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Mapping the contemporary terrorism research domain ☆

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Abstract

A systematic view of terrorism research to reveal the intellectual structure of the field and empirically discern the distinct set of core researchers, institutional affiliations, publications, and conceptual areas can help us gain a deeper understanding of approaches to terrorism. This paper responds to this need by using an integrated knowledge-mapping framework that we developed to identify the core researchers and knowledge creation approaches in terrorism. The framework uses three types of analysis: (a) basic analysis of scientific output using citation, bibliometric, and social network analyses, (b) content map analysis of large corpora of literature, and (c) co-citation analysis to analyse linkages among pairs of researchers. We applied domain visualization techniques such as content map analysis, block-modeling, and co-citation analysis to the literature and author citation data from the years 1965 to 2003. The data were gathered from ten databases such as the ISI Web of Science. The results reveal: (1) the names of the top 42 core terrorism researchers (e.g., Brian Jenkins, Bruce Hoffman, and Paul Wilkinson) as well as their institutional affiliations; (2) their influential publications; (3) clusters of terrorism researchers who work in similar areas; and (4) that the research focus has shifted from terrorism as a low-intensity conflict to a strategic threat to world powers with increased focus on Osama Bin Laden.

Keywords: Terrorism; Visualization; Bibliometrics; Co-citation analysis; Intellectual structure

1. Introduction

The multidisciplinary field of contemporary terrorism is experiencing explosive growth largely driven by the heightened global war against terrorism. This has spawned numerous research communities, new research centers (e.g., UK New Security Challenges Programme and US Department of Homeland Security Centers of Excellence), and increased US Federal Research and Development (R and D) funding for FY2003 to $3 billion in an effort to improve understanding and prediction of terrorism (Knezo, 2003; Zahn and Storm, 2004, p. 113; RIIA, 2005). Contemporary terrorism research has generated a reservoir of knowledge accumulated through three decades of terrorism studies. These have been dominated by traditional research interests in political science, law, history, psychology, sociology, and international and military studies (Kennedy and Lum, 2003; Deflem, 2004; Silke, 2004, p. 188).

The current range of terrorism threats spans personal, organizational, and societal levels and is targeted at wreaking havoc on economic, political, psychological, and social systems. Work by various scholars from many fields, such as mass communication (Gordon, 2004, p. 114), behavioral and social sciences (Silke, 2004, p. 194), medicine (Gordon, 2005, p. 409), and computer science (Hollywood et al., 2004; Sun et al., 2005), contributed to the exponential growth in the number of terrorism publications (Deflem, 2004; Silke, 2004).

This expanding group of terrorism researchers is beset with fundamental questions as soon as they embark on this domain. "Who are the leading researchers in terrorism?" "What are their relevant publications?" "What are their institutional affiliations and collaboration patterns?" The task of responding to these questions is difficult because of the explosive growth in the volume of terrorism publications, the interdisciplinary and international nature of the

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field, and the lack of a professional association to nurture the terrorism research area and provide a platform for organizing and providing systematic access to terrorism studies (Gordon, 1999; Reid, 1983). For example, terrorism information is spread across many electronic databases, government and research center's websites, and the large number of journals that deal with various specialized aspects of the phenomenon (Gordon, 2004).

The task of answering the questions can be facilitated by applying domain visualization techniques to map the contemporary terrorism research domain. These can include data mining, analyzing, charting, and visualizing the terrorism research area according to experts, institutions, topics, publications, and social networks. As identified in prior works by McCain (1990) and Shiffrin and Börner (2004), domain mapping is critical for understanding the growth of scientific research, tracking the dynamics of the field, discovering potential new areas of research, and creating a big picture of the field's intellectual structure as well as challenges.

This paper extends and updates an earlier study that was presented at the IEEE International Conference on Intelligence and Security Informatics (Reid and Chen, 2005). It elaborates more on the intellectual structure of the terrorism research domain and provides a comparison of the most frequently cited (MFC) terrorism publications in 2003 with those identified two decades ago.

The remainder of the paper is organized as follows. In Section 2 we present a brief review of the related literature in terrorism research and knowledge mapping. Section 3 describes our research questions and the research design. Section 4 presents the results of the terrorism literature mapping with three types of analysis: basic analysis, content map analysis, and co-citation network analysis. The final section, Section 5, provides conclusions and directions for future research.

2. Related work

In this section, we review some developments in contemporary terrorism research and knowledge mapping methodologies. The developments update the related works described in the earlier study (Reid and Chen, 2005) and focus on the roles of the invisible college of terrorism researchers in shaping contemporary terrorism domain. Because of technological developments, the invisible college and their research have become visible and available for mapping the intellectual structure.

2.1. Contemporary terrorism research

Although terrorism is as old as recorded history and acquired its modern name from the French Reign of Terror of 1793–1794 (Laqueur, 1977), contemporary terrorism is a form of political violence that evolved in the 1960s and is characterized by increased terrorist attacks across international boundaries, involving citizens of more than one country (Merari, 1991; Wilkinson, 2003). For example, the Munich Massacre occurred at the 1972 Summer Olympic Games in Munich, Germany, when members of the Israeli Olympic team were taken hostage by the Black September terrorist group (Wilkinson, 1986b).

According to Jenkins (2002), the Munich and Lod Airport Massacres were considered as signals to governments that a new mode of warfare involving terrorist actors from multiple countries had begun. In response, several governments created counter-terrorism police forces. For example, the Federal Police of Germany established the GSG-9 counter-terrorism unit in October 1972 while the New York Police Department formed the Hostage Negotiating Team in 1972 (Wilkinson, 1986a, p. 114).

2.1.1. Invisible college of terrorism researchers

During the 1970s, governments, international organizations, and research centers such as the RAND Corporation, the Center for Strategic and International Studies (CSIS), Georgetown University, and the Jaffee Center for Strategic Studies, Tel Aviv University, also sponsored numerous terrorism conferences, research projects, specialized anthologies, study groups, and official inquiries into terrorism (Reid, 1983, p. 12; Schmid and Jongman, 1988, 2005). The efforts helped to nurture terrorism research and create numerous forums which allowed cross-fertilization of ideas, sharing of resources, and creation of an invisible college of terrorism researchers.

Some of the invisible college's renowned members include Brian Jenkins, RAND Corporation; Paul Wilkinson, the Centre for the Study of Terrorism and Political Violence (CSTPV), St. Andrews University, Scotland; and Aerial Merari, Tel Aviv University, Israel (Reid, 1983; Schmid and Jongman, 1988). They communicated informally, convened periodic terrorism meetings, developed terrorism incident databases (Dugan et al., 2005) shared ideas, and secured funding (Merari, 1991, p. 89; Reid, 1997, p. 97; Ellis, 2004, p. 523). According to Cronin's (1982) review of invisible colleges, informal communication and collaboration among a social network of specialists is essential for the exploration of new ideas and expansion of knowledge, especially in the social sciences. Invisible colleges of terrorism researchers, as described two decades ago by Reid (1983), have become progressively "visible colleges" (Koku et al., 2001) because of the Internet's capability to 'identify' and connect people beyond immediate organizational and community groups. Despite this, the full spectrum of their intellectual contributions, networks, and social relations in influencing contemporary terrorism research have not been fully explored.

