A REVISED BIBLIOGRAPHIC ANALYSIS OF THE LEAN LITERATURE

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1. INTRODUCTION

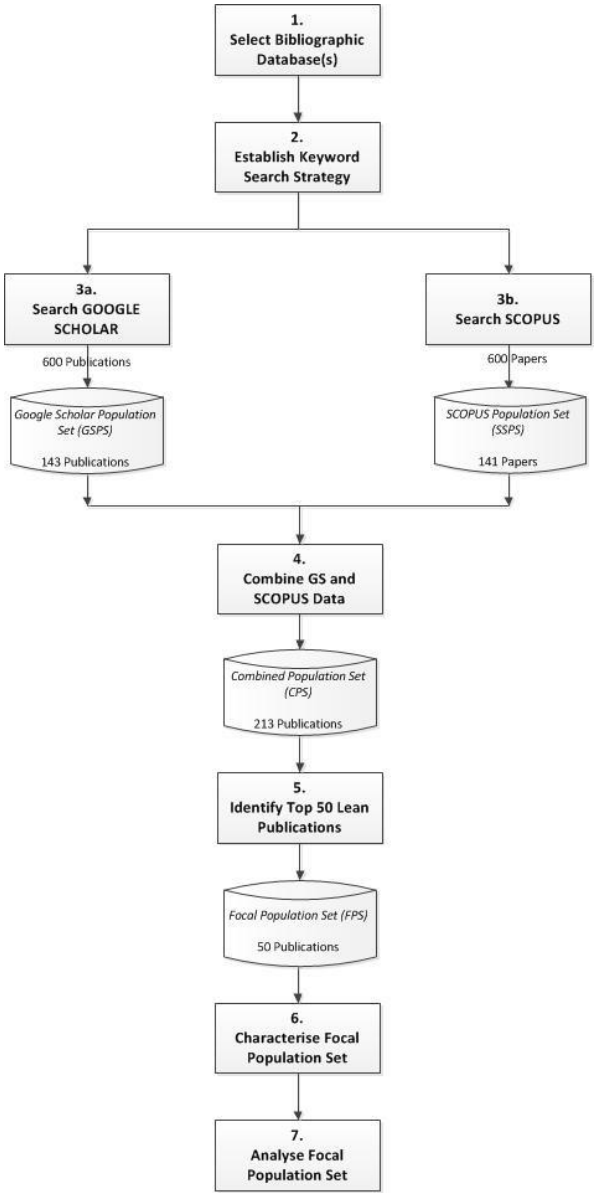
As part of an ongoing stream of research into the conception of 'value' within logistics and supply chain management (SCM), the authors presented a working paper at ISL 2015 (Francis *et al*., 2015) that explored the interpretation of this concept within the Lean operations and management paradigm (after Womack and Jones, 1996). Our paper presented an evolving bibliographic analysis (BA) approach. Using that approach, it drew upon Google Scholar to identify the most highly cited Lean publications. Using this as a starting point, the purpose of our ISL'16 paper is to detail a more fully developed BA method that draws upon Scopus as well as Google Scholar, to first identify and then characterise the top 50 most highly influential publications on Lean as measured by citation. This method yielded rich findings. However, inherent space constraints preclude the detailing of these. As a consequence, the following paper focuses on explaining the method and the top 50 publications identified by using it. The ISL'16 conference presentation at Kaohsiung will be dedicated to the characterisation and analysis of these findings, although a brief overview of some of the key summary statistics and top 50 Lean publications is provided within the discussion section of this paper.

2. METHODOLOGY

An overview of the BA method developed for this exercise is presented in Figure 1. The first step in this method was to select the bibliographic databases that were to form the source of the raw material for subsequent analysis. Recalling that the intent was to identify the most highly *cited* publications, then such databases were to be limited to those that provided *citation statistics* per individual publication. The extensive personal experience of the authors with the Lean literature suggested that this topic is highly un-theoretical, and that many of the most influential publications were likely to be books and reports as opposed to journal papers. Google Scholar (GS) was consequently selected as the first database as this claims to be among the most extensive of indexing sources, and includes such publication types. However, in order to triangulate the journal papers that were identified via GS, it was decided to also use a second database that was dedicated to academic journal articles. After deliberation, Scopus (SS) was selected as this is the most extensive abstract and citation database of this type; covering nearly 22,000 journal titles from over 5,000 publishers, of which 20,000 are peer-reviewed journals in the scientific, technical, medical, and social sciences.

