CHAPTER IV

KNOWLEDGE DIFFUSION METHODS

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4.0 Introduction

Many times, we have heard the term viral. Yes, we know that this is a 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 through the internet using social media platforms. In simple words, the term means it is spread in the community. The same thing has also happened in the academic world 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 from the context in which we use viral. Why diffusion over viral it is because the various studies are conducted to study the diffusion of knowledge in the academic community. Researchers are studying various antecedents and consequences of knowledge diffusion in a range of disciplines i.e. statistical physics and computer science to sociology and management sciences and with the very diverse backgrounds. Thus, this has led to confusion of the concepts and procedure. Therefore, the various issues related to the knowledge diffusion have been discussed in detail further (**Ozel, B., 2012; Kumar, A. and Shivrama, J., 2017).**

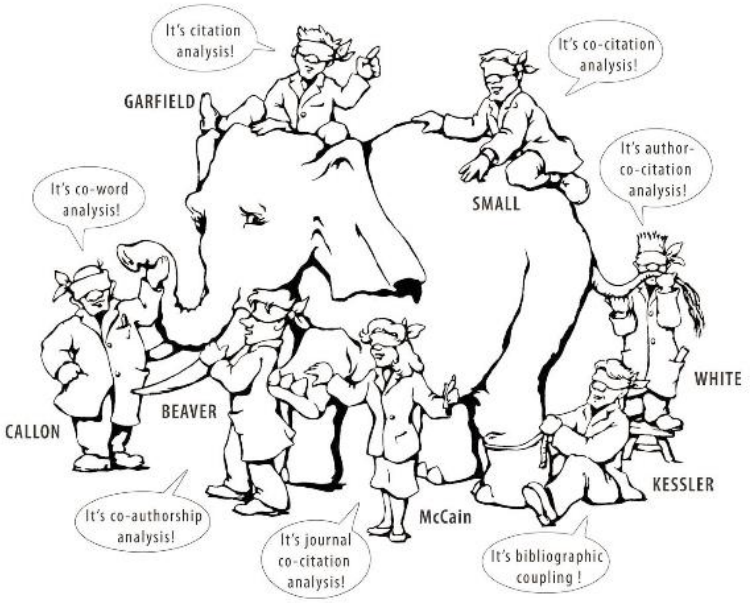

Figure 4.1: The Blind Men and the Elephant.
Source: Ozel, B., 2012, p.184

Till so far various theories, conceptual frameworks, models and approaches have been deployed by the researcher to study the various research questions of knowledge diffusion. Most of the inquiries are answering that (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.

4.1 Knowledge Diffusion

Usually, we denote that the scientific process of disseminating knowledge is diffusion of knowledge. This diffusion of knowledge takes place between individuals or groups and organisations for communication of research and innovations in the society. This spreading of knowledge can be seen as an indicator of the progress of the society because without effective diffusion of knowledge society may not progress. Thus, in simple words, it is the process of knowledge transfer.

However, according to Chen, Chaomei and Hicks, Diana (2004):
"Knowledge diffusion can be defined as the adaptations and applications of knowledge documented in scientific publications and patents".

Thus knowledge diffusion is a phenomenon which studies how knowledge diffused, why knowledge diffused, and at what rate knowledge diffused through academic community.

4.2 Data, Information and Knowledge

How the data, information and knowledge are interlinked with one other is discussed here.

4.2.1 Data

as per the definition published in Online Dictionary of Library and Information Science (ODLIS) the "data is the plural form of the Latin word *datum*, meaning 'what is given', it is commonly used as a singular collective noun representing facts, figures, or instructions presented in a form that can be processed, comprehended, interpreted, and communicated by a human being or machines" (Reitz, Joan M., 2016).

4.2.2 Information

As defined by Joan M. Reitz (2016) "data presented in the readily comprehensible form to which meaning has been attributed within the context of its use. In a more dynamic sense, the message conveyed by the use of a medium of communication or expression, whether a specific message is *informative* or not depends in part on the subjective perception of the person receiving it. The more concretely, all the facts, conclusions, ideas, and creative works of the human intellect and imagination that have been communicated, formally or informally, in any form". (Reitz, Joan M., 2016).

According to the 10th Edition of Concise Oxford Dictionary, Pearsall, Judy (1999) described information as "the facts or knowledge provided or learned as a result of research or study. What is conveyed or represented by a particular sequence of symbols, impulses, etc., genetically transmitted information" **(Pearsall, Judy (1999), p.727).**

4.2.3 Knowledge

The Reitz (2016) explained the knowledge as the "information that has been comprehended and evaluated in the light of experience and incorporated into the knower's intellectual understanding of the subject" (**Reitz, Joan M. 2016**).

The Concise Oxford Dictionary defined knowledge as "information and skills acquired through experiences or education, the sum of what is known, true justified belief as opposed to opinion. Awareness and familiarity gained by experiences" **(Pearsall, Judy., (1999), p.727).**

4.3 Knowledge Creation

The 21st century is regarded as the 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 words, raw data when processed and some attached value is derived from the processed data becomes the information and when this information is passed to others it becomes knowledge.