2.1.2. Characteristics of terrorism research

Terrorism is not a topic that is easily researchable because of the clandestine nature of terrorist groups (Merari, 1991, p. 88; Silke, 2001, p. 2). It is difficult to penetrate terrorist cells and explore both individual and group motivations, although the consequences of terrorism

Table 1
Studies that analyse terrorism research

Discipline	Methodology	Data	Challenges in terrorism research
Criminology	Bibliometrics, Content analysis	Bibliographic data, abstracts	Terrorism research has been bereft of empirical data and advanced methodologies (Kennedy and Lum, 2003)
Information science	Bibliometrics, Citation analysis, Interview	Bibliographic data, conference participants, etc.	Problems in identifying/ retrieving terrorism information and nurturing new researchers (Reid, 1983, 1997)
Information science	Content analysis of meta-information	Masters and doctoral dissertations (1969–1997)	Problems in scattering of terrorism literature and nurturing terrorism researchers (Gordon, 1999, 2004)
Political science	Survey of active terrorism researchers	Survey data, documents	Problems in defining terrorism, limited data collection and methodologies. Over reliance on secondary data analysis (Schmid and Jongman, 1988, 2005)
Psychology	Critical analysis of literature	Terrorism studies	Lack of empirical data and over reliance on other terrorism authors' results (Merari, 1991)
Psychology	Content analysis	Journal articles from major terrorism journals (1990–1999)	Problems identified by Schmid and Jongman are still issues. Over reliance on cohort's publications and media-derived incident databases (Silke, 2001, 2004)

are visible and researchable. It is also difficult to identify the intellectual structure and characteristics of contemporary terrorism literature. Table 1 summarizes studies that analyse terrorism research and challenges in the domain.

In Table 1, it can be gleaned that some studies used bibliometrics to examine terrorism research publications and offer a view of the evolutionary development of the field. Bibliometrics is the quantitative study of the literature and scholarly communication processes in a field (Borgman and Furner, 2002). Reid (1983) used both citation and content analyses to identify the MFC terrorism publications, methodologies, and theories. Citations from other authors were used as a reflection of a publication's contribution to the field and as an indicator of the impact of earlier research (Garfield and Welljams-Dorof, 1992; Nguyen and Moy, 2000).

2.2. Knowledge mapping

There is extensive literature on knowledge mapping of scholarly literature and patents to analyse the structure, the dynamics, social networks, and development of a field such as medical informatics and information science (White and McCain, 1998; Garfield et al., 2002; Boyack, 2003; Huang et al., 2004). Mapping refers to an evolving interdisciplinary area of science aimed at the process of charting, mining, analyzing, sorting, enabling navigation of, and displaying knowledge (Shiffrin and Börner, 2004). For subject experts, mapping is useful for investigating trends and validating perceptions; for non-experts it provides an entry point into the domain and answers to domain-specific research questions (Boyack, 2004).

2.2.1. Citation data

Maps and snapshots of a field's intellectual space have been generated as a result of the pioneering work of Garfield and Small who stimulated widespread interest in using aggregated citation data to chart the evolution of scientific specialties (Cronin, 2002). By aggregating citation data, it is possible to identify the relative impact of individual authors, publications, and institutions, and highlight emerging specialties, new technologies, and the structure of a field (Garfield and Welljams-Dorof, 1992).

The advent of citation databases, such as the Institute for Scientific Information (ISI) Social Sciences Citation Index (SSCI) and Science Citation Index (SCI), which track how frequently papers are cited in a publication and by whom, have created tools for indicating the impact of research papers, institutions, and authors (Garfield and Welljams-Dorof, 1992). The web-version of SSCI, SCI, and the Arts and Humanities Citation Index is the Web of Science (WoS). Web-based tools such as Google and ResearchIndex (formerly CiteSeer) have been created to harness the similarities between citation linking and hyperlinking (Cronin, 2002; Park and Thelwall, 2003; Reid, et al., 2004). Searching the digital citation indexes have resulted in enormous amounts of citation data that are difficult to analyse, extract meaningful results, and display using traditional techniques.

This was illustrated in earlier citation network studies of terrorism researchers in which authors, institutions, and documents were used as units of analysis. The ISI databases were used to identify the invisible colleges of terrorism researchers, key research institutions, and their knowledge discovery patterns (Reid, 1983, 1997). This manual process was labor-intensive, relied on citation data, and involved a massive amount of data cleaning (Reid, 1983). While there are limitations in using the ISI citation data, e.g., it is seen as 'lagging indicators' of peer-reviewed research (Garfield and Welljams-Dorof, 1992), they are widely used in visualization studies and are the basis for identifying core terrorism researchers, influential publications, and subgroups of terrorism researchers in this study.

2.2.2. Visualization techniques

Recent developments in the field of domain visualization attempt to alleviate the "citation information overload problem" by applying information visualization techniques

to interact with large-scale citation data (Eggers et al., 2005). A limitation of information visualization techniques is that the quality of the visualization and interpretation of information depends largely on the quality of the data set provided (Ke et al., 2004, p. 5).

Several techniques have been applied to citation visualization. These include: Pathfinder network scaling (Chen and Paul, 2001), information visualization using social network analysis (Ke et al., 2004), and author co-citation analysis (White and McCain, 1998) which are particularly suited to investigation of intellectual structure because they provide the capability to interact with data and display it from different perspectives. An author co-citation map identifies interrelations among authors by analyzing the counts of the number of articles that cite pairs of authors jointly (White et al., 2001; Ke et al., 2004).

Content, or 'semantic', analysis is an important branch of domain analysis which relies on natural language processing techniques to analyse large corpora of literature (Eggers et al., 2005). The content map analysis technique produces content maps of large-scale text collections. The technique uses simple lexical statistics, key phrase co-occurrence analysis, and semantic and linguistic relation parsing. For example, Huang et al. (2004) uses a self-organizing map (SOM) algorithm to generate content maps for visualizing the major technical concepts appearing in nanotechnology patents and their evolution over time.

Another visualization technique is block-modeling which seeks to cluster units that have substantially similar patterns of relationships with others (Ferligoj et al., 1996). It has been applied in criminal network analysis to identify interaction patterns between subgroups of gang members (Chen et al., 2004). The application of visualization techniques to citation, content analysis, and author co-citation data provides a foundation for knowledge mapping. The techniques support the users' visual exploration of a domain to identify emerging topics, core researchers, communities, and other implicit knowledge that is presently known only to domain experts (Shiffrin and Börner, 2004). For example, the Namebase system (2004) mines names and organizations from terrorism books and periodicals included in its database and links names in a social network. Fig. 1 provides an example of a terrorism social network of researchers involving Brian M. Jenkins (name listed in the center in red), founder of terrorism research at RAND Corporation. The visualization is based on the number of times a name is listed on the same page with Jenkins.

Although the Namebase visualization does not indicate whether there is a relationship between Jenkins and the other names listed on the page or the context of their relationships, it is the only web-based tool readily available for visualizing social networks of terrorism researchers.

