

Publication Trends on Overlapping Boundaries among Capabilities related to Knowledge, Innovation and Technology Management in R&D Context

Zeeshan Asim, Shahryar Sorooshian, Muhammad Shahid Ahmad

Abstract: *The primary purpose of the systematic analysis is to capture closer attention on the contemporary publication trends that reflects the relationship in between capabilities related to knowledge, innovation and technology management. Based on their relationship this study developed a conceptual framework to draw the influence of capabilities related to knowledge, innovation and technology management on R&D. The author developed analysis based on keywords supplied by the authors from published articles that belongs to issues related to knowledge, innovation and technology management. WOS (Web of science) was chosen as a database source. The author emphasizes more on indexed publications from the period of 2012 to 2018. The authored supplied keywords have prioritized and aggregated to some extent. The VOS viewer tool was utilized to draw a graphical visualization of occurrence and co-occurrence keywords concerning their relevance among the rest of the analyzed group. The outcome of analysis showed some of the emerging trends that draw relationship among knowledge, innovation and technology management capabilities.*

Index Terms: *Knowledge, Innovation, Technology Management, Capability, Firm, Research and Development, Bibliometric mapping.*

I. INTRODUCTION

To comprehend and enable the capabilities related features of knowledge and innovation management with technological strength has been considering as an essential source to confront global challenges at the global scale [23]. More than 67% firms at R&D level somehow puzzled to distinguish the capabilities that belong to knowledge, innovation and technology management as supporting management discipline[24]. In most case R&D, obsess firms used to fuel to overestimate their R&D expenditure more than 15 % their original cost in order to achieve the resources that drives these capabilities in order to fulfill the fluctuating market demand[24]. In majority of cases, these decision makers at R&D level unable to under various trends that emerge over the period of time [23]. Most of the research and development

(R&D) obsesses firms witness on the rapid advancement in the field of science and technology [23]. Due to such rapid growth allow R&D obsess firm's to acquire new capabilities related to knowledge management to drive their new innovation process. Because of new industrial policies increasing focus on R&D along with advanced technological capabilities always consider as a strategic business advantage [23]. To restrain firms overall competitive advantageous and remain steady under the dynamic market trends most firms comprehensively relied upon the generation, adoption and transmission of capabilities related to knowledge management that were necessary for their survival such transformative characteristic consider as crucial enabler to any firm R&D policy makers in order confront market dynamism [16]. Similarly, to Innovate and maintain the business competency as robust as to confront trendy business climate in order to achieve long-term business goal. Therefore, capabilities related to innovation management allow R&D policy makers to prepare firms at R&D level in order to confront any uncertainty with respect to product or process categories [5]. Most of the R&D-driven firms consistently browsing to acquire capabilities related to innovation management as the ability to restrain their market position [5]. The main purpose of these firms is to utilize R&D as tool for sustainable business growth by absorbing external and internal knowledge to harvest novel capabilities in order to full fill market demand [5]. In case of technological advancement, significance of technical capabilities allows firms to adopt more complex knowledge for complex responsibilities [10]. Now companies much focusing on acquired capabilities belongs to technology management for their advance R&D and for strategic technology road mapping which comprise of experimental knowledge and ability to aligned potential technical capacity [10]. Based on a sketch of literature, the primary aim of this paper is to analyze the number of articles, not to exemplify it, but moderately figuring out the fundamental trends. The publication trends in previous literature same as follows in this paper. But more emphasis on searching the patterns related to the relationship between knowledge, innovation, and technology management capability and awareness of attributes for diffusion theory such as trialability, observability and adoption to connect with an online database [12]. In this research studies to identify the publications trends by applying an extensive text mining typological

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setting on WOS search engine to reclaim all the significant studies that draw some relationship among capabilities related to knowledge, innovation and technology management. Thus, this study defines the scope of argument by evaluating the relation among three supporting management discipline. Then highlight the debate on the data obtained from publication research, comprehensive discussion of results, and proposed further space for further research.

II. LITERATURE REVIEW

Considerably the capabilities belongs knowledge management somehow relate to a certain extent with innovation management capabilities mainly handling with unpredicted technological dynamism. Spender [29] mentions specific limitation regarding such capabilities for R&D planners during fluctuating business trends. Such limitations creating sustainable policy making more challenging for decision makers to select essential criteria's used to categories the capabilities for knowledge management (KM) that influence R&D activities to improve and expand under limited resource. Similarly, Kim, et al. [17] suggested that the capabilities related to Innovation Management (IM) continually encourages in rectifying the sensitive challenges regarding create new opportunity for new innovations and add value in case of restraining competitive advantageous. However, firms in majority cases puzzled to categories capabilities due to resources that behave differently with respect to dynamic market demand.

