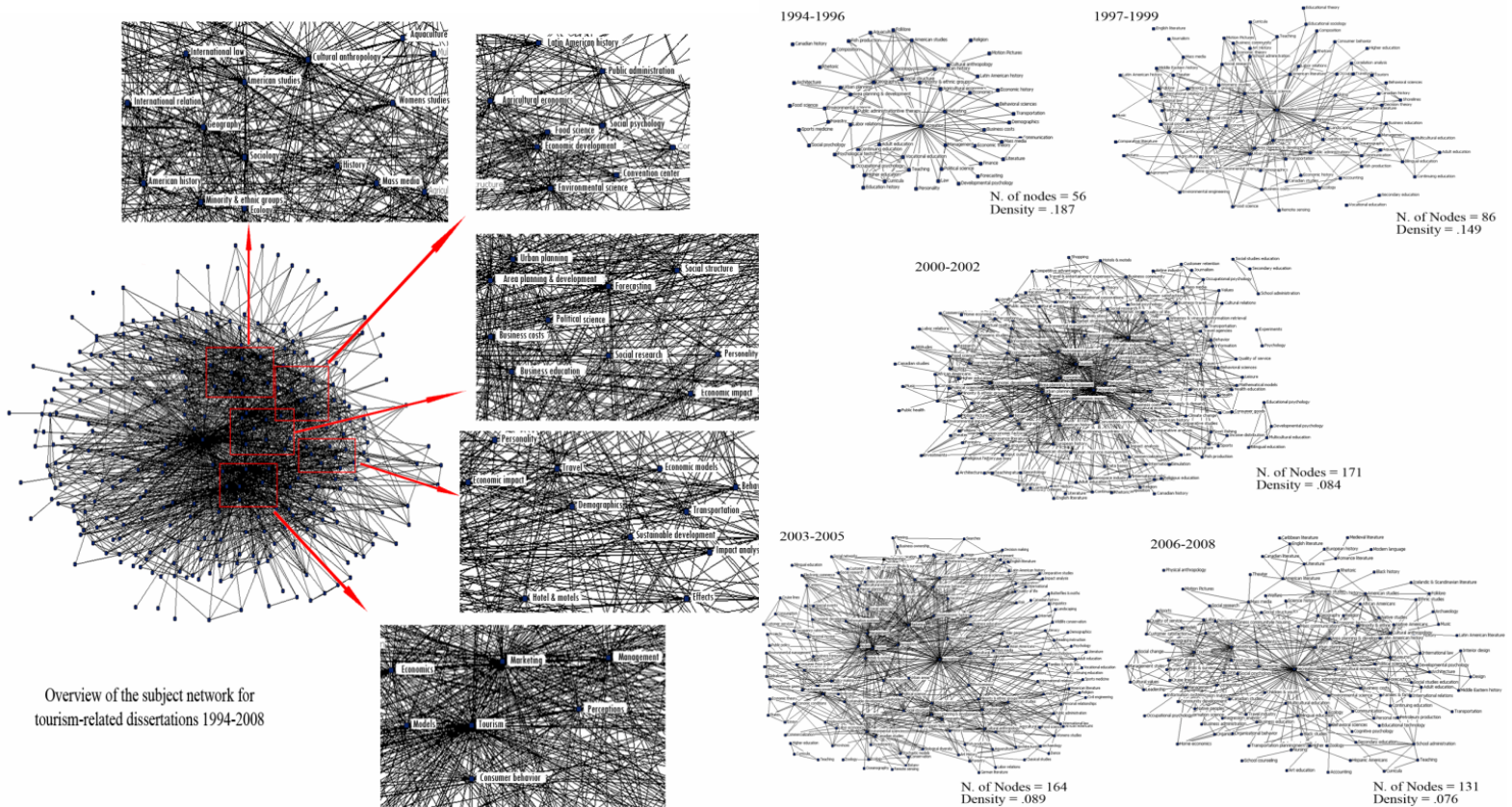
**Table 1 Longitudinal Subject Network Measures**

