Mapping Intermodal Transportation Through Bibliometrics

Sanjeev Kadam, Prabir Kumar Bandyopadhyay

Abstract—Almost every business operation necessitates the use of intermodal transportation at some stage in the supply chain. This study is aimed to map reputation and interconnectedness among existing literature in the area of intermodal transportation. For this purpose, firstly, bibliometric data of 1758 documents are retrieved using keyword ‘intermodal transportation’ from the Scopus database. Data has been processed to build bibliometrics between publications, authors, co-authors, sources, citations, affiliation, country of origin. Secondly, the reputation of literature in intermodal transportation being surveyed using citation and network analysis. Finally, considering citations literature of highly cited was reviewed. Opensource software such as table2net, sciencescape, gephi, has been used to build network diagrams. The outcome of this research would lay the groundwork to pursue detailed study in the area of intermodal transportation. Some of the findings are; researchers from the US and Europe are leading in publishing researches in this field; ‘intermodal transportation’ and ‘intermodal transport’ are popular keywords among the research fraternity; ‘engineering’ and ‘social sciences’ are preferred subject areas; mostly transportation and operations research journals are preferred journals; and increasing trends have been observed in intermodal transportation research since 2005.

Keyword—Bibliometrics, citation, intermodal transportation, literature review, network diagram.

I. INTRODUCTION

Intermodal transportation is a process of transportation of passenger or goods from origin to destination using a combination of different transportation modes. Nowadays, almost every business operation necessitates the use of intermodal transportation at some stage in the supply chain. Supply and demand from international suppliers and customers are on the rise due to effective and efficient intermodal transportation in the supply chain. Transportation infrastructure development such as roads, ports, airports have brought revolution in logistics operational services across the world. Designing a highly responsive and highly efficient supply chain has become extremely important in freight transportation. World trade volume in 2017 increased by 3.6%, which is twice the growth rate in 2016. World container traffic (measured in TEU’s) and air freight tonne-km increased by 4.8% and 9.0% respectively in 2017.

No doubt, today’s logistics operations intermodal transportation observes many benefits over unimodal transportation. Generally, intermodal transportation utilises any one or more channels for transportation form origin to destination as shown in Fig. 1.

Fig. 1. Typical model of intermodal transportation

A. Objectives of the study:
The study is aimed:
1. To explore existence of academic research in intermodal transportation
2. To conduct citation and network analysis for intermodal transportation literature
3. To conduct systematic literature review of highly cited publications in intermodal transportation.
4. To pinpoint the scope of further research

B. Methodology of the study:
Firstly, 1758 publications were retrieved using ‘intermodal transportation’ as a basic keyword search in Scopus database as shown in Fig. 2.

Fig. 2 Keyword research methodology

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Secondly, this retrieved and refined database further analysed by using metrics such as geographical analysis, bibliometric analysis, citation analysis and network analysis. Finally, a systematic literature review will be conducted using leading publications from the leading journals to understand the strength of academic research in the intermodal transportation area.

II. MAPPING INTERMODAL TRANSPORTATION.

In this section geographic, bibliometrics, citations and network analysis has been discussed in detail.

A. Geographical analysis:

Table 1 shows the top 10 countries in intermodal transportation research. Researchers from the United States has more interest in intermodal transportation followed by China and Italy.

Table 1 Top 10 Countries in the area of intermodal transportation research

| Country        | Number of Publications | Country         | Number of Publications |
|----------------|------------------------|-----------------|------------------------|
| United States  | 522                    | Belgium         | 68                     |
| China          | 129                    | United Kingdom  | 67                     |
| Italy          | 118                    | Canada          | 58                     |
| Germany        | 101                    | Spain           | 51                     |
| Netherlands    | 78                     | France          | 49                     |

Fig. 3 is drawn using gpsvisualizer.com which demonstrates geographical locations of publications and researchers associated with intermodal transportation. The size of the circle indicates that the United States has the highest number of researchers and publications in the area of intermodal transportation.