3. Research design

Using the integrated knowledge mapping framework proposed by Huang et al. (2004), this study purports to provide empirically based answers to the research questions (RQs) listed in Table 2. The framework includes three types of analysis to provide a multifaceted analysis of a research

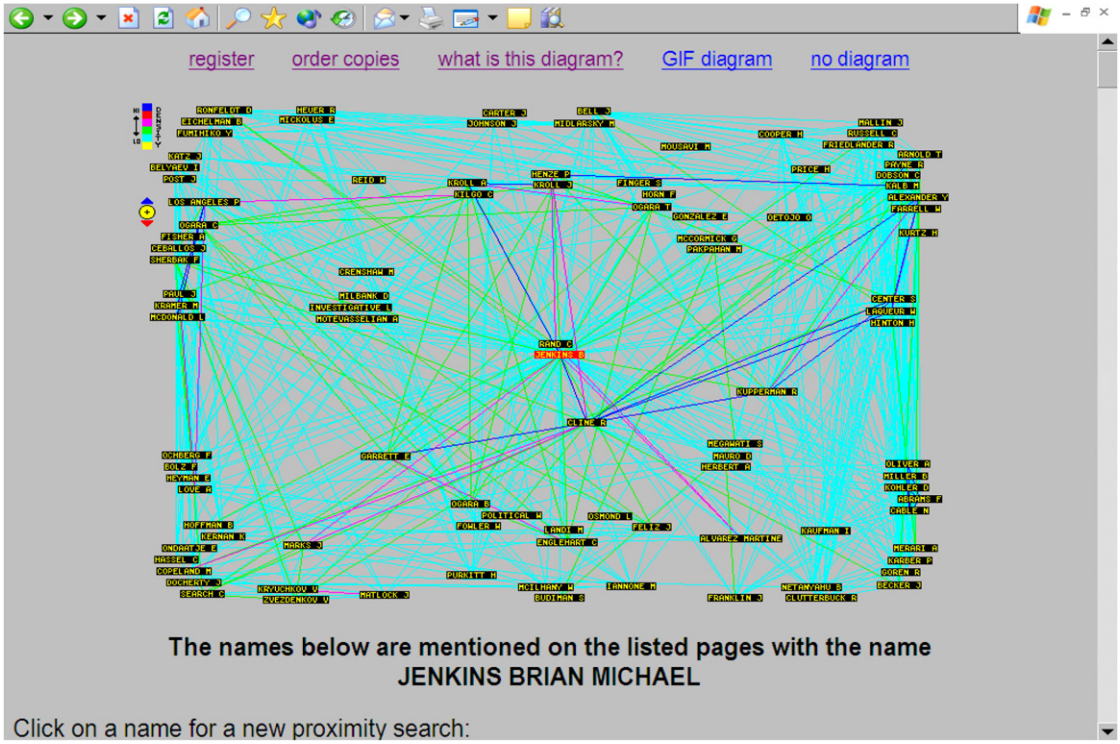

Fig. 1. An example of Brian Jenkins's Social Network (http://www.namebase.org).

Table 2
Knowledge mapping framework and research questions

Type of analysis	Unit of analysis	Measure	Research questions (RQs)
Basic analysis	Authors	Productivity	Who are the core terrorism researchers?
	Publications		What institutions are they affiliated with?
	Publication's citations	Impact	What are their influential terrorism publications?
			What are their collaboration patterns?
Content analysis	Documents words	Coverage	What are the dominant terrorism topics?
			What are the new areas of research?
Co-citation analysis	Author's co-citations	Linkage	What communities of authors have similar research specialties?

domain: basic analysis, content map analysis, and citation network analysis.

For the basic analysis, we analysed scientific output measures such as productivity (number of publications produced by a terrorism researcher) and impact (citation counts which allows one to find out how often a publication is cited). By analyzing documents and citation information, we identified core researchers, their influential terrorism publications, and research communities. The content map analysis visualizes the major subtopics and emerging concepts appearing in the publications while the co-citation map measures linkages and similarities among pairs of terrorism researchers as identified by citers. The co-citation data were also used in block-modeling to identify interaction patterns between subgroups of researchers within the terrorism scientific paradigms.

3.1. Basic analysis

For the basic analysis, the initial step is to identify a set of core terrorism authors. We compiled a list of authors from several sources: terrorism publications (Reid, 1997; Schmid and Jongman, 1988), active terrorism experts identified by the KnowNet virtual community (organized by the Sandia National Laboratories), and terrorism research center portals identified on the Internet. A total of 131 unique names were identified. These researchers are primarily affiliated with think tank groups, academic institutions, and government agencies located in 13 countries including the United Kingdom (18), Israel (7), and France (5). Sixty-four percent are from the United States.

The second step in the basic analysis is to identify the researchers' terrorism publications. A bibliography of English-language terrorism publications was compiled for each researcher using commercial databases. The publications include journal articles; books; book chapters; reviews; notes; newspaper articles; conferences papers; and reports. Table 3 lists the ten commercial databases that were searched using author's name and terrorism-related keywords such as terrorism; hijacking; Bombing; or political violence. the commercial databases were selected because of subject coverage and availability through the university of arizona library.

Table 3
Databases used to compile bibliographies

Database	Discipline	Records exported
ABI/inform	Business, management, information sciences	164
Academic Search Premier (ASP)	Multi-disciplinary	496
Expanded Academic ASAP (EA)	Multi-disciplinary	439
International Bibliographie der Zeitschriften Literature (IBZ)	International, European	161
ISI Web of Science	Social sciences, science, arts and humanities	360
PAIS International	Public affairs, business, social studies, international relations, economics	588
Political Science Abstracts (PSA)	Political science, international, politics	539
Science Direct	Science, technology, medicine	9
Sociological Abstracts	Sociology, family studies	279
WorldCat (materials cataloged by libraries around the world)	Multi-disciplinary	1154
Total		4189

Bibliographical data and abstracts were downloaded, parsed, and imported into a database for additional processing. After cleaning and purging duplicate records, 2,148 bibliographic records were manually reviewed to identify other records that may be duplicates (non-obvious) or non-terrorism publications. Database searches for 22 researchers failed to retrieve any terrorism-related publications while no English publications were retrieved for 21 other recommended researchers. As a result, terrorism publications (bibliographic data and abstracts) were retrieved for only 88 researchers.

The third step is to identify core terrorism researchers from the group of 88 researchers. The publications of the 88 terrorism researchers were analysed using basic citation analysis to identify how frequently they are cited in the literature. Aggregating citation data provides an indication of the impact of researchers, publications, institutions, and journals. However, solely measuring an author's contribution using citation frequency does have its limitations because of problems such as self-citation, bias towards journals in the English language, and inconsistencies in spelling (Garfield and Welljams-Dorof, 1992; Chua et al., 2002; Ke et al., 2004). In addition, methods papers tend to be cited far more frequently than theoretical papers. Therefore, we identified self-citation patterns, traced name variations, author's organizational affiliation history, type of publication, and pages cited. We also normalized the

author's name and manually checked for inconsistencies in spelling.

Basic citation counts for each researcher's terrorism-related publications were collected from the ISI Web of Science. Citations to each publication from any other article in the ISI data set are counted, and each indexed author is credited with the full tally of citations to that article (ISI, 2003b). If an author's total number of citations for a publication in our collection is four or more then he is considered a core terrorism researcher. Four is the threshold level in the social sciences field (ISI, 2003a). After an author is identified as a core researcher, his terrorism-related publication with the highest citation count is considered to be his influential publication (also known as most frequently cited (MFC)).

In addition, a coauthorship network was created to identify the collaboration patterns among the authors. The network covered the years 1965–2003. A hierarchical clustering algorithm was used to partition the core researchers who are connected if they coauthored a paper. This allows for visualization of collaboration, research teams, and institutions.

