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A NETWORK ANALYSIS OF THE SINGAPORE COURT OF APPEAL'S CITATIONS TO PRECEDENT

This article presents findings from an empirical network analysis of citation practices in Singapore's highest court. A network of all 987 reported Court of Appeal judgments handed down from 2000 to 2017 is constructed. Network centrality algorithms are used to rank judgments by centrality. Judgments on contract law, particularly on contractual interpretation and terms, emerge as the most central. Based on this, this article argues that more attention can be paid to interpretation *per se* as a legal skill. More generally, this article establishes a framework for applying network analysis to Singapore jurisprudence on a larger scale.

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I. Introduction

1 This article examines trends in the Singapore Court of Appeal's precedent citation behaviour using network analysis, an empirical technique hitherto not applied to Singapore jurisprudence. The main objective is to introduce network analysis and establish both a theoretical framework and an empirical methodology for applying it to Singapore jurisprudence at a larger scale than presently undertaken. More substantively, this article presents findings revealed by applying network analysis to a preliminary dataset of reported Singapore Court of Appeal judgments decided 2000–2017. There are two motivations for this.

2 First, network analysis can provide a deeper empirical look at the Singapore legal system than present methods allow. As Posner notes:[1]

> Scarcity of quantitative scholarship has been a serious shortcoming of legal research, including economic analysis of law. When hypothesis cannot be tested by means of experiments, whether contrived or

* The author is grateful to the guidance and constructive comments provided by Assoc Prof Goh Yihan and Asst Prof Lau Kwan Ho.

1 Richard A Posner, "An Economic Analysis of the Use of Citations in the Law" (2000) 2 Am L & Econ Rev 381.

> natural, and the results assessed rigorously by reference to the conventions of statistical inference, speculation is rampant and knowledge meagre.

As will be explained, network analysis is an emerging technique that precisely allows for hypotheses about the nature and use of legal precedent to be rigorously and scientifically tested. Insights relevant to how the law is practiced and/or taught may also surface.[2] For this reason, network analysis is receiving close attention from legal scholars around the world.[3]

3 Second, a network analysis of citation practices in the Singapore courts is timely. The Singapore legal system has certainly come of age more than 50 years after the nation's independence and almost 200 years after the Second Charter of Justice.[4] It is becoming less of a justification (if a justification it ever was) that not enough data on the Singapore legal system exists for meaningful analysis. More importantly, recent work on the Singapore legal system has established strong methodological foundations for empirically studying citation practices in our courts. A seminal work is Goh and Tan's comprehensive study on the development of the Singapore legal system,[5] which itself was a culmination of previous empirical work.[6] These studies have shed scientific light on how Singapore court judgments have over the years become longer, cited more local authorities[7] and increasingly referred to

2 Reference can also be made to Goh Yihan & Paul Tan, "An Empirical Study on the Development of Singapore Law" (2011) 23 SAcLJ 176 at 180–181, para 7, where the learned authors note that "for practitioners, understanding how the courts are shaping the law, how receptive they are to foreign decisions, or how readily they would accept the views of academic literature, is invaluable when crafting submissions to court". Though this article does not deal with foreign decisions or academic literature, it is submitted that an understanding of how our courts use *local* precedents would benefit practitioners as well.

3 Wolfgang Alschner, Joost Pauwelyn & Sergio Puig, "The Data-driven Future of International Economic Law" (2017) 20 J Int'l Econ L 217. See para 18 below for details.

4 Goh Yihan & Paul Tan, "An Empirical Study on the Development of Singapore Law" (2011) 23 SAcLJ 176 at 182.

5 Goh Yihan & Paul Tan, *Singapore Law: 50 Years in the Making* (Academy Publishing, 2015).

6 See Lau Kok Heng *et al*, "Legal Crossroads – Towards a Singaporean Jurisprudence" (1987) Sing L Rev 1; Goh Yihan & Paul Tan, "An Empirical Study on the Development of Singapore Law" (2011) 23 SAcLJ 176; Lee Zhe Xu *et al*, "The Use of Academic Scholarship in Singapore Supreme Court Judgments" (2015) 33 Sing L Rev 25; and Cheah Wui Ling & Goh Yihan, "An Empirical Study on the Singapore Court of Appeal's Citation of Academic Works: Reflections on the Relationship between Singapore's Judiciary and Academia" (2017) 29 SAcLJ 75.

7 See Cheah Wui Ling & Goh Yihan, "An Empirical Study on the Singapore Court of Appeal's Citation of Academic Works: Reflections on the Relationship between Singapore's Judiciary and Academia" (2017) 29 SAcLJ 75 at 99–102, paras 51–57.

academic works across all areas of law.[8] As Singapore's legal system continues to develop, and in light of its ambition to grow into the region's *lex mercatoria*,[9] it is opportune to build on these solid foundations.

4 Furthering this article's objectives, the complete network of all 987 reported Court of Appeal judgments handed down between the years from 2000 to 2017 will be constructed. The methodology and techniques used will also be described in some detail in order to establish a paradigm which subsequent studies can follow. Four broad questions are proposed to focus the enquiry. First, which judgments are empirically the most central within Singapore's appellate jurisprudence? Second, how has this changed over time, if it has? Third, what implications exist, if any, for the legal sector? Finally, what else can network analysis reveal on the use of authority by the Court of Appeal? These questions are crafted to demonstrate the usefulness of network analysis in uncovering academically and practically interesting insights about the Singapore legal system.

5 The rest of this article proceeds as follows. Part II[10] establishes the theoretical foundations for empirically studying legal citations, particularly using network analysis. Part III[11] outlines the data used for this article and how it was extracted. Part IV[12] presents the results, and Part V[13] concludes.

II. Theoretical foundations for citations analysis

A. Theoretical foundations for studying legal citations empirically

6 The empirical analysis of legal citations is well established in legal scholarship. As early as in 1954, Merryman had already conducted an empirical study on the number and nature of judicial citations to precedent and other secondary material by each of the seven (then)

8 See generally Cheah Wui Ling & Goh Yihan, "An Empirical Study on the Singapore Court of Appeal's Citation of Academic Works: Reflections on the Relationship between Singapore's Judiciary and Academia" (2017) 29 SAcLJ 75.

9 See generally *Report of the Committee to Develop the Singapore Legal Sector: Final Report* (September 2007) https://www.mlaw.gov.sg/content/dam/minlaw/corp/assets/documents/linkclicke1d7.pdf (accessed 10 September 2018).

10 See paras 6–28 below.

11 See paras 29–36 below.

12 See paras 37–77 below.

13 See paras 78–82 below.

sitting judges on the California Supreme Court.[14] He then conducted a follow-up study in 1974 on an expanded set of cases and found, *inter alia*, that concurring and dissenting judgments tended to have substantially fewer citations, including "some without any citation to authority at all".[15] In 1976, Landes and Posner developed an economic capital model to estimate how the precedential value of a judgment, as proxied for by the number of times it is cited by subsequent courts, depreciated over time in differing legal subject areas.[16] Subsequently, in 1993, Landes and Posner used citations analysis to study the influence of economics on law and found evidence that the economic approach had grown, particularly throughout the 1980s, at a rate exceeding that of any other interdisciplinary approach to law.[17]

7 The theoretical foundation underlying these empirical studies is worth examining. To Merryman, citations analysis went beyond simply revealing "patterns of citation which may be helpful but are not startling".[18] Interpreting a compiled list of secondary material cited by the court and their respective citation frequencies by each judge, Merryman opined that:[19]

> … [s]ome of the works listed, such as *Wigmore on Evidence*, *Williston on Contracts*, *Scott on Trusts and Paul on Estate and Gift Taxation*, are works of high quality prepared by men of established reputation and ability. Many of the others, however, are obvious hack jobs turned out by people nobody has ever heard of except as a name on the back of a book.

8 To Merryman, the data therefore illustrated the "unreflective and uncritical nature of the choices judges [in the California Supreme Court] make among the available works" when citing secondary material. This was a bold *qualitative* claim about judicial decision-making processes built upon *quantitative* observation of the effects of such processes. Although citations to precedent are no doubt "a conspicuous feature of most judicial opinions",[20] such a link between quantitative effect and qualitative cause is seldom self-evident, especially

14 John H Merryman, "The Authority of Authority" (1954) 6 Stan L Rev 613.

15 John H Merryman, "Towards a Theory of Citations: An Empirical Study of the Citation Practice of the California Supreme Court in 1950, 1960, and 1970" (1978) 50 S Cal L Rev 381 at 428.

16 William M Landes & Richard A Posner, "Legal Precedent: A Theoretical and Empirical Analysis" (1976) 19 J L & Econ 249.

17 See generally William M Landes & Richard A Posner, "The Influence of Economics on Law: A Quantitative Study" (1993) 36 J L & Econ 385.

18 John H Merryman, "The Authority of Authority" (1954) 6 Stan L Rev 613 at 672.

19 John H Merryman, "The Authority of Authority" (1954) 6 Stan L Rev 613 at 670–672.

20 Richard A Posner, "An Economic Analysis of the Use of Citations in the Law" (2000) 2 Am L & Econ Rev 381 at 383.

in a system as complex as the law. It is thus apposite to question the premise on which citations analysis relies when making claims about the legal system. This premise is that measurable empirical patterns in legal citations reflect intangible qualitative attributes of the legal system itself. Two conditions are implied.

9 First, there must be measurable empirical patterns in legal citations to begin with. This requires that citations in judgments are not wholly random, for then there is arguably not even "a practice of citation" to study.[21] This should not be controversial. Legal citations within common law systems serve a number of important legal purposes. The cited precedent may (a) be binding or persuasive for similarity of fact and/or law; (b) contain one of many competing rules under the judge's consideration; (c) be cited to lend authority to a position the judge wishes to adopt; (d) be cited as a pat on the back to the author; or (e) be cited so it may be questioned, doubted, distinguished or, in rare cases, overruled.[22] A citation is therefore more likely to be the product of certain non-random, legally grounded, generative processes rather than that of judicial dice-rolling. It is unlikely that no empirical patterns can be found. In any event, this need not be established *a priori*; it will be clear whether empirical patterns exist once the data in Part IV has been analysed.

10 Second, even if empirical patterns exist, they must correlate sufficiently to underlying attributes of the legal system in a way that makes extracting qualitative legal insight defensible. Sceptics taking a realist view may argue that citations are motivated primarily by the personal inclinations of the authoring judges. Therefore, the argument goes, empirical patterns in citations behaviour are more informative of judges' personality than any systemic characteristics of the legal system. But this is unlikely because:[23]

> … the extensive research and writing that lawyers, judges, and law clerks devote to discovering, marshalling, enumerating, and explaining precedents are not costless undertakings, and would not be undertaken if precedent did not enter systematically into the decision of cases.

21 Richard A Posner, "An Economic Analysis of the Use of Citations in the Law" (2000) 2 Am L & Econ Rev 381 at 383.

22 See John H Merryman, "The Authority of Authority" (1954) 6 Stan L Rev 613 at 614 and Richard A Posner, "An Economic Analysis of the Use of Citations in the Law" (2000) 2 Am L & Econ Rev 381 at 383–387. The latter also identified other extra-legal reasons for legal citations.

23 William M Landes & Richard A Posner, "Legal Precedent: A Theoretical and Empirical Analysis" (1976) 19 J L & Econ 249 at 252; William M Landes & Richard A Posner, "The Influence of Economics on Law: A Quantitative Study" (1993) 36 J L & Econ 385 at 390.

Put another way, there is usually a good *legal* reason why a precedent is cited.

