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## Knowledge Diffusion to Knowledge Dissemination: A Theoretical Study

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### ABSTRACT

*The purpose of this study is to review the literature to identify the major breakthroughs in the process of knowledge diffusion and dissemination. This will help in ascertaining the future course of action for further research activities. The study was executed by a systematic review of literature available on the subject. About 138 documents were reviewed out of which more than 100 articles are from peer reviewed journals. Thematic search for literature was conducted using the terms like knowledge, knowledge diffusion, diffusion models, collaboration, Scientometrics. E-resources (Springer link, Emeraldinsight, Oxford University Press, Jstor; etc., as subscribed the Tata Institute of Social Sciences was searched for literature. The core objectives are to understand the knowledge creation, theories and models of diffusion and dissemination, collaborative modes and quantitative aspects of knowledge diffusion. Based on the objectives following questions were answered that: a) How the knowledge is produced, b) Identification of knowledge diffusion models, c) Aspects of knowledge diffusion and d) The quantitative aspects of knowledge diffusion. The method of the systematic literature review was used to answer the research questions. The major milestone i.e. Theaetetus immortalized, SECI Model, Modes of Formation of Subjects, Diffusion of Innovations, The Epidemic Model, The Bass Diffusion Model, Research Collaboration and Team Science and Bibliometrics & Scientometrics quantitative methods are identified and described. However, this study may not be regarded to have a complete coverage of all the empirical literature on the subject. But, still, it seems to have reviewed the some of the pioneer studies.*

**Keywords:** Knowledge Diffusion, Knowledge Dissemination, Diffusion Models, Knowledge Adoption, Scientometrics, Cybermetrics, and Webometrics.

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### 1. INTRODUCTION

There are various types of theoretical frameworks and models available for explanation of knowledge diffusion. However, the study has discussed various prior studies and an overview of selected studies that are believed to be most useful for knowledge diffusion. In addition, relevant contemporary theories to complement these perspectives have been discussed. The studies have drawn from the knowledge diffusion, collaboration, and scientometrics theme based literature on understanding the differences as well as similarities of various theoretical aspects related to the knowledge diffusion and dissemination. There are varieties of theoretical perspectives available which are useful for Knowledge Diffusion or Dissemination (KD). These are spread across the disciplines making it difficult to locate and use them. Further poorly defined, non-clear, subject specific terms and imaginary thoughts often the hinder use of alternative or complementary perspectives. KD environments are complex and require the setting of assessing and prior selection of the appropriate theory should always be the first step in KD. Finding the relevancy between setting (context) and the theory is very important for the success of KD because a particular theory may not suit to all settings. Thus, it is useful to review and use several alternative theories of KD.

Many times we have heard the term the viral. Yes, we know that this is very common terminology used in medical sciences usually denoting the spread of an epidemic. In recent times it is often used for spreading of any multimedia content such as video, image, artwork over the internet

using social media platforms. In simple words, the term means it is spread among the community. The same thing has also happened in the academic world also but it is usually known by a different terminology called “diffusion”. Literally, diffusion also means the same thing which happened but it is much different in the context we use viral. Why diffusion over viral because the various studies are conducted to examine knowledge diffusion in the academic community. Researchers are studying different antecedents and consequences of knowledge diffusion in a range of multidisciplinary i.e. physics, computer science to sociology, Information science, operations research mathematic and management sciences and with the very diverse backgrounds. Thus this has led to confusion of the concepts and procedure. (Bulent, Ozel, 2012).

## 2. NEED OF THE STUDY

The purpose of this study is to explore the literature searched for pursuing the research work. The study has focused on understanding in which way the recorded knowledge flows. Especially, in which recorded form of literature is diffused. What are the major breakthrough have been identified. What are the associated aspects of collaborative diffusion and dissemination of knowledge.

## 3. OBJECTIVES OF THE STUDY

Following are objective of this study mentioned below:

- To understand how the knowledge is created.
- To understand the diffusion and dissemination models and theories.
- To study the aspects of the collaborative mode of knowledge diffusion.
- To identify the quantitative methods of knowledge diffusion.

## 4. RESEARCH QUESTIONS

Various theories, conceptual frameworks, models and approaches have been deployed to study the various research questions of knowledge diffusion and dissemination. Most of the inquiries have been answered (a) how the knowledge is produced (b) what kind of knowledge is diffused in the community; (c) what are the stages in knowledge diffusion; (d) what are the various modes of knowledge diffusion (e) Social structure and nature of knowledge diffusion. The following research questions have been developed in accordance with the aim and objectives of the paper:

*RQ1.* How is the knowledge produced?