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

4.3.1 Plato and Theaetetus Dialogues

In philosophy, the study of knowledge can be traced in ancient Greece. Where the Greek philosophers like Plato, Aristotle and Socrates discussed the phenomenon of knowledge. Although Theaetetus immortalised is one of the famous dialogues but it failed to provide a universally acceptable definition of knowledge, however it sources for further discussions.

(i) Knowledge is the various arts and sciences
(ii) Knowledge is perception
(iii) Knowledge is true judgement and
(iv) Knowledge is true judgement with an “account” (*Logos*)

Knowledge is the various arts and sciences (such as geometry, astronomy, harmonics, and arithmetic)	**Knowledge is perception** (The knowledge based on self-experience. For example, if the wind is cold, it will appear cold for X and if wind appears cold to X, X will perceive wind is cold)
Knowledge is true judgement (as the soul's internal reasoning function, is introduced for formulation of the knowledge with true judgement)	**Knowledge is true judgement with an "account" (Logos)** (that only that which has *Logos* can be known)

(Zina, Giannopoulou., 2016)

Based on the above dialogue Moser, Paul K. and Nat Arnold vander (2009) further explained human knowledge can be categorised into the following categories:

1) **Empirical (or, a posteriori) knowledge**: based on evidence, justification, component of sensory experience, Knowledge of physical objects).
2) **Non-empirical (or, a priori) knowledge:** depends on its evidence component solely on "pure reason" or "pure understanding and knowledge of logical and mathematical truths.
3) **Knowledge by description (a kind of propositional knowledge):** knowledge by description means knowledge that something is the case.
4) **Knowledge by acquaintance (a kind of non-propositional knowledge):** knowledge by acquaintance includes direct non-propositional awareness of something, and does not necessarily include knowledge that something is the case.
5) **Knowledge of how to do something.**

4.3.2 SECI Model by Nonaka and Takeuchi

Organisations are supposed to be the major players in producing knowledge. Organisations are intended to create, share and preserve knowledge for future retrieval. This process is popularly known as knowledge management in Management Science. In 1995 Ikujiro Nonaka and Hirotaka Takeuchi provided detailed analysis of knowledge creation among the Japanese firms, as discussed in their publication entitled "The Knowledge-Creating Company: How Japanese Companies Create the Dynamics of Innovation". This study revealed that the Japanese approach to knowledge is very much different as compared to the western approach. In the Japanese approach, the knowledge creation takes place at three levels: individual, group and organisational.

The Nonaka and Takeuchi explained the process of knowledge creation in four steps popularly known as the SECI Model (Socialisation, Externalisation, Combination, and Internalisation). This model explained the two different dimensions of knowledge and their transformation tacit knowledge to explicit knowledge and explicit knowledge to tacit knowledge. The term tacit knowledge was introduced by the Hungarian Michael Polanyi in 1958. The tacit knowledge refers to the cognitive knowledge which is not coded and which lays in the human brain i.e. personal skills, experiences, ideas. It is the knowledge that cannot be expressed in words. Whereas when this tacit knowledge is recorded in the form of articulated data, codified in a form which is suitable for communication in the universe it is regarded as explicit knowledge (Takeuchi, Hirotaka. 2006).

a) **Socialisation (Tacit to Tacit):** The mammoth share of knowledge lies in the human brain in the form of tacit knowledge. This knowledge can only be collected through the process of socialisation i.e. a process of sharing knowledge via personal and social interaction. Face to face sharing of personal experiences like tutor student relationship. However, people are not keen to disclose their personal secrets and skills.

b) Externalisation (Tacit to Explicit): when someone received tacit knowledge via socialisation and recorded it in the visible form (explicit knowledge). For example, when students take class notes during the teaching.

c) Combination (Explicit to Explicit): when recorded information is improved, re-synthesised, recombined to enhance and standardise the importance of existing recorded knowledge for universal acceptance and generalisation it is called the process of combination. For example, when notes prepared by the students are resynthesised based on the standard theories. Formulation of hypothesis and its testing according to the universally accepted process.

d) Internalisation (Explicit to Tacit): internalisation can be seen as a process of knowledge diffusion. When newly acquired knowledge is tested practically. Thus, it converts explicit knowledge in to tacit knowledge i.e. learning how to ride a bike after reading the manual. Thus, it converts acquired knowledge into personal experiences learning by doing.

Table 4.1
The Spiral of SECI Model

1	**Socialisation**	Sharing of tacit knowledge in personal social networks
2	**Externalisation**	Recording of tacit knowledge in physical form received via social contacts
3	**Combination**	Re-synthesising and improving the recorded knowledge
4	**Internalisation**	Using explicit knowledge to gain personal experience and skills

The figure 4.2: Nonaka and Takeuchi KM Model shows the process of knowledge diffusion.

