Trends in and Contributions to Tallinn Manual Research: An Assessment of the Literature from 1998 to November 2022

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Initially aimed at identifying trends and contributions in the extensive field of "Tallinn Manual," this article examines 26 academic publications related to Tallinn Manual, which were featured in journals indexed in the WoS (Web of Science) from 1998 to November 2022. In this survey, we have conducted a thorough analysis of relevant keywords and reviewed numerous articles to determine their connection with the subject matter. Our study encompasses various parameters, such as the amount of publications per year, classification of article types, primary authors, academic journals, and the highest frequently cited articles. Moreover, we have examined citation counts for journals, authors, and articles. The outcomes of our study suggest a noticeable growth in the number of articles related to the Tallinn Manual between 1998 and November 2022, indicating an increasing trend in the influence of Tallinn Manuals before 2020. The research on Tallinn Manual has captivated the attention of several scholars during the study period. Notably, scholars from the United States, Australia, England, the Netherlands, and South Korea have made substantial contributions to this subject. Our study stresses the fact that the notion of Tallinn Manual has piqued the interest of academic researchers, leading to noteworthy advancements in Tallinn Manual research.
Keywords: *Tallinn Manual, Citation analysis, Contribution, Trend, Literature review*
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1 Introduction

When it comes to cyber-attacks, the traditional approach is to view them through the lens of the law of armed conflict (LOAC), which dictates the use of force through authorized armed conflicts, specifically the jus in bello regulations. However, since cyber-attacks may not result in physical harm, they may not fall under the scope of LOAC. According to Haataja (2017), Paragraph 4 in Article 2 of the Charter of the United Nations disallows usage of force to maintain the essence of violence, meaning that regulations for armed conflicts must pertain to some form of physical damage to property or casualties. As a result, the LOAC may not fully cover the non-material harm caused by the Estonian cyber-attack [11].

In 2013, the NATO Cooperative Cyber Defense Center of Excellence (NATO CCD-COE) invited legal scholars from 47-member states to examine the principles of cyber warfare. The outcome of this effort was the creation of the "Tallinn Manual," which is considered to be the first set of norms for cyber warfare. The manual is organized into seven chapters and 95 rules, and it can be roughly divided into two parts:

(1) International Cyber-Security Law: the exercise of national cyber sovereignty and the right of self-defense in cyberspace.

(2) Law of armed conflict on the Internet: In armed conflict, the norms that should be observed for specific personnel, occupation, neutral countries etc.

The Tallinn Manual has a crucial role to play in the fields of Cyber Warfare, Cyber Attack, and Cyber Defense, at national, regional, and global levels. Scholars have defined the manual's significance in the context of cyber conflict. For example, Eichensehr (2014) provided a comprehensive definition, expressing that "The primary purpose of the Tallinn Manual is to offer clarity on the intricate legal matters related to cyber operations [8]. Specifically, it aims to elucidate the applicable lex

lata, which denotes the presently effective laws governing cyber warfare, as opposed to lex ferenda, which refers to the desirable policies or best practices". These authors suggest that the Tallinn Manual covers self-defense, countermeasures, human rights, evaluation, and sovereignty in cyberspace. Furthermore, Jensen (2017) added that the first version of Tallinn Manual focused on the law relevant to armed conflict, whereas the second version of manual takes a broader approach, covering cyber operations both within and outside of armed conflict [9].

The 2017 version of the Tallinn Manual includes 20 chapters and 154 articles. It primarily focuses on the rules of international law governing cyber operations during peacetime, addressing recurring cyber incidents that occur outside of armed conflicts in various countries. The manual's rules aim to serve as customary international law by providing specific guidelines on the subject.

It's important to note that the authors of the handbook are international law scholars or military law scholars from NATO countries, with the United States taking the lead. Consequently, the manual's legal framework may have a limiting effect on overall legal thinking regarding cyber warfare, and its influence on human rights and freedom of speech could be significant.

In the first version of the Tallinn Manual, the International Group of Experts recognized the challenge of unique members in a cyber levée en masse and the resulting difficulty for persons to meet the terms with the LOAC principle of distinction. Similarly, in the IHRL chapter of the second edition (Tallinn 2.0), the authors proposed that states have a right and a duty to take applicable measures to contradict the harmful effect of terrorism on human rights. However, the authors also noted that such measures could potentially impact human rights say freedom of illustration and the right to privacy.

These concerns stem from the fact that the contours of cyber terrorism and cyber warfare, as they apply to the cyber context, are not yet fully understood. As Barnsby et al. (2017) explained, these uncertainties make it hard to dispel concerns regarding the potential impact of cyber operations on human rights [1].

Also because when the Tallinn Manual was formulated, the diversity of participants was limited, and it violated the definition of customary international law, that is, "those accepted as law as evidence of general practice", plus the lack of transparency in the legislative process, and the judgment of the Internet The source of the attack and whether it meets the criteria of armed conflict on the Internet are relatively vague, and it is relatively difficult to win the recognition of non-NATO countries, which reduces the possibility of scholars from various countries investing in research, making the rules of this manual a mere formality.

Tanodomdej (2019) contended that international law is not only created through treaties but also by a communicative process involving various actors, not limited to states [21]. Consequently, manuals that disregard the generality of state practice are flawed. For example, in Tallinn Manual 2.0, the experts analyzed cyber operations along two axes: (1) the level of infringement on the target state's territorial integrity, and (2) intervention with or usurpation of fundamentally governmental functions. However, participation from country agency officers was not sought, making it challenging to identify cyber operations that would violate the manual (Schmitt, 2017). Boer (2019) criticized the Tallinn Manual authors for quietly accepting the manual's dictates, considering it problematic when one considers the manual as a form. If the drafting process of manuals fails to establish the legitimacy of the research group and ensure objectivity, there is a risk that political activism could influence the process [3].