11 Another common objection to correlating citation statistics with legal insight is that merely counting citations ignores the context in which they were cited. Surely a lukewarm or negative citation should not go towards a precedent's citation count? The answer to this is twofold. First, as will be explained below, citations analysis has evolved beyond merely counting citations. Second, the objection, while true to some extent, does not invalidate citations analysis entirely. It depends on what point is being made. If the aim is only to establish which cases have been the most influential (as opposed to being correct in law or the most "authoritative"), then analysis of citation context ceases to be absolutely necessary. As Landes and Posner note: [24]

> A common criticism of citation analysis when it is used as an evaluative tool is inapplicable, or largely so, when it is used to study influence: that a critical citation should not be weighted as heavily as a favorable one and maybe should not be counted at all or even given a negative weight. When speaking of influence rather than quality, one has no call to denigrate critical citations. Scholars rarely bother to criticize work that they do not think is or is likely to become influential. They ignore it. Many favorable citations, moreover, are tokens of friendship or obeisance to colleagues, influential seniors, acolytes, and journal editors; so, if critical citations should be discounted, favorable ones should be also, and it is easier to give all the same weight.

12 In other words, while citation context is no doubt legally significant, the *mere fact of citation* can nevertheless be telling. At minimum, a citation means the source was sufficiently relevant or otherwise of interest to be raised, however summarily. Thus, Fowler and Jeon describe citations as a "latent judgment by the justice who authors [the opinion] about which cases are more important for resolving questions that face the Court".[25] This applies, for example, where the court acknowledges without discussion precedents cited by counsel in the course of argument. The court could just as easily have omitted the citation altogether. The more one believes legal writing to be deliberate, the more this applies.

24 William M Landes & Richard A Posner, "Legal Precedent: A Theoretical and Empirical Analysis" (1976) 19 J L & Econ 249.

25 James H Fowler & Sangick Jeon, "The Authority of Supreme Court Precedent" (2008) 30 Soc Networks 16 at 18.

13 It is thus submitted that the empirical study of legal citations "enables rigorous quantitative analysis of elusive but important social phenomena" in the law.[26] This forms an important theoretical backdrop to applying citations *network* analysis – a specific type of citations analysis that has gained significant popularity amongst legal scholars in recent years.

B. Theoretical foundations for studying legal citations with network analysis

14 When Posner predicted the proliferation of citations analysis in the year 2000, he was perhaps unaware of a (then) recent breakthrough in computer science which would presumably have given him even greater cause for optimism.[27] A year earlier, four doctorate students at Stanford University had devised and published a new algorithm meant to facilitate information retrieval on the Internet. They named the algorithm "PageRank", after its ability to rank webpages by importance, and presumably also after its inventors.[28]

15 Powering Google's earliest search engines, PageRank would go on to fundamentally shape the Internet as we know it today. Yet the algorithm was built on the simple insight that the Internet was an interconnected web of pages. Pages were hubs and terminals, and hyperlinks relations between them. The Internet could thus be thought of as a "graph" or, equivalently, a "network". In mathematical theory, graphs are structures comprising entities (known as "vertices" or "nodes") and relationships between these entities (known as "edges").

16 To be sure, the idea that the Internet can be understood as a graph predated PageRank.[29] However, PageRank was a significant improvement over existing node-ranking algorithms, especially when applied to web search.[30] The ubiquity of web search today can hardly be overstated. Accordingly, numerous improvements to PageRank have been devised, published, and presumably commercialised by today's web

26 William M Landes & Richard A Posner, "The Influence of Economics on Law: A Quantitative Study" (1993) 36 J L & Econ 385 at 383.
27 Richard A Posner, "An Economic Analysis of the Use of Citations in the Law" (2000) 2 Am L & Econ Rev 381.
28 Larry Page *et al*, "The PageRank Citation Ranking: Bringing Order to the Web" Technical Report, Stanford Infolab (1998).
29 Larry Page *et al*, "The PageRank Citation Ranking: Bringing Order to the Web" Technical Report, Stanford Infolab (1998).
30 Larry Page *et al*, "The PageRank Citation Ranking: Bringing Order to the Web" Technical Report, Stanford Infolab (1998).

search giants.[31] Collectively, these graph algorithms and other analysis techniques built on mathematical graph theory form the basis of an empirical technique known as "network analysis".

17 Network analysis's relevance to the law rests likewise on the simple insight that the law can also be understood as a network. Judgments are nodes and citations between them edges. This had indeed been proposed as early as in 1970 by Marx, who advocated using citation networks to improve legal research.[32] Marx's work of course predated the advent of more modern network techniques such as PageRank. More recently, Fowler *et al*'s pioneering work constructed the complete network of all 26,681 majority opinions handed down by the US Supreme Court ("USSC") and cases citing those opinions, from 1871 to 2005.[33] Building on Kleinberg's hyperlink-induced topic search ("HITS") algorithm,[34] Fowler *et al* produced what they termed "inward" and "outward relevance" scores for all USSC majority opinions within their dataset. They then showed that these relevance scores were better predictors of whether that opinion would be cited by US courts within the following year compared to a number of logical alternative measures.[35] Fowler also demonstrated in a subsequent study that authority scores could be used to document the *dynamics* of precedential authority, that is, how the centrality of a case changes over time and in response to legally significant events like an overruling.[36]

18 Further, whereas resource constraints on hand-coding data meant early literature operated primarily on sample sizes within the hundreds, the new techniques just described are capable of processing tens of thousands. Technology automates data collection. For instance, Fowler and Jeon developed Python scripts to download and

31 See, *eg*, Weng Jianshu *et al*, "Twitterrank: Finding Topic-sensitive Influential Twitterers", Proceedings of the Third ACM International Conference on Web Search & Data Mining (3–6 February 2010) at p 261 for advancements in general web search theory.

32 Stephen Marx, "Citation Networks in the Law" (1970) 10 Jurimetrics 121.

33 James H Fowler *et al*, "Network Analysis and the Law: Measuring the Legal Importance of Precedents at the US Supreme Court" (2007) 15 Polit Anal 324.

34 John M Kleinberg, "Authoritative Sources in a Hyperlinked Environment" (1999) 46(5) *Journal of the Association for Computing Machinery* 604.

35 Such measures included simple citation counts, eigenvector centrality, whether *amici curiae* were involved and whether the decision appeared on the front page of *The New York Times*, on the *Guide to the US Supreme Court* (Congressional Quarterly Press) or the *Oxford Guide to Supreme Court Decisions* (Oxford University Press). See James H Fowler *et al*, "Network Analysis and the Law: Measuring the Legal Importance of Precedents at the U.S. Supreme Court" (2007) 15 Polit Anal 324 at 337–343.

36 James H Fowler & Sangick Jeon, "The Authority of Supreme Court Precedent" (2008) 30 Soc Networks 16.

"Shepardize"[37] every USSC decision.[38] Moreover, structured case data, including data on case citations, has become increasingly accessible through online databases. An example is the EUR-LEX system for decisions of the Court of Justice of the European Union, which has inspired several empirical studies.[39] This means the cost of citations analysis has fallen sharply.[40] Importantly, larger datasets enable more granular and statistically robust analysis. The confluence of the above two factors means that network analysis is gaining increasing attention as a tool for legal analysis.[41]

19 It is therefore opportune to examine how network analysis can build on existing empirical scholarship in the Singapore legal system.

C. Theoretical foundations for network centrality analysis

20 Legal network analyses typically focus on either network centrality or network structure.[42] The former seeks to uncover the most "important" cases in the network, while the latter looks for clusters or

37 Shepard's Citations Service is a citator software provided by LexisNexis which identifies cases citing a case. See LexisNexis, "Shepard's Citation Service" https://www.lexisnexis.com/en-us/products/lexis-advance/shepards.page (accessed 12 September 2018).

38 James H Fowler *et al*, "Network Analysis and the Law: Measuring the Legal Importance of Precedents at the US Supreme Court" (2007) 15 Polit Anal 324.

39 See, *eg*, Mattias Derlén M & Johan Lindholm, "Characteristics of Precedent: The Case Law of the European Court of Justice in Three Dimensions" (2015) 16 Ger LJ 1073; Mattias Derlén & Johan Lindholm, "Is It Good Law? Network Analysis and the CJEU's Internal Market Jurisprudence" (2017) 20 J Int'l Econ L 257; and Urška Šadl & Henrik Palmer Olsen, "Can Quantitative Methods Complement Doctrinal Legal Studies? Using Citation Network and *Corpus* Linguistic Analysis to Understand International Courts" (2017) 30(2) LJIL 327.

40 Indeed, Posner had identified this trend in 2000. See Richard A Posner, "An Economic Analysis of the Use of Citations in the Law" (2000) 2 Am L & Econ Rev 381.

41 Alschner *et al* provide a comprehensive account of this growing area in Wolfgang Alschner, Joost Pauwelyn & Sergio Puig, "The Data-driven Future of International Economic Law" (2017) 20 J Int'l Econ L 217. See also Ryan Whalen, "Legal Networks: The Promises and Challenges of Legal Network Analysis" (2016) Mich St L Rev 539. A recent work that exploits network analysis to study whether Indian court judgments that do not cite any precedent have omitted relevant precedents is Kawin Ethayarajh, Andrew Green & Albert Yoon, "A Rose by Any Other Name: Understanding Judicial Decisions That Do Not Cite Precedent" (2018) 15 J Empirical Legal Stud 563. Phahlamohlaka and Coetzee also use network analysis and topic models to build a case law ranking system meant to improve legal research processes. See Carington Phahlamohlaka & Marijke Coetzee, "CaseRank: Ranking Case Law Using Precedent and Principal Component Analysis", 2018 Conference on Information Communications Technology and Society – Proceedings (8–9 March 2018) at p 1.

42 Mattias Derlén & Johan Lindholm, "Is It Good Law? Network Analysis and the CJEU's Internal Market Jurisprudence" (2017) 20 J Int'l Econ L 257.

patterns of legal interest within the network. This article focuses on the former.

21 Identifying the most important cases, particularly within specified legal areas, is a matter of both academic and practical interest. Yet this task is not trivial. Factors including, without limitation, the case's factual matrix, subject matter, court level, issues raised, *ratio decidendi* and subsequent treatment must be considered. What makes a case "important" is therefore context-dependent and difficult to define numerically. What is important for exams may differ from what is important for making submissions; a case important for tort law may not be equally important for contract law, if at all. Even within a defined context, there may not be one objective measure of importance in the legal sense.

22 Network analysis avoids this problem by addressing a smaller one. Instead of attempting to define and measure "importance", the analysis constructs "centrality" measures that *proxy* for aspects of importance. The simplest centrality measure is the number of times other cases have cited it. This is known in graph parlance as the number of incoming edges, or the "indegree" of a node. The number of cases a given case cites is accordingly the "outdegree", and the sum of both simply the "degree". The "indegree centrality" of a given judgment is then defined as the fraction of judgments within the network that cite that judgment; that is, in a network with only ten judgments, a judgment cited by five is said to have an indegree centrality of 0.50.[43] The outdegree and degree centrality of a judgment can be calculated *mutatis mutandis* using the outdegrees or degrees of the judgment respectively.