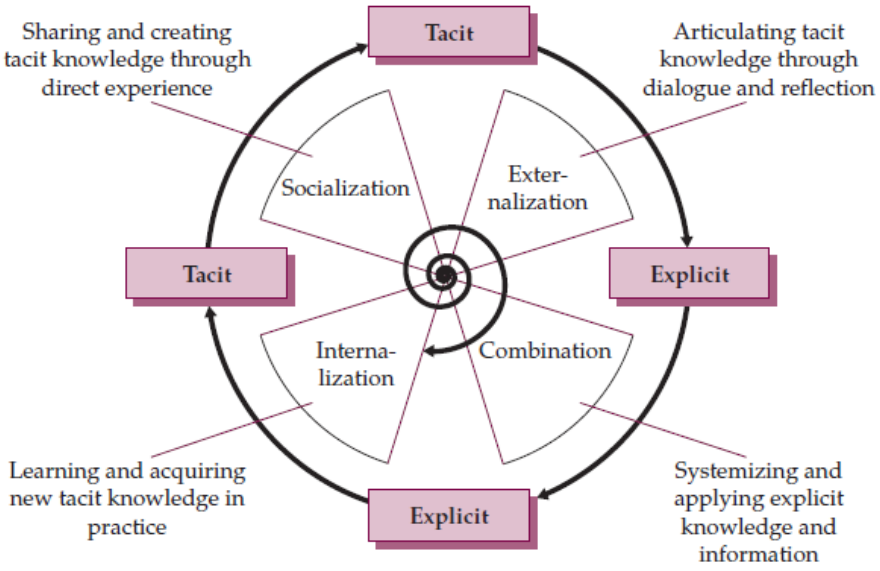

Figure 4.2: Nonaka and Takeuchi KM Model

Source: (Takeuchi, H, p.9)

4.3.3 Modes of Formation of Subjects

In 1950 Padmashree Dr. S.R. Ranganathan, the doyen of library and information from India. 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 in following steps:

i) **Lamination**: This is the result of the combination of the layer of a basic subject with an isolated idea.

ii) **Loose Assemblage:** It is the combination of basic or compound subjects.

iii) **Fission**: It takes place when we split a subject into two or more parts.

iv) **Fusion**: When two subjects are fused together they formed new subject this process is known as the fusion.

v) **Distillation:** During the distillation process a subject is distilled and a new subject is emerged out of the basic subject.

vi) **Cluster:** Clustering takes place when the subject of study is diversified and scattered in various fields is taken together for study.

vii) **Agglomeration:** Agglomeration (earlier called partial comprehensions) happened when the entities of larger masses collected together without cohesion (Ranganathan, S.R. 1967).

4.4 Knowledge Taxonomy and Ontology

The term taxonomy is popularly used in Science. Owing to the amount of content generated in other fields, the use of this term is increasing in other branches of knowledge as well. As the fundamental role, taxonomy categorises the subjects into subsets of knowledge on the basis of description, nomenclature, identification of the learning concept. Thus, taxonomy facilitates searching; categorisation and standardisation of content, one of the key challenges in knowledge diffusion. Meriam Webster Dictionary defines taxonomy as *"the process or system of describing the way in which different living things are related by putting them in groups*" (Merriam-Webster, 2016). Taxonomies are used for systematic organisation of knowledge. Taxonomy provide authoritative control over the usage of a term in a subject i.e. vocabulary and thesaurus. Taxonomies are specific according to the subject. Subjects like the library and information science have various systems for indexing of subject terms i.e. POPSI, PRECIS, KWIC, KWOC etc.

Meriam Webster Dictionary defines ontology as "branch of metaphysics concerned with the nature and relations of being". Ontology is a particular theory about the nature of being or the kinds of things that have existence. Ontology is also the representation of knowledge and the kinds of things that exist in the knowledge domain. Ontology provides the foundation to the subject constructed on well-founded concepts which can leverag to build meaningful higher-level knowledge (Merriam-Webster, 2016).

In knowledge organisation the terms used in formation of taxonomies and ontologies, are selected with great care, ensuring that the most basic foundational concepts and distinctions are defined and specified in a knowledge domain. The terms chosen form a

complete set, whose relationships to each other are predefined. It is the formally defined relationships that provide a semantic basis for the terminology chosen. If we focus on the difference between ontology and taxonomies, we found that ontology is more than a classification of terms in the knowledge domain, although taxonomy forms base to the semantics of term in a vocabulary of a subject (**Varma, Vasudeva 2007**).

Therefore, the taxonomy is a hierarchical arrangement of entities i.e. tree (parent-child) kind of relationship in a subject while ontology explains arbitrary complex relations between the concepts in a subject.

taxonomy	**Ontologies**
terms that are connected by	terms that are connected by
broader term, - Carnivorous animal	term - Carnivorous animal
narrower term - Panther	lion + lioness = Cubs
related term- Leopard	

4.5 Knowledge Diffusion Models

The knowledge diffusion research examines how the new knowledge is diffused (spread) in the society. The knowledge is get diffused in the form of ideas, 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. Thus, the adoption rate highly depends on the influencing power of the knowledge. The history of diffusion studies can be traced to the 1903 when French Sociologist Gabriel Tarde, plotted the original S-shaped diffusion curve, followed by Ryan and Gross in 1943, introduced the adopter categories which was later used by Everett Rogers in the first edition of his book entitled Diffusion of Innovations published in 1962 **(Kaminski, J. 2011).** The various diffusion models are discussed below in details:

4.5.1 Diffusion of Innovations

Everett M. Rogers in his book Diffusion of Innovations (3rd Ed.) described diffusion as a diffusion of innovations. According to him, "diffusion of innovations is the process by which an innovation is communicated through certain channels over the time among the members of a social system". Therefore, it is a special type of communication, in which the messages are concerned with sharing of new ideas to arrive at the mutual understanding and convergence (or divergence) among the individuals' exchanged information in order to move towards one another. The diffusion process by alteration in the structure and function of the social system brings social change in the society (Rogers, Everett M., 1983).

