Evolution of the Intellectual Structure of Operations Management: A Citation/Co-Citation Analysis

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Alan Pilkington: Research Areas

- Operations Management
- Innovation and Technology Management
- Bibliometrics – citation/co-citation analysis
  - Patent Analysis – key inventors, networks
  - OM discourses work
  - Alliances and joint ventures:
    - learning and operations practice transfer
  - Fuel cell innovation networks
- Enterprise Engineering
  - http://personal.rhul.ac.uk/uhtm/001/homepage.html

Introduction

- Overview of Bibliometric analysis
  - "field's view of itself" (White and Griffith, 1980)
- Illustrative study: Exactly what is OM?
- Pilkington and Meredith, "The Evolution of the Intellectual Structure of Operations Management—1980-2006: A Citation/Co-Citation Analysis," *JOM* (2009), 27 (3) pp.185-202.

Referencing Software

- To collect, manage and publish reference lists
- All software is very similar in function
  - EndNote – needs to be installed on PC
  - Refworks – on line via browser
  - JabRef – open source
  - Can import and export between these very easily
- Barrier was getting the information in…
- Now can import full information direct from databases:
  - SCOPUS
  - ZETOC
  - Other databases

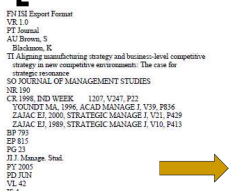
Bibliometrics: definition

- Scientific study of data in literature
- Patent citation analysis
  - Provides map of how technology develops
  - Linkages between
    - Technology fields
    - Inventors
    - Firms
- Citation study of literature
  - Main contributors
  - Ranking of journals
  - Themes and how they emerge

Bibliometrics: data

- Data sources
  - ISI Web of Science Citations Index
  - Patent databases
  - Any other source
- Analyse the publications themselves
  - Authors/co-authors
  - Titles
  - Keywords
  - Abstract words
- Analyse Citations
  - Frequencies and patterns

ISI Raw Data to tagged format



Tools to help: Bibexcel, SITKIS
Tutorial:
http://www4.rhbnc.ac.uk/~uhtm001/bibexcel-primer.pdf

Data Preparation - standardise

- Author names
  - How many initials?
- Journal/Book Title Variations
  - Many different ways need correcting
- Book editions
  - Hair et al, 1985, 1991, 1993, 1999...
- Use search and replace routines based on ranked frequency lists
- Construct database/excel files to analyse

Bibliometrics: measures

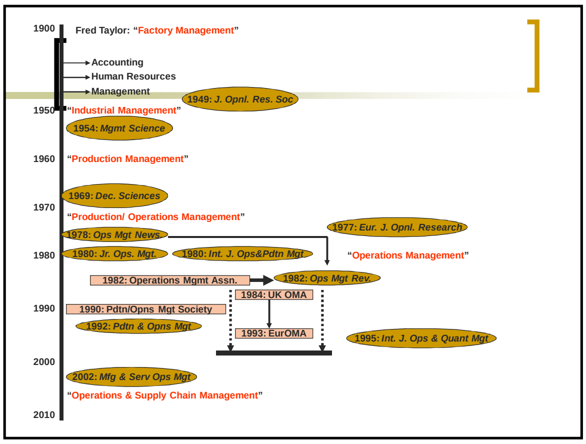
- Many different ways to examine data
  - Frequency tables and rankings
  - Groups in the data: Co-words, -authors, -citation frequency networks
    - Inter- and intra- discipline linkage
    - Concentrations of themes and their relations
  - Bibliometric coupling
    - How close are papers based on common citations
- Some Measures
  - Journal impact factor
    - No. citations relative to number of articles published
    - Compare size of waves made by journal compared to others
  - Immediacy index
    - Initial rate of citation
    - How quick are ideas spreading?
  - Citation half-life
    - How long does the impact last?