Swan and Scarbrough [30] suggested various initial theories that specify capabilities related to innovation management very much connect with basic concepts of knowledge management and considerably be precise when dealing with the core theories of intellectual property. However, they used to illustrate in general context unclear regarding their operating boundaries specifically when classifying relevant resources that drives capabilities belongs to knowledge and innovation management. Yaacob [32] debates regarding extensive influence on implementing the critical drivers for KM practices as fundament source for integrating capabilities belongs to knowledge and innovation management to developed KM innovation for military purpose. However, they reluctant to portray any strong policy that helps to develop any narrative for utilizing capabilities related to knowledge and innovation management for progressive R&D at institutional level. Ayse Gunsul [3] in common understanding, firm's capabilities compared to knowledge management were translated as driving factor to revive the existing capability to compete with their business competitor and managing their current innovational capabilities in such a pattern that firm respond before their business rivals [3]. However they more emphasis on organizational learning and organizational learning capability to draw missing link between knowledge and innovation management in general context [21]. Similarly, in recent years the numbers of questions with core criticism have come across regarding stretching the value and effectiveness when choosing appropriate technology for transforming new knowledge to practice [27]. Although, less attention has made on acquiring capabilities related to technology management because of various technology trends. There are some scholar's and researchers find un-explore studies that support R&D planners to spotlight on reliable connection between

capabilities related to knowledge and technology management to develop effective R&D competitiveness [11]. Chang, et al. [6] critically argue that to deal an industrial dynamism existing compatibility of capabilities related to knowledge and technology management requires reshaping in term of comprehensive transmission of knowledge across each function of the organization to get maximum competitiveness. Similarly, Pisano and Figgie [25] also draw some attention on redesigning to comprise of functional parameters with the collaborative and synchronizing approach in between knowledge and technology management. However, there model for general purpose and market specific capabilities. Accorsi and Costa [1] highlighted various capabilities belongs to technology management as instrument that have been engage in reconfiguring capabilities related to knowledge management such as Knowledge Management System (KMS). Similarly, Marinković, et al. [20] draw some relationship in between innovation and Technology Management (TM) by developing an Triple Helix Model to observe the behavior for organizational planning, control and process for firms at governmental level. However, there interpretation more towards performance measurement less emphases has made towards recognizing role of potential capabilities belongs to innovation and technology management with their effective influence on R&D at governmental institutions. Morales, et al. [22] present learning model focusing on competency, skill, tools and behaviors to analyze competencies based issues in between innovation and technology management among SMEs. However, they somehow adjust their interpretation to developed effective high educational master program based on European and Latin American realities. These studies used to presents relationship between and knowledge management and innovation management and technology management separately in general context. To the best of our knowledge, no review study has focused on presenting the relationship among the three concepts together. Therefore, to fill gap in the literature, we have looking to explore publication trends that allow the author to explore some of the concrete evidence that draws some association among three set of capabilities. Allow R&D policymakers to rethink prioritizes their resources according to their relevance.

III. METHOD

To investigate the proposed research articles that restrained the suggested connectivity, ten-year periods, Almost 5261 Journal article published during 2008 to 2018 in Web of Science (WOS) database, and was considers permitting greater comprehensiveness of the proposed area of research. The data was retrieve in form of 'Plain Text File' from Web of science (WOS) database and presented with application of the VOS Viewers software system which useful to deal with large number of dataset in case of visualizing large number of key terms. An extensive searching string applied on WOS data was performed based to reclaim all the significant studies related to Knowledge management. The following typology configuration was applied into Scopus search engine: Searched for article:



“Knowledge management” OR “Knowledge Organization OR Knowledge capabilities” OR “Knowledge”, “KMC” , “K.M.C”OR “Innovation Management” Innovation in organization, OR “IMC”, “Innovation Management Capability”, “Innovation management and organization” OR “Innovation Capabilities ” OR “K.M capabilities” OR “IM Capabilities”, “Technology Management”, “Technology Management Capability”, “TMC”, “”OR “TM”, Boolean operator “T-M”, “K&M and R&D”, “KM and T&M”, K.M and I&M, I.M,

selected for each diverse relationship with respect to corresponding year. Therefore, Figure 2 shows particular distribution of research publication over a period of years specifically belongs in research area of Knowledge Management, knowledge management capabilities, knowledge infrastructure capability, innovation management, innovation infrastructure capability, Technology Management, Technology management capability, Technology infrastructure capability, industrial management, R&D management, operational management, Strategic management and strategic technology management

IV. RESULTS

The diversity of each relationship was concentrate on quantitatively by summing up the number of publications

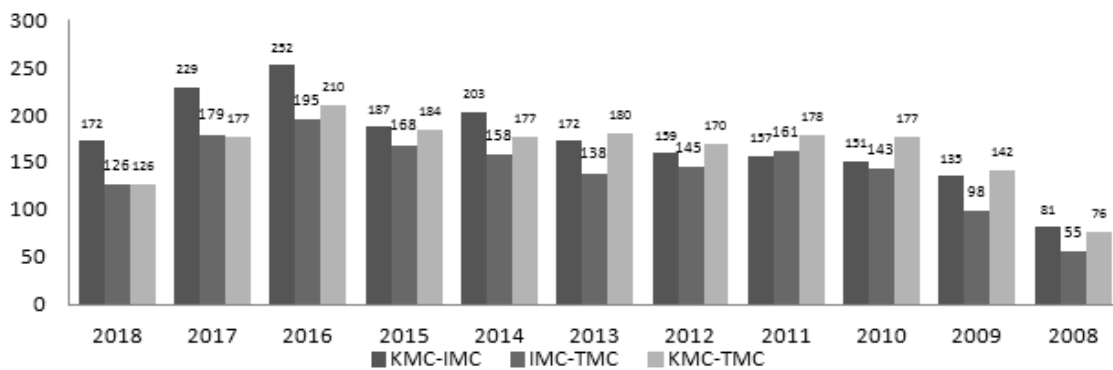


Figure 1: Analysis on the logical relationship on the basis of publication per years