23 It should not be difficult to see how degree centrality captures aspects of case importance. Intuition for this can be developed by considering the measures at their limits. A case cited by every other case (that is, an indegree centrality of one) is probably worth a read; a case cited by no others (that is, indegree centrality of zero) probably less so. Likewise, a case that cites every other case (that is, outdegree centrality of one) is probably more interesting than a case that cites no other (that is, outdegree centrality of zero). That said, degree centrality cannot be conclusive of a judgment's importance, particularly in its intermediate ranges. A case cited three times is not necessarily less

43 This being the result of dividing five by ten. Expressing centrality as a fraction has the advantage of limiting possible centrality values to the real interval between zero and one. Applied to law, this interval is inclusive of zero but exclusive of one, since it is possible for a judgment be cited by no others, but impossible for a judgment to cite itself. This allows for more convenient comparisons across different centrality measures.

important than a case cited four, five, or even ten times. This is especially if most of the latter case's citations originate from less important cases. Further, degree centrality is correlated to a judgment's age, since older judgments would have had a longer window of time during which subsequent judgments could have cited them. Degree centrality would thus unfairly penalise recent judgments.[44]

24 This brings us back to PageRank. Formally, PageRank was conceived to calculate the probability that a person randomly surfing the web will land on each given webpage by following a link from another.[45] PageRank's precise mathematical formulation is beyond this article's scope.[46] The author proposes to explain only the idea behind it by way of an (over)simplification. Consider a conscientious (but somewhat misguided) law student who wants to find out which cases in Singapore law are the most central. Not knowing much about the law, he devises the following strategy. First, the student assumes all cases are equal, each with a centrality value of one. The student then randomly picks a judgment to read. When the student is done, one of three things may happen. First, if he gets bored of the current line of cases, he randomly chooses another to read. Second, if the case does not cite any case at all, he randomly chooses a new case as well. Third and most commonly, he may continue along the same line of cases by randomly choosing one of the cases cited by the current case. If this happens, the student records an increase to the centrality value of the cited case by an amount equal to the centrality value of the current case. That is, if he follows a citation from Case A with a centrality value of two to Case B with a centrality value of one, he then updates Case B's centrality value from one to three.[47]

25 Suppose the student repeats this process 1,000 times. One would expect him to have come across a few oft-cited judgments more than once by following citations from other judgments. Each time, the oft-cited judgment's centrality value is increased. At the end of this process, this centrality value which was initialised at one would now reflect a value proportional not only to the absolute number of times

44 Mattias Derlén M & Johan Lindholm, "Is It Good Law? Network Analysis and the CJEU's Internal Market Jurisprudence" (2017) 20 J Int'l Econ & L 257 at 261.

45 Larry Page *et al*, "The PageRank Citation Ranking: Bringing Order to the Web" Technical Report, Stanford Infolab (1998).

46 The interested reader is directed to the original paper in Larry Page *et al*, "The PageRank Citation Ranking: Bringing Order to the Web" Technical Report, Stanford Infolab (1998).

47 Note that this is an oversimplification. The actual PageRank formula is more refined and uses more parameters to induce desirable mathematical quantities, including making PageRank a legitimate probability distribution. See Larry Page *et al*, "The PageRank Citation Ranking: Bringing Order to the Web" Technical Report, Stanford Infolab (1998) for details.

this judgment has been cited, but *also* to how often those citing judgments themselves have been cited. This strategy thus captures the legal intuition that citations from central cases should be given more weight than citations from peripheral cases. Perhaps the student is not so misguided after all.

26 The concept behind PageRank underpins another centrality measure that has come to be a "standard measurement for measuring precedential power" in legal network analysis.[48] Kleinberg's HITS algorithm produces two distinct scores for each case: a "hub" score and an "authority" score.[49] It should be noted that "authority" here is not meant, and should not be taken, as equivalent to "authority" in the legal sense. Rather, Kleinberg's algorithm was meant to exploit the fact that the Internet as it then was comprised many "directories" which were curated webpages primarily containing categorised links to other pages. A directory was useful not because of its own content but because it pointed to other webpages with useful content. A webpage many good directories linked to was thus more likely to be useful, whereas a directory which links to many useful pages is likely a better directory as well. Thus, a node's hub score is calculated using the authority scores of nodes it links to, while a node's authority score is calculated using the hub scores of nodes linking to it.[50]

27 As explained above, Fowler *et al* have empirically demonstrated the validity of using hub and authority scores in the legal context using data on all USSC majority opinions.[51] Specifically, Fowler *et al* use the percentile rank of each judgment's hub and authority scores in the network as measures of a judgment's "outward" and "inward relevance".[52]

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48 Mattias Derlén & Johan Lindholm, "Is It Good Law? Network Analysis and the CJEU's Internal Market Jurisprudence" (2017) 20 J Int'l Econ & L 257 at 266.

49 John M Kleinberg, "Authoritative Sources in a Hyperlinked Environment" (1999) 46(5) *Journal of the Association for Computing Machinery* 604.

50 Mattias Derlén & Johan Lindholm, "Is It Good Law? Network Analysis and the CJEU's Internal Market Jurisprudence" (2017) 20 J Int'l Econ & L 257 at 266. See also John M Kleinberg, "Authoritative Sources in a Hyperlinked Environment" (1999) 46(5) *Journal of the Association for Computing Machinery* 604 for the precise mathematical formulation, as well as James H Fowler *et al*, "Network Analysis and the Law: Measuring the Legal Importance of Precedents at the US Supreme Court" (2007) 15 Polit Anal 324 at 331 for a linear algebraic illustration of how to calculate the scores.

51 James H Fowler *et al*, "Network Analysis and the Law: Measuring the Legal Importance of Precedents at the US Supreme Court" (2007) 15 Polit Anal 324.

52 The percentile rank is derived by taking the absolute rank of the judgment, with larger numbers denoting higher ranks, divided by the total number of judgments in the network. To illustrate, a hypothetical judgment with the highest authority score in a network of ten judgments will have a rank of 10 and a percentile rank of 1. The percentile rank is equivalent to the relevance score. See James H Fowler

(*cont'd on the next page*)

Outward relevance scores reflected how "well grounded" the judgment was in law (since a hub that cites many strong authorities is good) while inward relevance scores reflected how "influential" a judgment is (since a strong authority is one many good hubs cite).[53]

28 To be sure, neither PageRank nor hub and authority scores are silver bullets for establishing case centrality. The claim is merely that they allow a deeper analysis of the citations data because they "contain information that cannot be gleaned" from simple citation counts.[54] Indeed, more sophisticated measures have since been developed, including for the legal citations context.[55] This article does not explore these measures because the present aim is to introduce network analysis and demonstrate its potential as a tool for exploratory legal analysis. In any event, using the least sophisticated methods means the study establishes a *lower bound* for network analysis's applicability. If the simplest methods yield results, then *a fortiori* should more advanced methods.[56] Having defined the theoretical parameters for citations network analysis, this discussion now turns to the empirical methodology used in this article.

III. Empirical methodology

A. Scope of data collected

29 This article uses data from all reported Court of Appeal judgments for cases decided from 2000 to 2017. This time frame was chosen to balance between keeping the data manageable on one hand and piloting network analysis on Singapore law on the other. Importantly, this time frame yields about six years of jurisprudence under Yong Pung How, Chan Sek Keong and Sundaresh Menon CJJ's benches respectively, facilitating longitudinal comparison.

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et al, "Network Analysis and the Law: Measuring the Legal Importance of Precedents at the US Supreme Court" (2007) 15 Polit Anal 324 at 332.

53 See generally James H Fowler *et al*, "Network Analysis and the Law: Measuring the Legal Importance of Precedents at the US Supreme Court" (2007) 15 Polit Anal 324 at 344.

54 James H Fowler *et al*, "Network Analysis and the Law: Measuring the Legal Importance of Precedents at the US Supreme Court" (2007) 15 Polit Anal 324 at 335.

55 For example, Mattias Derlén & Johan Lindholm, "Is It Good Law? Network Analysis and the CJEU's Internal Market Jurisprudence" (2017) 20 J Int'l Econ & L 257 introduces HubRank, a combination of the hyperlink-induced topic search and PageRank algorithms

56 Though note that more complex methods do not necessarily outperform simpler ones. The author's present claim relies only on the more conservative proposition that more complex methods do not underperform simpler ones.

30 Further, it was expedient to confine this first attempt at network analysis to judgments of the Singapore Court of Appeal for three reasons. First, insights on the use of authority by the Court of Appeal, as the land's highest appellate court, would have the greatest theoretical and practical implications. Second, the Court of Appeal's judgments most likely centre around issues of law and not fact. Identifying the most central appellate judgments would shed more light on which questions and areas of law are central to Singapore's jurisprudence. Third, comparing centrality measures *across* court levels may be problematic because higher court judgments would have a natural advantage. Had the analysis also included State Court judgments, for example, the analysis can be expected to simply and unhelpfully identify all Court of Appeal judgments to be central. If the analysis is instead limited solely to Court of Appeal judgments, then the question asked is more refined and interesting: *Within* all the Court of Appeal's judgments, which ones specifically are most central to Singapore law?

31 The study was also restricted to reported cases. As Goh and Tan note, "the Singapore Law Reports ('SLR') provide the most reliable and consistent reports of local cases".[57] Such consistency was even more important for the present study because the data extraction process was highly automated.[58] Given the above restrictions on the scope of data collected, it should be noted that the inquiry undertaken here is primarily *internal* to the Court of Appeal's citation precedents. Given further that the majority of Court of Appeal judgments would be reported, it should also be defensible to draw insights on Court of Appeal judgments in general.[59] However, claims made do not extend to how Court of Appeal judgments interface *externally* with other courts, local or foreign, nor to citation practices in any other Singapore court.[60]

B. Creating the citations network

32 An advanced LawNet search for SLR judgments decided from 1 January 2000 to 31 December 2017 yielded 987 results which this article assumes to collectively exhaust all reported Court of Appeal judgments within the aforementioned scope. Each judgment was then downloaded in its original hyper-text mark-up language ("HTML")

57 Goh Yihan & Paul Tan, *Singapore Law: 50 Years in the Making* (Academy Publishing, 2015) at para 1.33.

58 See paras 32–36 below for details.

59 At the time of this writing, an analysis of all reported appeals from 1965 onwards is planned.

60 The definition of and distinction between internal and external analysis is adopted from Goh Yihan & Paul Tan, *Singapore Law: 50 Years in the Making* (Academy Publishing, 2015) at paras 1.17–1.29.

format. Next, Python scripts were used to parse the HTML judgments and extract from each judgment the following data points:

(a) case title;

(b) neutral and reporter citations;

(c) catchwords used to describe the judgment;

(d) decision date;

(e) the relevant Bench the case was decided under[61]; and

(f) the full text of the judgment and its corresponding word count.[62]

33 Regular expressions were then used to extract reporter citations of Singapore cases from the judgment text. Regular expressions are a kind of pattern-based word search technique that looks within documents for multiple variations of text efficiently. Extracting reported appeal citations was relatively straightforward because they follow a highly consistent pattern that always begins with an open-square-bracket, contains either the string "SLR" or "SLR(R)" and ends with a number.[63] The regular expressions yielded, for each case, a list of

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61 Bench classification was based on whether a case's decision date fell before or on and after the precise day on which the new Chief Justice was appointed. It is true that this method does not account for transition cases that are substantially heard by a previous Chief Justice's bench yet accorded a decision date under a new Chief Justice's bench. However, since these statistics are meant only for preliminary descriptive analysis, it would have been disproportionately impractical to investigate every case decided near a change of Bench in order to determine when the "substantial decision" was made.

62 Word counts were derived by using the Python natural language tool-kit to split judgment texts into a list of individual words before taking the length of that list. This process may produce different word counts from, say, what Microsoft Word produces because the Python tokeniser may define what constitutes a word differently especially for special cases like hyphenated words or elements in bibliographic citations. The author took a random sample of judgments and checked that the word counts did not deviate significantly. In any event, note that this does not significantly bias results because it affects all judgments equally.