3.2. Content map analysis

The influential terrorism researchers' bibliographic data and abstracts were used in a content map analysis to identify the dominating themes and terrorism topics from 1965 to 2003. Since we want to examine more than simple frequency counts, we applied our previous research in large-scale text analysis and visualization for content map technology to identify and visualize major research topics. The key algorithm of our content mapping program was the SOM algorithm developed in our lab (Huang et al., 2004). It takes the terrorism titles and abstracts as inputs and provides the hierarchical grouping of the publications, labels of the groups, and regions of the terrorism document groups in the content map. Conceptual closeness was derived from the co-occurrence patterns of the terrorism topics. The sizes of the topic regions also generally corresponded to the number of documents assigned to the topics (Lin et al., 2001).

3.3. Co-citation analysis

Author co-citation analysis was used to visualize the similarities among the researchers and their intellectual influence on other authors. It uses authors as the units of analysis and the co-citations of pairs of author (the number of times they are cited together by a third party) as the variable that indicates their distances from each other (Andrews, 2003). It was conducted based on co-citation frequencies for the core terrorism researchers, for the period 1965–2003. The co-citation map was created using a GIS algorithm developed in our lab.

We conducted terrorism keyword searches in the Web of Science to retrieve records related to the topic of terrorism.

Table 4
Data sets summary

Data	Web of science (terrorism keyword searches)	10 Bibliographic databases (author and keyword searches)
Publications	7590	4129
Authors	6090	1168
Cited References	67 453	Not retrieved
Cited Authors	32 037	Not retrieved

The records were used to create a terrorism citation collection and included bibliographic records for 7590 terrorism-related articles that were downloaded. Results were parsed and loaded into a database which was used for the co-citation analysis. Table 4 summarizes the data sets used for this study.

Co-citation counts for each core terrorism researcher were derived using a program created by our lab. The program searched the citation field of each bibliographic record and counted the number of times two authors (or author pairs) were cited together. The result was the basis of the co-citation analysis portion of this study and offered a mapping of the field of terrorism research and the intellectual influence of the core researchers. Visualization of the relationships among researchers was displayed in a two-dimensional map that identifies their similarities, communities (clusters), and influence on emerging authors.

The co-citation data were also used in block-modeling to identify researchers' roles and positions in the terrorism research network. We used co-occurrence weight to measure the relational strength between two authors by computing how frequently they were identified in the same citing article (Chen and Paul, 2001). We also calculated centrality measures to detect key members in each subgroup, such as the leaders (Chen et al., 2004). The block-modeling algorithm is part of the social network analysis program developed in our lab.

4. Results

4.1. Core terrorism researchers

The basic analysis provides responses to the initial set of questions identified in Table 2 such as who are the core terrorism researchers. Forty-two authors were identified as core terrorism researchers. A total of 284 researchers (including coauthors) and their 882 publications made up the sample for this study.

Table 5 lists the 42 core researchers, the number of terrorism publications in our data set, and the number of times the researchers' publications were cited in the ISI databases. The core researchers are mainly affiliated with academic institutions (23), think tanks (15), media organizations (3), and the government (1). Their bases of operation are located in nine countries including the US (29), UK (4), and Ireland (1).

Table 5
Forty-two core terrorism researchers (based on citation score in ISI)

Author	No. of publications[a]	No. of times his publications in data set were cited	Author	No. of publications[a]	No. of times his publications in data set were cited
1. Wilkinson, Paul	87	229	22. Lesser, Ian O.	5	23
2. Gurr, T.R.	51	214	23. Bassiouni, M.C.	8	22
3. Laqueur, Walter	37	191	24. Carlton, David	1	21
4. Alexander, Yonah	88	169	25. Chalk, Peter	17	20
5. Bell, J.B.	47	138	26. Freedman, Lawrence	14	20
6. Stohl, M.	30	136	27. Merari, Ariel	25	19
7. Hoffman, Bruce	121	100	28. Post, Jerrold	12	18
8. Jenkins, Brian M.	38	96	29. Evans, Ernest H.	3	17
9. Ronfeldt, David	20	95	30. Bergen, Peter	10	16
10. Crenshaw, Martha	40	90	31. Gunaratna, Rohan	14	16
11. Arquilla, John	20	75	32. Cline, R.S.	8	15
12. Mickolus, Edward F.	25	73	33. Friedlander, R.A.	4	14
13. Crelinsten, Ronald	19	62	34. Paust, Jordon J.	11	13
14. Schmid, Alex P.	6	59	35. Ranstorp, Magnus	8	13
15. Wardlaw, G.	25	49	36. Flynn, Stephen E.	4	12
16. Hacker, F.J.	3	38	37. Cooper, H.H.A.	10	11
17. Rapoport, David	26	37	38. Wolf, J.B.	7	11
18. Sloan, Stephen R.	31	30	39. Horgan, John	13	10
19. Dobson, C.	6	25	40. Sterling, C.	5	10
20. Kepel, Gilles	6	25	41. McCauley, Clark	4	8
21. Stern, Jessica E.	21	25	42. Merkl, Peter	6	6

[a]Number of publications (pubs.) in our data set.

Table 6
Most Influential terrorism publications

Publication	No. of times cited	Topic	Author	Organization
1. Why men rebel, 1970	145	Political violence	Gurr, Ted	Univ Maryland
2. Terrorism, 1977	75	Terrorism historical aspects	Laqueur, Walter	Center for Strategic and Intl Studies (CSIS)
3. Terrorism and liberal state, 1977	66	Terrorism prevention	Wilkinson, Paul	Univ Aberdeen (formerly), CSTPV
4. Inside terrorism, 1998	47	Terrorism religious aspects	Hoffman, Bruce	Rand Corporation
5. Trans. Terrorism, a chronology, 1980	41	Terrorism incidents	Mickolus, Edward	CIA (formerly)
6. Crusaders, criminals, 1976	34	Terrorism case study	Hacker, F.J. (deceased)	USC Medical and Law Schools
7. Time of terror, 1978	33	Terrorism responses	Bell, J.B. (deceased)	Columbia Univ
8. State as terrorist, 1984	32	State-sponsored terrorism	Stohl, Michael	Purdue Univ
9. Political terrorism theory, tactics, 1982	31	Terrorism prevention	Wardlaw, Grant	Australian Institute of Criminology
10. Intl. terrorism national regional, 1976	30	Terrorism anthology	Alexander, Yonah	CSIS; SUNY
11. Political terrorism a new guide, 1988	29	Terrorism directory	Schmid, Alex P.	Royal Netherlands Academy of Arts and Science
12. Intl. Terrorism a new mode, 1975	27	Terrorism	Jenkins, Brian M.	RAND Corporation

4.2. Influential terrorism publications

The Appendix lists the most influential publication for each researcher which is based on the number of times cited in the ISI Web of Science. Table 6 lists the 12 most influential publications because they were cited more than twenty-five times in ISI databases.