*RQ2.* What are the types of knowledge diffusion models?

*RQ3.* What are the various aspects of knowledge diffusion?

*RQ4.* What are the quantitative aspects of knowledge diffusion?

## 5. METHODOLOGY

During the process of review literature process, the authors have borrowed the systematic review of the literature including:

- Comprehensive search for literature
- Quality assessment of the literature
- Data extraction from the literature
- Synthesis of literature and write-up.

A research plan was developed comprising the research questions, keywords or search, criteria for inclusion and exclusion of literature. The study was focused on the identification of literature comprises latest research works on knowledge diffusion and dissemination to identify the major related studies. Therefore, the multiple keyword approach was selected to identify related studies, such as knowledge, knowledge diffusion, diffusion models, collaboration, and Scientometrics.

The inclusion criteria was peer-reviewed research papers in published in English language only. Grey literature was excluded (i.e. reports, non-academic research). E-resources (Springer link, Emeraldinsight, Oxford University Press, Jstor, etc.) as subscribed the Tata Institute of Social Sciences was searched for literature using remote login facility. The authors had tried to specify all the relevant issues. The literature review included papers published until March 2016. To make the search relevant peer reviewed journals having the impact factor were searched. The literature is manually scanned and more than the 100 papers were assessed to know their relevancy to make sure that they come under the purview of research interest. This, resulting in limits the total number of articles for the review process. For convince, the papers were reviewed according to the themes respectively. The major findings have been discussed later. The data for synthesis from individual articles according to identified theme. This assisted in the demonstration of the latest studies of knowledge in relation to various aspects associated with KD. In the last the write-up of the findings is executed.

**6. DISCUSSION AND FINDINGS**

**6.1 KNOWLEDGE CREATION**

The 21st century is regarded as a knowledge based society, where the awareness of scientific knowledge is regarded as an indicator of socioeconomic development. Processed data leads to information and information leads to knowledge. In simple word raw data when processed and some attached valued is derived from them is become information and when this information is passed to other it become knowledge.

- Data (texts, numerals, images, etc.)
- Information (filtered and processed data within a relevant context)
- Knowledge: (systematically processed information)

<b>RQ1. How the knowledge is produced</b>				
<b>Table –I : MAJOR BREAKTHROUGH IN KNOWLEDGE CREATION</b>				
<b>Sl. No.</b>	<b>Author and Year</b>	<b>Main findings</b>	<b>Theoretical perspective</b>	<b>Source</b>
1	Theaetetus immortalized  Paul K. Moser, Arnold vander Nat (2009)	Based on the dialogue Theaetetus immortalized Moser and Nat explained and categorised human knowledge in the following categories : Empirical (or, a posteriori) knowledge Non-empirical (or, a priori) knowledge Knowledge by description (a kind of propositional knowledge) Knowledge by acquaintance (a kind of non-propositional knowledge) Knowledge of how to do	Discussed and explained the dialogue between Greek philosophers like Plato, Aristotle and Socrates explaining the phenomenon of knowledge. The Theaetetus immortalized is the basis of the study of their discussion.	Encyclopedia of Library and Information Sciences (2009)

		something.		
2	The SECI (Socialization, Externalization, Combination, Internalization) Model Ikujiro Nonaka and Hirotaka Takeuchi (1995)	Nonaka and Takeuchi explained the process of knowledge creation in four steps popularly known as the SECI Model Socialization: Sharing of tacit knowledge in personal social networks Externalization: Recording of tacit knowledge in physical form received via social contacts Combination: Re-synthesizing and improving the recorded knowledge Internalization: Using explicit knowledge to gain personal experience and skills	The SECI Model for Knowledge Management (KM) of scientific management was proposed for the study	The Knowledge-Creating Company: How Japanese Companies Create the Dynamics of Innovation. Oxford University Press.
3	Modes of Formation of Subjects Dr. S. R. Ranganathan	Dr. S. R. Ranganathan expressed his views that individual subject in the universe of knowledge can be derived by following four modes of formation (a) Loose Assemblage, (b) Lamination, (c) Dissection and (d) Denudation	He generalized the concept of knowledge organization and subject structure by proposing the modes of formation of subjects. He explained how a subject develops over a period of time.	Philosophy of Library Classification. Ess Ess Publications.