These legislative issues of the Tallinn Manual will reduce the recognition of non-NATO countries, making it difficult to implement the Manual to all countries.

Jensen and Watts (2017) point out that rule 6 of The Tallinn Manual 2.0 express that a state has a responsibility to apply due diligence in the cyber context to prevent its territory or cyber infrastructure within its governmental control from being used for cyber operations

which produce serious adverse consequences and affect the rights of other states [10].

International law now lacks a definitive standard for determining when a cyber operation qualifies as a use of force. Nevertheless, there is a consensus that the severity of the offensive operation must be sufficiently high to secure such classification.

In this regard, some scholars have proposed strategies to fill the shortcomings of the above-mentioned "Tallinn Manual" to strengthen the implementation of regulations, including the construction and comparison of assessment mechanisms for cyber-attacks, to apply the rules of the manual and propose response strategies (Pipyros et al, 2018) [17], transnational notification Resilience mechanism (Schaller, 2017).

Pipyros et al. (2018) have noted that while Rule 10 of the Tallinn Manual is built on Article 2(4) of the United Nations Charter, the charter doesn't give clear standard for determining when an act constitutes a "use of force" or an "armed attack." Additionally, it doesn't specify the measures that the Security Council should take to uphold or rebuild international peace and security. To address this, based on their properties to advance the modeling and assessment of cyber-attacks, the authors propose a new strategy that combines decision-making algorithms and launches a new grouping of Schmitt's criteria [19]. Schaller (2017) recommends that states develop a customized multilateral cyber warfare and response framework to reduce the risk of acceleration and solve cyber incidents while securing their cyber infrastructure anti malicious activities [20]. The framework should establish procedural standards, and states should demonstrate their willingness to cooperate in good faith with other countries. Furthermore, states should avoid using the reason of necessity as a pretext for influential action in the cyber domain. This article provides a summary of important literature and identifies that since the inaugural version of the Tallinn Manual, some scholars have raised questions about its author, procedures, and potential human rights violations. Due to the complexity of security and international law, few legal scholars have presented research results in the literature. Additionally, some rules in the manual are relatively abstract, making it challenging to implement strategies or methods. However, various scholars in the fields of information security and law have proposed evaluation methods, transnational cooperation promotion strategies, and joint defense methods. Therefore, this article aims to use quantitative means to address the aforementioned concerns and construct a legal literature system for the Tallinn Manual.

In recent times, indexes like the Sciences Citation Index (SCI) or Social Sciences Citation Index (SSCI) have become increasingly significant in academic circles. These indexes aim to evaluate the influence of scholars and publications in their particular domains. Selected high-profile academic journals are included in SCI or SSCI, and each time a reference from these journals is cited by another author, it is considered as a measure of the impact factor. Bhupatiraju et al. (2012) have also highlighted the importance of citations as indicators of intellectual influence and the flow of ideas between and within different fields [2]. However, it is important to exercise caution while analyzing citation data, as it can be influenced by various factors such as field-specific habits and norms, strategic motivations, personal preferences, etc. Despite these limitations, researchers still rely on citation analysis to supplement their knowledge. In this context, our study aims to find the key researchers in the field of Tallinn Manual, quantify their contributions, and analyze the amount of times they have been cited and published using the ISI WOS database. We have calculated the credits for every publication by researchers, journals, and contributions to the Tallinn Manual literature using SCI/SSCI.

We conducted a comprehensive literature review and analyzed 26 articles related to the Tallinn Manual that were published in 20 academic journals from 1998 to November 2022. Our aim was to explore the wide-ranging domain of business studies covered by Tallinn Manual research. To identify the relevant publications, a keyword search was conducted in the WOS databases, following the

methods proposed by previous researchers such as Zou (2005) for advertising literature [22], Latchem (2006) [12] for content analysis of the British Journal of Educational Technology (BJET), and Luor et al. (2008; 2014; 2022) for computer-assisted learning, entrepreneurship, and twice-exceptional. In this study, data-gathering methods was described our findings were presented based on these methods.

2 Research Methods

Scope of study

To conduct our analysis, we chose 1998 as the starting year and performed a keyword search using terms related to the Tallinn Manual in the WOS databases, identifying 26 relevant articles in 20 academic journals from 1998 to November 2022. The keywords used were "Tallinn Manual", "Tallinn Manual", and "Tallinn-Manual". The articles were then categorized into eight categories based on their relevance to the Tallinn Manual, namely Law, International Relations, Political Science, Computer Science Information Systems, Communication, Ethics, Information Science Library Science, and Telecommunications. Table 1 shows the distribution of articles across these categories.

Table 1. Top Web of Science Categories and numbers of articles (1998-Nov. 2022)

	Subject Area	Number of articles	% of 26 articles
1.	Law	18	69.2
2.	International Relations	7	26.9
3.	Political Science	4	15.4
4.	Computer Science Information Systems	3	11.5
5.	Communication	1	3.85
6.	Ethics	1	3.85
7.	Information Science Library Science	1	3.85
8.	Telecommunications	1	3.85

Total Subject Areas: 8

(**Note:** The number of articles displayed may be greater than the listed record Count, because that some articles may across multiple subject areas.