Gurr's political violence study, *Why Men Rebel,* received 145 citations. In an earlier study where Reid (1983) used ISI databases to identify the MFC terrorism publications, *Why Men Rebel* also received the highest number of citations. It is an award-winning study that outlines a framework for understanding political violence. It presents the frustration-aggression theory which posits that

Table 7
Most frequently cited (MFC) terrorism publications in two decades

Publication	Author	Citation ranking in 2003	Citation Ranking in 1983 (Reid, 1983)
1. Why men rebel, 1970	Gurr, Ted University of Maryland	First	First
2. Terrorism, 1977	Laqueur, Walter CSIS	Second	Tenth
3. Terrorism and liberal state, 1977	Wilkinson, Paul CSTPV (UK)	Third	Sixth
4. Intl. terrorism national regional, 1976	Alexander, Yonah CSIS; SUNY	Tenth	Thirteenth
5. Intl. Terrorism a new mode, 1975	Jenkins, Brian M. RAND Corporation	Twelfth	Eighth

aggression (the product of anger) is the main response to frustration and that men who are frustrated have "an innate disposition" to strike out at the source of their frustration (Gurr, 1972). Table 7 provides a comparison of the most influential (MFC) terrorism publications in 2003 with those identified by Reid in 1983.

For the last two decades, five publications have consistently been identified as the MFC terrorism research. For example, Laqueur's *Terrorism,* which used to be the tenth MFC terrorism publication in 1983, is now the second. This publication provides a general history of the philosophical and sociological background of modern terrorism. Notably, all of the five influential publications were authored during the 1970s when contemporary terrorism as a field of research was taking root.

4.3. Collaboration patterns

After identifying influential publications of the core researchers, we answer the question about their collaboration patterns. An investigation of the core researchers' coauthorship patterns provides an understanding of their social network patterns. The social network graph in Fig. 2 exhibits the coauthorship network of core researchers in scientific collaboration networks. The nodes represent researchers who coauthored papers. The boxes represent research centers at RAND Corporation, the CSIS, and the St. Andrews' CSTPV, Scotland.

In the lower right corner of Fig. 2, the RAND research teams led by Jenkins and Hoffman are one of the most active clusters. Except for Gunaratna, all of the researchers in the cluster, such as Chalk and Ronfeldt, are RAND employees. Gunaratna coauthored publications with Chalk and Hoffman. The latter was his Ph.D. advisor at St. Andrews University, Scotland, where Hoffman founded St. Andrews' CSTPV and created the Rand-St. Andrews terrorism incident database which provides data for their studies (Hughes, 2003). Later, Gunaratna went to the Institute of Defence and Strategic Studies, Singapore, and founded the ICPVTR. Now, ICPVTR has created a terrorism database focusing on the Asia Pacific region. The database is a repository of information on terrorist groups, individuals, incidents, and other general information on terrorism (IDSS, 2003).

In Fig. 2, the cluster in the lower left corner that includes Ranstorp from CSTPV is sparse and shares few coauthorships. As chairman of the Advisory Board for CSTPV, Wilkinson does not have collaborations with researchers at CSTPV (see Wilkinson's node outside of CSTPV cluster). He often works alone.

Another cluster includes researchers such as Alexander and Cline at the Center for Strategic and International Studies (CSIS). Since Alexander has 82 coauthors, this cluster displays a pattern of one to many coauthors. We found that Alexander's coauthorships do not seem to be sustainable because many authors produce only a single publication with Alexander and did not publish with other terrorism researchers in this sample.

4.4. Dominant terrorism topics

Regarding the next set of questions identified in Table 2, several dominant terrorism topics have been identified for 1965–2003. Fig. 3 displays the contemporary terrorism content map that was generated based on the title and abstracts of the 882 terrorism-related publications in our data set. The topic map interface contains two components, a folder tree display on the left-hand side and a hierarchical content map on the right-hand side (Huang et al., 2004). The terrorism publications are organized under topics that are represented as nodes in the folder tree and colored regions in the content map. These topics were labeled by representative noun phrases identified by our programs. The number of terrorism publications that were assigned to the first-level topics is displayed in parenthesis after the topic labels.

Major terrorism topics (large regions with depth in the content map) include "low intensity conflicts," "rand corporation paper series," "osama bin," "political violence," "rand st andrews chronology," and "irish republican army." The topics "rand corporation paper series" and "rand st andrews chronology" highlight the major roles that Brian Jenkins and Paul Wilkinson, pioneers of contemporary terrorism studies, played. They established terrorism research centers, created databases of terrorism incidents, secured funding for terrorism research projects, organized terrorism conferences, produced terrorism studies, and supervised students' research on terrorism (Reid, 1983).

Several interesting shifts in the cognitive structure of contemporary terrorism research are identified. A traditional terrorism topic, "low intensity conflicts," first

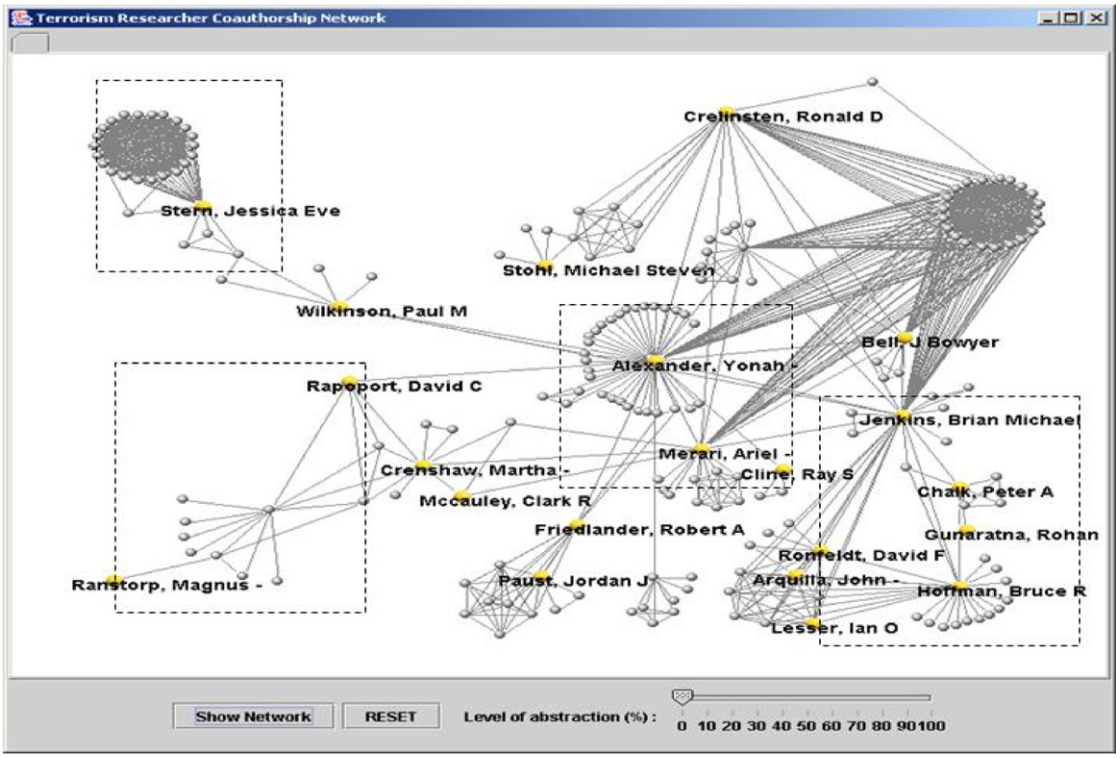

Fig. 2. Core terrorism researchers' coauthorship network.