63 Note that this holds only because the dataset is limited to post-2000 cases. Before the Singapore Law Reports ("SLR") were established in 1992, Singapore appeals were also reported in the Malayan Law Journal ("MLJ") and other older reports. This would have introduced a second level of complexity because MLJ citations would also include Malaysian cases. The same applies to Lloyd's Law Reports, which notably still publishes reports of selected Singapore judgments. However, the author's approach would only omit such cases if *only the Lloyds'* citation *and not* the parallel SLR citation has been used in the judgment. This is unlikely since (a) only a small proportion of Singapore cases are reported in Lloyd's to begin with; and (b) the SLR citation should in most cases be preferred by judgment drafters. See also para 74(6) of the Supreme Court Practice Directions (2010 Rev Ed) which identifies the SLR but not Lloyd's Law Reports as an example

(*cont'd on the next page*)

SLR/SLR(R) judgments cited by that case. As these were not guaranteed to themselves be reported *appeals*, all extracted reporter citations not found within the set of reported judgments initially downloaded were removed. A random sample of 50 judgments was manually inspected to confirm that all relevant citations had been extracted.

34 Thus far, the unit of analysis has been individual cases. The unit of network analysis is, however, at the level of individual *citations*. The dataset was thus reshaped so that each dataset observation (that is, a row in the table) would capture information not about one case but about one citation. Citation-level metadata was also extracted from case-level metadata. Each final citation-level observation comprised the following information:

(a) the reporter citation of the citing case;

(b) the reporter citation of the cited case;

(c) the date the citing case was decided (this is taken to be the date the individual citation was created);

(d) the subject matter(s) of the citing case; and

(e) the word count of the citing case.

35 Judgment subject matters were determined using top-level catchwords assigned by the SLR headnoters. These are in turn based on (but not limited to) concepts from the Singapore Academy of Law Subject Tree. To illustrate, *Zurich Insurance (Singapore) Pte Ltd v B-Gold Interior Design & Construction Pte Ltd*[64] ("*Zurich*") has the following catchwords (truncated for brevity):

(a) Contract – Contractual terms – Admissibility of extrinsic evidence …

(b) Contract – Contractual terms – Whether common law contextual …

(c) Insurance – Brokers – Agent's insurance company …

The only two top-level catchwords, being the first word or phrase that appears before the first en-dash in any given catchword sequence, to appear in this case are "contract" and "insurance". Citations from this case were thus recorded to fall under both subject matters.

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of a reporter that "should be used for citation". A final possibility is if the appeal judgment cited *only* the neutral "SGCA" citation of a reported appeal but *not* its SLR citation, perhaps because the cited case had yet to be reported at that time. Again, these form only a small minority of cases. This was confirmed by counting matches from a regular expression search for the "SGCA" citation pattern.

64 [2008] 3 SLR(R) 1029.

36 To summarise, the preceding extraction procedure yielded two datasets. The first is a case-level dataset detailing, for each reported appeal, a list of the other reported appeals cited as well as case metadata like its decision date, word count, Bench and subject matter(s). The second is a citation-level dataset detailing, for each citation within each reported appeal, the citing case, the cited case, as well as the decision date, word count and subject matter(s) of the citing case. The data was then ready to be analysed.

IV. Results and discussion

A. Preliminary analysis

37 This part has two aims. The first is to verify the reliability of the automatically extracted data by examining if the statistics it produces are (a) consonant with existing literature; and (b) not manifestly illogical. The second to is explore preliminary trends in the dataset. Table 1 below provides a statistical overview broken down by the relevant Bench. Adopting terminology from the literature, this article refers to citations *in* a judgment as that judgment's "outward citations" and citations *of* a judgment as that judgment's "inward citations".[65]

	Yong CJ	Chan CJ	Menon CJ	Overall
Judgment word count	6,172.84 (3415.99)	12,128.1 (8872.38)	13,253 (8033.19)	10,581.9 (7879.25)
No of outward citations	3.2413 (3.3049)	7.2133 (6.4119)	8.0932 (5.1206)	6.2229 (5.571)
No of inward citations	2.0762 (2.4313)	3.072 (3.8283)	1.1994 (1.977)	2.16413 (3.01)
No of outward citations per thousand words	0.628 (0.6675)	0.6624 (0.4735)	0.7293 (0.5161)	0.6725 (0.556)
Judgments in sample	315	361	311	987
Days in sample	2,292	2,304	1,978	6,574

Table 1: Selected summary statistics by Bench[66]

65 James H Fowler *et al*, "Network Analysis and the Law: Measuring the Legal Importance of Precedents at the US Supreme Court" (2007) 15 Polit Anal 324.

66 Mean values are presented for all variables except number of years and cases in the sample. Standard deviations are in brackets. Days in sample include all calendar

(*cont'd on the next page*)

38 The "overall" statistics presented in the rightmost column suggest that the "average" reported appeal judgment over the last 18 years has around 10,000 words, cites six past SLR/SLR(R) appeals decided on or after year 2000, and is cited by two subsequent reported appeals. There is also an average of 0.67 citations per thousand judgment words. Unsurprisingly, however, in all of these statistics the standard deviation across judgments is large relative to the mean. These large variances imply that the global averages are not strongly indicative of how the number of citations and words are distributed across individual judgments.

39 The Bench-level statistics tell a more granular story. All three time periods, representing approximately six years under each Bench, saw upwards of 300 reported appeal decisions, or about one every calendar week.[67] Average word counts and outward citations approximately doubled between the Yong CJ and Chan CJ benches. Word counts and outward citations also increased on average between the Chan CJ and Menon CJ benches, albeit less dramatically.[68]

40 The above statistics are consistent with Goh and Tan's findings that the length of the average judgment has increased significantly from 2000 to date, with most of this increase attributable to the transition between the Yong CJ and Chan CJ benches.[69] This can in turn be attributed to a concerted judicial effort to develop Singapore's commercial laws. On the day of his appointment as Chief Justice,

days on and after the day the relevant Chief Justice was appointed up till the day before the next Chief Justice was appointed. To illustrate, 2,292 is the number of calendar days beginning from 1 January 2000 (the start of the sample period) up till and including 10 April 2006. Chan Sek Keong CJ was appointed Chief Justice on 11 April 2006 while Sundaresh Menon CJ was appointed Chief Justice on 6 November 2012: see Prime Minister's Office, Singapore, "Re-appointment of Chan Sek Keong As Chief Justice" (11 April 2009) <https://www.pmo.gov.sg/newsroom/re-appointment-chan-sek-keong-chief-justice> (accessed 10 September 2018).

67 This number is derived by taking 300 divided by 6 years and then divided by 52 weeks per year.

68 One caveat specific to the outward citation counts in this paper is that citations to cases reported before year 2000 were excluded. As the older Yong Pung How CJ bench cases are logically more likely to cite pre-2000 cases, this could have reduced the outward citation count of these cases more than that of cases decided under more recent benches. These statistics should be interpreted in this light, though it should be noted that the accuracy of the outward citation counts is not critical to the rest of this article.

69 Goh and Tan rely on the number of pages in the law reports for cases decided between 1965 and 2008: see Goh Yihan & Paul Tan, "An Empirical Study on the Development of Singapore Law" (2011) 23 SAcLJ 176 at 204–205.

Chan CJ made his judicial intention clear in a response to his appointment speech:[70]

> It is, therefore, important that we develop and enhance our commercial laws to meet the legal needs of the business and financial sectors of the economy. Our commercial laws are, in terms of scope, maturity and modernity, comparable to the most favoured national laws in global finance, *viz*., New York law and English law … The Judiciary will play its part in developing the principles of commercial law. [emphasis added]

41 To illustrate this further, Figure 1 provides a heat-map visualisation of how average word counts and the number of reported appeals has varied across both years and months.

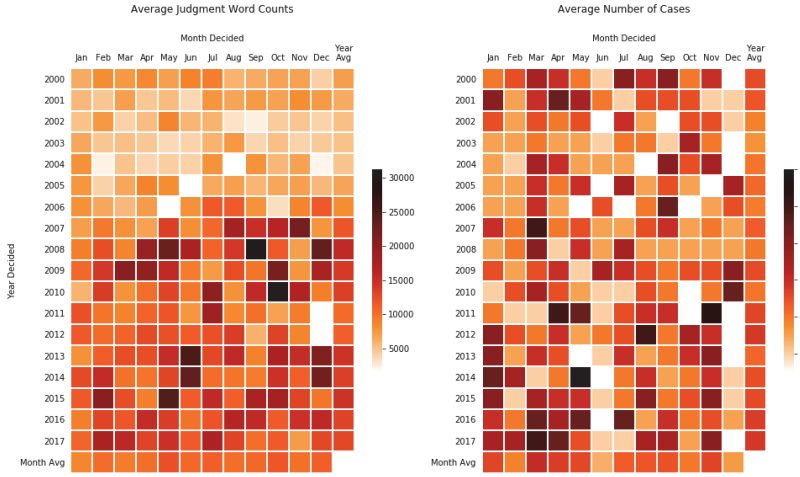

Figure 1: Month and year averages of word counts and number of cases, reported Court of Appeal judgments, 2000–2017[71]

70 See Chief Justice Chan Sek Keong, Supreme Court of Singapore, "Welcome Reference for the Chief Justice – Response by Chief Justice Chan Sek Keong" (22 April 2006) <https://www.supremecourt.gov.sg/news/speeches/welcome-reference-for-the-chief-justice---response-by-chief-justice-chan-sek-keong> (accessed 10 September 2018) at paras 20–21.

71 Across both subplots, the vertical axis denotes one calendar year while the horizontal axis denotes one calendar month. Cells of each plot are shaded based on the respective year and month averages and in accordance with the colour bar on the right. For example, the average word count for reported appeals decided in January 2000 is relatively lightly shaded because the exact number falls between 5,000 and 10,000. The rightmost and bottommost column represent the row- or column-wise *average of the average* values for the corresponding year or month respectively. White cells represent periods in which no reported appeal was decided.

42 Focusing first on the left subplot, the increase in judgment word count over the years and across the three Benches is self-evident in the downward colour gradients. Years under the Chan and Menon CJJ benches are consistently darker-shaded than years under the Yong CJ Bench. The subplot also shows no evidence of monthly seasonality in judgment word counts (that is, that judgments published in certain months tend to be longer or shorter than others). Turning to the right subplot, it is evident that the number of cases decided in each year and month across the last 18 years has been relatively uniformly distributed. There are no clear shade patterns or clusters, save that June and December tend to have fewer cases decided (except in June and December 2009).[72]

43 Returning to Table 1,[73] it is noteworthy that cases decided under the Yong CJ bench, though older, have on average fewer inward citations than cases decided under the Chan CJ bench. The average Yong CJ bench reported appeal judgment published from 2000 to 2006 has been cited about twice, while the average Chan CJ bench judgment has been cited about three times.[74] This ostensibly goes against the logic that "the older the work, the more time it has had to accumulate citations".[75] Compared to cases decided under the Chan CJ bench, cases decided under the Yong CJ bench have on average had six more years of subsequent case law that could have cited them as precedent.