C. Bibliometric analysis:

Table 2. Top 10 author statistics in intermodal transportation

| Author | Number of Publications |
|--------|------------------------|
| Caris, A. | 22                   |
| Macharis, C. | 19                |
| Janssens, G.K. | 17              |
| Anon    | 16                     |
| Dotoli, M. | 16                 |

Table 3. Top 10 keywords statistics in intermodal transportation

| Keywords | Number of Associated Publications |
|----------|-----------------------------------|
| Intermodal Transportation | 446                          |
| Freight | 158                          |
| Transportation | 336                          |
| Planning | 138                          |
| Containers | 322                          |
| Logistics | 266                          |
| Optimization | 195                          |

Table 4. Top 10 subject areas statistics in intermodal transportation

| Subject Area | Number of Associated Publications |
|--------------|-----------------------------------|
| Engineering  | 1064                              |
| Environmental Science | 176                          |
| Social Sciences | 817                          |
| Mathematics | 125                              |
| Computer Science | 360                          |
| Economics, Econometrics and Finance | 60                          |
| Decision Sciences | 214                          |
| Energy | 37                              |
| Business, Management and Accounting | 197                          |
| Earth and Planetary Sciences | 28                           |
| Engineering | 1064                              |
| Environmental Science | 176                          |

Fig. 4 reveals that in 1995 there were 76 publications which has fallen to 40 in 2005 and since then yearly publications in intermodal transportation is on rise as indicated by trendline.
Table 6 Top 10 source titles statistics in intermodal transportation

| Source Title                        | Number of Associated Publications | Source Title                        | Number of Associated Publications |
|-------------------------------------|------------------------------------|-------------------------------------|------------------------------------|
| Transportation Research Record      | 55                                 | Transportation Congress Proceedings | 29                                 |
| Transportation Research Part        | 48                                 | Transportation Research Part A       | 24                                 |
| E Logistics and Transportation      |                                    | Policy and Practice                 |                                    |
| Review                              |                                    |                                     |                                    |
| Journal of Transport Geography      | 38                                 | Transportation Planning and Technology | 22                                |
| Quarterly                            |                                    |                                     |                                    |
| Railway Gazette International       | 30                                 | Transport Means Proceedings of The International Conference | 20 |

Though USA tops the list of publications in intermodal transportation, the affiliation statistics shown in Table 7 reveals that, European universities are leading in affiliating researches in intermodal transportation.

Table 7 Top 10 affiliation statistics in intermodal transportation

| Affiliation           | Number of Associated Publications | Affiliation            | Number of Associated Publications |
|-----------------------|-----------------------------------|-------------------------|-----------------------------------|
| Delft University of   | 53                                | Vrije Universiteit Brussel, Belgium | 20 |
| Genoa, Italy          | 31                                | University of Zilina, Slovakia | 18 |
| Vilnius Gediminas    | 26                                | Mississippi State University, USA | 17 |
| Technical University, |                                    |                         |                                    |
| Lithuania             |                                    |                         |                                    |

Table 8 Yearly citations analysis for publications in intermodal transportation

| Year | Number of Citations |
|------|---------------------|
| <2009 | 1729 |
| 2009  | 456 |
| 2010  | 590 |
| 2011  | 752 |
| 2012  | 971 |
| 2013  | 1100 |
| 2014  | 1294 |
| 2015  | 1563 |
| 2016  | 1777 |
| 2017  | 2028 |
| 2018  | 2371 |
| >2018 | 159 |
| Total | 14790 |

Table 9 shows list of top 10 cited publications in the area of intermodal transportation