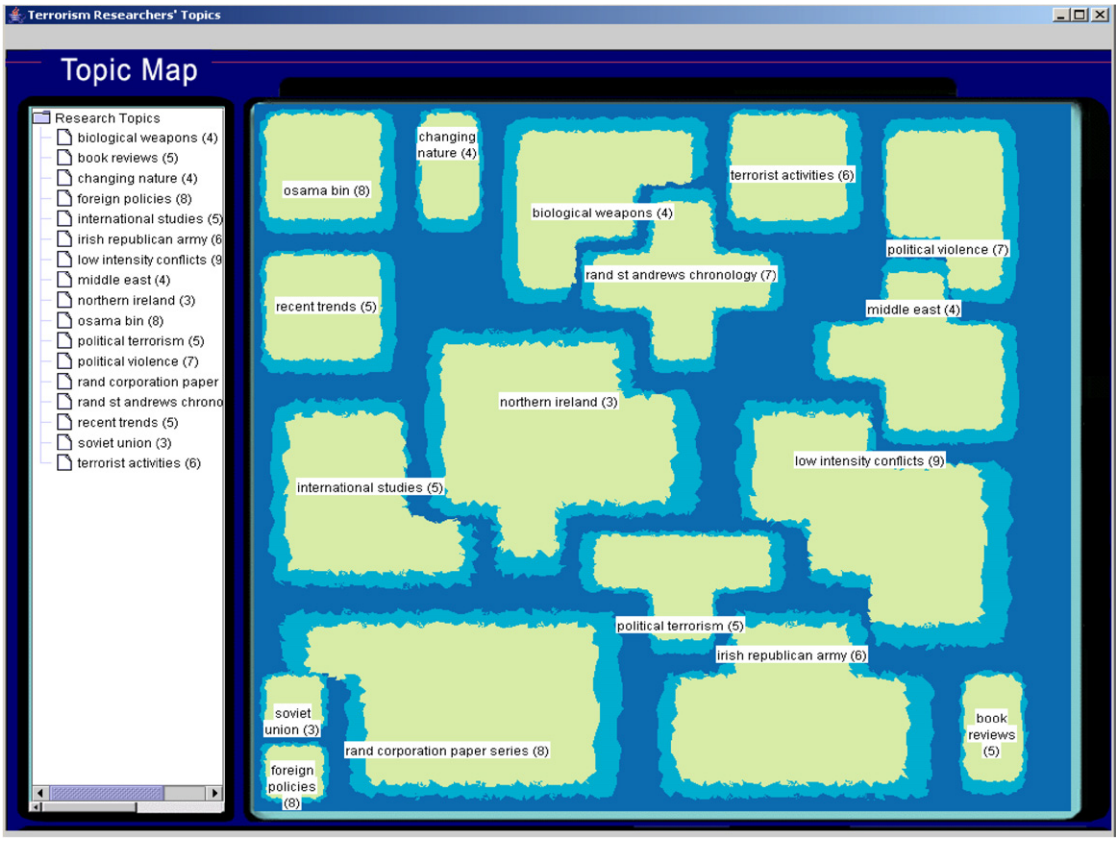

Fig. 3. Contemporary terrorism content map that was generated based on 882 terrorism-related publications: 1965–2003.

appeared in 1991 and appeared seven other times in the 1990s but only one time in the 2000s. Prior to 11th September 2001, the conventional wisdom was that the use of terrorism was endemic in low intensity conflict but that it rarely, if ever, posed a strategic threat to the security of major international powers (Wilkinson, 2003). After 1997, there was an increasing appearance of the topic "osama bin" which first emerged in our data set in 1998 as the subject of an article by Peter Bergen (1998). "Osama bin," referring to Osama Bin Laden, is a new topic of interest.

4.5. Clusters of research specialties

For the final set of questions identified in Table 2, such as what groups of authors have similar specialties, the author co-citation analysis is used to visualize the closeness of research interests among the core terrorism researchers and their intellectual influences on others. The raw co-citation data derived from keyword searches of the ISI Web of Science were used for the analysis conducted in this part of the study. We created author co-citation networks to identify which core researchers in terrorism are often cited together.

Fig. 4 shows a sample of pairs of authors (researchers) linked by co-citation counts of 1–3. Authorship nodes are represented either by a square or circle followed by the last name of the first author, publication source, and year. The square node identifies a publication that cites the core terrorism researchers (circular nodes). The width of the arrows connecting authorship nodes have been made proportionate to their co-citation counts in size. The narrow arrow width reflects a count of one co-citation link while a thick one reflects a count of at least two co-citation links.

To illustrate the findings represented through the author co-citation map, boundaries were drawn around clusters of researchers. Fig. 4 illustrates four groupings of author co-citation patterns.

The groupings provide a way of clustering pairs of researchers who share areas of interest. For example, publications cited in Group A focus on terrorism and foreign policy (based on terms from the titles and abstracts of their publications). In Group A, Wardlaw's article on terror as an instrument of foreign policy cites several of the most frequent co-cited pairs. The most frequently appearing author co-cited pairs are Laqueur and Wardlaw (13 times), Stohl and Wardlaw (12 times), and Cline and Stohl (12 times). Cline and Stohl specialized in state-sponsored terrorism.

Group B emphasizes the organizational perspectives of terrorism. It includes Oots' publication entitled "Organizational Perspectives on the Formation and Disintegration of Terrorist Groups." Oots cites seven of the core researchers and identifies almost fifty author co-citation pairs. Group C deals with historical aspects while Group D's focus is legal aspects of terrorism.

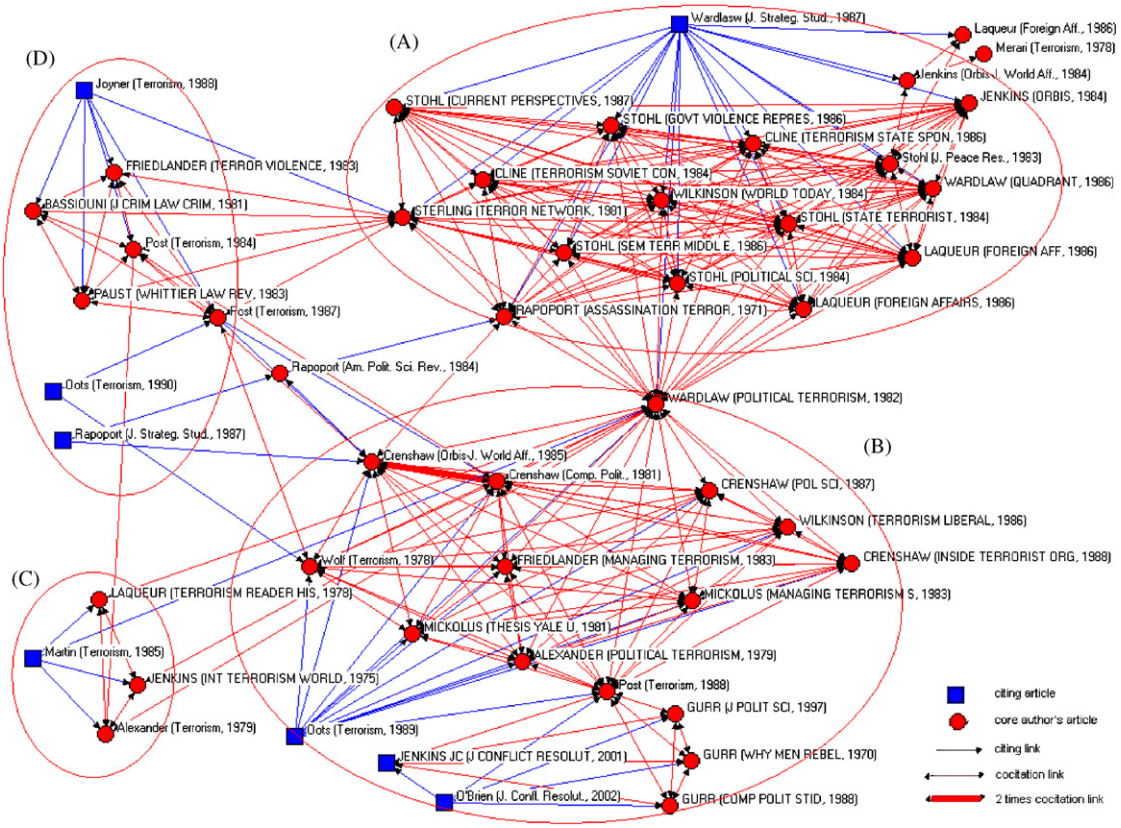

Fig. 4. Core terrorism researchers' co-citation networks.