Diffusion of innovation is a special type of communication as it is intentionally held between the sender and receiver through a medium/channel over a period of time.
Roger had explained the following four components in the diffusion process:

- The Innovation (perceived new knowledge)
- Communication Channel (medium)
- Time
- The Social System (sender and receiver)

i) **The Innovation (perceived new knowledge):** according to Roger an innovation is an idea, practice or project that is perceived as new knowledge by an individual. For someone who had perceived the knowledge is new to him, it was there before since long ago will be an innovation for him. Uncertainty is the main obstacle to innovation adoption. By adopting or rejecting innovation some changes occur as consequences of adoption in the individual or social system. The consequences can be classified as desirable or undesirable (functional and dysfunctional), direct and indirect, anticipated and unanticipated (Sahin, Ismail 2006).

   The deterministic characteristics of innovation adoption rate are:

   - Relative advantage
   - Compatibility
   - Complexity

- Trialability
- Observability to those people within the social system.

ii) **Communication channel (medium):** communication is a special activity where two entities are voluntarily agreed to create, share communicate information with each other to reach a mutual understanding. The channel is the medium between sender and receiver that involves an interpersonal relationship.

iii) **Time:** the time component first time was involved in the process when the innovation started taking place to happen (individual's mental process)**.** Secondly, the innovativeness is the degree of adoption of innovations of an individual or social system in adoption relatively to others. Thirdly it is involved in the rate of adoption of innovation among the social systems or individuals.

iv) **The Social System (sender and receiver):** In a diffusion process social system is the fourth component. It could be defined as an interrelated unit having the common and mutual objective. An individual, group, and organisation could be treated as a unit of the social system. The innovations are diffused between individuals, groups or organisations, interrelated and common in nature. The figure 4.3 reflects various categories of adopters. **The figure 4.3:** Rogers' Bell Curve of Innovation Adoption revels the various users of innovation adopters.

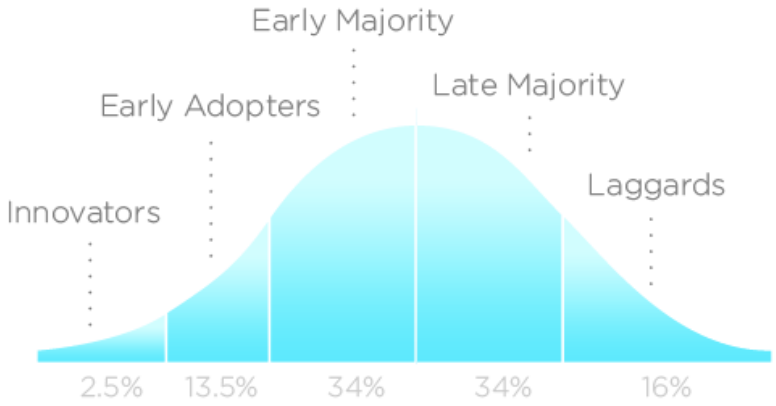

Figure 4.3: Rogers' Bell Curve of Innovation Adoption

(Source: Wikipedia, 2017)

4.5.2 Mathematical Modelling

Dr. William Goffman and Dr. Vaun A. Newill in (1964) his article Generalisation of Epidemic Theory had proposed mathematical modelling of transmission of ideas. They have studied transmission of ideas as the spread of diseases in the population. The base of their study was principles of epidemiology. The necessary elements caused spread if the infection is (i) specified population (ii) exposure to infectious material. The population further classified as (a) infective – hosting infection (b) susceptible- can become infective and (c) removal – due to death, immunity, hospitalisation etc., susceptible or infective at the time of removal. This process of infection is time deepened. The individual can become infective by direct contact or from someone infective. The infection development period is called "latency period" (or incubation period) (William, G. and Vaun, A. N.,1964).

4.5.3 Price Mechanism

The Price Mechanism is an economic term which determined the price of goods according to the demand and supply of that particular goods or service. In the context of knowledge diffusion here knowledge is managed as goods which are captured in knowledge repositories to be transferred between users and vendors. The knowledge as goods where knowledge is codified and protected under Intellectual Property Rights (examples are written codes, documents, best practices, case studies, research reports, patents, trade licenses, export and import permissions, software's and consultancy services, etc.).