| Year | Publications Title                                      | Authors                  | Source Title                      | Number of Citations |
|------|--------------------------------------------------------|--------------------------|-----------------------------------|---------------------|
| 2004 | Opportunities for OR in intermodal freight transport research: A review | Macharis C., Bontekoning Y.M. | European Journal of Operational Research | 309 |
| 2004 | Is a new applied transportation research field emerging? - A review of intermodal rail-truck freight transport literature | Bontekoning Y.M., Macharis C., Trip J.J. | Transportation Research Part A: Policy and Practice | 253 |
| 2003 | Storage space allocation in container terminals         | Zhang C., Liu J., Wan Y.-W., Murty K.G., Linn R.J. | Transportation Research Part B: Methodological | 240 |
| 2007 | Modelling the full costs of an intermodal and roadfreight transport network | Janic M. | Transportation Research Part D: Transport and Environment | 206 |
| 2014 | Multimodal freight transportation planning: A literature review | Steadieeif M., Dellaert N.P., Nuijten W., Van Woensel T., Raoufi R. | European Journal of Operational Research | 173 |
| 1981 | Containerization and the load center concept.           | Hayat Y. | Economic Geography | 167 |
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| Year | Source Title | Authors | Journal Title | Total Citations |
|------|--------------|---------|---------------|---------------|
| 2004 | Modelling a railroad transportation system | Arnold P., Thomas I. Peeters D. | Transportation Research Part E: Logistics and Transportation Review | 152 |
| 2002 | Empty container management for intermodal transportation networks | Choong M.H., Kutanoglu E. | Transportation Research Part E: Logistics and Transportation Review | 143 |
| 2005 | Optimal location of intermodal freight hubs | Racunica I., Wynter L. | Transportation Research Part B: Methodological | 135 |
| 2000 | Intermodal and international freight network modeling | Southworth F., Peterson B.E. | Transportation Research Part C: Emerging Technologies | 133 |

Table 10 is a list of top 10 source titles in the area of intermodal transportation. ‘Transportation Research Part E: Logistics and Transportation Review’ is a topmost journal with 48 publications which have been cited 1441 times till date of retrieval of the data used for this research.

| Journal Title | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | Total |
|---------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|-----|------|
| Transportation Research Part E: Logistics and Transportation Review | 48   | 119  | 49   | 69   | 82   | 102  | 136  | 117  | 164  | 168  | 189  | 229  | 17   |      |      | 1441 |
| European Journal of Operational Research | 21   | 107  | 65   | 68   | 79   | 110  | 97   | 115  | 151  | 146  | 172  | 188  | 8    |      |      | 1306 |
| Transportation Research Part A: Policy and Practice | 25   | 102  | 42   | 48   | 55   | 75   | 77   | 99   | 97   | 110  | 124  | 115  | 7    |      |      | 951  |
| Transportation Research Part B: Methodological | 20   | 125  | 43   | 45   | 46   | 67   | 77   | 81   | 85   | 83   | 99   | 136  | 9    |      |      | 896  |
| Journal of Transport Geography | 38   | 43   | 17   | 19   | 40   | 51   | 69   | 86   | 100  | 138  | 136  | 171  | 17   |      |      | 887  |
| Transportation Planning and Technology | 22   | 40   | 10   | 24   | 44   | 53   | 36   | 62   | 59   | 61   | 64   | 47   | 3    |      |      | 503  |
| Transportation Research Part D: Transport and Environment | 19   | 42   | 16   | 20   | 29   | 39   | 32   | 38   | 57   | 66   | 74   | 84   | 2    |      |      | 499  |
| Transportation Science | 9    | 119  | 12   | 19   | 17   | 20   | 32   | 45   | 45   | 35   | 42   | 52   | 4    |      |      | 442  |
| Transport Policy | 19   | 10   | 8    | 20   | 13   | 11   | 25   | 45   | 58   | 86   | 61   | 88   | 5    |      |      | 430  |
| Computers and Operations Research | 7    | 13   | 6    | 11   | 25   | 28   | 37   | 42   | 48   | 51   | 58   | 74   | 4    |      |      | 397  |

**D. Network analysis:**

Network analysis is a graphical representation used to build the relationship between different statistical parameters. Open source software such as ‘ScienceScape’ and ‘Table2Net’ is used to build a basic network and in turn, is used as basic input for ‘gephi’. With the help of ‘gephi’ we can visualise and explore bibliometrics through graphs and networks. Fig. 5 represents an association between main authors, main keywords and main journals.
Fig. 6 is created using authors and author keywords, coappearing in the same papers with the following configuration:

Nodes: 3824 Edges: 11042; Filtering Mode: Remove nodes < 3 links; Disconnected nodes removed: 2358

Further, it is filtered manually setting degree filter to 15-323. It builds a network diagram shown in Fig. 6 with 160 nodes and 413 edges. It is evident that ‘Macharis, C’, ‘Caris, A’ and ‘Janssens, G.K’ are the prominent authors connected with the top keywords ‘intermodal transportation’ and ‘intermodal transport’ as shown in Fig. 6.
Fig. 7 shows association between authors and source titles, co-appearing in the same papers with the following configuration: Nodes: 374; Edges: 672; Filtering Mode: Remove nodes < 3 links; Disconnected nodes removed: 3476.