| Time Period | Overall | 1994-96 | 1997-99 | 2000-02 | 2003-05 | 2006-08 |
|---|---|---|---|---|---|---|
| No. of Dissertations | 812 | 101 | 130 | 168 | 188 | 225 |
| Network Size | 304 | 56 | 86 | 171 | 164 | 131 |
| No. of Ties | 3650 | 290 | 586 | 1552 | 1584 | 852 |
| Network Density | .0396 | .0942 | .0802 | .0534 | .0593 | .05 |
| Betwn. Central. Index | 52.75% | 67.63% | 64.63% | 49.77% | 48.67% | 65.48% |

Betweenness centrality refers to the extent to which a particular point lies 'between' the various other points in a network (Scott, 2000), while betweenness centralization describes the betweenness existing in the entire network by calculating the ratio of the actual sum of betweeness centrality for each nodes to the maximum possible sum (Freeman, 1979). A high betweenness centralization score indicates a hierarchical network structure where a single or a number of nodes might be more central than the rest. The Betweenness Centralization in this study show that, overall, there is a substantial degree of concentration in the five periodical subject networks, as even the lowest score for the 2003-05 network was around 50%. It suggests that in all the five periodical networks, there were certain subjects that had been rather influential within the networks. From 1994 to 2005, the betweenness centralization index for the subject network kept decreasing, suggesting a growing diversity in tourism dissertations' emphasis areas. However, this diversifying trend in tourism dissertation studies did not last for long, as the betweenness centralization for the 2006-08 period had risen back to the 1990s' level.

**Structural correlations of periodical subject networks**

The structural similarities among the five periodical subject networks were also investigated by calculating their metric correlations in the UCINET program. Based on metric multidimensional scaling, the structural correlations among the five periodical subject networks were presented in a 2-dimensional scatter plot of proximity (see figure 3). Two major clusters can be found among the five periodical subject networks based on their structural similarities. One cluster consists of the networks for 2000-02 and 2003-05 periods, and the other cluster includes the networks for the rest three periods. This clustering indicated a relatively different use pattern of subjects for the tourism dissertations completed from 2000 to 2005, comparing to the dissertations finished in other years. As showed in the plot, the structure of the subject network encountered its most substantial variation when it evolved from the 1997-99 period to the 2000-02 period, which suggest that there was a primary transition taking place at the turning of centuries in either the research emphasis or the subject using pattern of tourism dissertation studies. In addition, the over time evolution of the subject network structure from 1994 to 2008 was found not following a static direction but falling into a U-shape pattern. The turning point was in the 2000-2002 period, after when the structure of subject network tended to evolve in a completely opposite direction. This "U-turn" in the longitudinal evolvement of subject network structure indicates that the conduction of tourism-focused dissertation studies may be turning back to its old fashion as was in the early 1990s.