Calculation of authorial "contribution"

To evaluate the contributions of authors and personal publications in the domain of Tallinn Manual, this study employed the "times cited" data obtained from the ISI Web of Science database." The total of times an article is cited reflects its contribution, as authors assess the value of the cited works for authors' research and the research community in general. This makes the number of citations a suitable metric to evaluate an article's influence on the literature. Despite the possibility of bias due to factors such as auto-citations or methodological articles by the authors, citation analysis is widely regarded as a dependable measure of an article's influence in academic circles. Hence, in this study, the authors extracted the impact factor, or the amount of times each author was cited, from the ISI Web of Science database for the 26 research articles on Tallinn Manual.

The amount of times an article is cited reflects the relevance of the cited works to the author(s)' own research and the progress of their field of study (Chandy and Williams, 1994; Cote et al., 1991; Luor et al., 2008, 2014, 2022) [7,14,15,16]. Thus, assessing the frequency of citations for a published journal article is a suitable measure to gauge its influence on the literature [5].

Academically, the SCI/SSCI is widely accepted as a reliable measure of an article's impact. This study evaluated the impact of each author on the 26 research articles on Tallinn Manual by adding up the SCI/SSCI citation count of all the articles they have published in.

For multiple articles published by an author in the pool, the SCI/SSCI citation count of each article determined its impact, while the sum of all counts indicated the author's influence on the research literature of Tallinn Manual. The citation data for each article in the pool were sourced from the ISI Web of Science database, which was accessed online. To determine the author's credited contribution to a publication, each individual author was credited with one (1) count for a single-authored article, while authors of a two-authored article each received 0.5. The same rule was applied to articles with multiple authors to calculate each author's credited contribution. Finally, the credited contributions of an author across all articles they authored or co-authored within the 26 Tallinn Manual article pool were added up.

Application of Lotka's Law and Bradford's Law

Two recognized empirical laws in information science are Lotka's law of scientific productivity, which was introduced by Lotka in 1926 to compute the scientific productivity of authors in chemistry, and Bradford's law of bibliographic scattering [4], which was formulated in 1934. According to Lotka's law [12], if c authors publish precisely one paper each, then the amount of authors a_b contributing b papers would be given by:

$$a_b = c/b^2 \text{ for } b = 1, 2, \ldots$$

In this study, the Chi-square test was adopted as outlined by Radhakrishnan and Kernizan in 1979 [18] to determine whether the Tallinn Manual papers published in SCI/SSCI between 1998 and November 2022 conform to Lotka's Law. To conduct this analysis, we divided authors into five groups based on the number of publications they have contributed: a_1 (authors published one article) and a_2 (authors published two articles), considering that the maximum amount of publications by a single author is two. Second, the Chi-square test for changeable $x/1^2$, and $x/2^2$ for groups a_1 and a_2 were calculated and tested.

Bradford's Law suggests that when conducting a comprehensive literature search on multiple subjects within a specific timeframe, the literature is generally distributed in a normal pattern across several sources. After arranging these sources in descending order of productivity, with the most productive journals listed first and the least productive listed last, the sources can be segmented into primary periodicals that center on the subject matter, along with multiple groups or zones consisting of an equivalent number of articles as the core. The number of periodicals in the core and subsequent zones are signed as such $1:j:j^2$: ... for some constant j (Chen and Leimkuhler, 1986) [6].

To verify the accuracy of Bradford's Law, the journals were classified into three distinct categories. The first category encompassed a comparatively small number of core journals that published approximately one-third of all articles. The second category comprised a greater number of journals that published the same number of articles as the first group. Finally, the third category consisted of an even larger number of journals but still published an equal number of articles as the other two categories.

3 Research Results

Frequency of Tallinn Manual research in journals

Figure 1 illustrates the citation count and total number of Tallinn Manual articles published in academic journals from 1998 until the conclusion of November 2022. The yearly count of published articles rose, and a linear regression equation was obtained as Y = 0.3571X + 1.6429, indicating a positive upward trend. However, the overall citation counts decreased each year, and a linear regression equation was obtained as Y = -0.619X + 22.536. It is important to note that both slope values were determined based on a linear function assumption.