Further, it is filtered manually setting degree filter to 6-35. It builds a network diagram shown in Fig. 7 with 54 nodes and 96 edges.

In Fig. 7, comparatively big size of the fonts of source titles based on citations received by the publications ‘transportation research part e: logistics and transportation review’, ‘European journal of operational research’ and ‘journal of transport geography’ indicates topmost journals in intermodal transportation. However, despite having maximum number of publications but less citations source title ‘transportation research record’ could not be seen prominently in the network diagram.

Fig. 8, 9, 10, 11 & 12 are partially picked up from original network diagram generated using networks of authors linked by co-publication in intermodal transportation with the following configuration:

Nodes: 1333; Edges: 3013; Filtering Mode: Remove nodes < 3 links; Disconnected nodes removed: 1853.

The size of the fonts in these diagrams indicates the most prominent author linked in that network of co-author.
‘The issue, traffic, health, environment; intelligent solutions sustaining urban economies’ has been co-authored by 17 authors ‘Bouffier J., Wells A., Dibnah S., Cioloşko-Štyk A., Spallone F., Khoudour L., Goodyer E., Edwards C., Anand S., Converse D., Chiriči G., Lasserre B., Raventos T., Kwiatkowski P., Saari H.-K., Groom A., Corvino M.’ which have been reflected in Fig. 12 as a single network.

III. LITERATURE REVIEW

Top cited publications along with few other intermodal transportation publications had reviewed in this section.

Simulation of intermodal transport risks and costs have been studied by Lorenz and Kuznar (2017) considering three different variants through the supply chain. This help to identify risk and take appropriate action to reduce cost[6].

Roso et al., (2015) studied types of services for three seaport-inland port dyads in three different continents. Understanding of four standard services such as rail drayage transport, transhipment, storage, customs clearance and thirteen value added services such as cleaning, repair, inspection, quarantine, stripping and stuffing, empty container depots, reefer plugs, cross-docking, quality and inventory control, pre-assembly, packing/unpacking/repacking, freight forwarding, and non-drayage container haulage could be used as benchmark for inland ports for devising business portfolio[7].

Steadiesiefi et al., (2014) considered tactical, strategic and operational level issues and concluded that integrating different levels of planning might provide more reliability, flexibility, and more important sustainability, generating more efficient solutions for multimodal transport planning[8].

Metro cities need integrated transport systems consisting of different modes including bus, suburban trains, bicycles considering demand and topography of the area. These might help to improve travel time ratio, travel cost ratio and service ratio. Intermodal transfer facility plays a vital role in intermodal transportation. In metro cities public transport system should be integrated with many other systems such as park and ride facilities, integrated fare and ticketing strategies, quality interchange system and passenger information system. It is necessary that all integrated systems should complement not compete (Shrivastava and O’Mahony, 2010)[9].

Intermodal planning approach has been studied by Goetz et al., (2007) for seven states by the department of transportation (DOT) in the United States in two different regions. DOT’s are becoming intermodal agencies for planning intermodal transports system efficiently and effectively. However, highway planning’s has been dominant over intermodal approaches[10].

Merrina et al., (2006) discussed random networks and inhomogeneous networks[11].

Role of rail transport in intermodal transportation had been studied by Racunica and Wynter (2005) using hub
and spoke model[12]. The study conducted on 32 terminals in the Alpine region for three cost scenarios. Empirical sensitivity analysis shows that the model appears to be quite sensitive to scale economies.

Intermodal transportation is a necessity for moving human or cargoes using different transportation modes. It’s an emerging field of operation research which can be explored using different network models (Macharis and Bontekoning, 2004)[13].