**Figure 3 MDS of Five Periodical Networks**
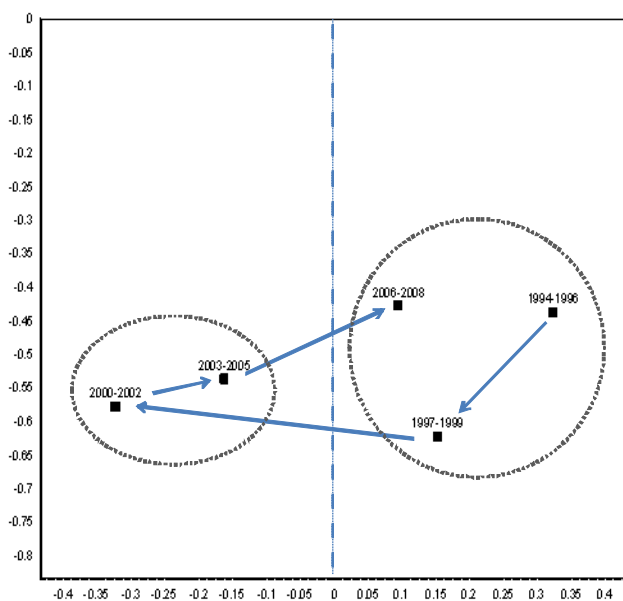
**Figure 4 Correspondence Analysis of 21 Key Subjects**
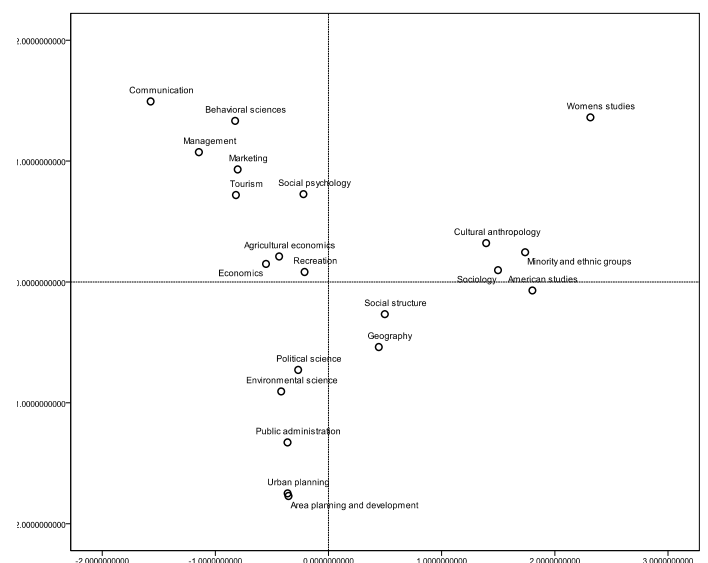
**Network reduction and key subjects identification**

The connections among subjects in both the overall network and the five 3-year periodical networks all seemed to present, to varying extent, a "core/periphery" structure. As a common notion in social network analysis, a core/periphery model is described as "…consist[ing] of two classes of nodes, namely a cohesive subgroup (the core) in which actors are connected to each other in some maximal sense and a class of actors that are more loosely connected to the cohesive subgroup but lack any maximal cohesion with the core" (Borgatti & Everett, 1999: 377). Using the UCINET 6.0 program, core/periphery analyses were run on the overall and the five 3-year periodical networks. For each network, the program used genetic algorithm to fit a core/periphery model to the corresponding subject dataset and also classified each subject based on their membership to either the core or the periphery partition. Results in table 2 show that the overall subject network did not fit the core/periphery model quit well (model fit =.126), although its connection densities of the three subject partitions seemed to vary substantially. The subject networks for 1997-99, 2000-02, and 2006-08 fitted the core/periphery model at an acceptable level (model fit around .4) and a small number of subjects were identified as "core" subjects. The subject networks for 1994-96 and 2003-05 period, however, did not fit the core/periphery model quite well either.

**Table 2 Core/Periphery Model Measures for Five Periodical Subject Networks**

| Time Period | Density | | | Model Fit | N. of Core Subjects | % of 'Core' Subjects |
| --- | --- | --- | --- | --- | --- | --- |
| | Core Partition | Core/Periphery Partition | Periphery Partition | | | |
| Overall | .487 | .039 | .005 | .126 | 112 | 36.8% |
| 1994-96 | .61 | .075 | .037 | .22 | 27 | 48.2% |
| 1997-99 | 2.086 | .212 | .04 | .465 | 15 | 17.4% |
| 2000-02 | 2.288 | .223 | .023 | .394 | 18 | 10.5% |
| 2003-05 | .137 | .016 | .023 | .041 | 128 | 78% |
| 2006-08 | 1.385 | .215 | .031 | .409 | 13 | 9.9% |

Based on the core/periphery analyses for the five periodical subject networks (i.e. those categorized as 'core' subjects for at least four time periods were identified as key subjects), 21 major subjects were identified for further examination, including Agricultural economics, American study, Area planning and development, Behavioral Science, Communication, Cultural anthropology, Economics, Environmental science, Geography, Management, Marketing, Minority & ethnic groups, Political Science, Public administration, Recreation, Sociology , Social Psychology, Social structure, Tourism, Urban planning, and Women's study.