The knowledge has its own economics of acquisition. The price mechanism helps to understand the knowledge preference of an individual. Thus, it provides insight into the study of knowledge transfer which takes place in the hierarchical structure of the organisation. It is obliged to the employee to leave the technology or process of innovation (knowledge) at the time of leaving the organisation. Bilateral information diffusion also takes place within the organisation by practising the collaborations (joint knowledge creation). Huang, Wang and Seidmann (2007-08) in their paper have

examined the theoretical perspectives of user's irrational price and knowledge preferences by the economic approach. Can the price mechanism facilitate the knowledge transfer in an economic market. If so, are the knowledge users always rational in their price and knowledge preferences. The paper answered to these two key questions. To explain users' irrational price and knowledge preferences the economic approach can be utilised to examine two competing theoretical perspectives. User's preference for commercial repositories and their inconsistent preferences bring new insights for transfer of knowledge. Management of Knowledge transfer is traditionally focused on collaborative organisational contexts. The Market mechanisms seem to be a viable approach for knowledge transfer within and across the organisation to overcome the dilemma of competitive collaboration as the user prefers outsider's knowledge as to internal competitor. Thus, avoiding internal competition market mechanism brings an opportunity for acquiring diversified knowledge from external competitors **(Huang, M., Wang, E.T.G. and Seidmann, A., 2007-08**)

4.5.4 The Bass Diffusion Model

The rate of the influence of innovators and imitators for diffusion of knowledge depends on several characteristics, such as complexity, relative, advantage, status value or observability etc. The Bass Model popularly known as Bass Diffusion Model was developed by Frank M Bass (1969) explaining the adoption of a product by the customers over the time through mathematical differential equations. He proposed that the probability 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 adopt as innovation independently of the decision of the individual. Bass Model implies exponential growth of an initial purchase to a peak and then exponential decay. Bass Model is widely used to predict in forecasting of adoption of new product, idea, technology, information, innovation. In literature, the following classes of adopters are specified: (1) Innovators, (2) Early Adopters, (3) Early Majority, (4) Late Majority; and (5) Laggards, on the basis of the timing of adoption by the various groups **(Bass, F. M., 1969).** The **f**igure 4.4 reflects the growth of a new product

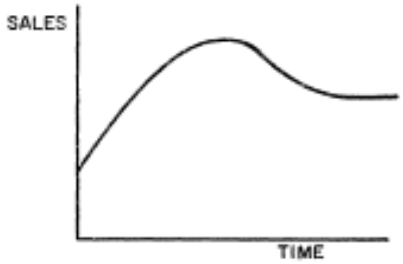

Figure 4.4: Growth of New Product

Source: (Bass, F. M., 1969, p.216).

4.5.5 The Strength of the Weak Ties

The Strength of the Weak Ties is one of the most cited theories of Social Network theory given by Mark Granovetter in 1973. He explained social network as "a tool for linking micro and macro level of social theory". The embeddedness between individuals create social networks and lead to social capital. Though the individual is intra-correlated in the group but they are somewhat independent (Granovetter, Mark, 1973). Suppose there are two different groups, Group A and Group B (see fig. 4.5) mentioned below. Each of these groups is having individuals directly or indirectly associated with each other. The connecting node between Group A and Group B are X and Y. If the connection between these two gets disconnected, the network nodes will not be able to connect with the nodes of each other's network. Both the networks are dependent on X and Y for communication to each other network. The tie between X and Y is a weak tie. The weak ties provide us the opportunities to connect with nodes of other networks.

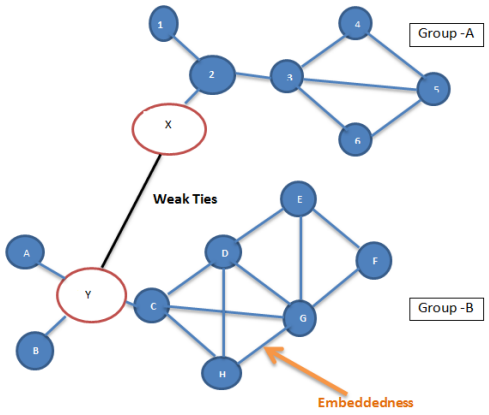

Figure 4.5: The Strength of Weak Ties

4.5.6 The Theory of Structural Holes

R.S. Burt propounded the concept of structural holes popularly in the study of social networks. Burt introduced this concept to explain the origin of differences in social capital. Burt in his theory suggested that individual's positional advantages/disadvantages are dependent on the embeddedness with the neighbourhood's or other social structures. In simple words, a structural hole can be understood as a gap between two nodes that have complementary sources of information among the network. As explained above the embeddedness between two networks are depended on X and Y (see figure 4.6) for communication. If this link gets disconnected, it will lead to the break between networks, thus, in the technical term is known as the structural hole (Wikipedia, 2016).