It can be scrutinized that a compelling growth in the interest among the theoretical concept that represents the interconnectivity among the knowledge, innovation and technology management in indexed publications based on the WOS database. In the year 2016, such ideas draw attention a set of considerations in scientific papers. In following years, the numbers of publication on this topic ripple down at low numbers as compared to the previous year. During the period 2008 to 2009, limited amounts of published articles have observed that represents the logical connectivity in between innovation and technology management capabilities especially their impact on the R&D. While the focus was a change from the year 2010 to 2015 as most of the published article quantitative with more emphasis on developing firm advance innovation strength by acquiring the technological capability to sustain firms competitively advantageously. In case of analyzing the relationship in between capabilities related to knowledge management and innovation management over the period of 6 years starting from 2010 to 2015 researchers have made more emphasis on describing the processes, infrastructural perspective of both knowledge and innovation management capabilities[2]. A little similarity that can be put researchers to draw some relationships in between the capabilities that shows infrastructural and processes perspective related to knowledge and innovation management

for progressive R&D outcome. After 2015, the trends have shifted to illustrate more about the strategic standpoint of knowledge and innovation management; researchers were more focus on developing strategic capabilities for long-term R&D stability. Similarly in case of innovation management and technology management capabilities over the period of 10 years starting from 2008 to 2018 more attention has made towards the transformation of firm innovation strength rely on existing management infrastructure to enhance existing product and services. To some extent, previous researchers draw little relationship among capabilities related to innovation and technology management for instance: Project management; inbound and outbound innovation; R&D management; strategic management. In case of assessing the publication trends that draw relationship in between knowledge and technology management over the period of 10 the year 2008 to 2018. Researchers were more emphasis to build a strategic and infrastructural narrative that can be put the small relationship in between the capabilities of knowledge and technology management. Especially in dealing with research scope related to strategic management; intellectual property rights, knowledge management; and project management

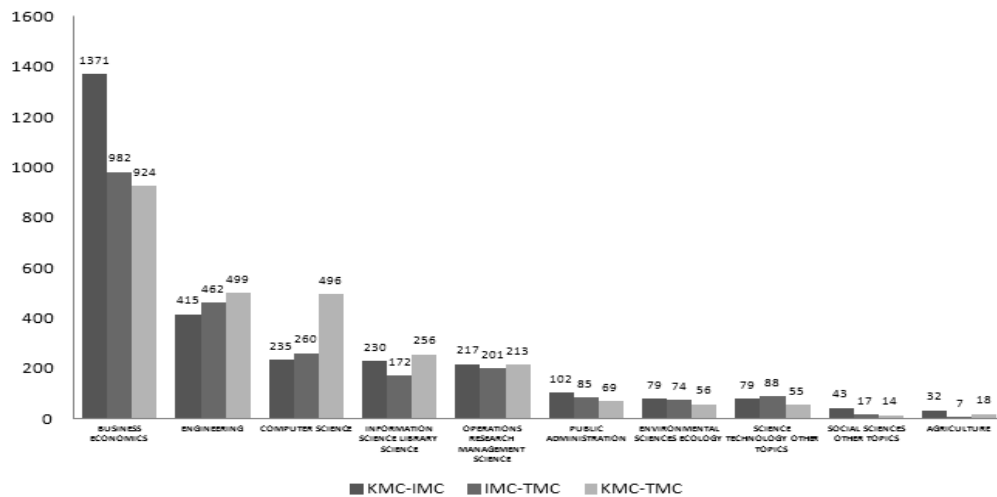


Figure 2: Analysis on Research Area on the basis of publication per years

The general breakdown of the subject areas from the duration 2008 to 2018, into which the articles in the WOS database are arranged, can lead to the evaluation that all the identified papers mainly distinguished into two areas: business, management and Economics (3277 publications), and engineering (1376). The other areas, where the number of publications exceeded 50 papers were: computer science (991), Information science library science (658), Operational Research and Management Science (631), Public Administration (256), Environmental Science and Ecology (209), Science technology and other topics (222), Social Science and Other topic (74), and Agriculture (54). Geography, psychology, and Health care service are considering as research group with low publications outcomes.

Table 1: Author’s frequently publishing Article within Same research field

Authors	KMC-IMC	Authors	IMC-TMC	Authors	KMC-TMC
KIANTO A	12	WU WW	12	KIANTO A	6
LIN HF	10	GARCIA-MORALES VJ	7	KIM Y	6
ALEGRE J	9	LI Y	7	LEE JN	6
LIAO SH	9	MARTIN-ROJAS R	7	LIN HF	6
ZHAO XD	9	YU B	7	MARTIN-ROJAS R	6
LI Y	8	FRATTINIF	6	WU WW	6
NAVAS-LOPEZ JE	8	LEE JN	6	YANG J	6
WU WW	8	LICHTENTHALER U	6	CHEN CJ	5
CEPEDA-CARRION G	7	SOTO-ACOSTA P	6	CUNNINGHAM SW	5
FRATTINI F	7	CHEN CC	5	FOSS NJ	5

Table: 1 shows a list of some of authors that quit often emerges during the evaluation a data set from Web of Science (WOS) as most researchers’ emphasizes on developing the relationship in between knowledge; innovation and technology management capabilities. The table also represents the number of articles associated with each author’s were indexed in WOS. The table includes list of author’s that published more than five articles in the exploring context.