**6.2 KNOWLEDGE DIFFUSION AND DISSEMINATION**

It is very difficult for the human beings to survive in this world if there is no knowledge available to them. Therefore, the need to have a model or effective mechanisms for knowledge diffusion is essential. As the human's beings are social animals and lived in the closely connected society. Thus, this is important for their survival to transfer the knowledge created by them. This has happened through the social interactions called Knowledge Diffusion by which knowledge is spread. According to Melissa and Gretchen (1999), knowledge diffusion is the movement of useful ideas between organizations. Chen and Hicks (2004) had defined Knowledge diffusion as the adaptations and applications of knowledge documented in scientific publications and patents. Thompson, Estabrooks, and Degner (2006) expressed their opinion over knowledge diffusion as the process of communicating research, innovations and or knowledge to individuals, groups or organizations. Thus, knowledge diffusion is a phenomenon which studied how the knowledge diffused, why knowledge diffused, and at what rate of knowledge diffused through academic community.

Dissemination: The people who studied knowledge dissemination deemed different meanings in different context. The very common understanding of knowledge dissemination is regarded as

knowledge transfer across the community in the settings. The motive behind dissemination is to acquire new knowledge for learning and will leads to the enlightenment and creation of new knowledge for future. Knowledge dissemination increases awareness, selection of appropriate information, information exchange. Dissemination is made use of knowledge as instrument and concept to achieve the desired results.

**6.3 MAJOR STUDIES OF KNOWLEDGE DIFFUSION AND DISSEMINATION**

The knowledge diffusion research examines how the new knowledge diffused (spread) among the society. The knowledge is get diffused in the form of idea, innovations, technology, products or practices, influencing the individual adopters. The knowledge is adopted by the adopters in time gaps as the adopters are reluctant to adopt new knowledge until and unless they are satisfied that new knowledge is more effective as compared to the existing one. (Kaminski, J. 2011).

<b>RQ 2: What are the types of knowledge diffusion models?</b>				
<b>Table –II: MAJOR STUDIES OF KNOWLEDGE DIFFUSION</b>				
<b>Sl. No.</b>	<b>Author and Year</b>	<b>Main findings</b>	<b>Theoretical perspective</b>	<b>Source</b>
1	Diffusion of Innovations Everett M. Rogers (1962)	Roger had explained following four components of in a diffusion process: (a) The Innovation (perceived new knowledge), (b) Communication channel (c) Time and (d) The Social system (sender and receiver). Further, it explained the unit of adoption of new knowledge by members of other social systems. Roger proposed five categories of adopter on the basis of adoption of innovativeness (1) Innovators (2) Early adopters (3) Early majority (4) Late majority and (5) Laggards	Discussed and explained the diffusion of innovations as the process of communication of innovation among the members of a social system via certain channels	Diffusion of Innovations, 3rd Edition. New York: The Free Press.
2	Mathematical Modelling The Epidemic Model Dr. William Goffman and Dr. Vaun A. Newill (1964)	The study emphasise s the two diffusion modals as follows Deterministic: studies the spread of the 'disease' D within the population N of the discipline F. Stochastic Models: In a stochastic model of the process described above the actual number of now infective occurring in a short time interval would be replaced with the probability of a new case occurring in that interval. Applicable when	Proposed mathematical modelling of transmission of ideas is the base of the study. The principles of epidemiology provided a framework.	Nature (1964).

		dealing with small populations.		
3	Price Mechanism	The knowledge has its own economics of acquisition as goods where the knowledge is codified and protected under Intellectual Property Rights. The price mechanism helps to understand the knowledge preference of an individual.	The economic term Price Mechanism has served as a base for the study according to the demand and supply of that particular goods or service.	Journal of Management Information Systems, (2008)
4	The Bass diffusion model (1969)	The possibility of adoption or purchase of a product is linearly based on the number of previous buyers interacting with potential and de facto adopters or users because in a social system some individuals decided to borrow innovation independently of the decision of the individual.	The Bass Model of diffusion of innovations and the various economic theories are the base of the study	Management Science (1969)
5	The Strength of Weak Ties Mark Granovetter (1973)	Application of social networks as a tool for relating the micro and macro levels of research domain.	Theory of Social Network Analysis	American Journal of Sociology, (1973)
6	The theory of structural holes R.S. Burt	Introduced this concept to explain the origin of differences in social capital.	Sociology and Theory of Social Network Analysis	Research in Organizational Behaviour (2000)