Bontekoning et al., (2004) reviewed 92 publications to identify the characteristics of the intermodal research community and scientific knowledge base. They have examined studies related to drayage, rail haul, transshipment, standardisation, multi-actor chain management and control, mode choice and pricing strategies, intermodal transportation policy and planning and all other remaining categories[14].

Arnold et al., (2004) used a linear programming approach for locating rail-road terminals for freight transport. The model had been applied to the Iberian Peninsula using five scenarios considering variations in the supply of transport. They concluded that variation of the relative cost of rail has an impact on location. However, relocation of new terminals within Spain or Portugal will not significantly increase the market share[15].

Choong et al., (2004) studied empty containers movement for potential container-on-barge activities in the Mississippi River basin using integer programming and concluded that a longer planning horizon helps in better empty container distribution[16].

Janic (2003) developed a model to determine the internal and external costs of intermodal and road freight transport networks. He investigated the effects of European Union policy on the prospective competition between two networks from a social perspective[17].

Problems related to storage yards of terminals such as quality control, yard cranes, storage space and IT studied by Zhang et al., (2003). They proposed a rolling horizon approach to reduce workload imbalance in the yard using mathematical programming model in two levels[18].

It’s easy to anticipate and understand the need for investments in intermodal transportation using the geography of freight transportation networks. GIS mapping was used to construct and process shipment routes considering different combinations of truck, rail and water transportation. Mapping allows the different mode to be linked together via more than one transportation terminals (Southworth & Peterson, 2000)[19].

Hayut (1981) demonstrated the dynamic development process of a container port system as a five-phase model. He used North American container port as a case study containing implications of containerization to ship operators, ports, and the inland distribution system[20].

IV. FUTURE SCOPE OF THE STUDY & RESULTS

Designing highly responsive and highly efficient supply chain has become extremely important in freight transport. No doubt, today’s logistics operations intermodal transportation observes many benefits over unimodal transportation. Many other aspects in association with intermodal transportation could be extended using the bibliometrics presented herewith to achieve efficiency and effectiveness in the supply chain.

V. LIMITATIONS, IF ANY

Data used in this research is retrieved using the Scopus database only. Though most of the transportation-based journals indexed in the Scopus database, there might be some researches missed out. The citation data used herewith is the Scopus database only, which might differ from other databases. Though, enough care has been taken to check downloaded data sheets, error if any may lead to different interconnectedness in a network diagram. Many other combinations of networks would possible using different input criteria’s, but only a few considered in this research paper.

VI. CONCLUSION

Intermodal transportation is a need of the hour in every emerging field. Intermodal transportation research is happening across the world.

Though intermodal transportation developments and research is happening across the world, researchers from the US and Europe have taken lead in publishing researches in intermodal transportation.

The keyword ‘intermodal transportation’ used for retrieval of the database from Scopus is a popular keyword among the intermodal transportation research fraternity. The subject area for these researches mostly classified under ‘engineering’ and ‘social sciences’ category. Since 1985 almost all transportation and operations research journals have been considering intermodal transportation studies for inclusion, however, increased trends have been observed form 2005 till date. Citation analysis reveals that researches published in transportation and operations research journals have been referred by almost all researchers in intermodal transportation. In this paper, network diagram portrays the interconnectedness among authors, citations, co-authors linkage and leading journals in the area of intermodal transportation. This Scopus database based comprehensive research in terms of bibliometrics will lay the foundation for the researchers looking forward to learning popular and significant researches in intermodal transportation for further research.