**Correspondence analysis of major subject associations**

A correspondence analysis was conducted based on a dissertations-by-21 subject data table to understand how the 21 major subjects have been connected to each other for tourism research. Figure 4 presents the structural associations among the 21 major subjects through the first two dimensions which respectively represent the theory versus application (the horizontal dimension), and the humanistic versus non-humanistic (the vertical dimension) distinctions among these subjects. It is found that research subjects in tourism dissertations have clustered into a number of sub-domains of tourism knowledge. Notably, these clusters are represented by *Recreation* which bears a weak dimensionality with other sub-domains; a business-oriented sub-domain of tourism knowledge, which is characteristic of subjects such as *Agricultural economics, Economics, Marketing, Management, Behavioral Science, Social Psychology,* and *Communication;* a sub-

domain consisting of theoretical and humanistic dimensions from subjects like *Cultural anthropology, Minority & ethnic groups, Sociology,* and *American Studies;* and another sub-domain which consists of *Political Science, Environmental Science, Public Administration, Urban Planning*, and *Area Planning and Development*. In addition, *Geography* and *Social Structure,* and *Women Studies* have formed relatively distinct sub-domains of knowledge in doctoral tourism research.

**Ego-network analysis of major subjects**

By definition, an ego-centric network consists of a focal actor (i.e., *ego*), a set of alters who have direct ties to ego, and ties among these alters (Wasserman & Faust, 1994). In order to have a better understanding of the opportunities and constraints the 21 major subjects had faced over time for their collaborations with other subjects in tourism research, ego-network analysis was run on each of them with five major measures presented in table 3. The measure of egonetwork size suggests the dominances of *Recreation, Tourism* and *Marketing* in tourism research, as each of them embraced over or almost half of all the subjects identified in this study. Connecting to at least 20% of the total subjects, *Economics, Management,* and *Cultural Anthropology* also had a prominent influence in the subject network. Other important subjects also included *Urban Planning*, *Area Planning & Development*, *Environmental Science*, *Geography* , *American Studies*, and *Sociology*. These observations of tourism dissertation are neat reflections of the multidisciplinary nature of the field and confirmed the prior reports on source knowledge of tourism research (Xiao & Smith, 2005, 2006).