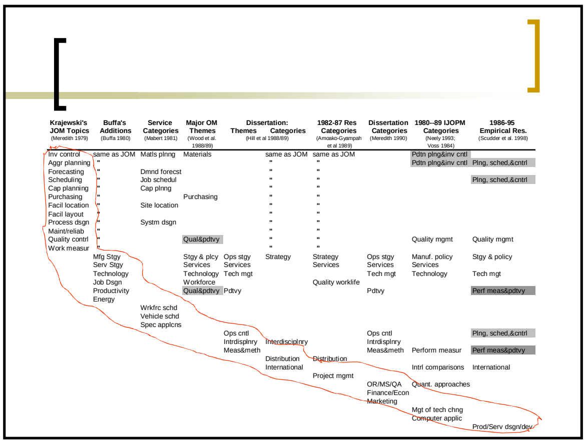
Analysis tools

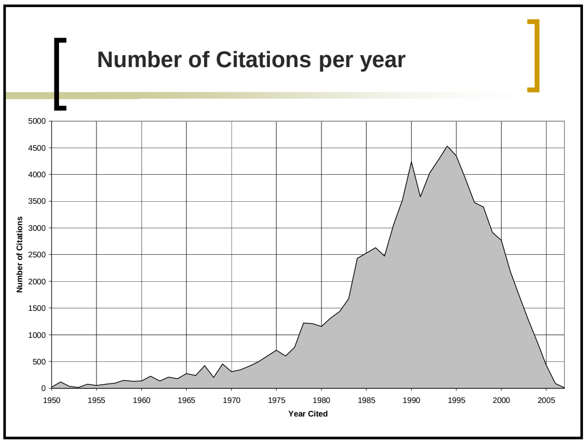
- Frequencies
  - Tables and rankings
- Network Data (co-citations, coupling, etc)
  - SPSS/SAS etc
    - Principal components
    - MDS
    - Clustering routines
  - UCINET/Netdraw/Pajek/Gephi
    - Network measures and graphs

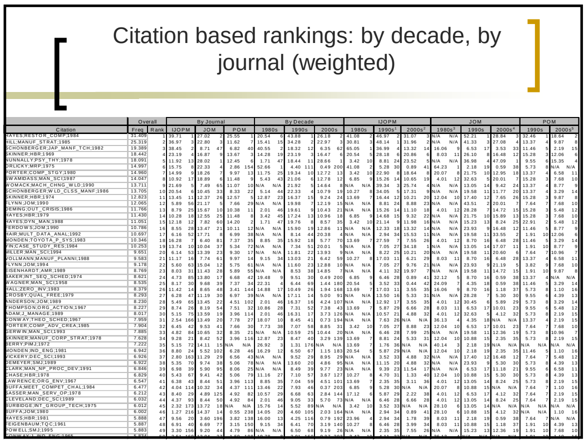
OM Study: Method and Data

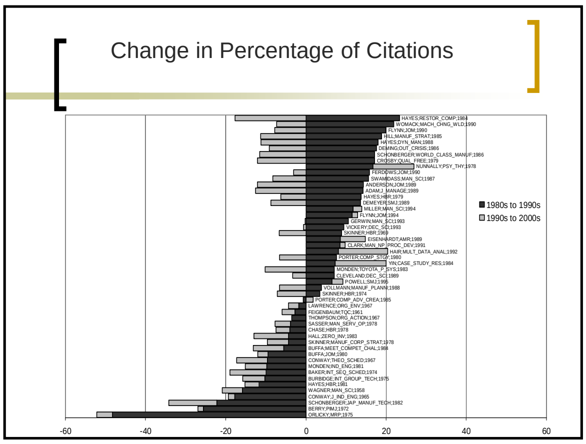
- Citation/co-citation analysis
- Full contents (1980 to 2006) of:
  - *JOM* and *IJOPM* and *POM* (started 1990)
- Sources:
  - Social Science Citations Index – not complete
  - Own generated – html, pdf's, import and convert
- Source articles: 2,978
- Giving 80,917 citations
- Data standardisation – missing data, spellings, book editions, author initials