Having established the databases, the second step was to formulate the key word (KW) search strategy. Even though 'Lean' can boast a lineage of over three decades (Francis *et al*., 2015), it suffers from an issue of interpretive viability (after Benders & van Veen, 2001), whereby the term means different things to different people within the operations and management field (Papadopoulou & Ozbayrak, 2005; New, 2007, Shah & Ward, 2007). Taken in conjunction with lay meanings of the word 'Lean', this issue poses a particular challenge to constructing a KW search strategy that will identify the population set of publications that are specifically and most pertinent to the Lean paradigm. In due course, we chose to use six separate KW search queries across GS, and then duplicate these across SS (ie twelve KW searches in total). Each KW search was for an *exact phrase match* in the article *title*, with no date restrictions and for articles only (excluding patents, case law and citations). Based upon a consensus between the authors, the six selected Lean synonym KW phrases were: *'lean manufacturing', 'lean production', 'lean thinking', 'lean management', 'value stream'* and *'Toyota'*. These were identified as S1-S6 respectively, and prefixed with a 'G' for the searches across GS and 'S' for those across Scopus (ie the use of KW search phrase '*lean thinking'* across Scopus is labelled 'SS3').

Figure 1. Overview of revised bibliographic analysis method



Any number of additional KW search phrases could have been added to increase the relevance of the identified population set, but some practical limit needed to be established. For example, we subsequently chose not to use the potential synonyms '*Japanese manufacturing'* or '*world class manufacturing'*. We likewise chose not to use any of the many Lean tool specific phrases such as '*kanban'*, *kaizen'* or '*SMED*'. This was because a 'sanity check' of the population set derived using G/SS1-6 revealed that these additional phrases would yield a diminishing marginal return of relevant publications; ie those with a high enough citation count to be included in the *Combined Population Set (CPS)* – see following. The only exception to this was Womack *et al*.'s seminal (1990) book entitled *The Machine That Changed the World*, which is the most highly cited of all Lean publications[1]. However, the authors decided that the inclusion of an additional KW search phrase specifically to include this single publication would represent an inappropriate distortion. This omission should therefore be recognised as a notable limitation.

Step 3 of the method was to now implement this KW search strategy. The six KW searches were first applied to GS. Each individual search (GS1-6) presented its results in the sequence of highest to lowest number of citations per publication. For some searches, thousands of publications were identified. The top 100 *most relevant* publications for *each* such search were then identified, and the full reference details copied into an Excel spreadsheet. This entailed reading the abstracts of each publication to ensure relevance to the Lean paradigm in question, until the 100 most highly cited relevant publications were identified. For example, many of the publications identified by GS6 '*Toyota'* concerned technical issues such as the Prius' power train rather than the Toyota Production System (synonym of Lean), and needed to be rejected for our purposes. The net result was 600 individual reference details contained within the spreadsheet. These were then merged and [the many] duplicate entries removed to form a *Google Scholar Population Set (GSPS)* of 143 unique Lean publication reference details; ranked in descending total GS citations sequence. The KW search strategy implementation exercise was then repeated within Scopus (SS1-6) to yield a further 600 individual reference details, which were copied into a separate spreadsheet. Again, these were merged and the duplicates removed to form a *Scopus Population Set (SSPS)* of 143 unique Lean academic journal paper reference details; ranked in descending total SS citations sequence.

Step 4 was to combine the GSPS and SSPS to form the *Combined Population Set (CPS).* Where a [journal paper] publication appeared in both the GSPS and SSPS, its GS and SS citation counts were *added together* to form a *total citations* figure. This is contentious as there is a clear risk of 'double counting' some of the same citation sources. However, due to the number of citations attributed to each of the publications that made it into the CPS, it was not practical to deconstruct and compare these sources. It was also felt that this simple cumulation of the two database citation totals would reflect the importance of those publications that were influential enough to have been included in both database population sets. After the above exercise was completed, there were 213 unique publication details remaining in the CPS.