**Table 4 Ego-network Measures for the 21 Subjects in Overall Network**

| Subject | Overall Size | Den-sity | N. Ego. Betwns | Periodical Egonetwork Size | | | | | Period. Egonetwork Tie Changes | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 94-96 | 97-99 | 00-02 | 03-05 | 06-08 | T1 | T2 | T3 | T4 | Mean |
| Recreation | 249 | 4.55 | 61.22 | 42 | 69 | 141 | 129 | 90 | 47 | 108 | 138 | 123 | 104 |
| Tourism | 157 | 7.59 | 38.72 | 0 | 7 | 87 | 87 | 34 | 6 | 84 | 110 | 89 | 72.25 |
| Marketing | 135 | 8.46 | 35.33 | 12 | 23 | 78 | 61 | 36 | 23 | 73 | 85 | 71 | 63 |
| Economics | 85 | 16.42 | 31.41 | 6 | 13 | 47 | 39 | 13 | 11 | 50 | 62 | 42 | 41.5 |
| Management | 75 | 14.38 | 35.12 | 8 | 9 | 27 | 42 | 18 | 11 | 30 | 49 | 48 | 34.5 |
| Cult. anthropology | 63 | 21.52 | 32.54 | 11 | 28 | 33 | 30 | 26 | 21 | 23 | 33 | 28 | 26.25 |
| Urban planning | 54 | 27.95 | 15.52 | 8 | 19 | 24 | 31 | 20 | 13 | 21 | 31 | 31 | 24 |
| Area plan. & dvlpt | 53 | 28.16 | 15.48 | 8 | 19 | 24 | 31 | 18 | 13 | 21 | 31 | 29 | 23.5 |
| Envir. science | 51 | 24.16 | 28.05 | 7 | 16 | 31 | 28 | 6 | 13 | 31 | 31 | 24 | 24.75 |
| Geography | 45 | 26.36 | 26.79 | 22 | 13 | 21 | 20 | 9 | 17 | 20 | 21 | 19 | 19.25 |
| American studies | 42 | 28.34 | 21.76 | 11 | 18 | 16 | 19 | 18 | 17 | 18 | 19 | 17 | 17.75 |
| Sociology | 40 | 32.56 | 17.85 | 13 | 15 | 9 | 25 | 16 | 10 | 12 | 18 | 23 | 15.75 |
| Social structure | 38 | 43.24 | 10.63 | 11 | 16 | 22 | 17 | 8 | 15 | 16 | 23 | 17 | 17.75 |
| Agri. economics | 35 | 28.75 | 26.9 | 5 | 8 | 19 | 12 | 6 | 9 | 21 | 25 | 12 | 16.74 |
| Min. & ethnic grps | 33 | 40.15 | 14.3 | 8 | 12 | 14 | 18 | 9 | 8 | 14 | 18 | 17 | 14.25 |
| Political science | 29 | 39.9 | 16.59 | 4 | 8 | 9 | 17 | 12 | 8 | 13 | 14 | 19 | 13.5 |
| Women's studies | 22 | 38.53 | 24.01 | 0 | 11 | 11 | 9 | 11 | 10 | 10 | 12 | 14 | 11.5 |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Public admin. | 21 | 47.14 | 17 | 3 | 10 | 11 | 6 | 8 | 9 | 11 | 9 | 6 | 8.75 |
| Social Psychology | 21 | 44.76 | 16.85 | 3 | 6 | 9 | 5 | 10 | 5 | 7 | 10 | 11 | 8.25 |
| Behavioral Science | 21 | 39.56 | 72.88 | 4 | 3 | 6 | 5 | 8 | 3 | 5 | 3 | 9 | 5 |
| Communication | 17 | 45.59 | 20.45 | 3 | 9 | 0 | 11 | 3 | 8 | 8 | 10 | 10 | 9 |

*T1: Egonetwork Tie Change from the 1994-96 period to the 1997-99 period; T2: Egonetwork Tie Change from the 1997-99 period to the 2000-02 period; T3: Egonetwork Tie Change from the 2000-02 period to the 2003-05 period; T4: Egonetwork Tie Change from the 2003-05 period to the 2006-08 period;

The egonetwork density measures the degree of cohesion among the subjects directly connected to a given focal subject. To some extent, a relatively higher density in this study suggested a more stable and enclosed knowledge system for tourism research on a specific subject area (e.g., *Public Administration, Communication, Social Psychology, Social Structure, Minority and Ethnic Groups, Political Science, Behavioral Science,* and *Women's Studies*); while a relatively lower density indicated a more open and vibrant knowledge setting for studies on a given subject area (e.g. *Recreation, Tourism, Marketing, Economics*, and *Management*), where there were lots of potential for existing subject areas to further collaborate with each other.

The normalized egobetweenness indicates the focal subject's potential for engaging other subjects by measuring the extent to which the ego subject is a part of the relationships among the rest alter subjects. Subsequently followed by *Tourism, Marketing, Management, Cultural Anthropology,* and *Economics, Recreation* had the highest normalized egobetweenness index, suggesting that many knowledge domains would not be connected to each other in tourism research if they were not used for studies on recreation-related topics. The relatively lower egobetweenness indices found for *Minority & Ethnic groups, Social Psychology, Planning, Area Planning & Development, Political Science, Public Administration* and *Sociology* indicated that these subjects had a much flatter egonetwork structure, where the alter subjects had a higher chance to be connected in tourism research even without the involvement of the ego subjects.