44 While a few reasons can be offered to explain this, the simplest explanation is the already identified trend that judgments under the Chan and Menon CJJ benches were more comprehensive and tended to cite more SLR judgments themselves. When these longer judgments were written, the more recent cases decided under Chan CJ's bench would have generally speaking been more relevant candidates for citation. It can thus be hypothesised that the Chan CJ bench cases

72 This roughly corresponds to the holiday months, including the court holiday, but the potential time lags between when cases are decided and their "decision date" as recorded in the Singapore Law Reports mean one should not make too much out of this without further study.

73 See para 37 above.

74 Though note the large standard deviations of both statistics.

75 Richard A Posner, "An Economic Analysis of the Use of Citations in the Law" (2000) 2 Am L & Econ Rev 381 at 388.

"benefited" more in terms of inward citations from the increase in judgment word counts.[76]

45 This can be tested empirically by examining if the number of inward citations is positively correlated with the word counts of *subsequent* judgments. As expected, the Pearson correlation coefficient between average inward citations per year and average word counts of judgments decided in the *following* year is 0.2903.[77] This positive correlation implies that the longer the judgments written the following year, the more inward citations a case decided today tends to receive. Note that this argument neither relies on nor suggests any direct causality between future word counts and inward citations. Indeed, the correlation, while positive, is not high. This suggests that other variables should be considered in explaining trends in inward citations over the years.

46 Two opposing forces therefore seem to be at work in determining how often a case is cited. On one hand, older cases would have had more subsequent cases which could have cited them. On the other, more recently decided cases may prove more relevant candidates to cite. When an external force, such as a significant increase in judgment length, affects the system, one dominates the other, producing the phenomenon observed above.[78]

47 Delving deeper into the case-level data, Figure 2 below charts the distribution of subject matters occurring across all 987 reported appeals within the study period. Note that the numbers do not sum to 987 because many judgments have more than one subject matter.

76 This argument may be tricky to interpret. An invalid counterargument is to attribute this to there being slightly more cases under the Chan Sek Keong CJ bench compared to the Yong Pung How CJ bench (361 *versus* 315). This would not have affected a comparison of average citation counts between the two because the averages are derived after dividing by the respective totals. Another invalid counterargument is to attribute it simply to the Court of Appeal preferring to cite recent cases – there was also a point in time when the Yong CJ bench cases were the most recent.

77 If judgments decided two years later are used instead, the correlation increases to 0.3251. For judgments decided three years later, the correlation is 0.1888.

78 For a more detailed treatment of the "depreciation" of precedential authority over time, see William M Landes & Richard A Posner, "Legal Precedent: A Theoretical and Empirical Analysis" (1976) 19 J Law & Econ 249 at 259. This is dealt with in more detail at paras 37–77 below as well.

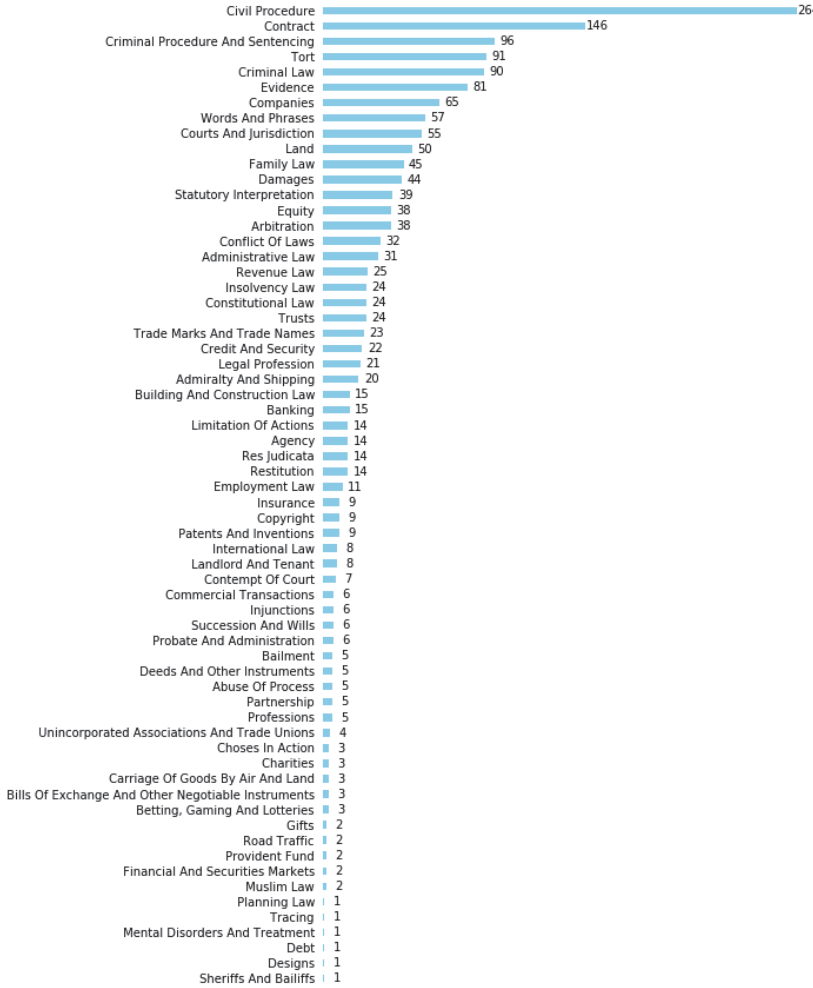

Figure 2: Frequency distribution of subject matters assigned by headnoters, reported Court of Appeal judgments, 2000–2017

48 Civil and criminal procedure dominate the top spots, occurring a total of 360 times in the 987 cases within this article. In 264 unique cases, or about one in four reported appeals, a civil procedure issue is raised. This is logical because procedural issues can arise in any dispute, regardless of its underlying factual matrix. Turning to substantive law subjects, the three most frequent are, in descending order, contract, tort and criminal law. This empirically confirms that these subjects, traditionally regarded as foundational areas of law that must be taught as core subjects in law school, are also subjects of significant practical interest. Notably, "words and phrases" ranks within the top ten subjects most frequently at issue in reported Court of Appeal judgments. It is also noted that "statutory interpretation" ranks 13th by frequency.

Although it goes without saying that interpreting words and phrases is a core aspect of what lawyers do, at least anecdotally, few courses in law school focus on interpretation *per se*.

49 To develop this further, Table 2 provides summary statistics of citations and word counts for the ten most frequent subject matters.[79]

	Word count	Outward citations	Inward citations	Outward citations per 1,000 words	Number of cases
Courts and jurisdiction	13,040.8 (12,002.4077)	9.6727 (7.4834)	4.1818 (3.6519)	0.9491 (0.6445)	55
Words and phrases	11,227.8 (10,749.1161)	5.4211 (6.3159)	2.5263 (3.3118)	0.4723 (0.3684)	57
Companies	11,132.6 (7,502.284)	5.2308 (4.4503)	2.3692 (3.0289)	0.4535 (0.2622)	65
Evidence	12,390.3 (9,995.4226)	7.8765 (7.5753)	2.7037 (3.2956)	0.6964 (0.5711)	81
Criminal law	11,625.1 (10,253.8431)	9.3 (8.0997)	2.2667 (2.7957)	0.9137 (0.6537)	90
Tort	15,334.2 (10,249.412)	7.8242 (6.1583)	3.2747 (3.4191)	0.5476 (0.4194)	91
Criminal procedure and sentencing	10,752.9 (9,809.3564)	10.0729 (8.1606)	2.3333 (3.0076)	1.1587 (0.7576)	96
Contract	11,924.2 (7,527.8648)	6.089 (5.4062)	2.774 (4.419)	0.5223 (0.4178)	146
Civil procedure	9,416.76 (7,779.7703)	6.3864 (5.3361)	2.5265 (3.1027)	0.7997 (0.6106)	264

Table 2: Selected summary statistics by subject matter[80]

79 It was not fruitful to present statistics on more subject matters as sample sizes decline quickly as one goes down the rankings.

80 Mean values are presented for all variables except the number of observations in the sample. Standard deviations are in brackets. When perusing these statistics, note that the same case may appear in more than one topic. This, however, does not bias comparisons across topics, since subtracting one statistic from the other would difference out the contribution of the shared cases. To illustrate, *Zurich Insurance (Singapore) Pte Ltd v B-Gold Interior Design & Construction Pte Ltd* [2008] 3 SLR(R) 1029 ("*Zurich*") would contribute to statistics for both contract and insurance. The judgment is lengthy, at 36,680 words, and would have raised the average word count of both subject matters. If one were to subtract the average

(*cont'd on the next page*)

50 An important statistic that emerges from Table 2 is that judgments involving civil or criminal procedure issues are on average *the shortest* amongst the top ten subjects. Since procedural issues can wrap around substantive debates, one may perhaps expect the converse to be true. It turns out that average word counts for civil and criminal procedure cases are skewed downwards because a sizeable number of cases discuss *solely* procedural issues within relatively brief judgments. Specifically, 95 (36%) of the 264 civil procedure cases involve only civil procedure issues and average to 6,225.28 words per judgment; 34 (35%) of the 96 criminal procedure cases involve only criminal procedure issues and average to 6,670.29 words per judgment. Evidence cases are slightly different in that only eight (10%) of the 81 cases involve solely evidence issues. Nonetheless, these eight cases average to a relatively concise 7,760.50 words as well. By contrast, 27 (30%) of the 91 cases that involve solely tort issues average to 12,781.81 words per judgment, and 51 (35%) of the 146 cases that involve solely contract issues average to 11,207.16 words.

51 As for citation counts, it should again be noted that outward citations in this article include only citations of other Singapore reported appeals. That subjects like criminal law and criminal procedure have the highest number and density of outward citations could thus indicate that local jurisprudence has a bigger role to play in these areas relative to others. This proposition is ostensibly attractive since Singapore's criminal law and procedure likely differs from its foreign (English) counterparts significantly. However, a deeper comparative analysis which falls beyond the scope of this article should be conducted to confirm this.[81]

52 The discussion thus far yields the following propositions:

(a) The number of words and outward citations to other Singapore reported appeals have increased over successive Benches. Outward citations on a *per word basis* have also increased, though to a smaller extent. This is consistent with findings in the literature.[82]

word count for contract from that of insurance, *Zurich*'s uplifting impact on both averages would net off (albeit not entirely, since the numbers of cases differ). The overlap thus does not preclude comparisons between word counts for contract and insurance.

81 For a comparative data analysis on citations to English judgments in Singapore criminal law and procedure cases, see Goh Yihan & Paul Tan, *Singapore Law: 50 Years in the Making* (Academy Publishing, 2015) chs 7 and 8.

82 Goh Yihan & Paul Tan, "An Empirical Study on the Development of Singapore Law" (2011) 23 SAcLJ 176.

(b) The average Yong CJ bench reported appeal has been cited less often by subsequent Court of Appeal judgments as compared to the average Chan CJ bench reported appeal. This difference hints at a tension between age and recency where precedential authority is concerned.

(c) Procedural issues are frequently raised in Singapore's highest court, though judgments that revolve solely around such issues tend to be more concise.

53 It may be that none of these are particularly "startling" (to borrow Merryman's words). Recall, however, that this section aims only to show that the data extracted is reliably consistent with empirical findings in previous literature.

54 It is also submitted that the third proposition could be relevant to legal educators. That procedural issues occur so frequently at the appellate level highlights in two ways the importance of teaching procedural law. First, since Court of Appeal judgments represent the fount of Singapore's common law, procedural issues are a significant and important part of the same. Second, practically speaking, this means lawyers who foresee themselves making submissions at the appellate level must be prepared to deal with issues of procedural law. If so, then teaching procedural law should perhaps not be deemed secondary to teaching more "substantive" subjects. Neither should students shy away from learning procedural subjects simply because they are "not substantive". Nonetheless, in so far as word counts are taken as proxies for how complex the issues involved in a judgment are, that procedural judgments tend to be shorter in length *could* suggest that these subjects need not be taught to the same conceptual *depth* as substantive law subjects. Instead, a wider *breadth* of procedural issues could be covered. With these propositions in mind, this article turns now to network analysis proper.