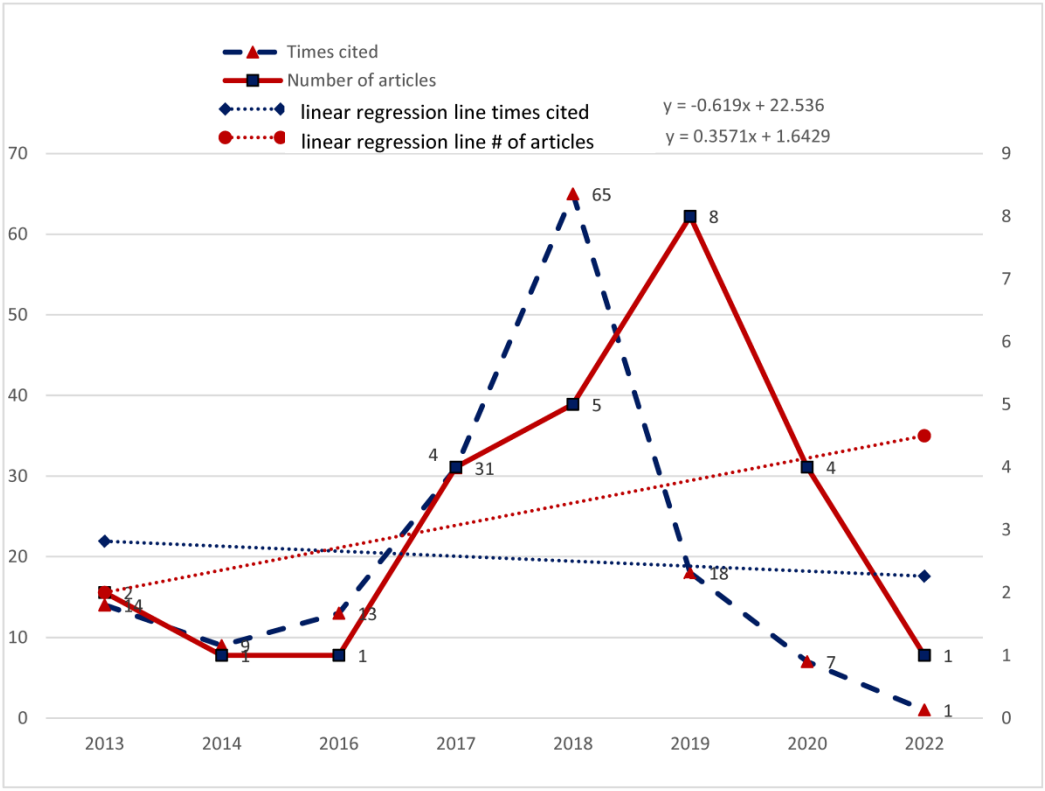

Fig. 1. Number of articles and times cited publications (1998-Nov.2022)

Between 1998 and November 2022, a total of 20 journals were identified as relevant to Tallinn Manual research, publishing articles on the subject matter. Table 2 presents the number of articles and their respective citation counts credited to each journal. The top five journals based on the number of articles published are AJIL UNBOUND (3 articles or 11.5%), TEXAS LAW REVIEW (2 articles or 7.7%), LEIDEN JOURNAL OF INTERNATIONAL LAW (2 articles or 7.7%), INTERNATIONAL REVIEW OF THE RED CROSS (2 articles or 7.7%), and INTERNATIONAL JOURNAL OF CYBER WARFARE AND TERRORISM (2 articles or 7.7%). Figure 2 displays the number of articles published by each journal in descending order, illustrated as a solid line.

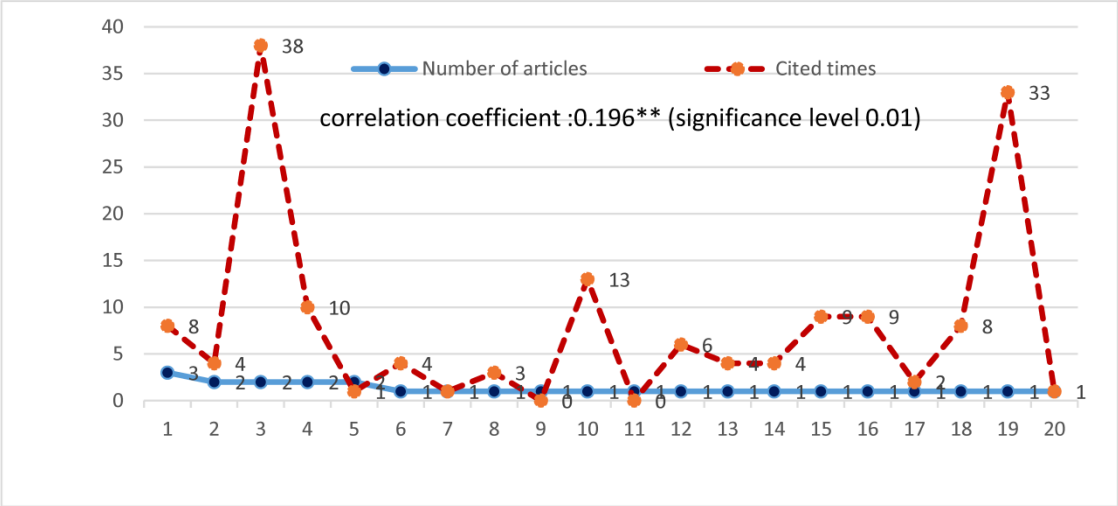

Fig. 2. Number of articles and times cited by journals (1998-Nov.2022)

Table 2. Most frequent venues of journals for Tallinn Manual publications among 522 journals (1998-Nov. 2022)

	Journal title	# of articles (% of total)	Credit of cited times (% of total)
1.	AJIL UNBOUND	3 (11.5%)	8 (5.1%)
2.	TEXAS LAW REVIEW	2 (7.7%)	4 (2.5%)
3.	LEIDEN JOURNAL OF INTERNATIONAL LAW	2 (7.7%)	38 (24.1%)
4.	INTERNATIONAL REVIEW OF THE RED CROSS	2 (7.7%)	10 (6.3%)
5.	INTERNATIONAL JOURNAL OF CYBER WARFARE AND TERRORISM	2 (7.7%)	1 (0.6%)
6.	WASHINGTON INTERNATIONAL LAW JOURNAL	1 (3.8%)	4 (2.5%)
7.	UNIVERSITY OF PENNSYLVANIA JOURNAL OF INTERNATIONAL LAW	1 (3.8%)	1 (0.6%)
8.	NETHERLANDS YEARBOOK OF INTERNATIONAL LAW 2016: THE CHANGING NATURE OF TERRITORIALITY IN INTERNATIONAL LAW	1 (3.8%)	3 (1.9%)
9.	MELBOURNE JOURNAL OF INTERNATIONAL LAW	1 (3.8%)	0 (0.0%)
10.	KSII TRANSACTIONS ON INTERNET AND INFORMATION SYSTEMS	1 (3.8%)	13 (8.2%)
11.	KOREAN JOURNAL OF DEFENSE ANALYSIS	1 (3.8%)	0 (0.0%)
12.	JOURNAL OF THE ASSOCIATION FOR INFORMATION SYSTEMS	1 (3.8%)	6 (3.8%)
13.	JOURNAL OF INTERNATIONAL HUMANITARIAN LEGAL STUDIES	1 (3.8%)	4 (2.5%)
14.	INTERNET POLICY REVIEW	1 (3.8%)	4 (2.5%)
15.	INTERNATIONAL POLITICS	1 (3.8%)	9 (5.7%)
16.	INTERNATIONAL & COMPARATIVE LAW QUARTERLY	1 (3.8%)	9 (5.7%)
17.	ETHICS & INTERNATIONAL AFFAIRS	1 (3.8%)	2 (1.3%)
18.	COMPUTERS & SECURITY	1 (3.8%)	8 (5.1%)
19.	AMERICAN JOURNAL OF INTERNATIONAL LAW	1 (3.8%)	33 (20.9%)
20.	AIR & SPACE LAW	1 (3.8%)	1 (0.6%)