Step 5 was a simple process that involved ranking the CPS in descending total citations sequence, then copying the top 50 most highly cited into a separate Excel spreadsheet to form the *Focal Population Set (FPS).* This marked the start of Step 6, which involved establishing the structure and content of the data fields summarised in Figure 2 for every FPS publication. The *IDENTIFICATION* and *REFERENCE DETAILS* were yielded during the course of the previous steps.

[1] 13,376 citations on Google Scholar when checked on 02/02/2016.

However, characterisation of the subsequent data fields necessitated additional processing. Completion of the *ABS (2015) DETAILS* simply required reference to ABS (2015) for each journal paper concerned. The remaining details required more extensive effort.

Table 1. The focal population set (FPS) record structure

FIELD	**COMMENT**
IDENTIFICATION DETAILS	
Rank number (total citations)	Rank 1-50 based upon *Total citations* figure.
Total citations	*GSPS total citations* + *SSPS total citations*.
Rank number (average citations per annum)	Rank 1-50 based upon *Average citations per annum* figure.
Average citations per annum	*Total citations* / number of years since year of publication.
GSPS rank number	Publication rank posn. within GSPS (based on *GSPS total citations*).
GSPS total citations	Total citations identified within GS for this publication.
GS source search	Source GS search that identified this publication (GS1-GS6).
SSPS rank number	Publication rank posn. within SSPS (based on *SSPS total citations*).
SSPS total citations	Total citations identified within SS for this publication.
SS source search	Source SS search that identified this publication (SS1-SS6).
REFERENCE DETAILS	
Authors	List of authors in Harvard format (surname, initials).
Year	Year of publication.
Publication title	The title of the book, paper.
Publication details	Publisher, place, journal title, volume, issue, pages, etc.
Publication type	'Book' or 'Journal Paper'.
Journal acronym	Unique acronym for journal title, if publication type 'Journal Paper'.
ABS (2015) DETAILS	
Listed?	Is the journal title listed in ABS (2015)?
Journal rank	The journal rank (1-4*) if the journal title is listed in ABS (2015).
Journal subject area	The journal subject area if the journal title is listed in ABS (2015).
FOCAL SUBJECT MATTER DETAILS	
Focal criterion	The focal criterion discussed (eg 'model changeovers').
Lean aspect	Aspect of Lean discussed (eg 'Application', 'Paradigm' or 'Tools').
Geographic context	The geographic location of fieldwork.
Sector/ industry domain	The sector/ industry within which the fieldwork was undertaken.
METHODOLOGICAL DETAILS	
Publication category	Based on the 'Article type' classification used by Emerald.
Methodological disclosure	Degree to which methods/ procedures explained/ justified.
Research strategy	Methodological strategy claimed (eg 'Case' or 'Survey').
Data collection instruments (DCIs)	List and number of data collection instruments (DCIs) used.
Type of data collected	Overarching approach ('Qualitative', 'Quantitative' or 'Mixed/ Both').
Type of data source	'Primary only', 'Secondary only', 'Primary & Secondary', 'Theoretical'.
Amount of source data	Actual data derived via the DCIs (extend of evidence base).
List of informants/ types	List and classification of informants (eg 'Executives', 'Managers' etc).
CONCLUSIONS	
Position/ conclusions on Lean	Position adopted on *Lean aspect* discussed within the publication ('Positive', 'Negative', 'Indeterminate').

Each of the 50 FPS publications was read then systematically scanned. Using the 'comment' feature of Excel, every sentence that was possibly pertinent to each of the remaining field entries was cut and pasted from the source publication into the spreadsheet cell comment space in order to form an 'evidence base' per publication/ field. On completion of this exercise, the authors were then able to establish the final content per field with reference to this evidence. For some of these fields, such as *Data collection instruments (DCIs)*, this entailed merely paraphrasing the evidence pasted into the associated cell comment space. However, for others, it necessitated the development and application of a taxonomy. For example, the development of the 'None', 'Partial' and 'Comprehensive' categories for the *Methodological disclosure* exhibited by a publication, along with the criteria for classifying each. Such an undertaking is by nature a subjective exercise. Therefore to maximise consistency, all such criteria were made explicit and transparent, and three independent iterations of this classification exercise were conducted by the authors to finalise the characterisation of the FPS that was analysed in Step 7 of the method summarised in Figure 1.