B. Citations network analysis

55 To motivate this section, Figure 3 below charts the entire network of reported appeals as a directed graph.[83] This network physically manifests the (growing) sophistication and complexity of Singapore jurisprudence. A nucleus of interconnected cases that cite and are cited by each other is supported by an orbital of peripheral jurisprudence. Indeed, what is seen here is merely the tip of the iceberg since the dataset was restricted only to reported appeals. One can

83 "Directed" means edges are drawn considering the direction of the citation.

imagine that, in the full network of all Singapore jurisprudence,[84] both core and peripheral judgments would be connected to more sub-nuclei of judgments, each with their own sub-orbitals.

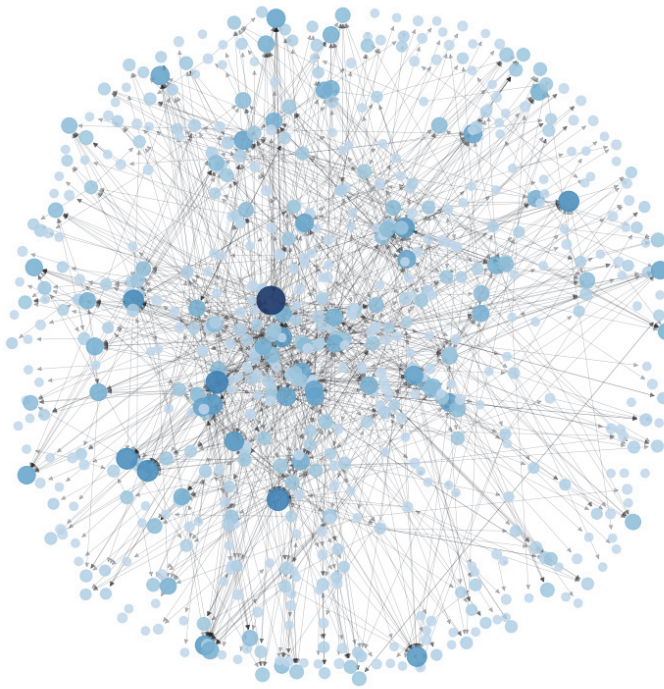

Figure 3: The network of reported Court of Appeal judgments, 2000–2017[85]

56 The biggest and darkest-coloured dot at the centre is *Zurich*, being the reported appeal cited most often by subsequent reported appeals (31 citations). *Zurich* also has the highest authority score within the network. Thus, the immediate utility of using network analysis to construct a *visible* jurisprudential web lies in making it easy to *see* which cases warrant more attention, as well as the citation structures surrounding them. In this light, Table 3 below presents centrality measures and rankings for the top five cases by authority score.

84 This being the object of a planned subsequent study.

85 For ease of visualisation, nodes without inward edges (*ie*, judgments which received no inward citations from other reported appeals) and their associated outward edges were suppressed. The shade and size of the circular node is proportional to the number of inward citations the relevant judgment received.

	Inward citations	Outward citations	PageRank	Hub score	Authority score	Word count
Zurich	31 [1]	5 [108]	0.0057 [8]	0.0043 [68]	0.0669 [1]	36,680 [16]
Sembcorp Marine Ltd v PPL Holdings Pte Ltd[86] ("*Sembcorp*")	18 [2]	8 [29]	0.0025 [69]	0.0157 [6]	0.0373 [2]	26,560 [46]
Sandar Aung v Parkway Hospitals Singapore Pte Ltd[87] ("*Sandar*")	12 [14]	0 [660]	0.0034 [35]	0.0 [660]	0.0199 [3]	5,404 [720]
Panwah Steel Pte Ltd v Koh Brothers Building & Civil Engineering Contractor (Pte) Ltd[88] ("*Panwah*")	16 [4]	4 [151]	0.0055 [10]	0.0035 [88]	0.0192 [4]	3,792 [847]
Man Financial (S) Pte Ltd v Wong Bark Chuan David[89] ("*Man Financial*")	13 [11]	6 [66]	0.0026 [65]	0.0062 [46]	0.0186 [5]	29,000 [34]

Table 3: Centrality scores and rankings, all reported Court of Appeal judgments, 2000–2017[90]

57 As theory predicts, both PageRank and authority scores are closely but not perfectly correlated with a judgment's in-degree; hub scores are closely but not perfectly correlated with a judgment's out-degree.[91] As earlier explained, this is a desirable property that allows centrality measures to capture more nuance than simple citation counts.

86 [2013] 4 SLR 193.
87 [2007] 2 SLR(R) 891.
88 [2006] 4 SLR(R) 571.
89 [2008] 1 SLR(R) 663.
90 Raw centrality scores are presented. Values in square brackets represent the numerical rank of the judgments by the relevant score: 1 is the highest rank and 987 (being the number of judgments within the dataset) the lowest rank. Judgments with equal raw scores are assigned the higher possible rank.
91 Across all cases, the Pearson correlation between PageRank and in-degree is 0.75. Between authority score and in-degree, the correlation is 0.70. Between hub score and out-degree, it is 0.54.

Thus, even though cases like *Sandar* and *Man Financial* fall *outside* the top ten cases by inward citations, because they are cited by more influential "hubs", their authority scores rank within the top five. This point is worth emphasising – it means that network centrality measures which, as explained above, consider to some extent the *quality* of citations to a judgment rather than simply numerical *quantity*, have the power to automatically uncover patterns and important precedents which traditional citation counts would miss. Further, even where both citation counts and centrality scores point in the same direction, network analysis contributes by providing further *conceptual* defensibility and rigour to what citation counts indicate.

58 Against this backdrop, it is noteworthy that *all* five judgments with the highest authority scores deal specifically with issues concerning either the interpretation or implication of contractual terms. *Zurich* is the *locus classicus* for the contextual approach to contractual interpretation. *Sembcorp* reinforces the contextual approach and is itself a leading case on terms implied in fact. *Panwah* and *Sandar*, which predate *Zurich* and *Sembcorp*, are also authorities on contractual interpretation. These two cases are especially interesting because both are relatively concise. *Panwah* comes in at a mere 3,792 words but has attracted 16 inward citations and ranks fourth overall by authority score. Likewise, *Sandar* clocks only 5,404 words and indeed cites no other Singapore judgment but has been cited by subsequent Court of Appeal judgments 12 times, ranking third overall by authority score.[92] Brevity, it seems, should not be taken for lack of substance. Finally, *Man Financial* is a leading authority on, *inter alia*, the condition-warranty approach to contractual terms. Importantly, these judgments also rank amongst the top 15 by inward citations and within the top 10% of cases by PageRank.[93]

59 These results can be partly attributed to how frequently contract issues arise at the Court of Appeal (recall that contract is second only to civil procedure in Figure 2).[94] More contract cases logically means precedents on contract get cited more often. Inward citations, PageRank and authority scores for contract cases are naturally higher. Nonetheless, recall that civil procedure issues are almost twice as frequent, yet no civil

92 Manual inspection of this case revealed that it did not cite any judgments of the High Court or lower courts as well.

93 In fact, the sixth to tenth cases by authority score are also contract law cases. In order, they are: *RDC Concrete Pte Ltd v Sato Kogyo (S) Pte Ltd* [2007] 4 SLR(R) 413; *Jet Holding Ltd v Cooper Cameron (Singapore) Pte Ltd* [2006] 3 SLR(R) 769; *Tan Chin Seng v Raffles Town Club Pte Ltd* [2003] 3 SLR(R) 307; *Ng Giap Hon v Westcomb Securities Pte Ltd* [2009] 3 SLR(R) 518; and *Chwee Kin Keong v Digilandmall.com Pte Ltd* [2005] 1 SLR(R) 502.

94 See para 47 above.

procedure judgment ranks within the current top five. Moreover, the ubiquity of contract law issues at the appellate level arguably goes towards rather than against its centrality to the law. Recall also that centrality scores capture more nuance than raw citation counts. Specifically, PageRank scores capture the probability that someone randomly reading reported appeals will come across a given judgment by following a citation from one to another. In other words, if one does not know what topics a hypothetical judgment reader is most interested in, a mathematically informed guess for what he or she is most likely to end up reading in fact would be contract law. Put another way, if one does not know what kind of legal issues one would end up having to deal with as a lawyer, the safe bet would be to study the law of contract in general and the rules on contractual terms in particular. Indeed, so central are questions of contractual interpretation to Singapore law that V K Rajah JA (as he then was) has made the following extra-judicial remark:[95]

> The rules governing the interpretation of contracts are not generally considered by law schools and practitioners alike to be voguish or to merit close study. For those reasons, it does not occupy a prominent position in law school curricula; and few academic minds are animated by it. Less forgivably, many commercial lawyers seem unsure about how to approach the more ticklish points. This is disappointing, because disputes on the interpretation of contracts arise all too frequently in practice – contentions stand or fall depending on whether a particular interpretation prevails. Many more disputes never make it to the courts or to arbitration because the parties are satisfied on the basis of the already settled rules how a contract ought to be interpreted and acted on. It is therefore no great exaggeration to regard the subject as the 'lifeblood of commercial law'.

60 Through citations analysis, strong empirical support has been found for the above. Although this can to some extent already be derived from looking at the subject matter frequencies and average citation counts presented in this article's previous section, network centrality measures allow not only a *confirmation*, but also a *refinement*, of the analysis by revealing one most central subject matter out of a few possible candidates (for example, between civil procedure, contract and tort).

61 That is not to declare contract law as the only important subject for legal study. Before *Zurich* rose to its present position, the judgments with the highest authority scores over the years were *Panwah* (end 2012 to end 2013), *Aberdeen Asset Management Asia Ltd v Fraser & Neave*

95 See V K Rajah, "Redrawing the Boundaries of Contractual Interpretation: From Text to Context to Pre-text and Beyond" (2010) 22 SAcLJ 513 at [1].

Ltd[96] (end 2009 to end 2011) and *Nomura Regionalisation Venture Fund Ltd v Ethical Investments Ltd*[97] (end 2002 to end 2010).[98] The latter two cases were judgments on civil procedure. This is not surprising; Figure 2 has shown that civil procedure is the most frequently raised subject matter. In any event, to facilitate more granular analysis and exclude any problems posed by the unequal distribution of subject matters, this article now constructs a network using *only judgments involving contract as a subject matter* before calculating the relevant centrality scores. Table 4 presents the results.

	Inward citations	Outward citations	Page Rank	Hub score	Authority score	Word count
Zurich	22 [1]	5 [29]	0.0205 [2]	0.0078 [45]	0.1037 [1]	36,680 [4]
Sembcorp	13 [3]	8 [7]	0.0093 [12]	0.0369 [1]	0.0616 [2]	26,560 [16]
Man Financial	12 [4]	6 [18]	0.0129 [7]	0.0131 [36]	0.045 [3]	29,000 [11]
RDC Concrete Pte Ltd v Sato Kogyo (S) Pte Ltd[99] ("*RDC*")	14 [2]	2 [61]	0.0152 [6]	0.0047 [55]	0.0413 [4]	19,424 [37]
Sandar	8 [7]	0 [97]	0.0115 [10]	0.0 [97]	0.0307 [5]	5404 [209]

Table 4: Centrality scores and rankings, reported contract appeal judgments only, 2000–2017[100]

61 These centrality rankings are substantially similar to the global rankings, save that *RDC* has displaced *Panwah* from the top five. *RDC*, of course, is trite authority on contractual breach, having established a

96 [2001] 3 SLR(R) 355.