The weaker connections between networks are the holes in the social structure of the society. These holes in social structure create a competitive advantage for an individual. Structural holes are thus an opportunity facilitates the knowledge flow between people that brings together people from the opposite sides of the hole. (**Burt, Ronald S., 2000).**

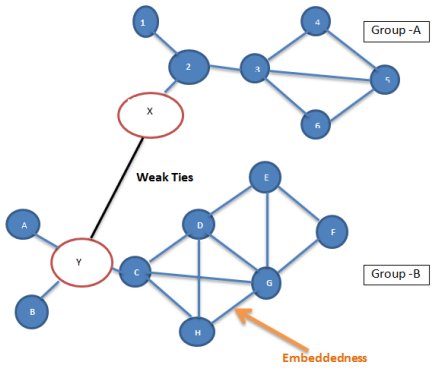

Figure 4.6: The Structural Holes

4.6 Collaboration

Although human mind has some incredible ability to generate and execute new knowledge. But this fact should be realised 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 become necessary for every field of scientific and technical research. It is regarded that in today's time in most scientific and technical domains about ninety percent of research studies and publications are collaborative, which often result in high-impact. Nowadays in most of the areas of science, collaboration is not a preference but a work prerequisite (Bozeman, B. and Boardman, C., 2014*)*

4.7 Research collaboration

The very basic question that comes to everyone's mind is how we can define research collaboration or in actual what is collaboration is all about. It is a ''social process whereby human beings pool their human capital for the objective of producing knowledge". The term ''research collaboration'' can be described as the relationships between individuals or organisations. However, it is difficult to distinguish the individual collaborations from organisational collaborations. After all, when the organisations collaborate, it is actually individuals who are collaborating with each other on behalf of organisations. It is very difficult to measure collaboration with traditional methods i.e. observation, interviews or questionnaire. Many of us think that co-authorship is a good indicator of measuring collaboration. Due to its several advantages like verifiability, stability over time, data availability and ease of measurement, the co-authorship is a convenient indicator of collaboration measurement. So, the possible answer to the question that who collaborates is that almost every one collaborates.

4.8 Types of collaboration

According to the Bozeman, B., et.al. there are two types of collaboration

a) **knowledge-focused** (R and D activity increments to the knowledge productivity. It can be measured in terms of scientific and technical articles produced, cited or, more rarely, demonstrably used) and
b) **Property-focused** (collaborations increment to wealth typically measured in terms of patents, new technology, new business start-ups, and, more rarely, profits). **(Bozeman, B., Fay, D., and Slade, C. P., 2013).**

4.9 Organising Framework of Research Collaboration

The topical review of published literature on the subject of collaboration organises three main collaboration attributes categories. These are collaborator attributes, collaboration attributes and organisational attributes. These three major categories have subcategories of attributes of collaboration as mentioned in figure 4.7 below. Each one of them having different roles and responsibilities.

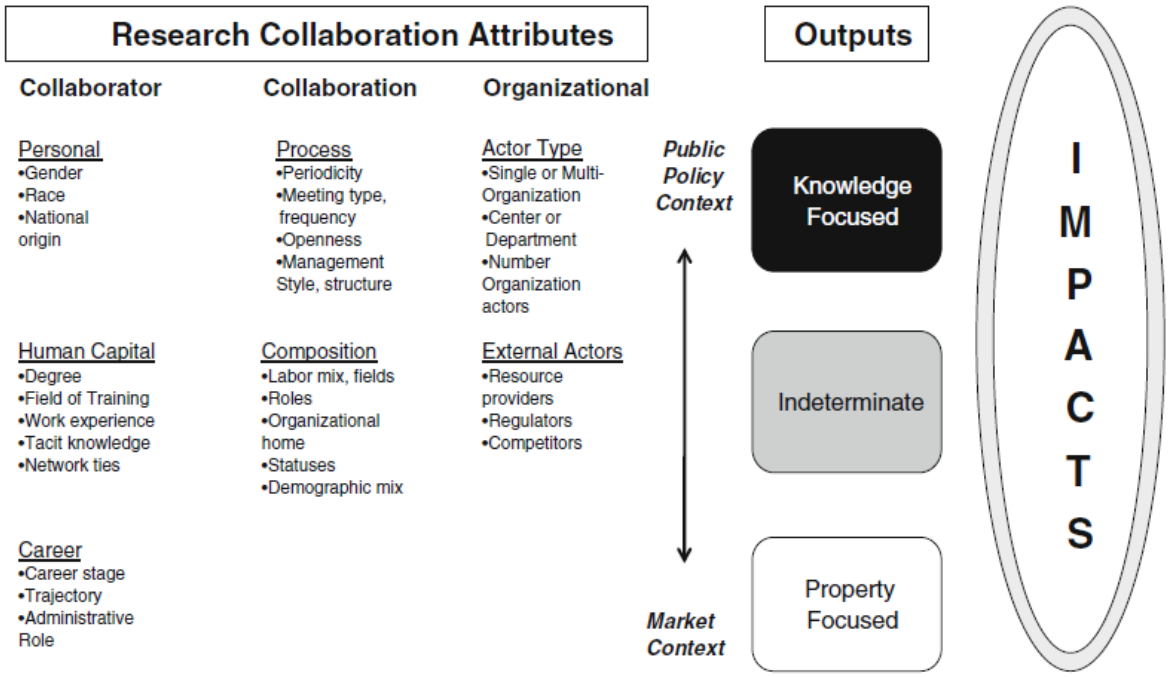

Figure 4.7: Framework for Organising the Research Collaboration

(**Source:** Bozeman, B., Fay, D., and Slade, C. P., 2013, p.6.**)**

4.10 Approaches to Study Collaboration

As mentioned above co-authorship is now regarded as a good indicator of measuring collaboration. It has several convenient advantages already discussed. The Bozeman, B., (2014) during his study entitled "Enhancing Research Collaboration Effectiveness: A Report on a 10 – Year Programme of Study" used the following approaches to study scientific collaboration:

1. Publications based or patents based.
2. CV-based.
3. Questionnaire based.
4. Interviews, Questionnaires, Anonymous posts.