Table 2 also includes the credited citation number for each journal, listed in the right-hand column. The top four journals, which published the most articles, contributed 60 citation counts (38%) out of the total 158 citation numbers in the 26-article pool. The remaining 16 journals contributed 98 credited citation counts (62%). Interestingly, some journals, such as the AMERICAN JOURNAL OF INTERNATIONAL LAW and KSII TRANSACTIONS ON INTERNET AND INFORMATION SYSTEMS, published a minor percentage of articles nevertheless provided a greater percentage of credited citation count. Figure 2 shows the credited citation count by journal (marked by a dotted line). The correlation coefficient between credited citation count of journals and the number of articles was 0.196 and was tested to be significant. Notably, some journals with fewer published articles contributed a substantial credited citation count, such as the AMERICAN JOURNAL OF INTERNATIONAL LAW [Number of articles: 1 (3.8% of article pool), Credited citation count: 33 (20.9% of article pool)] and KSII TRANSACTIONS ON INTERNET

AND INFORMATION SYSTEMS [Number of articles: 1 (3.8% of article pool), Credited citation count: 13 (8.2% of article pool)].

Frequency of Tallinn Manual research by country and institution

Table 3 and Figure 3 illustrate the 14 leading countries that have published Tallinn Manual-related articles, including the USA, Australia, England, Netherlands, South Korea, Belgium, Germany, and others. Furthermore, the upper section of Table 4 shows that three institutions, namely Vrije Universiteit Amsterdam, Korea University, and University of Exeter, have contributed 7 articles, accounting for 26.9% of the 26 Tallinn Manual-related articles published.

Table 3. Most frequent venues of top countries for Tallinn Manual publications among 20 journals (*1998-Nov. 2022*)

	Top 14 Countries	# of articles	% of total
1.	USA	7	26.9
2.	AUSTRALIA	4	15.4
3.	ENGLAND	4	15.4
4.	NETHERLANDS	4	15.4
5.	SOUTH KOREA	4	15.4
6.	BELGIUM	2	7.7
7.	GERMANY	2	7.7
8.	CANADA	1	3.8
9.	FRANCE	1	3.8
10.	GREECE	1	3.8
11.	ISRAEL	1	3.8
12.	ITALY	1	3.8
13.	PEOPLES R CHINA	1	3.8
14.	SWEDEN	1	3.8