97 [2000] 2 SLR(R) 926.

98 These cases were identified in the following way: For each year in the study period, a network comprising only judgments that had been handed down on or before 31 December of that year was constructed. For each year's network, authority scores were then calculated and the case with the highest authority score was identified.

99 [2007] 4 SLR(R) 413.

100 Raw centrality scores are presented. Values in square brackets represent the numerical rank of the judgment by the relevant score: the highest rank is 1 and 247 (being the number of judgments within the dataset that either have "contract" as a subject matter or are cited by such judgments) is the lowest rank. Judgments with equal raw scores are assigned the higher possible rank.

concrete framework for categorising contractual breach upon which *Man Financial* subsequently expounds.[101] These results reinforce the view that contractual interpretation and determining when and what happens when terms are breached is a highly central (and often litigated) aspect of contract law.

62 It is also interesting to note differences in the number of inward citations for each case across Tables 3 and 4. *Zurich* in particular has been cited 31 times globally but only 22 times within contract cases. This means nine reported appeals which cite *Zurich* have not been with labelled with "contract" as a top-level catchword. Across these nine judgments are issues involving company law (the interpretation of corporate constitutions),[102] trust law (the admissibility of extrinsic evidence to prove a gift),[103] arbitration (whether parties are bound by the arbitration agreement),[104] credit and security (the construction of performance bond contracts),[105] conflict of laws (the interpretation of a jurisdiction clause),[106] shipping law (the interpretation of bills of lading)[107] and the interpretation of settlement deeds.[108] In the ninth case, *Zurich* was discussed in the context of ascertaining whether a question relating to the interpretation of a compromise letter would be more suitably determined at trial rather than summarily under O 14 r 12 of the Rules of Court.[109] It seems therefore that the influence of contract law, particularly the rules on contractual interpretation, stretches far beyond its own four corners.

63 Network analysis allows a precise examination of how *Zurich* rose to become the most central judgments in the jurisprudential network. Figure 4 below charts how authority scores for *Sembcorp*, *Zurich*, and *Sandar* – the three most central judgments on contractual interpretation highlighted in Tables 3 and 4 – have evolved over time.

101 See *RDC Concrete Pte Ltd v Sato Kogyo (S) Pte Ltd* [2007] 4 SLR(R) 413 at [113] and *Man Financial (S) Pte Ltd v Wong Bark Chuan David* [2008] 1 SLR(R) 663 at [152]–[191].

102 *Lian Hwee Choo Phebe v Maxz Universal Development Group Pte Ltd* [2009] 2 SLR(R) 624 at [11].

103 *Tan Yok Koon v Tan Choo Suan* [2017] 1 SLR 654 at [110].

104 *International Research Corp plc v Lufthansa Systems Asia Pacific Pte Ltd* [2014] 1 SLR 130; *Rals International Pte Ltd v Cassa di Risparmio di Parma e Piacenza SpA* [2016] 5 SLR 455 at [47].

105 *Master Marine AS v Labroy Offshore Ltd* [2012] 3 SLR 125 at [34].

106 *Orchard Capital I Ltd v Ravindra Kumar Jhunjhunwala* [2012] 2 SLR 519 at [27].

107 *The Vasiliy Golovnin* [2008] 4 SLR(R) 994.

108 *Yamashita Tetsuo v See Hup Seng Ltd* [2009] 2 SLR(R) 265 at [61]–[65].

109 Cap 322, R 5, 2006 Rev Ed. *Olivine Capital Pte Ltd v Chia Chin Yan* [2014] 2 SLR 1371 at [54].

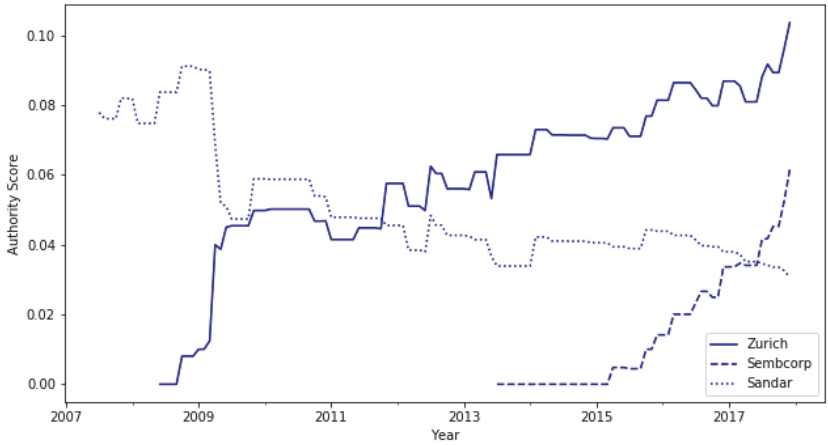

Figure 4: Authority scores over time (*Sandar*, *Zurich* and *Sembcorp*)[110]

64 Figure 4 tells a tale of three cases. The tale begins in 2007 with *Sandar*, the leading authority on contractual interpretation. Decided on 30 March 2007, *Sandar* laid the foundations for a contextual approach to contractual interpretation, relying not on any previous Singapore judgment but on observations by Lords Hoffmann and Wilberforce in *Charter Reinsurance Co Ltd v Fagan*[111] and *Reardon Smith Line Ltd v Yngvar Hansen-Tangen*[112] respectively.[113] *Sandar*'s authority score, however, diminished after *Zurich* was decided and the latter's influence grew. *Zurich* did not detract from *Sandar* (indeed, *Zurich* confirmed the contextual approach), but it likely displaced *Sandar* as the "judgment to cite" for issues on contractual interpretation.

65 The year 2009 was an important one for *Zurich*. Its authority score shot up to near-*Sandar* levels after four important contract law judgments citing *Zurich* were handed down. Ordered by the earliest first, these cases are: *Gay Choon Ing v Loh Sze Ti Terence Peter*,[114] *Ng Giap Hon v Westcomb Securities Pte Ltd*,[115] *Sports Connection Pte Ltd v*

110 These scores were derived following Fowler and Jeon's partitioning approach: James H Fowler & Sangick Jeon, "The Authority of Supreme Court Precedent" (2008) 30 Soc Networks 16 at 25. For each month in the study period, a new network comprising only citations from judgments involving contract issues that had been decided within or before that month was constructed. Authority scores for that network were then calculated and the relevant scores extracted.

111 [1996] 2 WLR 726.

112 [1976] 1 WLR 989.

113 See *Sandar Aung v Parkway Hospitals Singapore Pte Ltd* [2007] 2 SLR(R) 891 at [28]–[30].

114 [2009] 2 SLR(R) 332.

115 [2009] 3 SLR(R) 518.

Deuter Sports GmbH[116] and *Tan Jin Sin v Lim Quee Choo*.[117] These are all cases which dealt at length with numerous issues in contract law other than interpretation *per se*, citing many precedents in the process. They were thus strong hubs which in turn contributed significantly to *Zurich*'s authority score.

66 While these judgments cemented *Zurich*'s place in the contract law books, it was not until early 2012 that *Zurich*'s authority score surpassed *Sandar*'s. The steady growth of *Zurich*'s authority score can be attributed to (a) cases citing *Zurich* becoming more central hubs themselves;[118] and (b) the judgments of *Lim Keenly Builders Pte Ltd v Tokio Marine Insurance Singapore Ltd*[119] and *Ang Tin Yong v Ang Boon Chye*[120] being handed down in 2011. Both judgments referred to *Zurich*. Once *Zurich*'s authority score broke the *Sandar* barrier, it continued climbing from 2012 to 2017 to the point where, as noted in Tables 3 and 4, it is now the most central judgment by authority score across all reported appeals in this paper (both globally and within contract law).

67 Meanwhile, the *Sembcorp* judgment which was handed down on July 2013 did not gain momentum immediately. Nonetheless, its authority score began to grow exponentially post-2015, after the judgment was reaffirmed in *Xia Zhengyan v Geng Changqing*[121] and *Y.E.S. F&B Group Pte Ltd v Soup Restaurant Singapore Pte Ltd*[122] ("*Y.E.S. F&B Group*"). In the latter judgment, the Court of Appeal emphasised *both Zurich's and Sembcorp's* positions as "lodestars in the Singapore legal landscape in so far as contractual interpretation is concerned".[123] Thus, by the end of 2017, the gap between *Zurich* and *Sembcorp*'s authority scores had narrowed significantly.

68 Will *Sembcorp* eventually dethrone *Zurich*? Unlike the dynamics between *Sandar* and *Zurich*, authority scores for *both Zurich and Sembcorp* have grown in tandem. The *Sembcorp* court was explicit in stating its intention to:[124]

116 [2009] 3 SLR(R) 883.
117 [2009] 2 SLR(R) 938.
118 Recall that a judgment's authority score is proportional to the hub scores of judgments citing it.
119 [2011] 4 SLR 286.
120 [2012] 1 SLR 447.
121 [2015] 3 SLR 732.
122 [2015] 5 SLR 1187.
123 *Y.E.S. F&B Group Pte Ltd v Soup Restaurant Singapore Pte Ltd* [2015] 5 SLR 1187 at [41].
124 *Sembcorp Marine Ltd v PPL Holdings Pte Ltd* [2013] 4 SLR 193 at [72].

> … refine [Singapore's] approach [to contractual interpretation] by synchronising [its] rules of pleading and evidence with the contextual approach to contractual construction laid down in *Zurich*.

Why then did *Sembcorp*'s refined approach not compete *Zurich* out of the market for inward citations, as *Zurich* did to *Sandar*? The first post-*Sembcorp* reported contract appeal to cite *Zurich*, *KS Energy Services Ltd v BR Energy (M) Sdn Bhd*[125] ("*KS Energy*"), cited both *Sandar* and *Zurich but not Sembcorp* as authority for the contextual approach.[126] *KS Energy* was decided more than six months after *Sembcorp*; Menon CJ sat on the bench for both cases. It was unlikely that *Sembcorp* had not been considered by the *KS Energy* court.

69 Closer inspection reveals the difference to be a product of what *Sembcorp* noted as a "fundamental, even obvious, proposition of law". That is, "the [Evidence Act][127] only governs the admissibility of evidence. It is not concerned with and so does not prescribe rules of contractual construction".[128] A distinction must thus be made between the evidence law rules on the *admissibility* of contextual documents as aids to interpretation and the contract law rules on *contractual interpretation* itself. Where (as was the case in *KS Energy*) the issue revolves solely on the latter, *Zurich* remains the leading authority, the "judgment to cite".