3. DISCUSSION

The KW search strategy developed and applied during Step 2-3 of the above method underscored the sheer scale of the Lean literature in terms of the number of 'hits' (publications matching the search criteria) achieved using each KW search query. These are summarised in Table 2, along with the associated hits for each query when 'anywhere in the article' rather than 'in the title of the article' was used as the exact phrase match criterion. This table clearly reveals that the citations indexed in GS are of a significantly larger scale than Scopus. It also reveals that hits achieved for each phrase are proportionally comparable between GS and SS in each case.

Table 2. Scale of the lean literature

	IN THE TITLE OF THE ARTICLE (About …)	ANYWHERE IN THE ARTICLE (About …)
GOOGLE SCHOLAR (GS1-6)		
GS1 (*Lean manufacturing*)	2,090	35,300
GS2 (*Lean production*)	1,470	54,400
GS3 (*Lean thinking*)	617	20,400
GS4 (*Lean management*)	1,020	22,800
GS5 (*Value stream*)	831	22,800
GS6 (*Toyota*)	2,630	429,000
SCOPUS (SS1-6)		
SS1 (*Lean manufacturing*)	391	1,944
SS2 (*Lean production*)	381	4,700
SS3 (*Lean thinking*)	143	569
SS4 (*Lean management*)	311	4,049
SS5 (*Value stream*)	200	11,013
SS6 (*Toyota*)	328	1,218

The 213 publications represented in the CPS established in Step 4 represented a total of 68,950 citations. This was composed of 32 books (15%) yielding 25,055 citations (36%), 3 conference papers (1%) yielding 305 citations (0.5%), 2 reports (1%) yielding 241 citations (0.5%) and 176 journal papers (83%) drawn from 91 separate journal titles yielding 43,349 citations (63%).

By contrast, the 50 publications of the FPS established in Step 5 of the method represented a total of 52,745 citations (equivalent to 77% of the CPS total). The FPS was composed of 14 books (28%) yielding 22,877 citations (43%) and 36

journal papers (72%) yielding 29,868 citations (57%). There were no conference papers or reports. The key identification and reference details of the FPS are summarised in Table 3. Those [journal papers] that were identified via both GS and Scopus are highlighted in bold.