The periodical egonetwork sizes were also given in this study to count the number of alter subjects that the ego subject had for each of the five 3-year periodical egonetworks. The majority of the 21 subjects experienced a substantial increase in their egonetwork size for the six years from 2000 to 2005, except for *Geography* whose egonetwork had been shrinking ever since the 1994-1996 period. *Tourism* and *Women's Studies* did not show up in the first 3-year period and *Communication* was absent for the period from 2000 to 2002.

Since the over time subject variation of the egonetworks could not be uncovered by simply looking at the periodical changes in the egonetwork size, the periodical egonetwork tie changes were also examined by summing up the old subject ties lost and the new subject ties emerged when the egonetwork evolved from one period to the next. The results showed that for the majority of the 21 subjects, their largest egonetwork tie changes occurred when the networks evolved from the 2000-02 to the 2003-05 period. It suggests that the six years from 2000 to 2005 might be the most active period for most major subjects to incorporate different knowledge sub-domains into their corresponding studies. In addition, a higher average periodical egonetwork tie changes indicates a less stable egonetwork structure (e.g., *Recreation, Tourism, Marketing, Economics,* and *Management*, etc.) as there tend to be more periodical changes in alter subjects involved with the focal subject area, while a smaller mean of the egonetwork tie changes referred to a more stable knowledge network for tourism studies in the specific subject area (e.g. *Behavioral Science, Social Psychology, Public Administration,* and *Communications*, etc.).
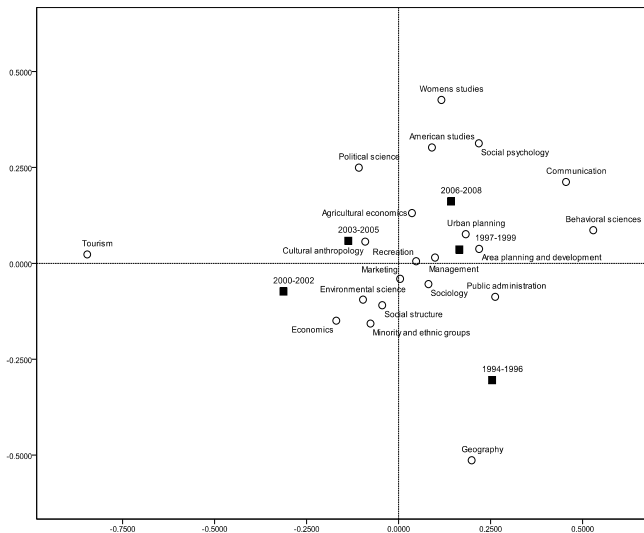
**Association between time and major subjects**

By aggregating the connections among the 21 key subjects at the five 3-year periodical levels, a correspondence analysis was conducted to examine the association between time period and the major subjects. Figure 5 shows that dissertations produced in the 1997-99 and 2006-08 periods shared more structural similarities than they did with the others regarding their use of the 21 major subjects. With varying degree, the use of nearly all the key subjects in tourism-focused dissertation studies was timely skewed. Comparing to those sitting within, the subjects lying outside the area circled up by the five periodical square spots in the plot tended to be more timely specific with respect to their appearances in tourism-focused dissertations. For example, *Geography* was most used in the 1994-96 period, while *Tourism* showed up more often in the first six years (2000-2005) of the new century than it did in other periods. The majority of the American studies, women studies, and social psychological studies in tourism field were found completed in the 2006-08 period.