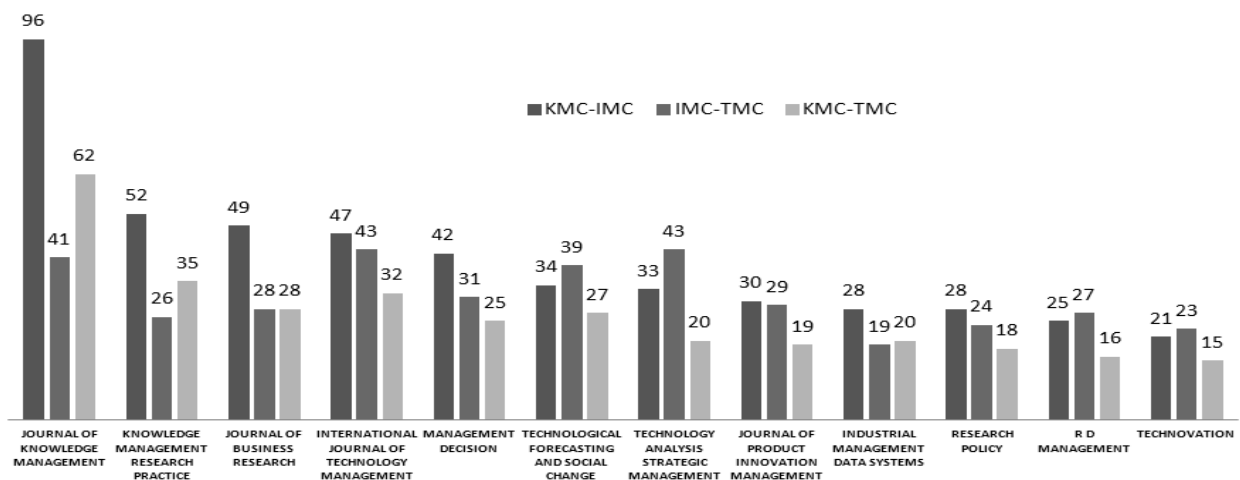


Figure 3: Analysis on the Journals Producing Publications on Selected Topic

The *journal of knowledge management (200)* is top in a list produced with the highest number of publication relevant to selected research topics around 200 relevant research articles published during the period from 2013 -2018. The chosen research article reflects some of the themes related to knowledge management capabilities and technology management capabilities. The primary research trends related to this journal based on linking knowledge management to performance initiatives also cover a range of themes linking knowledge management and innovation management, integrated learning and knowledge infrastructure, utilizing information technology to developed knowledge management and measuring knowledge already existing with the organization. The *journal 'International Journal of Technology Management (122)'* second among the publication list producing around 122 relevant article during the period of 2013-2018 addressing some research theme that describes the relationship in between Knowledge management and Technology management capabilities and covering scope research related to technology Monitoring Audit and Evaluation. The *'journal of knowledge management and research practice'* third among the publication producing around 113 relevant article from 2013 to 2018 providing an article under the scope of an information system, general management, organizational sociology or human resources. These articles discussed some of the core themes that shows some association among capabilities related to knowledge management and technology management. Similarly, the *journal of business research* was fourth on the list and producing around 105 relevant articles closer to selected research topics during the last five years. Most of these articles reflect publication themes related to buyer behavior, finance, organizational theory and risk and insurance and international business and marketing. The *Journal of 'Technology forecasting and social change'* was fifth on the list and producing 100 articles related to selected research topic period of 2013-2018. Most of these articles published belong to themes that interrelated to social, environmental and technological factors which reflect some portion of emerging trends aligned with the selected research topic. The *Management decision journal (98)* sixth on the list and producing around 98 relevant article from 2013 to 2018 drew some attention on research trends related to business policy and strategic management, operational management and logistic Research Legal issue, business ethics and firm governance. The *'Technology Management and strategic Analysis' (96)* is the seven highest publication list with almost 96 articles related to selected research domain more focusing on resolving the technological issue at corporate and organizational level through acquiring national and international capabilities. Major trends related to this journal are related to promoting strategic thinking regarding science and technology that can be exploited industrially. The *'Journal of Product innovation management'* was eighth on the list with 78 articles were published related to selected research topic from 2013 to 2018. Most of these articles were producing the concepts which interdisciplinary and developing theoretical and administrative knowledge related to product and services. The journal *'Research policy'* nine on the list and producing 70 journal article under the scope of policy management, environmental management, and some other challenges posed by innovation, technology, and R&D management. The journal *'R&D management'* considers as

tenth on the list to published around 68 article around five years under connecting scope of technology and innovation management. R&D Management journal more specific on publishing full range research topics in research and development, the innovation related to the strategic human resource, also examine some of the topics related to innovation and technological capabilities under the social and economic domain The *Industrial management and data system* was second last on the list and producing 66 articles relevant research trends that reflect some extent to the selected research topic. Most of the articles published under the scope of innovation management, knowledge management, Performance measurement, and sustainable green supply chain. *Technovation' (15)* is the last among publication list with almost 59 articles were published during the period from 2013 -2018 related to selected research domain more focusing on connecting innovation and technological capabilities under social innovation. Major trends associated with this journal are managing technological innovation capabilities, Investment strategies for technological intense entrepreneurial ventures