Table 3. Top 50 most highly cited Lean publications

RANK NO.	TOTAL CITATIONS	AUTHOR(S)	YEAR	PUBLICATION TITLE	PUBLICATION DETAILS
1	6,729	Womack, J.P. and Jones, D.T.	1996, 2010	*Lean Thinking: Banish Waste and Create Wealth in your Corporation*	Simon & Schuster: New York
2	**4,751**	**Dyer, J and Nobeoka, K**	**2000**	**Creating and managing a high performance knowledge-sharing network: the Toyota case**	***Strategic Management Journal,* 21(3), pp.345-367.**
3	4,329	Ohno, T	1988	*Toyota Production System: Beyond Large-Scale Production*	Productivity Press: New York
4	3,747	Liker, JK	2005	*The Toyota Way*	McGraw-Hill: New York
5	**1,920**	**Shah, R and Ward, PT**	**2003**	**Lean manufacturing: context, practice bundles, and performance**	***Journal of Operations Management,* 21(2), pp.129-149**
6	**1,804**	**Naylor, B, Naim, MM and Berry, D**	**1999**	**Leagility: integrating the lean and agile manufacturing paradigms in the total supply chain**	***International Journal of Operations and Production Management,* 62(1-2), pp.107-118.**
7	1,679	Monden, Y	2011	*Toyota Production System: An Integrated Approach to Just-In-Time*	4th ed, CRC Press: Boca Raton, Florida
8	1,545	Shingo, S	1989	*A Study of the Toyota Production System: From an Industrial Engineering Viewpoint*	Productivity Press: New York
9	**1,520**	**Adler, PS, Goldoftas, B and Levine, DI**	**1999**	Flexibility versus efficiency? A case study of model changeovers in the Toyota production system	***Organization Science,* 10(1), pp.43-68.**
10	**1,317**	**Hines, P., Holweg, M. and Rich, N.**	**2004**	**Learning to evolve: a review of contemporary lean thinking**	***International Journal of Operations and Production Management,* 24(10), pp.994-1011**
11	1,310	Spear, S and Bowen, HK	1999	Decoding the DNA of the Toyota Production System	*Harvard Business Review,* Sept-October, 77(5), pp.96-106.
12	**1,297**	**Sugimori, Y, Kusunoki, F, , Cho, F and Uchikawa, S**	**1977**	**Toyota production system and kanban system materialization of just-in-time and respect-for-human system**	***International Journal of Production Research,* 15(6), pp.553-564**
13	**1,286**	**Shah, R. and Ward, P.T.**	**2007**	**Defining and developing measures of lean production**	***Journal of Operations Management,* 25(4), pp.785-805**
14	1,259	Rother, M and Shook, J	2003	*Learning to See: Value Stream Mapping to Add Value and Eliminate Muda*	The Lean Enterprise Institute: Cambridge, MA.
15	**1,040**	**Holweg, M**	**2007**	**The genealogy of lean production**	***Journal of Operations Management,* 25(2), pp.420-437**
16	972	Krafcik, JF	1988	Triumph of the Lean Production System	*Sloan Management Review,* 30 (1), pp.41-52.
17	**950**	**Hines, P and Rich, N**	**1997**	**The seven value stream mapping tools**	***International Journal of Operations and Production Management,* 17(1), pp.46-64.**
18	**828**	**Abdulmalek, FA and Rajgopal, J**	**2007**	**Analyzing the benefits of lean manufacturing and value stream mapping via simulation: a process sector case study**	***International Journal of Production Economics,* 107(1), pp.223-236.**
19	**779**	**Davies, A**	**2004**	**Moving base into high-value integrated solutions: a value stream approach**	***Industrial and Corporate Change,* 13(5), pp.727-756.**
20	**750**	**King, AA and Lenox, MJ**	**2001**	**Lean and green? An empirical examination of the relationship between lean production and environmental performance**	***Production and Operations Management,* 10(3), pp.244-256**
21	681	Morgan, JM and Liker, JK	2006	*The Toyota Product Development System*	Productivity Press: New York
22	659	Ward, A, Liker, JK, Cristiano, JJ and Sobek II, DK	1995	The second Toyota paradox: how delaying decisions can make better cars faster	*MIT Sloan Management Review, Spring,* 36(3), pp.43-61
23	**658**	**Karlsson, C and Ahlstrom, P**	**1996**	**Assessing changes towards lean production**	***International Journal of Operations and Production Management,* 16(2), pp.24-41.**