1900
Fred Taylor: "Factory Management"
Accounting
Human Resources
Management
1949: J. Opnl. Res. Soc
1950
"Industrial Management"
1954: Mgmt Science
1960
"Production Management"
1969: Dec. Sciences
1970
"Production/ Operations Management"
1977: Eur. J. Opnl. Research
1978: Ops Mgt News
1980
1980: Jr. Ops. Mgt.
1980: Int. J. Ops&Pdtn Mgt
"Operations Management"
1982: Operations Mgmt Assn.
1982: Ops Mgt Rev.
1984: UK OMA
1990
1990: Pdtn/Opns Mgt Society
1992: Pdtn & Opns Mgt
1993: EurOMA
1995: Int. J. Ops & Quant Mgt
2000
2002: Mfg & Serv Ops Mgt
"Operations & Supply Chain Management"
2010


Krajewski's JOM Topics (Meredith 1979)
Buffa's Additions (Buffa 1980)
Service Categories (Mabert 1981)
Major OM Themes (Wood et al. 1988/89)
Dissertation: Themes Categories (Hill et al 1988/89)
1982-87 Res Categories (Amoako-Gyampah et al 1989)
Dissertation Categories (Meredith 1990)
1980--89 IJOPM Categories (Neely 1993; Voss 1984)
1986-95 Empirical Res. (Scudder et al. 1998)
Inv control, Aggr planning, Forecasting, Scheduling, Cap planning, Purchasing, Facil location, Facil layout, Process dsgn, Maint/reliab, Quality contrl, Work measur
same as JOM
Matls plnng, Dmnd forecst, Job schedul, Cap plnng, Site location, Systm dsgn
Materials, Purchasing, Qual&pdtvy
Pdtn plng&inv cntl
Plng, sched,&cntrl
Quality mgmt
Mfg Stgy, Serv Stgy, Technology, Job Dsgn, Productivity, Energy
Stgy & plcy, Services, Technology, Workforce, Qual&pdtvy
Ops stgy, Services, Tech mgt, Pdtvy
Strategy
Strategy, Services, Quality worklife
Ops stgy, Services, Tech mgt, Pdtvy
Manuf. policy, Services, Technology
Stgy & policy, Tech mgt, Perf meas&pdtvy
Wrkfrc schd, Vehicle schd, Spec applcns
Ops cntl, Intrdisplnry, Meas&meth
Interdisciplnry, Distribution, International
Distribution, Project mgmt
Ops cntl, Intrdisplnry, Meas&meth
Perform measur, Intrl comparisons, International
OR/MS/QA, Finance/Econ, Marketing
Quant. approaches
Mgt of tech chng, Computer applic
Prod/Serv dsgn/dev







Example: Co-citation matrix

	AAKER (1989)	ABERNATHY (1985)	ABERNATHY (1978)	ALLEN (1977)	AMIT (1993)	ANSOFF (1966)	ANSOFF (1990)
AAKER (1989)	XXX						
ABERNATHY (1985)	0	XXX					
ABERNATHY (1978)	0	1	XXX				
ALLEN (1977)	0	1	0	XXX			
AMIT (1993)	3	0	0	0	XXX		
ANSOFF (1966)	2	0	0	0	1	XXX	
ANSOFF (1990)	0	0	0	0	0	2	XXX
ARCHIBUGI (1992)	0	0	0	0	0	0	0
ARGYRIS (1978)	3	0	0	0	5	0	0
BARNEY (1991)	4	0	0	0	4	2	0

Analysis Procedures: Network, MDS or PC analysis of matrix

Citation/co-citation values (weighted)