Table 2: Map of current research trends based on co-occurrence of the authors' keywords in publications

Cluster 1		Cluster 3		Cluster 5		Cluster 7					
Keywords	Occ	Co-occ	Keywords	Occ	Co-occ	Keywords	Occ	Co-occ			
Ambidexterity	11	26	Business model	8	16	Competitive advantage	20	31			
Big data	15	19	Collaboration	14	27	Innovation capability	11	7			
Business process management	7	7	Corporate	6	9	Knowledge creation	13	20			
Business strategy	5	6	Eco-innovation	8	8	Knowledge management	83	11			
Cloud computing	12	9	Governance	6	8	Knowledge management systems	5	8			
Dynamic capabilities	49	67	Malaysia	5	8	Knowledge sharing	25	35			
Exploration	5	5	Performance	25	37	Knowledge transfer	24	37			
Internet of things	5	3	Sme	9	14	Mediating effect	9	22			
Process innovation	8	15	Supply chain management	11	17	Organizational capabilities	6	5			
Product innovation	16	26	Sustainability	13	21	Organizational culture	8	15			
Resource based view	5	7	Value creation	5	16	Structural equation modelling	8	12			
Strategic management	10	11	Cluster 4		Cluster 6		Cluster 8				
Tacit knowledge	7	8	Keywords	Occ	Co-occ	Keywords	Occ	Co-occ			
Internet of things	5	3	Automotive industry	7	13	Big data analytics	5	7			
Cluster 2		Keywords		Occ		Co-occ		Cluster 9			
Keywords	Occ	Co-occ	Entrepreneurial orientation	9	13	Business performance	5	10	Keywords	Occ	Co-occ
Capabilities	18	22	Environmental dynamism	7	13	Business value	5	7	Human capital	13	23
Knowledge acquisition	5	9	Firm performance	21	28	China	15	20	Human resource management	8	8
Knowledge-based view	9	16	Green innovation	6	11	Information systems	7	13	India	12	16
Networks	10	17	IT capability	5	5	Resource-based view	17	30	Innovation performance	17	23
New product development	13	18	Market orientation	10	20	Risk management	5	4	Intellectual capital	27	41
Open innovation	25	35	Partial least squares	7	10	Strategy	10	1	Organizational change	7	6
Service innovation	8	8	Spain	6	14	Supply chain	7	14	Quality management	6	8
Servitization	8	7	Cluster 10		Keywords		Occ		Co-occ		
Systematic literature review	13	20	Keywords	Occ	Co-occ	Technology management	16	20	Relational capital	6	13
Social capital	7	6	Case study	17	30				Training	6	14
Technology	11	13	Competitions	5	13				Cluster 9		
Uncertainty	5	4	Coordination	5	3				Keywords	Occ	Co-occ
			Grounded theory	5	7				Absorptive capacity	48	81
			Innovation management	17	22				Entrepreneurship	8	15
			Organisational learning	6	8				Financial performance	6	11
			Smes	16	31				Innovation	110	149
			Case study	17	30				Innovativeness	9	12
			Competitions	5	13				Management innovation	5	11
									Organizational performance	14	27
									Technological innovation	7	18
									Technology transfer	6	7

For systematic analysis, the author acknowledged 2748 relevant article by systemically searching on WOS. After removing duplicate research article, a total of 1540 in -duplicate items were recognized from 2013-2018. Research article analyzes the bases of Title, Author Keywords, and Abstract. Because of the characteristic of acknowledging in eligibility criteria, we exclude overall 1200 article. Figure 5 represents the visualized map. The inner portion of the map includes the most repeatedly occurring keywords. Also, the strength and size of nodes illustrate the intensity of the emerging term. The concepts related to Innovation, Innovation management, Product innovation, Absorptive capacity, innovation performance, Technology management, knowledge management, and open innovation, appear to be emerging trends in the analyzed set of publications due to high relevance ratio. While reviewing Figure 5 it is observed from the visualized map that the emerging networks is quite dense and is specified by various connections. The concepts mainly associated with others emerging trends within the network were: Innovation, knowledge capabilities, Innovation management, Product innovation, Absorptive capacity, innovation performance, capabilities, and innovation capabilities, technology management, technology transfer due to high co-occurrence ratio. As an outcome visualization pattern, VOS viewer software system also allowed to distinguish the number of clusters in which the most repeatedly occurring term was obtained. The resulting map comprises ten clusters as shown in Table 3

V. DISCUSSION

The 1st cluster comprises with emerging themes is *big data*. Big data exhibited a strong relationship with *internet on the thing* and *cloud computing*. However, both of them are also associated with some of key trends related to *process innovation*, *product innovation*, and *business process management*. Both research trends- big data and process innovation- are frequently related with 'Ambidexterity issues' such as *learning and exploration*. The 2nd cluster based on number of emerging trends that occur over the period of 5 years. Most frequently appearing theme is

known as *Capabilities*. There are few other trends that co-occur in same cluster such as '*new product development*', '*open innovation*' along with strong group within same cluster known as *knowledge acquisition* which is associated as potential driver for knowledge management of process capability. This cluster also contains publication theme related to *service innovation*, *servitization*, *technology*, *knowledge-based view* in the context of the systematic review.