Another way of viewing subgroups and core members in contemporary terrorism research is to analyse their interaction patterns to identify the roles and positions that they play. It was found that, as Fig. 5 shows, 17 terrorism researchers from the resulting network were co-cited in ISI.

Fig. 6 shows the subgroups identified by the system. They have the labels of their leaders' names (e.g., Crenshaw, Post, and Stohl). The thickness of the straight lines indicates the strength of relationships between subgroups.

For example, Crenshaw's group consists of Mickolus (cited with Crenshaw eight times), Post (cited with Crenshaw six times), Wolf (cited with Crenshaw six times), etc. Those familiar with terrorism research would not be

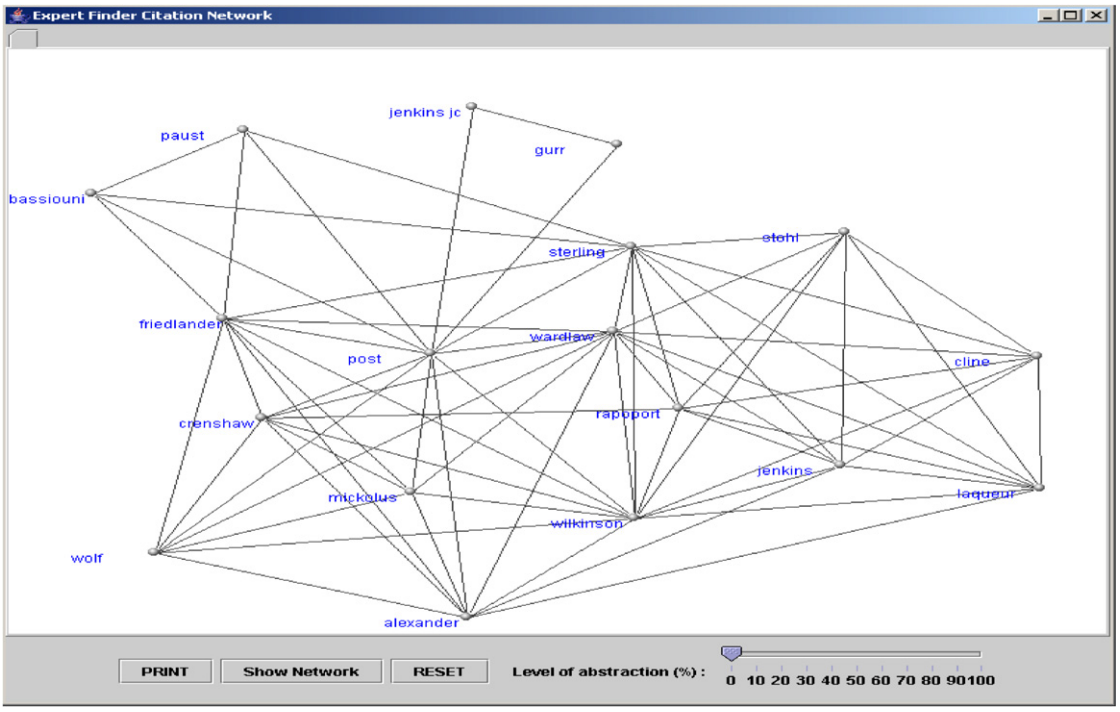

Fig. 5. The 17 core terrorism researchers who were co-cited in ISI Web of Science.

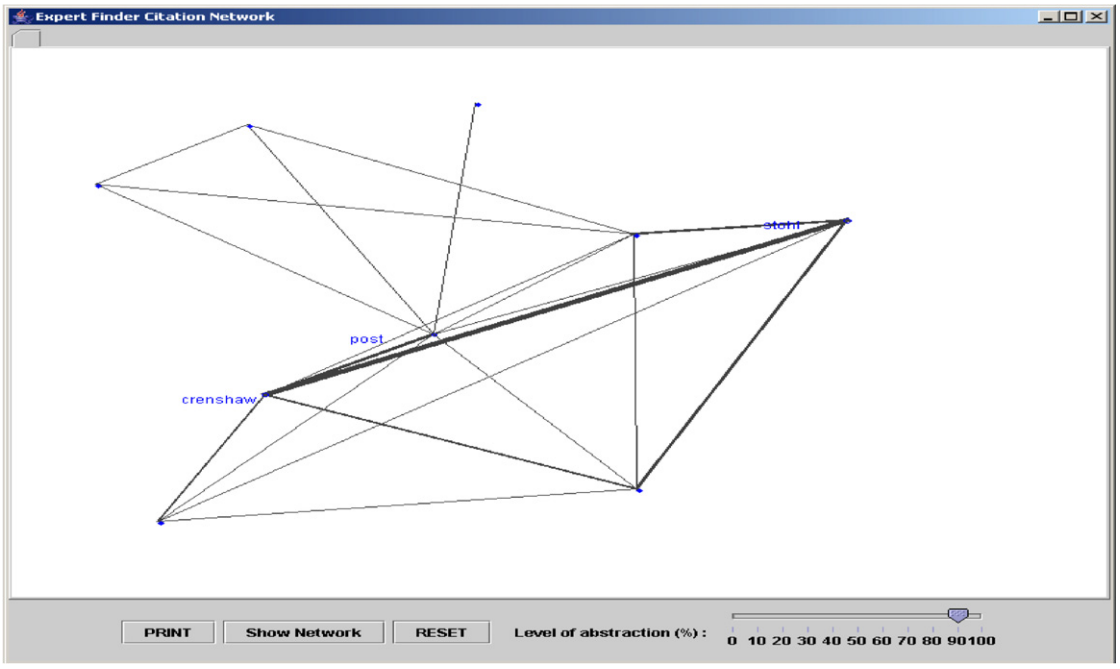

Fig. 6. Subgroups of co-cited authors tagged with leaders' names.

surprised by the close co-cited relationship between Crenshaw and Post because they focus on the psychological aspects of terrorism, with Crenshaw (2000) positing that there is no profile of the typical terrorist.

5. Conclusion

The intellectual structure of contemporary terrorism research reveals the existence of several subfields of research such as international conflict, foreign policies, regional studies, and political violence. These subfields reflect the influences of several social science disciplines such as political science, international studies, and history, and substantiate the fact that terrorism research from the 1960s to early 2000s mainly attracted attention from a narrow section of the social science disciplines. This may be explained by the limited importance of studying terrorism as a research topic, the risk associated with terrorism, and the few resources (e.g., research centers, funding, data, methodologies, and scholarships) that were previously available for investigating the phenomenon prior to the September 11 attacks.