**Association between institutions and major subjects**

A total of 79 universities were identified for having produced at least three Ph.D.s in tourism research from 1994 to 2008. The top ten institutions producing the most tourism dissertations were Michigan State (34), Texas A&M (34), Purdue (27), Clemson (25), Penn. State (24), Illinois (22), Waterloo (17), Virginia Tech (17), Florida (14), and Oklahoma State (11). Figure 6 presents the correspondence analysis on the association between degree granting institutions and the 21 major subjects. Three major clusters could be identified among the 79 universities based on the different research emphases of tourism dissertations completed in their PhD programs. The first cluster (e.g., UC Berkley, NYU, U. of Chicago, Emory, U. of Texas Austin, etc.) was found with their major interests in sociological and anthropological issues, particularly related to minority and ethnic groups, women's studies and American studies in tourism field. With a particular PhD. Program of recreation and tourism studies, another group of institutions (e.g., Clemson, Virginia Tech, Penn. State, Taxes A&M, Purdue, Michigan State, and Oklahoma State, etc.) were found mainly focus on recreation, tourism and marketing topics. The third group had a relatively more general and broader range of interest areas, such as urban and area planning, geography, environmental science, economics, political science, and public administration, etc. Schools belonging to this group include U. of Minnesota, Washington U., U. of Florida, and U. of Waterloo, etc.

**Figure 5 Relations between Time and Subjects**   **Figure 6 Relations between Institution and Subjects**
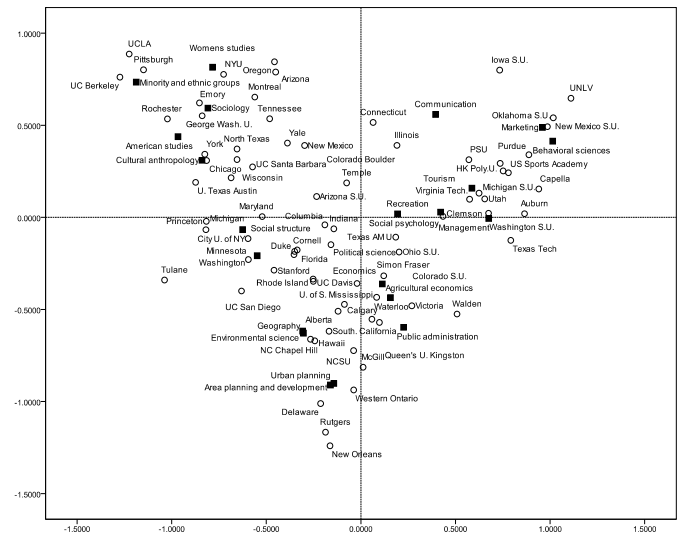
## CONCLUSION

Based on social network analysis of dissertation subjects, this study examined the structure of knowledge network in tourism research. The large network size as well as the low density of connection among the subjects indicates the openness and vibrancy of tourism research as a developing knowledge domain. Although the longitudinal examination of the subject network structure suggests that the knowledge use pattern for tourism research has been evolving, 21 key subjects are identified having been somehow anchoring the dynamic tourism knowledge system over time. Through a correspondence analysis, this study demonstrates the dimensionalities of and the associations among the major research subjects. The associations between subject areas and academic research programs for tourism research in North America were also examined.

This study contributed to a new perspective on knowledge network in the field of tourism research. However, a number of limitations in both data collection and data analysis should also be acknowledged. With only five keywords used for tourism dissertation searching, the data collection of this study bears its own limitation due to the possibility that there might be tourism-related dissertations failed to be recognized by this study simply because they used none the five indexing keywords. Another limitation in data collection concerns the relative short time span (i.e., 15 years) that the tourism dissertation search had covered in this study. In addition, this study revealed a U-shape pattern in the evolution of the knowledge network structure in tourism research, but did not provide a sound explanation on the causes of this dynamic structural change. Likewise, the current analysis identified 21 major subjects in the tourism knowledge network and examined how they connected to each other in the context of tourism dissertation studies, but it did not demonstrate how the associations among these subject areas evolved over time/periodically in tourism field. Subsequently, these un-answered questions may infer possible directions for further scientific inquiries in the area.

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