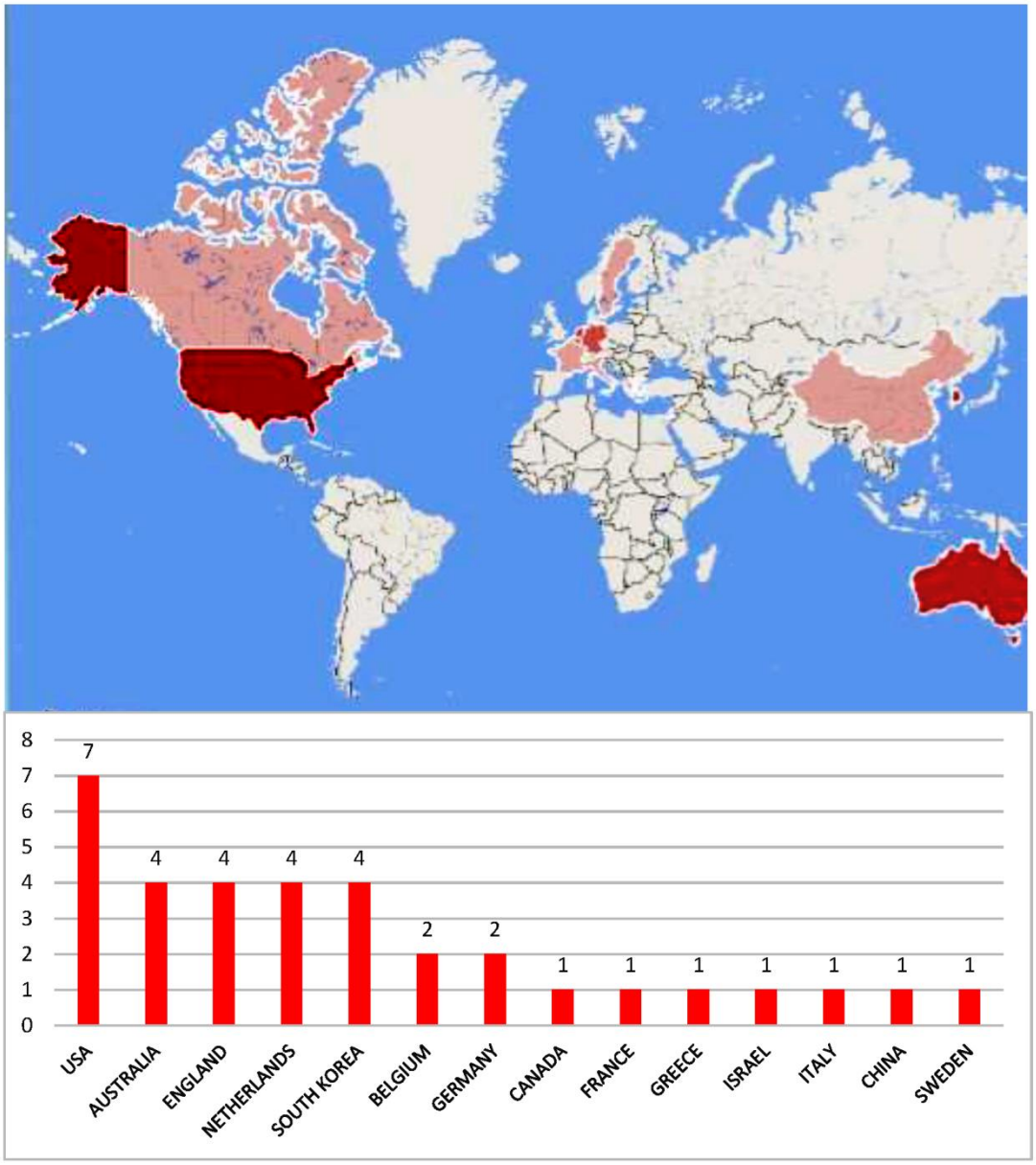

Fig. 3. *Number of articles published by countries (1998-Nov.2022)*

Table 4. Most Active Institutional Contributors and Researchers (1998-Nov. 2022)

	Institutional Contributors	**Number of articles**	**% of 26 articles**
1.	VRIJE UNIVERSITEIT AMSTERDAM	3	11.5
2.	KOREA UNIVERSITY	2	7.7
3.	UNIVERSITY OF EXETER	2	7.7
	41 Institutions	1	3.8
	Researcher	**Number of articles**	**% of 26 articles**
1.	Boer LJM	2	7.7
2.	Chircop L	2	7.7
	37 authors	1	3.8

Total Authors: 39

Main individual contributors and most frequently published credited authors of Tallinn Manual

The lower part of Table 4 shows that among the authors of the 26 Tallinn Manual-related articles, two scholars have published two publications, and 37 other authors have published one publication from 1998 to November 2022. Boer LJM and Chircop L are the two authors who have published the most Tallinn Manual-related articles, contributing 8.9% of the 14 citation counts. Fig. 4 shows the number of articles and credited citation counts of authors. The correlation coefficient between the credited citation counts of authors and the number of articles was just about 0.133, suggesting that a larger amount of Tallinn Manual articles published by an author resulted in a slightly greater citation count (about 13%). Table 5 shows the first three authors have the greatest credited citation counts (greater than ten), along with the number of published articles for each author in parentheses. Most of the authors who have published one article, except for Boers. Additionally, Table 5 lists the authors who have published one article however have contributed a noteworthy credited citation amount, such as Macak, Kubo, Efrony, Dan, and Shany, Yuval. These numbers describe certain peaks that are inconstant with the trend of the number of published authors.

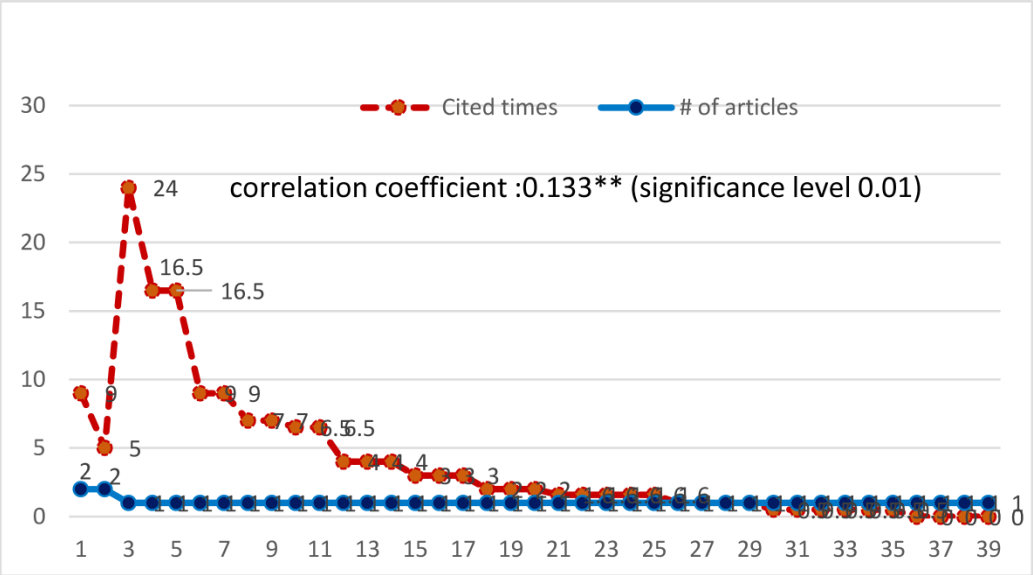

Fig. 4. Number of articles and times cited by authors (1998-Nov.2022)

Table 5. Most Active Researchers' Credit of cited times (1998-Nov. 2022)

	Researcher	Credit of cited times (# of articles)	% of 158 cited times (26 articles)
1.	Macak, Kubo	24 (1)	15.2%
2.	Efrony, Dan	16.5 (1)	10.4%
3.	Shany, Yuval	16.5 (1)	10.4%
4.	Chircop, Luke	9 (2)	5.7%
5.	Schmitt, Michael N.	9 (1)	5.7%
6.	Stevens, Tim	9 (1)	5.7%
7.	Kessler, Oliver	7 (1)	4.4%
8.	Werner, Wouter	7 (1)	4.4%
9.	Lee, Kyung-bok	6.5 (1)	4.1%