For example, from the 1970s through the early 2000s organizations such as the RAND Corporation mainly secured funding from government agencies to conduct terrorism research, investigated policy-oriented research questions, created a terrorism research center, created their own terrorism incident databases based on the popular press' coverage of terrorism, and generated numerous RAND reports on terrorism. These reports, which were heavily cited, include for example, International Terrorism: a New Mode of Conflict (cited 27 times), and were later integrated into terrorism anthologies and journal articles.

Although St. Andrews' CSTPV also received government funding for terrorism research and created their own terrorism incident database with the help of RAND Corporation, CSTPV was heavily influenced by academic scholars who generated high quality theoretical studies such as Wilkinson's[1] *Terrorism and the Liberal State* (cited 66 times). Both RAND and CSTPV are major centers for the recruitment, nurturing, and training of researchers in contemporary terrorism. Results further indicate that newer and highly cited (core) researchers, such as Rohan Gunaratna, an expert on al Qaeda and a former research associate at CSTPV, (a former Ph.D. student of Bruce Hoffman at St. Andrews; Hoffman is currently Vice President at RAND), are influenced by the early terrorism authors and their research foci. Recently, Gunaratna founded a terrorism research center at the Institute of Defense and Strategic Studies, Singapore, coauthored a book with Hoffman, and created a new incident database on terrorism and political violence in the Asia Pacific region.

[1]Before his appointment at St. Andrews, Paul Wilkinson was at the University of Aberdeen, Scotland. http://www.st-andrews.ac.uk/academic/intrel/research/cstpv/pages/pw.html.

The growth and maturity of contemporary terrorism research has been, in fact, influenced by the pioneering contributions of core researchers and their affiliated research centers. These include concepts, methodologies, and theories that are important for understanding the terrorism phenomenon. According to Andrew Silke (2001, 2004), terrorism researcher at the University of East London, UK, and Honorary Research Associate at CSTPV, some of these early terrorism research approaches have also generated weaknesses in methodology, data collection, and theory generation. This clearly represents new challenges and opportunities for future researchers.

While the application of visualization techniques supports the exploration of the terrorism domain to identify implicit knowledge that is presently known only to domain experts, visualization is not a substitute for the extensive reading and detailed content analysis necessary to understand the development of a field. For new researchers, it can provide an alternative approach to gain a quick understanding of the structure and development of a field.

Additionally, the research findings may be useful for IS researchers who want to expand the analysis of scholarship in terrorism by using alternative methods, such as a survey of terrorism experts, bibliometric analysis, and sociometric analysis, to validate the results of this study. They can also build on their proven disciplinary insights in theoretical and methodological approaches by applying them to investigations of relevant topics such as the invisible colleges of terrorism researchers, knowledge management approaches in terrorism, diffusion of the Internet in terrorism operations, organizational learning strategies of terrorist groups, and the effectiveness of terrorist groups' information operations.

In the near future, we intend to supplement this work with other studies that use time-series topic maps to present the development trends in terrorism across various periods and further examine the evolution and topic changes in the field. We will also include author content map analysis to group individual researchers based on their common research interests. Our ultimate goal is to develop a terrorism expert finder application that supports domain visualization and field test it with new and experienced terrorism researchers.

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Appendix

The list of 42 core terrorism researchers are given in Table A1.

Table A1
List of 42 core terrorism researchers (as of December 2003)

Author	No. of publications	No. of active Years	No. of times publications in data set were cited	Most frequently cited (MFC) terrorism publication	Date	No. of times cited
1. Alexander, Yonah	88	32	169	Intl. terrorism national regional[a]	1976	30
2. Arquilla, John	20	30	75	Cyberwar is coming	1993	18
3. Bassiouni, M.C.	8	17	22	Intl. terrorism and political	1975	16
4. Bell, J.B.	47	35	138	Time of terror[a]	1978	33
5. Bergen, Peter	10	7	16	Holy war inc	2001	15
6. Carlton, David	1	2	21	Terrorism theory and practice	1979	21
7. Chalk, Peter	17	26	20	West European terrorism	1996	7
8. Cline, R.S.	8	14	15	Terrorism the Soviet	1984	14
9. Cooper, H.H.A.	10	25	11	Terrorism and the Media	1977	7
10. Crelinsten, Ronald	19	28	62	Political terrorism a research guide	1993	22
11. Crenshaw, Martha	40	35	90	Why violence spreads	1980	23
12. Dobson, C.	6	14	25	Black September	1974	8
13. Evans, Ernest H.	3	4	17	Calling a truce	1979	17
14. Flynn, Stephen E.	4	4	12	Beyond border	2000	8
15. Freedman, Lawrence Z.	14	21	20	Terrorism and Intl Order	1986	7
16. Friedlander, R.A.	4	10	14	• Terror violence	1983	7
				• Terrorism documents	1979	7
17. Gunaratna, Rohan	14	8	16	Inside al qaeda	2002	14
18. Gurr, T.R.	51	41	214	Why men rebel[a]	1970	145
19. Hacker, F.J.	3	5	38	Crusaders, criminals[a]	1976	34
20. Hoffman, Bruce	121	27	100	Inside terrorism[a]	1998	45
21. Horgan, John	13	18	10	Technology vs terrorism	1986	5
22. Jenkins, Brian M.	38	30	96	Intl. terrorism new mode[a]	1975	27
23. Kepel, Gilles	6	4	25	Jihad expansion	2000	16
24. Laqueur, Walter	37	28	191	Terrorism[a]	1977	75
25. Lesser, Ian O.	5	30	23	Intl. terrorism a chronology	1975	13
26. McCauley, Clark	4	12	8	Terrorism research and public	1991	8
27. Merari, Ariel	25	26	19	Readiness to kill and die	1990	8
28. Merkl, Peter	6	18	6	Political violence and terror	1986	6
29. Mickolus, Edward F.	25	28	73	Trans. terrorism, a chronology[a]	1980	41
30. Paust, Jordon J.	11	30	13	Federal jurisdiction over…	1983	11
31. Post, Jerrold	12	19	18	Terrorist psycho logic	1990	12
32. Ranstorp, Magnus	8	13	13	Hizb'allah in Lebanon	1997	7
33. Rapoport, David	26	33	37	Assassination and terrorism	1971	20
34. Ronfeldt, David	20	30	95	• Cyberway is coming	1993	18
				• Networks and netwars	2001	18
35. Schmid, Alex P.	6	7	59	Political terrorism a new guide[a]	1988	29
36. Sloan, Stephen R.	31	34	30	Simulating terrorism	1981	10
37. Sterling, C.	5	7	10	Terror network	1981	10
38. Stern, Jessica E.	21	13	25	Prospects of domestic bioterrorism	1999	12
39. Stohl, M.	30	28	136	State as terrorist[a]	1984	32
40. Wardlaw, G.	25	23	49	Political terrorism theory, tactics[a]	1982	31
41. Wilkinson, Paul	87	32	229	Terrorism and liberal state[a]	1977	66
42. Wolf, J.B.	7	16	11	Fear of fear	1981	5

[a]Indicates the 12 most influential publications (cited > 25 times).

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