VII. REFERENCES

1. https://www.itf-oecd.org/sites/default/files/docs/key-transport-statistics-2018.pdf (accessed on 22 Dec 2018)
2. Pritchard, A. (1969). Statistical bibliography or bibliometrics. Journal of documentation, 64(1), 45-80.
3. Ding, Y., & Cronin, B. (2011). Popular and/or prestigious? Measures of scholarly esteem. Information Processing & Management, 47(1), 80–96.
4. Bornmann, L., & Daniel, H. D. (2008). What do citation counts measure? A review of studies on citing behavior. Journal of documentation, 64(1), 45-80.
5. Hong Yeoh, K., & Kaur, K. (2008). Subject support in collection development: Using the bibliometric tool. Collection Building, 27(4), 157-166.
6. Lorenc, A., & Kuźnar, M. (2017). The impact of cargo monitoring systems usage on intermodal transport risk and costs. World Review of Intermodal Transportation Research, 6(4), 336-351.
7. Roso, V., Russell, D., Ruamsook, K., & Stefansson, G. (2015). Seaport-inland port dyad dynamics: an investigation of service provisions and intermodal transportation linkages. World Review of Intermodal Transportation Research, 5(3), 263-280.
8. SteadieSeifi, M., Dellaert, N. P., Nuijten, W., Van Woensel, T., & Raoufi, R. (2014). Multimodal freight transportation planning: A literature review. European journal of operational research, 233(1), 1-15.
9. Shrivastava, P., & O’Mahony, M. (2010). Integrated approach towards sustainable development. Oceania, 12(1.1), 13-4.
10. Goetz, A. R., Szyliowicz, J. S., Vowles, T. M., & Taylor, G. S. (2007). Assessing intermodal transportation planning at state departments of transportation. World Review of Intermodal Transportation Research, 1(2), 119-145.
11. Merrina, A., Sparavigna, A., & Wolf, R. A. (2006). The intermodal networks: a survey on intermodalism. arXiv preprint physics/0609085.
12. Racunica, I., & Wynter, L. (2005). Optimal location of intermodal freight hubs. Transportation Research Part B: Methodological, 39(5), 453-477.
13. Macharis, C., & Bontekoning, Y. M. (2004). Opportunities for OR in intermodal freight transport research: A review. European Journal of operational research, 153(2), 400-416.
14. Bontekoning, Y. M., Macharis, C., & Trip, J. J. (2004). Is a new applied transportation research field emerging? — A review of intermodal rail–truck freight transport literature. Transportation Research Part A: Policy and Practice, 38(1), 1-34.
15. Arnold, P., Peeters, D., & Thomas, I. (2004). Modelling a rail/road intermodal transportation system. Transportation Research Part E: Logistics and Transportation Review, 40(3), 255-270.
16. Choong, S. T., Cole, M. H., & Kutanoglu, E. (2002). Empty container management for intermodal transportation networks. Transportation Research Part E: Logistics and Transportation Review, 38(6), 423-438.
17. Janic, M. (2007). Modelling the full costs of an intermodal and road freight transport network. Transportation Research Part D: Transport and Environment, 12(1), 33-44.
18. Zhang, C., Liu, J., Wan, Y. W., Murty, K. G., & Linn, R. J. (2003). Storage space allocation in container terminals. Transportation Research Part B: Methodological, 37(10), 883-903.
19. Southworth, F., & Peterson, B. E. (2000). Intermodal and international freight network modeling. Transportation Research Part C: Emerging Technologies, 8(1-6), 147-166.
20. Hayut, Y. (1981). Containerization and the load center concept. Economic geography, 57(2), 160-176

VIII. AUTHORS PROFILE

Sanjeev Kadam is an academician in the field of operations management with a mechanical engineering background. Presently he is associated with Amity University Mumbai as an Assistant Professor. He carries versatile military experience in mechanical engineering operations and maintenance field. Also, he had experience in manpower consultancy for oil, gas, petrochemical, power and manufacturing sectors. His scholarly areas of interest include – operations management and operations research, logistics and supply chain management, business research methods, quality management and project management. He is currently pursuing his PhD research work from Symbiosis International (Deemed University), Pune, India.

Prabir Kumar Bandyopadhyay is a Professor at the Symbiosis Institute of Business Management, Symbiosis International (Deemed University), Pune, India. He has a PhD in engineering and had a long stint in management consultancy and training with National Productivity Council, India. He worked with ISPAT Group and Hindustan National Glass looking after various initiatives like TPM, Six Sigma, enterprise risk management and business excellence. He is a Six Sigma black belt and qualified business excellence assessor.