#### 6.4 COLLABORATION

Although human mind has some incredible ability to generate and execute new knowledge this fact should be realized that an individual cannot address all the challenges. Thus we have to collaborate with others. Collaboration is very common in the process of knowledge diffusion. Thus an individual gains specialization over complex subjects. Therefore, the collaboration has been regarded as mandatory in research. It is regarded that nowadays in most the scientific and technical fields there is more than 90% of research studies and publications are of collaborative nature, this often leads to high-impact of research and development of commercial output. Therefore, in many of the scientific fields collaboration is a work prerequisite. (Bozeman and Craig, 2014)

**RQ3: What are the various aspects of knowledge diffusion?**

**Table – III: MAJOR STUDIES OBSERVING KNOWLEDGE DIFFUSION BY COLLABORATION**

Sl. No.	Author and Year	Main findings	Theoretical perspective	Source
1	Research Collaboration and Team Science  Barry Bozeman, and Craig Boardman (2014)	The study was focused on the study collaborative research. The study seeks to identify the theoretical gaps in existing theory and future research in collaboration.	The theoretical perspective of the study is to assess the collaborations using Scientific and Technical Human Capital (STHC) as a framework to improve public policy for collaboration and project-level Management.	Research Collaboration and Team Science: A State-of-the-Art Review and Agenda. New York (2014)
2	Research collaboration Bozeman, B., Fay, D., and Slade, C. P. (2013).	The study explains the types of collaboration for KD. It emphasizes that there are two types of collaboration, knowledge-focused (i) Property-focused	Literature provides a theoretical framework for the study.	Journal of Technology Transfer, (2013).
3	Enhancing Research Collaboration Effectiveness  Barry Bozeman,	Identification of approaches to study research collaboration following approaches to study scientific collaboration are focused Publications based or patents based, CV--based, Questionnaire based, Interviews, Questionnaires/ Anonymous posts.	Based on the studies supported by the National Science Foundation, Virginia, USA	Enhancing Research Collaboration Effectiveness: A Reportona10--Year program of study By, Center For Organization Research And Design And Consortium For Science, Policy And Outcomes Arizona State University (2014)

**6.5 MEASURING KNOWLEDGE DIFFUSION**

Nowadays Bibliometrics, Scientometrics and Social Network Analysis approached are widely in

use for measuring research collaboration. A trend to analyses and visualize hot topics in the study of KD or scientific collaboration using metrics based evaluation (i.e. Bibliometrics, Scientometrics) for measurement are very high. Research domain visualization techniques are also being adopted to describe the evolution of collaboration.

**6.6 QUANTITATE METHODS FOR MEASURING KNOWLEDGE DIFFUSION**

The word metrics is derived word, "metricus" means measurement. When the term metrics is suffixed to a subject domain, it indicates the application of mathematical and statistical measurement techniques to that subject domain. For example, when the term "metrics" is suffixed to the subjects i.e. biology, sociology, psychology, economics, it gives birth to the subjects like biometrics, socio-metrics, psychometrics, and econometrics, where various standard mathematics and statistics techniques extensively used for measurement. Therefore, the terms like librametrics, bibliometrics, informetrics, and scientometrics have been derived by combining the metrics with disciplines such as library, bibliography, information, and science. In 1948 at the Aslib's Annual Conference, held in Leamington, S.R. Ranganathan first proposed the term Librametry. He emphasis on the need to develop the mathematical and statistical method for measurement at par with sociometric or psychometric. Alan Pritchard proposed the term Bibliometrics in 1969. It is proposed as an alternative to the terms like scientometrics and librametry. Bibliometrics involves the application of mathematical methods to books and other communication media. It provides quantitative analysis of recorded knowledge (bibliographic literature). According to the Egghe the term 'informetrics is the broad term which includes all-metrics based studies related to study of information science including bibliometrics, scientometrics, webometrics. The term Scientometrics is very well known as the sociology of science. It is truly a multidisciplinary subject which has developed over a period of time. It is a perfect tool of science policy and research analysis, evaluation and prediction. Used for studying structural, dynamics, identification of indicators, mapping, scientific growth and knowledge diffusion, etc in a subject domain. Since its introduction in 1969 by Nalimov and Mulchenkotwo Russian, is widely exercised by many organisations/ countries as a dependable technique to measure the performance of any individuals, organisation in a specific field to map its effectiveness. (Stock and Weber, 2006). Cybermetrics/Webometrics: The term coined by the Norbert Weiner in 1948. The word cybermetrics consists two distinct Greek words "cyber" denotes to skilled in steering or governing and "metrics" measure. Thus, it is the application of quantitative techniques to study the cyber objects (B K Sen, 2004). Webometrics is the metrics study of WWW. (Björneborn and Ingwersen, 2001). Altmetrics: In Sept 2010 Jason Priem propounded the term #altmetrics. The Altmetrics is popularly known as 'Alternative Metrics' (ALM) used or enhancing and complementing the traditional citation based ways of impact assessment by expanding the idea of the impact. (Dhiman, 2015).