The 3rd cluster shows a group of concerning themes related to *performance* that frequently appear not only associated some of emerging theme same cluster but also connected to some of themes related to *innovation and knowledge management*. Within same clusters, another emerging trend that frequently appeared known as '*sustainability*' that not only connected within element of same group and also characterized as the strong association with the element of other clusters. For instance, *sustainability* has strong association *supply chain management* and *eco-innovation* a group element within the same cluster. While, it also connected with *innovation and knowledge management* the component of cluster 5 and cluster 9. There some other publications theme such as *corporate entrepreneurship*, *SMEs*, *collaboration*, *governance*, and *value creation* that directly linked with performance.

The outcome of 4th cluster is based upon a common notion of the *automotive industry*, which is strongly interrelated and commonly appeared in the entire group. This emerging trend strongly twisted within the cluster and being the scope of discussions among various authors. It can be observed that *automotive industry* strongly associated with '*green innovation*' and '*IT capability*' within the group of the same cluster and also exemplified as strong association with *knowledge management*, *organizational learning*, *innovation and organizational culture* as the component of cluster 5, 9, and 7.

Another emerging term appeared in various publications is “firm Performance” strongly associated with ‘entrepreneurial orientation’ and ‘market orientation’. This cluster also includes some of the general concepts of *sustainable development* and *environmental dynamism*.

The outcome of 5th cluster classified as with most popular publication trends that emerges over the period of time “*knowledge management*” strongly associated with some of emerging resources related to knowledge management process and infrastructure capabilities for instance: ‘*knowledge sharing*’, ‘*knowledge creation*’, ‘*knowledge transfer*’, ‘*knowledge management system*’ and *organizational culture* are considered as most occurring phenomena appear among various publication trends over the years. This cluster also includes publication trends such as *organizational capabilities* and *innovation capability* few other emerging terms that directly associated with firms “*competitive advantage*”.

The 6th cluster is considered as one of the diffused clusters. The publication trends here mostly associated with term ‘*Resource-based view*’ strongly associated with *business performance and business values* within the group of same clusters and also relates some publication trends of other clusters, i.e., *knowledge-based view*, *Absorptive capacity*, and *dynamic capabilities* which belongs to cluster 1, 2, and 9 respectively. This includes “*Technology management*” as another emerging trend that frequently occurs and directly linked with *business performance and business values*. There are few publication themes that appeared to be associated with *supply chain and risk management along information system* as a core concept that belongs to *big data analytics*. The 7th cluster based on some of key terms related to “*knowledge*” and considers a most frequently occurring trend that directly associated with “*learning*” or “*organizational learning*”, as potential driver for “*management principle*” and *information and technology*. These emerging trends appeared to be in group of same cluster; on the other hand it also, connects with some of the concepts of *knowledge management and innovation*. This cluster also includes some of term related to *project management and sustainable innovation*.

The 8th cluster more inclined towards some of the crucial concepts of *intellectual capital* that associated with *human capital, innovation performance and relation capital*. This cluster also reflects some of the core concepts of ‘human resource management’ and characterized some relationship with other clusters for instance: ‘*innovation*.’ Other emerging terms are related to organizational ‘*training*’ that associated *innovation performance* a term belongs to same cluster also reflects some association with *business performance and absorptive capacity* which belong to cluster 6, 9 respectively. This cluster also includes some emerging themes such as: ‘*quality management*’ and ‘*organizational change*’. The 9th cluster comprehends ‘*innovation*’ as frequently emerging trends. *Absorptive capacity* is another key research theme appeared with same frequency both research trends directly associated with ‘*Technology innovation*,’ ‘*technology transfers*,’ ‘*organizational performance*,’ ‘*innovativeness*’ and *Financial performance*. This cluster also includes some of the key publication trends based on *Entrepreneurship and Management Innovation*.

The 10th cluster includes some of the essential research trends associated draw a relationship with *competitions*, coordination along with ‘*ground theory*.’ This clusters also comprehend some other frequently appear research themes such as *Innovation management, organizational learning*, and issues related to SMEs

VI. BUILDING A CONCEPTUAL FRAMEWORK

The outcome of co-word analysis as shown in Table: 3 allow author to trace out suitable studies belongs to capabilities related to knowledge, innovation and technology management. By utilizing these key phrases on Web of Science (WOS) search engine helps author to screen out some studies that portrays capabilities perspectives of knowledge, innovation and technology management in R&D context. As shown in Table 4, 5, 6. These studies allow author to draw a conceptual framework to enhance understanding regarding the role of capabilities related to knowledge, innovation and technology management. This helps R&D policymaker to resolves issues related to classification of capabilities that belongs to knowledge, innovation and technology management as supporting management discipline due to behavior of their resources that drives these capabilities. The theory behind conceptual model based on a modification of theoretical evidence presented by Unsal and Cetindamar [31]