Apart from these, bibliometrics, scientometrics and social network analysis approaches are widely used for measuring research collaboration. Trends to analyse and visualise hot topics in the study of scientific collaboration using metrics based evaluation (i.e. Bibliometrics, Scientometrics) for measurement are very high. Research domain visualisation techniques are also being adopted to describe the evolution of collaboration.

4.11 Factors Motivating Collaboration

Despite the common fact the collaboration leads to increased productivity, inter-relationship, and understanding of complex subject the fundamental questions comes to mind that: who collaborates, differences in patterns of collaboration, what affects successful collaboration, what causes and determinants research collaboration. Probable answers to these questions are that most of us are collaborating, it could be individual or organisational, the success is caused and determined by various factors, some of them are:

- To pursue common research interest;
- To provide mutual support to the researchers (in terms of man, machine, method materials to fulfil intellectual needs) and promote efficiency;
- For accumulation of research experiences,
- Language fluency and increased work productivity;
- Helpful for co-authors career;
- To gain tenure and promotions;
- To gain academic reputation and recognition among peers; **(**Hou, Jianhua, Chen, Chaomei and Yan, Jianxin., 2010)

4.12 Science of Research Measurement

The basic need of any discipline is to pursue the scientific research for the advancement of the society. Thus, it is the fundamental need to identify the gap and level of measurement. Therefore, the outcome of this process results for the development of new scientific methods, tools and techniques also discussed in section 3.6 of chapter three.

4.12.1 Librametry/Librametrics

The term Librametrics has two roots, namely, Libra, and metrics. The term Libra connotes library, and metrics means measurement. In 1948 at the Aslib's Annual Conference, held in Leamington, S.R. Ranganathan first proposed the term *Librametry*. He emphasised the need to develop the mathematical and statistical method for measurement at par with sociometric or psychometric. According to him, the statistical and mathematical analysis is the key technology for understanding the structural analysis and forecasting studies. He knew that library work and services involve a large number of statistics. Sengupta (1985) defined librametrics as: "Quantitative analysis of various facets of library activities and library documents by application of mathematical and statistical calculus with a view to seek the solution to library problems" **(Jeyasekar, J. John. and Saravanan, P., 2015).**

4.12.2 Bibliometrics

Alan Pritchard proposed the term *Bibliometrics* in 1969. It was proposed as an alternative to the scientometrics and librametry. Pritchard defined bibliometrics as the application of mathematical methods to books, and other media of communications. The bibliometrics is used to provide quantitative analysis of bibliographic literature (Pritchard, Alan., 1969). Fairthorne in 1969 defined bibliometrics as the "quantitative treatment of properties of recorded discourse, and behaviour appertaining it". While, Potter (1981) defined Bibliometrics as "the study and measurement of the publication patterns of all forms of written communications and their authorship" (Potter, 1981).

4.12.3 Informetrics

Leo Egghe has defined informetrics in a broader sense. The term ‘informetrics is comprising all-metrics based studies related to information science which includes bibliometrics and scientometrics. Hood, W.W. and Wilson, C. S., further defined informetrics as “the quantitative study of collections of moderate sized units of potentially informative text, directed to the scientific understanding of information processes at the social level” **(Wood, and Wilson, 2001, Wolfgang, and Sonja, 2006).**

4.12.4 Scientometrics

It was introduced by Nalimov and Mulchenko in 1969. Scientometrics is widely exercised by organisations and countries for measurement of the performance of an individual, organisation, in a specific field to map its effectiveness. It has been discussed in details in section 3.6 of chapter three.

4.12.5 Cybermetrics

The term cyber comes from the Greek, it was coined by the Norbert Weiner in 1948**.** Cybernetics was concerned with the study of communication and control systems in living beings and machines. The word cybermetrics consists of two distinct Greek words “cyber” meaning *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).

4.12.6 Webometrics

The metrics analysis of world wide web (hyperlinks, in links, out links, usage pattern) is known as webometrics. Michael Thelwall **(2009)** explained “webometrics concerned with measuring aspects of the www”. According to Bjorneborn, Lennart and Ingwersen, Peter “webometrics consists of four main research areas, (1) content analysis of the webpage; (2) structural analysis of weblink; (3) usage analysis of web; (4) Web technology analysis” (Bjorneborn and Ingwersen, 2001). Content analysis of web pages is a special kind of subject analysis, the study of the structure of web links has its roots in citation analysis.