**RQ4 What are the quantitative aspects of knowledge diffusion?**

<b>Table – IV: MAJOR STUDIES OF QUANTITATIVE ASPECTS OF KNOWLEDGE DIFFUSION</b>				
Sl. No.	Author and Year	Main findings	Theoretical perspective	Source
1	S.R. Ranganathan (1948)	Proposed the term Librametry	Development of the mathematical and statistical method for measurement for library data	Rao, I. K. R. (1998). Informetrics: scope, definition, methodology and conceptual questions,



2	Alan Pritchard (1969)	The term Bibliometrics was proposed in 1969	The application of mathematical and statistical methods to books and other media of communication	William and Wilson. (2000) <i>Scientometrics</i>
3	Nacke (1979)	The term informetrics was coined by O. Nacke in 1979.	In the broadest term as it includes all kinds of information	Stock and Weber, (2006). <i>Facets of Informetrics.</i>
4	Vassily V. Nalimov and Z. M. Mulchenko (1969)	Introduced the term scientometrics in 1969.	The application of those quantitative methods which are dealing with the analysis of science viewed as an information process	William and Wilson. (2000) <i>Scientometrics</i>
5	Norbert Weiner (1948)	The term Cybermetrics was coined.	The application of quantitative techniques to study the cyber objects.	B K Sen. (2004).
6	Tomas C. Almind and Peter Ingwersen (1997)	Webometrics was propounded	Metrics study of World Wide Web (types of the hyperlinks, structure of the World Wide Web and usage pattern).	Björneborn, and Ingwersen. (2001). <i>Scientometrics.</i>
7	Jason Priem (2010)	In Sept 2010 the term #altmetrics was propounded.	Alternative Metrics to enhancing and complementing the traditional citation data.	Dhiman. (2015) <i>DESIDOC Journal of Library &amp; Information Technology</i>
<b>Metrics Laws</b>				
1	Samuel Clement Bradford (1934)	<i>Law of Scattering or Law of frequency Distribution</i> in a subject.	Mathematical application (1:n:n <sup>2</sup> )	Viju. (2013). <i>Library Philosophy and Practice (e-journal)</i>
2	George Kingsley Zipf	Word Frequency Distributions.	American linguist proposed ( $r \times f = k$ ) the Law of	Powers. (1998). <i>NeMLaP3/CoNLL98 : New Methods in Language Processing and Computational Natural Language Learning.</i>
3	Alfred J. Lotka	Inverse Square Law of Scientific Productivity. Describes the frequency of publication by authors in a given field. It states that	It is one of a variety of special applications of Zipf's law. Mathematical formula (1/n <sup>2</sup> )	Bensman and Smolinsky. (2016). <i>arXive.org</i>
4	Eugene Garfield	Garfield's Law of Concentration.	An extension of Bradford's law.	Bensman. (2001). <i>Journal of The American Society For Information Science And Technology.</i>

## CONCLUSION

During the literature review, it was experienced the term knowledge diffusion gained larger importance in 1950. During this time major breakthroughs happened. Some of them made the base for future research. These classic works like the mathematical theory of communication by Shannon, Roger work Diffusion of Innovation, Granovetter's work the strength of weak ties in social networks. Nonaka and Takeuchi's model of Knowledge generation still referred as a theoretical foundation for the future study. The mathematical advancements and development of well-established laws for quantitative analysis of information have been developed. This has evolved the field of Scientometrics and Bibliometrics. Scientometrics is gaining popularity in the world and now widely used as evaluation and measurement tool to assess the Knowledge diffused in recorded or documented form like journal articles, books, patents, thesis, monographs etc.

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