Publication	Citation Frequency	Maximum Co-citation Value	Publication Most Co-cited With
HAYES;RESTOR_COMP;1984	31.4	15.3	HILL;MANUF_STRAT;1985
HILL;MANUF_STRAT;1985	25.3	15.3	HAYES;RESTOR_COMP;1984
SCHONBERGER;JAP_MANUF_TECH;1982	19.4	3.6	SCHONBERGER;WORLD_CLASS_MAN;1986
SKINNER;HBR;1969	18.4	12.2	HAYES;RESTOR_COMP;1984
NUNNALLY;PSY_THY;1978	18.1	7.1	HAIR;MULT_DATA_ANAL;1992
ORLICKY;MRP;1975	15.0	2.2	CRONBACH;PSYCHOMETRIKA;1951
PORTER;COMP_STGY;1980	15.0	8.1	HAYES;RESTOR_COMP;1984
SWAMIDASS;MAN_SCI;1987	14.0	9.5	HAYES;RESTOR_COMP;1984
WOMACK;MACH_CHNG_WLD;1990	13.7	5.0	HAYES;RESTOR_COMP;1984
SCHONBERGER;WORLD_CLASS_MANUF;1986	13.7	5.4	HAYES;RESTOR_COMP;1984
SKINNER;HBR;1974	12.8	7.5	HAYES;RESTOR_COMP;1984
FLYNN;JOM;1990	12.1	4.6	NUNNALLY;PSY_THY;1978
DEMING;OUT_CRISIS;1986	11.8	6.0	CROSBY;QUAL_FREE;1979
HAYES;HBR;1979	11.4	5.3	HAYES;RESTOR_COMP;1984
HAYES;DYN_MAN;1988	11.1	5.9	HAYES;RESTOR_COMP;1984
FERDOWS;JOM;1990	10.8	6.9	HAYES;RESTOR_COMP;1984
HAIR;MULT_DATA_ANAL;1992	10.7	7.1	NUNNALLY;PSY_THY;1978
MONDEN;TOYOTA_P_SYS;1983	10.3	3.5	SCHONBERGER;JAP_MANUF_TECH;1982
YIN;CASE_STUDY_RES;1984	10.3	5.4	EISENHARDT;AMR;1989
MILLER;MAN_SCI;1994	9.7	6.7	HAYES;RESTOR_COMP;1984
VOLLMANN;MANUF_PLANNI;1988	9.6	1.5	HILL;MANUF_STRAT;1985
FLYNN;JOM;1994	9.2	4.9	NUNNALLY;PSY_THY;1978
EISENHARDT;AMR;1989	8.8	5.4	YIN;CASE_STUDY_RES;1984
BAKER;INT_SEQ_SCHED;1974	8.6	1.1	BAKER;JOM;1981
WAGNER;MAN_SCI;1958	8.5	2.1	OLEARY;KELLY;JOM;1998
HALL;ZERO_INV;1983	8.4	2.1	SCHONBERGER;JAP_MANUF_TECH;1982
CROSBY;QUAL_FREE;1979	8.3	6.0	DEMING;OUT_CRISIS;1986
ANDERSON;JOM;1989	8.2	5.2	HAYES;RESTOR_COMP;1984
THOMPSON;ORG_ACTION;1967	8.2	2.5	HAYES;RESTOR_COMP;1984
ADAM;J_MANAGE;1989	8.0	4.8	HAYES;RESTOR_COMP;1984
CONWAY;THEO_SCHED;1967	8.0	1.9	SKINNER;HBR;1969
PORTER;COMP_ADV_CREA;1985	7.9	2.7	HAYES;RESTOR_COMP;1984
GERWIN;MAN_SCI;1993	7.9	5.3	SWAMIDASS;MAN_SCI;1987
SKINNER;MANUF_CORP_STRAT;1978	7.6	3.5	HAYES;RESTOR_COMP;1984

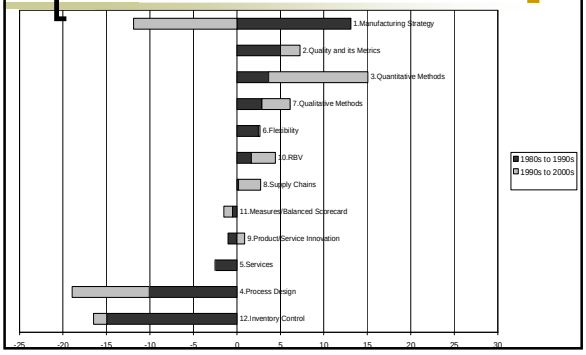
Factor Analysis of Co-citation Matrix

Loading of Citations onto Factor Groupings (% and rank order)