24	**646**	**Landsbergis, PA, Cahill, J and Schnall, O**	**1999**	**The impact of lean production and related new systems of work organization on worker health.**	***Journal of Occupational Health Psychology,* 4(2), pp.108-130.**
25	**640**	**Bruce, M, Daly, L and Towers, N**	**2004**	**Lean or agile: a solution for supply chain management in the textiles and clothing industry?**	***International Journal of Operations and Production Management,* 24(2), pp.151-170.**
26	583	Liker, JK and Meier, D	2006	*The Toyota Way Fieldbook*	McGraw-Hill: New York
27	**522**	**MacDuffie, JP and Helper, S**	**2002**	**Creating lean suppliers: Diffusing lean production through the supply chain.**	***California Management Review,* 39(4), pp.118-151.**
28	**494**	**Lewis, MA**	**2000**	**Lean production and sustainable competitive advantage**	***International Journal of Operations and Production Management,* 20(8), pp.959-978.**
29	492	Cusumano, MA and Nobeoka, K	1998	*Thinking Beyond Lean: How Multi-Project Management Is Transforming Product Development at Toyota and Other Companies*	The Free Press: New York
30	**464**	**Spear, SJ**	**2004**	**Learning to lead at Toyota**	***Harvard Business Review,* May, 82(5), pp.78-86.**
31	452	Berggren, C	1993	*Alternatives to lean production: Work organization in the Swedish auto industry*	Cornell University Press: Ithaca, NY.
32	421	Dennis, P	2007	*Lean Production Simplified: A Plain-Language Guide to the World's Most Powerful Production System*	2nd ed., Productivity Press: New York
33	**451**	**Bowen, DE and Youngdahl, WE**	**1998**	**"Lean" service: in defense of a production-line approach**	***International Journal of Service Industry Management,* 9(3), pp.207-225.**
34	**407**	**Parker, SK**	**2003**	**Longitudinal effects of lean production on employee outcomes and the mediating role of work characteristics**	***Journal of Applied Psychology,* 88(4), pp.620-634**
35	430	Dahlgaard, JJ and Dahlgaard-Park, SM	2006	Lean production, six sigma quality, TQM and company culture	*TQM Magazine,* 18(3), pp.263-281
36	**394**	**Pettersen, J**	**2009**	**Defining lean production: some conceptual and practical issues**	***The TQM Journal,* 21(2), pp.127-142**
37	**390**	**Sako, M**	**2004**	**Supplier development at Honda, Nissan and Toyota: comparative case studies of organizational capability enhancement**	***Industrial and Corporate Change,* 13(2), pp.281-308.**
38	387	Arnheiter, ED and Maleyeff, J	2005	The integration of lean management and six sigma	*TQM Magazine,* 17(1), pp.5-18
39	382	Feld, WM	2000	*Lean Manufacturing: Tools, Techniques, and How to Use Them*	CRC Press: Boca Raton, FL
40	**366**	**De Treville, S and Antonakis, J**	**2006**	**Could lean production job design be intrinsically motivating? Contextual, configurational, and levels-of-analysis issues**	***Journal of Operations Management,* 24(2), pp.99-123**
41	**354**	**Pavnaskar, SJ, Gershenson, JK and Jambekar, AB**	**2003**	**Classification scheme for lean manufacturing tools**	***International Journal of Production Research, 41(13), pp.3075-3090***
42	**347**	**Yang, MGM, Hong, P and Modi, SB**	**2011**	**Impact of lean manufacturing and environmental management on business performance: an empirical study of manufacturing firms**	***International Journal of Production Research,* 129(2), pp.251-261**
43	327	Rinehart, JW, Huxley, CV and Robertson, D	1997	*Just another car factory?: Lean production and its discontents*	Cornell University Press: Ithaca, NY.
44	319	Womack, JP and Jones, DT	1996	Beyond Toyota: how to root out waste and pursue perfection	*Harvard Business Review, Sept-October, 74(5), pp.140-158*
45	**312**	**Liker, JK and Morgan, JM**	**2006**	**The Toyota way in services: the case of lean product development**	***The Academy of Management Perspectives,* May, 20(2), pp.5-20.**
46	**310**	**Lincoln, JR, Ahmadjian, CL and Eliot, M**	**1998**	**Organizational learning and purchase-supply relations in Japan: Hitachi, Matsushita, and Toyota compared**	***California Management Review,* Spring, 40(3), pp.241-264.**
47	**309**	**Forza, C**	**1996**	**Work organization in lean production and traditional plants: what are the differences?**	***International Journal of Operations and Production Management,* 16(2), pp.42-62.**
48	304	Liker, JK and Hoseus, M	2008	*Toyota Culture*	McGraw-Hill: New York

49	303	Melton, T	2005	The benefits of lean manufacturing: what lean thinking has to offer the process industries	*Chemical Engineering Research and Design,* 83(6), pp.662-673.
50	**301**	**King, D.L., Ben-Tovim, D. and Bassham, J.**	**2006**	**Redesigning emergency department patient flows: application of Lean Thinking to health care**	***Emergency Medicine Australasia,* 18(4), pp. 391-397**

4. CONCLUSIONS

As indicated in the Introduction to this paper, the analysis and hence conclusions drawn will be detailed during the ISL'16 conference presentation session at Kaohsiung. However, even the brief summary statistics presented in the previous section lead us to conclude that the Lean literature is indeed vast and continuing to grow, underlining its continuing influence within the field of operations and supply chain management. The proportion of the FPS made up of academic journal papers (72%) was a genuine surprise, and seems in conflict to the claim made by some commentators that the Lean paradigm is inherently a-theoretical in nature. However, by contrast the [citation] influence of the books contained within the FPS is in no doubt, as the average number of citation per book was 1,634 as opposed to an average of 830 citations per journal paper (nearly twice as much). Interestingly these books were overwhelmingly categorised as 'Viewpoints' (journalistic opinion pieces). This dichotomy and other issues will be explored in more detail at Kaohsiung.

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