70 The preceding point is probably obvious to most experienced lawyers. The point was made, however, to illustrate another dynamic of precedential authority that network analysis concretises. *Sandar* and *Zurich* revolved around the same issue, so in this regard they can be thought of as *substitutes* in the market for citations. Lawyers and judges in need of authority for propositions of law on contractual interpretation can cite either one. It is of course possible to cite both *Sandar* and *Zurich*, but since *Zurich* outlines a more comprehensive and recent approach to contextual interpretation, it likely became more and more apposite to simply cite *Zurich*, especially as *Zurich*'s influence grew.[129] Thus, the most recent reported contract appeal citing *Sandar* in

125 [2014] 2 SLR 905.
126 *KS Energy Services Ltd v BR Energy (M) Sdn Bhd* [2014] 2 SLR 905 at [44].
127 Cap 97, 1997 Rev Ed.
128 *Sembcorp Marine Ltd v PPL Holdings Pte Ltd* [2013] 4 SLR 193 at [40].
129 Except, of course, if *Sandar Aung v Parkway Hospitals Singapore Pte Ltd* [2007] 2 SLR(R) 891 is being relied on for similar facts or other doctrines of law.

the dataset is *Y.E.S. F&B Group*,[130] while *Zurich* has been referred to in many more recent cases.[131]

71 On the other hand, *Sembcorp* and *Zurich* are more like *complements* in the citations market. In so far as cases which raise questions of contextual interpretation tend also to raise questions of the admissibility of contextual evidence, that *Sembcorp* has been cited for the latter question would likely not affect the likelihood that *Zurich* is cited for the former. This explains why *Sandar*'s authority score fell post-*Zurich*, but *Zurich*'s authority score increased despite *Sembcorp*.

72 As is almost customary in the economic analysis of law, Posner had already alluded to this in a previous work:[132]

> [T]hink of the citer as a shopper among competing 'brands.' Because no citation royalty is paid to the author of the cited work, the more familiar the brand the cheaper it is to cite it rather than to cite a substitute. John Rawls is thus the standard citation for the concepts of the original position and the veil of ignorance, even though those concepts were explained earlier by John Harsanyi; Harsanyi is less well known than Rawls and so it is 'costlier' to cite him. The cost of citing the better-known work is lower not only to the citer, but also to his audience, to which a citation to a familiar work may convey more information. A raw comparison of the number of citations to Rawls and to Harsanyi would thus exaggerate the relative quality, originality, or even influence of the two theorists.

73 The *Sandar-Zurich-Sembcorp* dynamics observed above are an empirical instance of this economic concept. There is scope for a more detailed law and economics analysis of the metaphorical market for legal citations alluded to here. The economics concepts of substitutes and complements are not the only analytical tools available to generate hypotheses on how and why cases are cited; neither is centrality analysis the only string on the network analysis bow that can be used to test them.[133] Network analysis is precisely capable of producing both time

130 *Y.E.S. F&B Group Pte Ltd v Soup Restaurant Singapore Pte Ltd* [2015] 5 SLR 1187 at [31].

131 See, *eg*, *Centre for Laser and Aesthetic Medicine Pte Ltd v GPK Clinic (Orchard) Pte Ltd* [2018] 1 SLR 180; *CIFG Special Assets Capital I Ltd v Ong Puay Koon* [2018] 1 SLR 170; and *Lee Wei Ling v Attorney-General* [2017] 2 SLR 786.

132 Richard A Posner, "An Economic Analysis of the Use of Citations in the Law" (2000) 2 Am L & Econ Rev 381 at 389.

133 There is a host of other graph analysis techniques that are well established in sociology and political science (and increasingly being applied to law) at one's disposal. For example, network analysis can be used to analyse statutes by examining references within sections in a statute to other sections and other legal documents: Michael J Bommarito II & Daniel M Katz, "A Mathematical Approach to the Study of the United States Code" (2010) 389 Physica A 4195. Network techniques have also been used to analyse social relationships between lawyers, law

(*cont'd on the next page*)

series and cross-sectional data that can be used for econometric study. This theory, as well as other forms of network analysis techniques that can be used, deserves a deeper treatment beyond this article's remit.

74 Importantly, the precedential dynamics examined above would have been far less obvious had one only examined simple citation counts because such counts capture less nuanced information on precedential authority. To illustrate, Figure 5 below plots citation counts over time for the same three judgments.

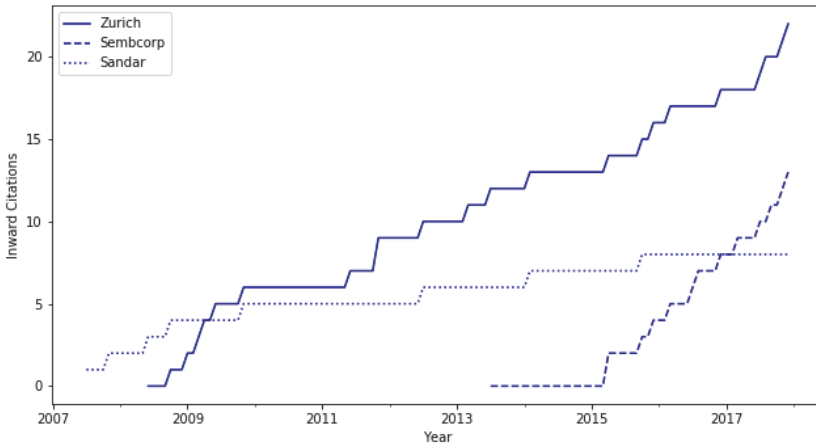

Figure 5: Inward citations over time (*Sandar*, *Zurich* and *Sembcorp*)

75 First, Figure 5 does not capture *Sandar*'s pre-*Zurich* weight. Indeed, citation counts seem to suggest that *Sandar* was not a significant incumbent that *Zurich* had to contend with upon entry, even though an examination of the cases above shows that this was so. Second, because citation counts can only increase over time, Figure 5 does not capture *Sandar*'s post-*Zurich* drop in authority scores.[134] One may argue that the substitution effect can still be observed from how *Sandar*'s citation counts seemed to increase *more slowly* after *Zurich*, but this phenomenon is far less obvious in Figure 5 than 4, if it is at all noticeable without the benefit of hindsight. Thirdly, detecting whether a new judgment is a substitute to or complement of an earlier one would also be more challenging since citation counts for both judgments can only

schools and judges: Daniel M Katz et al, "Reproduction of Hierarchy? A Social Network Analysis of the American Law Professoriate" (2009) J Legal Educ 76; Thomas A Smith, "The Web of Law" (2007) San Diego L Rev 309. Criminologists have used network analysis to understand criminal behaviour: see generally Ryan Whalen, "Legal Networks: The Promises and Challenges of Legal Network Analysis" (2016) Mich St L Rev 539 for a comprehensive review of the different threads of network analysis that legal scholars have conducted.

134 See Figure 4 at para 63, around the year 2009.

continue increasing in either case. Figure 5 does provide some hint of these dynamics in the way that *Zurich* and *Sembcorp*'s inward citation counts increased in tandem post-2015 (especially when juxtaposed against *Sandar-Zurich*) but this is, again, far from obvious and in any event not as clear as in Figure 4.

76 Finally, it is true that precedential dynamics, as well as the centrality of *Zurich* and contract law to begin with, can be derived from reading the judgments themselves and examining the issues canvassed (just as this article did earlier to explain Figure 4). But this would be to miss the point that network analysis provides an automated empirical method to identify these patterns without resort to manually analysing each case. While network measures are by no means a perfect substitute for close legal reading and qualitative analysis, network analysis's potential lies in the ability to quickly analyse hundreds if not thousands of cases and identify the most interesting legal phenomena and precedential structures. Although this article hand-picked three cases as illustrative examples, there is no reason why authority scores over time cannot be generated for any other Singapore judgment and compared against others. The value of quantitative analysis here lies not in *replacing* qualitative analysis but in (a) *confirming* hypotheses generated from the analysis; or (b) *suggesting* hypotheses for deeper qualitative examination.

77 It is thus submitted that network analysis is a useful empirical tool for studying the Singapore legal system that can and should be explored in greater detail. For a practical example, citations network analysis could help practitioners select the most central authorities to cite in the course of submissions (particularly to support propositions of law). If a proposition on contractual interpretation is being made and the submission drafter, working under time and page-length constraints,[135] wants to identify the best authority to cite out of several candidates, then centrality measures can quickly show that *Zurich* should be preferred to *Sandar*. This holds *a fortiori* in more esoteric areas of law where the drafter may not have the experience necessary to lead him or her to the *Zurich*-equivalent judgment in that area immediately. Network measures would also be useful when simple citation counts do not point decisively to a clear leading case. Indeed, for these areas of law, network analysis could lead the drafter to central authorities he or she did not otherwise anticipate.[136]

135 See para 87(4A) read with para 87A of the Supreme Court Practice Directions (2010 Rev Ed) which imposes a 50-page limit for appellate submissions unless leave of court is obtained.

136 See also Kawin Ethayarajh, Andrew Green & Albert Yoon, "A Rose by Any Other Name: Understanding Judicial Decisions That Do Not Cite Precedent" (2018) 15 J Empir Leg Stud 563, which uses, amongst other things, network centrality

(*cont'd on the next page*)

V. Conclusion and future work

78 This article conducted an empirical inquiry into citation practices in Singapore's highest appellate court using a preliminary dataset of 987 reported Court of Appeal decisions handed down from 2000 to 2017. The aim was to demonstrate the usefulness of citations analysis, buttressed by relatively new techniques adapted from graph theory, towards revealing important theoretical and practical insights on the Singapore legal system. A secondary aim was to explore patterns in and glean insights from the Court of Appeal's citations practices.

79 One such insight is the centrality of questions of *interpretation* in Singapore's appellate jurisprudence. Issues of "words and phrases" and "statutory interpretation" are canvassed very frequently in the Court of Appeal.[137] More importantly, questions of contractual interpretation not only are fundamental *within* contract law but also impact areas such as company law, arbitration and shipping. If a lawyer's words are his or her weapons, perhaps more attention can be paid to learning how to wield them. It bears emphasis that the centrality of contract law in Singapore, as indicated by traditional citation counts, is further reinforced and indeed refined by network centrality measures that make use of higher-order formulas to produce metrics more consonant with the importance, in legal analysis, of considering both the *quality* and quantity of citations to a judgment.

80 The enquiry also confirmed existing literature documenting the growing complexity of Singapore's jurisprudence.[138] The author finds that word counts have increased on average across the Yong, Chan and Menon CJJ benches, with most of the increase attributable to the transition between Yong CJ and Chan CJ. As judgments get more comprehensive, more local reported appeals are cited in each judgment. Outward citations on a *per word basis* have also increased, though to a smaller extent.

81 Finally, the enquiry has shed light on the dynamics of precedent in Singapore's jurisprudence. Where inward citations are concerned, a tension exists between a judgment's age and recency. Older judgments have more time to accrue citations, but newer judgments may be more topical or relevant. The authority of precedent can also rise and fall as substitute or complementary judgments are handed down. This is an important dynamic of precedential authority that is likely to remain

measures to identify Indian court judgments that may have omitted to cite relevant precedents.

137 See Figure 2 at para 47 above.

138 Goh Yihan & Paul Tan, *Singapore Law: 50 Years in the Making* (Academy Publishing, 2015).

hidden if only simple citation counts are used. There is scope for a marketplace metaphor to analyse citation practices in more detail.

82 One caveat is that all these insights are *internal*. They should be interpreted considering that the study looked only at post-2000 Singapore reported appeals. More philosophically, this article has argued for the theoretical soundness and practical utility of citations network analysis. It bears mention that the techniques presented here scratch only the surface of the network analysis toolbox. Beyond procuring a larger dataset of Singapore cases, more sophisticated centrality measures and/or an altogether different line of network analysis (such as network cluster analysis) can be used. That even basic methods yield results reinforces the potential of network analysis as a technique that goes beyond producing colourful graphs and charts. Rather, network analysis can discover from citations data insights that could guide the subjects, skills and case judgments that lawyers and law schools choose to study or teach. A deeper understanding of the nature of authority could influence when, how and why cases are cited by lawyers and judges.