4.12.7 Altmetrics

In 2010 Jason Priem propounded the term #altmetrics. The Altmetrics is also known as 'Alternative Metrics' (ALM) or 'Alt-metrics' enhancing and complementing the traditional citation based impact assessment. It supports multidimensional measurements beyond citation analysis. The altmetrics provides the online measurement of scholars or scholarly content based on the web 2.0 social media platforms. Altmetrics is diversified in nature and categorised into five categories i.e. (i) recommended (ii) cited (iii) saved (iv) discussed and (v) viewed **(Dhiman, A.K., 2015).**

4.13 Metrics Laws

Various empirical laws of scientometrics are discussed below.

4.13.1 Bradford's Law

S.C. Bradford gave the "Law of Scattering or Law of Frequency Distribution". The law describes the degree of distribution of literature in journals in the ratio of 1: n: n2. He also proposed the term 'core journal'. This law is discussed in detail in the section 3.16.2 of chapter three (Bradford, S.C., 1934 and Sudhier, K.G. 2010)

4.13.2 Zip's Law

The George Kingsley Zipf proposed the Law of "*Word Frequency Distributions"* (r x $f = k$). Zipf's Law is often used to predict the frequency of words within a text (Potter, W. G., 1988).

4.13.3 Lotkas Law

Alfred J. Lotka propounded the "Inverse Square Law of Scientific Productivity". This law described the *"frequency of publication by authors in any given field"*. It has been discussed in chapter three under section 3.16.1 (Potter, W.G., 1988 and Lotka, A.J., 1926).

4.13.4 **Garfield's Law**

Eugene Garfield proposed "Garfield's Law of Concentration". His law is an extension of Bradford's law". (Bensman, S. J., 2001).

4.14 Science Indicators

Lord Kelvin, (2017) had said: "*when you can measure what you are speaking about, and express it in numbers, you know something about it; but when you cannot measure it when you cannot express it in numbers, your knowledge is of a meagre and unsatisfactory kind*". In the light of above quote, it is emphasised that measurements have provided opportunities for future improvements otherwise no improvement. The modern day science has evolved many standard measurements techniques and procedures for this purpose. These measurements indicate the positive and negative effects of the development of the society.

4.14.1 Indicators

It is general feeling that the indicators are the data of specific field but the indicators are somewhat different from the data. Data is raw and does not have any significant value attached to it until and unless it is processed whereas, an indicator is the abstract form of theprocessed information, which incorporates information in it and reveals the impact of the processed information. Very common examples are GDP of the country revealing economic condition; literacy rate reveals literate people, BMI Index revealing the biological growth of humans, etc. Based on their speciality there could be various types of indicators, some of them can be categorised as:

- Input Vs Output
- Quantitative Vs Qualitative
- Activity, Productivity and Progress
- Quality, Importance and Impact
- Functional Vs Instrumental Indicators.

4.14.2 Literature based Indicators

Research evaluation is not a rocket science it is an art. Researchers, Policy Makers, Academicians are using many evaluation methods for analysing and comparing the research output. Each one has its own strengths and weaknesses. Thus, one should select the evaluation method with utmost care. Evaluation of literature based data is one of the core areas of research in bibliometrics and scientometrics. Literature based indicators are derived from the published knowledge in the form of journal articles, publication types other than the article, letter, note and review are often omitted. The popular publication indicators are:

- Publication Counts
- Production Index (PI)
- Activity Index (AI)
- Relative Specialisation Index (RS1)

4.14.3 International Collaboration Indicators

Well established indicators are discussed below.

- **Co-authorship (COA):** set of co-authored articles indicates output.
- **Cooperative effort (COP):** indicator of cooperative efforts of a country through co-authored publication (to know the degree of collaboration between two countries).
- **International Cooperation Index (ICI)**: the number of joint publications divided by the square root of the product of the number of total publications.
- **Affinity Index (AFI):** is the amount of collaboration between two countries in comparison to the to the total collaboration of the given country with world.
- **Internationalisation Index (INI):** it is a percentage of a total number of coauthored articles of a given country with the total number of articles published in the same given country during the same period.

4.14.4 Citation-based Indicators

Citations based indicators used globally are discussed in this section.

- **Observed citation rate:** actual number of times a paper is cited. The mean value is the number of citations per publication.

- **Expected citation rate:** the average of the number of citations of all papers published in the same journal in the same year
- **Relative citation rate:** the ratio of observed citation rate divided by the expected citation rate.

4.15 Mapping of Science

The maps are used by geographers to provide a two-dimensional representation to scale the world. Similarly, scientometrics maps provide two dimensional representation of scientific knowledge, by depicting spatial relationships. Scientometrics is used for the mapping of science. Scientometrics analyses are very efficient in future forecasting and prediction of trends in information diffusion. Analyst and planner execute metrics studies for policy formulation. The metaphorical use of the word mapping consists of cognitive mapping and descriptive mapping of science. Common mapping activities are - journal inter-citation mapping, document co-citation mapping, author co-citation mapping, journal co-citation mapping, co-word mapping and co-classification mapping. Domestic and international mapping using author addresses in multi-authored collaborated papers.

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