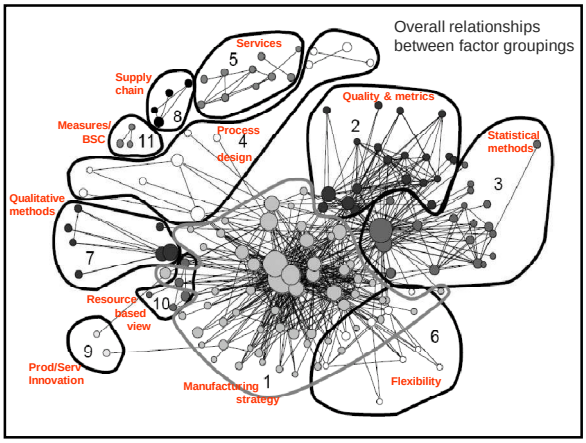
	Overall	By Decade			IJOPM	JOM	POM	IJOPM			JOM			POM		
Factor Name (cum var expl. %)	Total	Rank	1980-89	1990-99	2000-06				1980-89	1990-99	2000-06	1980-89	1990-99	2000-06	1990-99	2000-06
1.Manufacturing Strategy (25)	44.2%	1	39.1	1	52.2	1	40.3	1	46.3	1	41.6	1	43.7	1	42.4	1	52.3	1	41.8	1	34.3	1	51.9	-1	39.1	1	51.9	1	39.3	1
2.Quality and its Metrics (35)	11.0%	3	4.7	5	9.7	3	11.9	3	8.4	3	13.7	3	13.3	2	4.0	9	7.6	3	9.2	3	5.7	5	15.2	2	13.6	3	10.0	3	15.1	2
3.Quantitative Methods (43)	11.2%	2	0.4	10	4.1	4	15.5	2	6.5	4	19.0	2	7.7	4	0.7	9	2.4	7	10.1	2	0.0	9	8.8	3	22.5	2	3.7	7	9.8	3
4.Process Design (49)	9.5%	4	25.0	2	14.9	2	6.1	5	13.7	2	4.7	4	7.3	5	27.2	2	19.4	2	8.4	4	21.9	2	4.6	5	4.1	5	11.6	2	4.9	6
5.Services (54)	3.8%	6	6.3	4	3.8	5	3.7	8	2.6	10	3.9	6	8.1	3	7.9	4	2.8	5	2.1	10	3.8	6	4.1	6	3.9	6	7.4	4	8.4	4
6.Flexibility (59)	3.3%	8	0.8	9	3.3	6	3.5	9	3.2	8	3.4	7	3.4	7	1.3	8	2.8	6	3.6	9	0.0	12	4.1	7	3.4	7	3.9	6	3.1	9
7.Qualitative Methods (62)	4.9%	5	0.0	11	2.9	8	6.1	4	5.6	5	4.6	5	3.2	8	0.0	10	2.4	8	8.3	5	0.0	10	5.6	4	4.5	4	0.7	11	4.5	7
8.Supply Chains (65)	3.0%	9	1.2	8	1.4	11	3.9	7	3.0	9	2.4	9	4.5	6	1.3	7	1.9	9	4.0	8	1.0	8	0.6	12	3.0	9	0.5	12	6.7	5
9.Product/Service Innovation (67)	1.9%	11	2.3	7	1.3	12	2.2	10	1.4	11	2.3	10	2.8	10	2.0	6	1.2	12	1.5	11	2.9	7	1.7	8	2.5	10	1.2	10	3.7	8
10.RBV (70)	3.4%	7	0.0	12	1.7	10	4.4	6	4.3	6	2.6	8	2.2	11	0.0	11	1.8	10	6.5	6	0.0	11	1.3	9	3.0	8	1.9	8	2.4	10
11.Measures/Balanced Scorecard (71)	2.4%	10	3.5	6	3.0	7	2.0	11	4.0	7	0.7	12	1.1	12	0.0	12	3.9	4	4.2	7	8.6	4	1.1	10	0.3	11	1.9	9	0.6	12
12.Inventory Control (73)	1.3%	12	16.8	3	1.9	9	0.3	12	1.1	12	1.0	11	2.9	9	13.2	3	1.3	11	0.2	12	21.9	3	1.0	11	0.2	12	5.6	5	1.4	11
Chi-square: ns=not sig., s=sig. at 0.000					ns;80		ns;90		s;J,P		s;I,P		s;I,J		ns;80		s;J,P90		s;J,P00		ns;80		s;I,P90		s;I,P00		s;I,J90		s;I,J00	