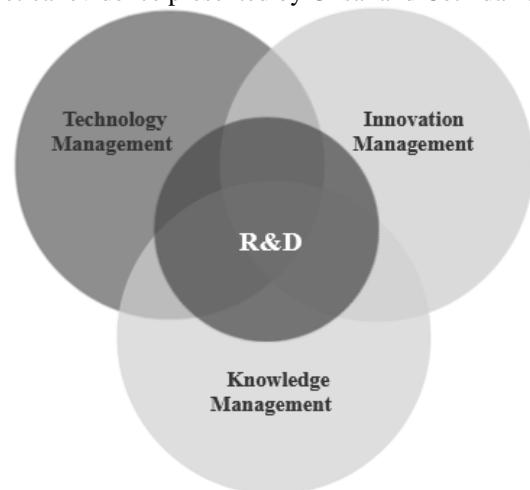


Figure 5: Boundaries among innovation, technology and knowledge Management with in R&D [31]

Table 4: KM Capabilities Dimension in R&D Context

	Author	Process	Infrastructure	Strategy
Knowledge Management Capabilities	Denicolai, et al. [8]	N/A	N/A	- External Knowledge source
	Bäck and Kohtamäki [4]	-Knowledge sharing -Joint scene-making -Knowledge Implementation	N/A	Joint learning : -Internal collaboration -External collaboration
	Žemaitis [33]	-Knowledge Transfer	N/A	-Tacit Knowledge (Personalization) -Explicit Knowledge(Codification)
	Potgieter, et al. [26]	-Knowledge sharing -Knowledge creation	-Organizational learning -Culture -Structure	-Personalization
	He-jiang [15]	Knowledge Acquisition	N/A	N/A

Table 5: IM Capabilities Dimension in R&D Context

	Author	Process	Infrastructure	Strategy
Innovation Management Capabilities	Rodriguez and Wiengarten [28]	-R&D cooperation -Internal R&D -External R&D	N/A	N/A -
	Chanwoo Cho [7]	N/A	R&D investment, -External Networking -R&D Employee	N/A
	Kondratiuk-Nierodzińska [18]	-Knowledge Transfer	-New Knowledge -Absorptive capacity	N/A
	García-Granero, et al. [13]	Decision Making process -Internal R&D - External R&D	-External knowledge -Formulation	-Innovative Performance

Table 6: TM Capabilities Dimension in R&D Context

	Author	Process	Infrastructure	Strategy
Technology Management Capabilities	Dilek Cetindamara [9]	-Technology Acquisition -Technology Exploitation -Technology Identification -Technology learning -Technology Protection -Technology Selection	N/A	N/A
	Günther Schuh [14]	-Technology Planning -Technology Development -Technology deployment -Technology protection -Technology Assessment -Technology Forecasting	N/A	N/A
	Lee [19]	N/A	N/A	-Strategic Technology Road mapping
	Unsal and Cetindamar [31]	N/A	-Management Competency -Facility, -Organization Potential, - Personal skill	N/A

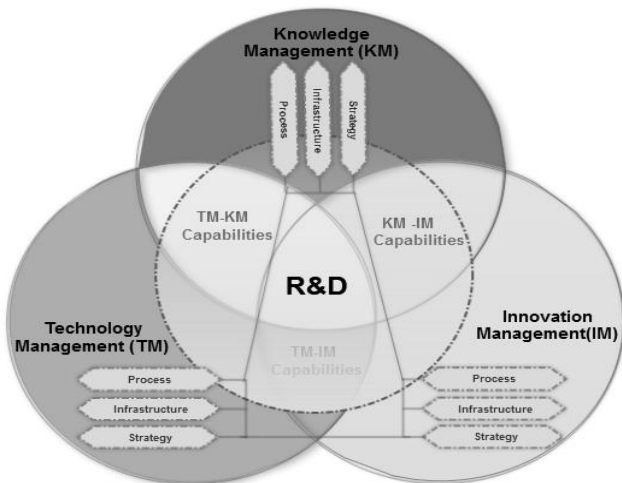


Figure 6: Theoretical Framework based on outcome of current publications trend

VII. CONCLUSION

The publication duration is considering one of the restrictions to perform analysis that has to be mentioned. The publications trends recognized based on indexed papers within the WOS databases represent the reflection of discipline with some frequency. Despite there were many traditional ways that allow researchers to oversee various trends. According to the author, this is yet another way to draw a responsive and wide range of challenges undertaken by the scientist as well as

acquainted with the exciting progress and directions of given issues. Such interpretation can be especially useful for the researchers at the initial stages to select their scientific and technical theories in a specified discipline to accurately distinguish the research themes already established and critically analyzed in literature as well as examine perspective functions that are worth dealing with scientific interest. Not all acknowledged research topic of the conducted analyses may turn into a novel research trend. However, the knowledge of systematic deliberations carried out in this area of research can instigate for the development of a novel vision related to addressing challenges mention in the question. The core objective of the Bibliometric analysis interprets in this article was to draw precise look at contemporary publication trends that reflects some relation among capabilities of supporting management disciplines such as knowledge, innovation and technology management. In the first stage of the Bibliometric analysis, the Author draws specific attention to the particular range of publication related to knowledge, innovation and technology management. In preceding years, a significance regards the subject was observed gradually low in numbers. An escalated growth in the number of publications occurred during the period from 2013-2017. The rising interest in the subject, which was observed in the preliminary years, steadily stabilized at the threshold of 250 publications yearly.