10. Lim, Jong-in	6.5 (1)	4.1%
11. Boer, Lianne J. M.	5 (2)	3.2%
28 authors	< 5	26.6%
Total Authors: 39		

Most frequently cited Tallinn Manual articles

The ISI WOS database was used to rank the 26 Tallinn Manual research articles according to their total citation count. Table 6 presents the most highly cited articles published between 1998 and November 2022, which includes the names of the authors, article titles, journal names and citation count. Among these articles, Efrony and Shany's (2018) study on the acceptance of the Tallinn Rules, which examines eleven case studies involving cyber operations, received the highest number of citations (33) and is ranked first. The study suggests that there is uncertainty surrounding the willingness of states to take on the Tallinn Rules and that not all states share the same level of advantage in supporting legal certainty in cyberspace. However, it also indicates that the increasing need for coordinated responses to cyberattacks could lead countries to consider the Tallinn Rules more promising.

Ranked second in Table 6 with 24 citations, the article "From Cyber Norms to Cyber Rules: Re-engaging States as Law-makers" by Kubo (2017) addresses the crisis at the core of international cyber security law. The article points out several indicators: (1) the restricted success of proposals for binding international treaties, which have been met with slight interest from states such as China and Russia; (2) states' reluctance to bind themselves to particular interpretations of controversial legal questions and state their cyber opinion juris; and (3) the tendency of state representatives to look for retreat in the vaguer term 'norms' rather than interpret or develop rules.

Table 6. The top-nine most frequently-cited Tallinn Manual articles (1998-Nov. 2022)

Rank	Authors	Times Cited	Article title	Journal
1	Efrony, Dan; Shany, Yuval	33	A RULE BOOK ON THE SHELF? TALLINN MANUAL 2.0 ON CYBEROPERATIONS AND SUBSEQUENT STATE PRACTICE	AMERICAN JOURNAL OF INTERNATIONAL LAW
2	Macak, Kubo	24	From Cyber Norms to Cyber Rules: Re-engaging States as Law-makers	LEIDEN JOURNAL OF INTERNATIONAL LAW
3	Kessler, Oliver; Werner, Wouter	14	Expertise, Uncertainty, and International Law: A Study of the Tallinn Manual on Cyberwarfare	LEIDEN JOURNAL OF INTERNATIONAL LAW
4	Lee, Kyung-bok; Lim, Jong-in	13	The Reality and Response of Cyber Threats to Critical Infrastructure: A Case Study of the Cyber-terror Attack on the Korea Hydro & Nuclear Power Co., Ltd.	KSII TRANSACTIONS ON INTERNET AND INFORMATION SYSTEMS
5	Chircop, Luke	9	A DUE DILIGENCE STANDARD OF ATTRIBUTION IN CYBERSPACE	INTERNATIONAL & COMPARATIVE LAW QUARTERLY
6	Stevens, Tim	9	Cyberweapons: power and the governance of the invisible	INTERNATIONAL POLITICS

7	Schmitt, Michael N.	9	Rewired warfare: rethinking the law of cyber attack	INTERNATIONAL REVIEW OF THE RED CROSS
8.	Pipyros, Kosmas; Thraskias, Christos; Mitrou, Lilian; Gritzalis, Dimitris; Apostolopoulos, Theodoros	8	A new strategy for improving cyber-attacks evaluation in the context of Tallinn Manual	COMPUTERS & SECURITY
9	Shin, Young Yung; Lee, Jae Kyu; Kim, Myungchul	6	Preventing State-Led Cyberattacks Using the Bright Internet and Internet Peace Principles	JOURNAL OF THE ASSOCIATION FOR INFORMATION SYSTEMS

The article argues that due to states' unwillingness to participate in international law-making, there is a power vacuum that undermines international law's ability to address contemporary challenges caused by rapid technological advancements. As a result, non-state-driven norm-making initiatives like Microsoft's cyber norms proposals and the Tallinn Manual project have emerged to fill the void. These initiatives have developed a body of non-binding norms, providing states with a crucial opportunity to regain their central law-making position, as seen in past legal regimes for Antarctica and nuclear safety. It remains uncertain whether this crisis will result in the decline of inter-state cyberspace governance or a recalibration of legal approaches. The article emphasizes that for states to achieve their strategic and political goals, they must assume a central role to prevent the power vacuum from undermining their efforts.

"How can international law discourse the challenges posed by emerging forms of irregular warfare? This question has been the subject of some reports published by international groups of experts in the field of conflict and security law over the past decade. Ranked third with 14 citations, the article "Expertise, Uncertainty, and International Law: A Study of the Tallinn Manual on Cyberwarfare" (Kessler & Werner, 2013) explores the Tallinn Manual and how experts have dealt with the complexity of defining the precise scope of the law and constructing legal interpretations, definitions, and institutional norms to apply to an ever-changing world. The authors argue that while experts may be able to manage uncertainty to some extent, the very process of doing so can also create new uncertainties. Ultimately, the value of experts lies not only in their knowledge, but also in their ability to navigate and control uncertainty and non-knowledge."