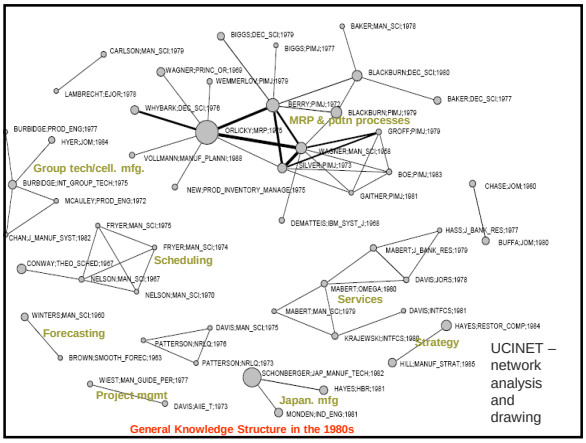
Factor Table: KMO measure of sampling adequacy = 0.202; Bartlett's test of sphericity: approx. chi-square = 27592, df = 9730, sig = 0.000

Percentage Change in Factor Groups



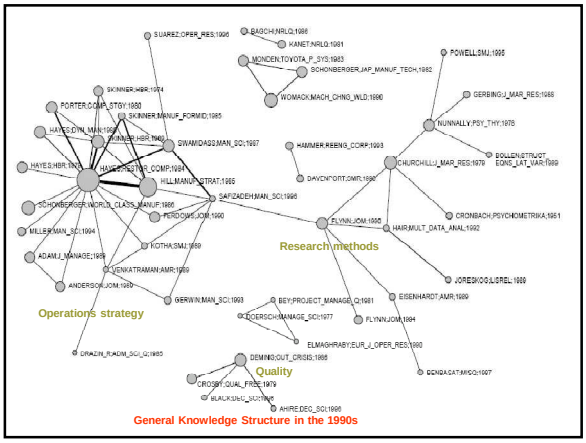
Overall relationships between factor groupings



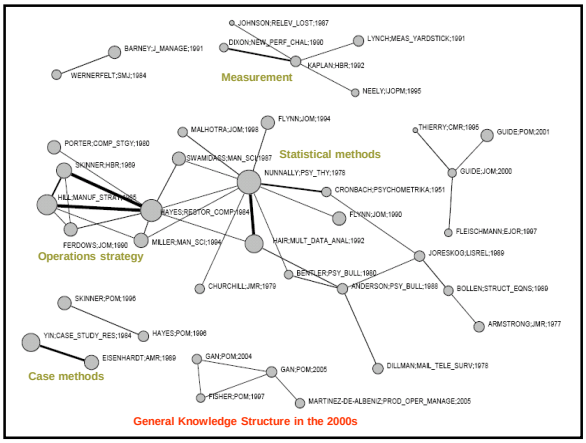


General Knowledge Structure in the 1980s

UCINET – network analysis and drawing



General Knowledge Structure in the 1990s



General Knowledge Structure in the 2000s

Tips for getting cited

- No substitute for publishing in the top journals
  - If looking at 2nd tier (i.e. none FT-40 list), ensure journal is indexed full text in one of the big databases
- Review type articles are easily cited as they justify many arguments
- Tell everyone about the article, including personal web pages, citeulike, etc.

Conclusions

- Citation/co-citation provides field's view of itself
- Intellectual structure of OM
  - 12 areas identified
  - Shift away from Inventory and process design
  - Focus towards robust research methods and integrated ideas (SCM)
  - Manufacturing strategy lost importance recently
- OM journals have different focus
- Future work: location of OM within the journal space – where is OM cited outside OM?