Chi-square tests of Bradford's Law for the number of Tallinn Manual research articles in journals

In Figure 2, the solid line plot displays the correlation between the amount of Tallinn Manual articles and the orders of journals. As expected, a few major journals have published a larger number of articles related to the Tallinn Manual. To evaluate the compliance of the Tallinn Manual literature with Bradford's Law, Table 7 shows the result of the Chi-square test. The literature is classified into three groups: 1st, 2nd, and 3rd. The 1st group comprises 4 journals that have published 9 articles, the 2nd group includes 8 journals that have published 9 articles, and the 3rd group has 8 journals that have published 8 articles. The Chi-square values indicate that Bradford's original suggestion of $1:j:j^2$ is not well-suited for the Tallinn Manual literature. However, after conducting the Chi-square test, it is observed that the prediction of $1:j:j^1$ is moderately close.

Table 7. Chi-squared test of Bradford's Law

Group	No. of Articles	No. of Journals
1st	9	4
2nd	9	8
3rd	8	8
Chi-squared value for 1:j:j^2: 4		
Chi-squared value for 1:j:j^1: 0		

Chi-square tests of Lotka's Law for authors' publications

Figure 4 shows the solid line plot of the number of Tallinn Manual articles versus the number of authors. The plot indicates a sharp decrease, which is expected. To test for Lotka's Law, we conducted a Chi-square test, and the results are presented in Table 8. This study considered three samples, namely with $100/b^2$ (%), with $100/b^4$ (%), and the grouped case (in percentage). The Chi-square values show that Lotka's original suggestion of c/b^2 is not applicable, but the c/b^4 prediction is quite close.

Table 8 Chi-squared test of Lotka's Law

Contribute n papers	No. of Authors
1	37
2	2
Chi-squared value for $37/n^2$: 5.68	
Chi-squared value for $37/n^4$: 0.04	

Research categories of Tallinn-Manual articles

The articles were evaluated for their relevance to the Tallinn Manual by reviewing their titles, abstracts, and content. After screened, the articles were classified into five categories: theory, method, empirical, review and operational, using the classification system proposed by Cote, Leong, and Cote in 1991 [7]. Theoretical articles presented theories, models, constructs, and/or described their applications in future research. Method articles investigated the development and/or refinement of research methods for data collection, analysis, and interpretation. Empirical articles included the review of literature and the progress and testing of explanatory data analyses or hypotheses. Review articles combined preceding works (e.g., book reviews) and discoursed issues in particular topic areas. Finally, operational articles investigated the means of defining constructs throughout mathematical specifications or the development of such measures.

Each article was assigned to one of the five categories based on its title, abstract, and content and the same article could not be classified into multiple categories. Table 9 displays the distribution of Tallinn Manual articles across the five categories. As a large portion of the articles were identified as operational and review studies, it is reasonable to assume that this reflects the relatively new and rapidly evolving field of information security.

Table 9. Types and numbers of articles related to Tallinn Manual articles (1998-Nov. 2022)

Empirical	**Method**	**Operational**	**Review**	**Theory**	**Total**
5	5	8	7	1	26

4 Discussion, Conclusions and Limitation

This research aims to evaluate the impact of personal and institutional contributors to Tallinn Manual research from 1998 to November 2022. A total of 26 articles were deemed suitable for analysis based on their scope, credibility, and importance. Additionally, the influence of personal articles and authors on the Tallinn Manual literature was evaluated using SCI/SSCI citation analysis. The study's findings are discussed, and concluding remarks are provided regarding Tallinn Manual research.

First, during the 16.5-year study period, Tallinn Manual research has fascinated a considerable number of researchers. Our findings indicate that the majority of contributions to this field have been made by scholars from Europe (including England, the Netherlands, Belgium, Germany, France, Greece, Italy, and Sweden), North America (including the USA and Canada), and Asia (including South Korea and the People's Republic of China). It can be concluded that researchers are more inclined to conduct research on Tallinn Manual in areas where cyber security was initially developed and presented.

Second, several prominent journals have published a substantial number of Tallinn Manual research articles. These journals, including Ajil Unbound, Texas Law Review, Leiden Journal of International Law, International Review of The Red Cross, And International Journal of Cyber Warfare and Terrorism, have each published more than two articles related to the Tallinn Manual and continue to contribute to the literature. Collectively, these five journals have contributed over 42.3% of the total number of articles among the 20 journals included in this study. It is important to recognize that some well-known journals may not have been incorporated into the study due to the restrictions of the algorithm and the selected keywords. This is not to undermine the value of these journals, but to acknowledge the notable contributions of the journals that were examined in this study.

Third, from 1998 to November 2022, a few key contributors have made substantial contributions to the field, exerting a notable influence on those who identify themselves as "Tallinn Manual" researchers. However, it is essential to have more participation from new scholars to further advance the field. These findings can guide future research on the continued development of Tallinn Manual.

Fourth, the study shows a slight increase in the number of articles related to Tallinn Manual between 1998 and November 2022. The trend is upward, indicating that the influence of Tallinn Manual is gradually increasing. These results can serve as a motivation for authors to pursue further research on Tallinn Manual in the future.

This study has certain limitations that require to be considered while illuminating the findings. Firstly, it only includes articles from SCI/SSCI-indexed journals and may have missed contributions from non-indexed journals. However, this study does not intend to examine the contributions of scholars published in those journals. Secondly, only articles published from 1998 to November 2022 and cited in the ISI WOS database were included. Therefore, earlier research may not have been captured. Moreover, the SSCI citation count only includes citations from other SSCI-indexed journals, which may undervalue the total amount of citations an article receives. Finally, the method used to rank the most cited articles or calculate the credit of cited times for authors possibly will have limitations. For instance, collaborative work may be less likely to be highly ranked than personal work, and authors who with more total citations may not appear on the list. These limitations should be considered while interpreting the results of this study.

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