Balancing the number of publications within the area of research individually at the lower level in contrast to that when it was particularly trendy which may suggest by various reviewers related to this field of research (In a simple word the topic or research area become faded but still worthy of further exploration). However, during the interpretation as abrupt change has observed within trends published in the WOS database, it could be noted that in spite at the preliminary stages the dominance of selected publication trends more inclined towards engineering. But over the period a substantial interest has been observed business, management and Economics, both research domains frequently remained the most occurring research areas of taxonomy in term of related published papers. In the second phase, which is considered most significant part of the analysis, the author examined potential keywords supplied by authors as a data that sufficiently symbolized as the source of debate, these keywords already available within publication texts and indexed one of the chosen databases The analysis showed an emerging trend of combining research themes that referred to knowledge management with the context of innovation and technology management or innovation management with the context of knowledge, and technology management and technology management with the context of knowledge and innovation management respectively. There were various emerging trends appear over the periods of time, but among them, there were few themes that were consistently referring to capabilities at describes the process, strategic and infrastructural perspectives of knowledge, innovation and technology management. Another appealing research theme that was analyzed closer to the center of the map is dynamic capabilities, absorptive capacity. This perspective appears as the debate in many publications. According to the author, these trends acknowledge the various changes in the different aspects of the relationship among processes, strategies and infrastructural refers to knowledge, innovation and technology management with covering many aspects of all three supporting management discipline. The bibliometric interpretation is indicating that capabilities related to knowledge, innovation and technology management with their overlapping impact rapidly developing research domain, characterized by integrative challenges with growing research potential. According to the author, the conducted analyses help in exploring various research themes that are novel within the discipline, particularly when it is indicating by a range of multiple publications. The relevance in this aspect permits the direction for gathering the stock of knowledge within the selected research discipline and promotes further searching of research niches that are worth exploring

REFERENCES

1. Accorsi and Costa, "Peer-to-peer systems consubstantiating the Ba concept.," *Electronic Journal of Knowledge Management*, vol. 6, pp. 1-12, 2008.
2. Z. Asim, S. Sorooshian, and M. Hasan, "Capabilities of R & D: Literature analysis," *International Journal of Mechanical Engineering and Technology*, vol. 9, pp. 316-324, 2018.
3. E. S. Ayse Günsel , A.Zafer Acar 2011."Knowledge Management And Learning Capability To Enhance Organizational Innovativeness," in *7th International Strategic Management Conference* vol. 24, ed: Procedia Social and Behavioral Sciences, 2011.
4. I. Bäck and M. Kohtamäki, "Joint Learning in Innovative R&D Collaboration," *Industry and Innovation*, 2016.

5. S. E. Börjesson, M. , "Developing Innovation Capabilities : A Longitudinal Study of a Project at Volvo Cars," *Creativity and Innovation Management*, vol. 20, pp. 171-184, 2011.
6. Chang, Chang, and Wu, "Fuzzy DEMATEL method for developing supplier selection criteria," *Expert Systems with Applications*, vol. 38, pp. 1850-1858, 2011.
7. S. Y. P. Chanwoo Cho, Jong Ku Son and Sungjoo Lee, "Comparative Analysis of R&D-Based Innovation Capabilities in SMEs to Design Innovation Policy," *Science and Public Policy*, pp. 1-14, 2016.
8. S. Denicolai, M. Ramirez, and J. Tidd, "Overcoming the false dichotomy between internal R&D and external knowledge acquisition: Absorptive capacity dynamics over time," *Technological Forecasting & Social Change*, vol. 104, pp. 57-65, 2016.
9. R. P. Dilek Cetindamara, David R. Probert, "Technology management as a profession and the challenges ahead," *Journal of Engineering and Technology Management*, vol. 41, pp. 1-13, 2016.
10. C. H. Duan, "Mapping the intellectual structure of modern technology management," *Technology Analysis and Strategic Management*, vol. 23, pp. 583-600, 2011.
11. I. V. Emenko and V. F. Khoroshevsky, "Peaks, Slopes, Canyons and Plateaus: Identifying Technology Trends Throughout the Life Cycle," *International Journal of Innovation and Technology Management*, vol. 14, p. 28, 2016.
12. F. K. a. F. B. F. Nazari, "Applying Rogers' Diffusion of Innovation theory to the acceptance of online databases at University Zone of Iran," *Malaysian Journal of Library & Information Science*, vol. 18, pp. 25-38, 2013.
13. A. GarcÁa-Granero, J. Vega-Jurado, and J. Alegre-Vidal, "Is R&D Enough to Take Advantage From External Knowledge? Focusing on Coordination Mechanisms," *Journal of Technology Management & Innovation*, vol. 9, 2014.
14. L. K. Günther Schuh, "Cybernetic Approach for Controlling Technology Management Activities," presented at the 48th CIRP Conference on manufacturing systems - CIRP CMS 2015.
15. G. He-jiang, "Study on Knowledge Acquisition Affecting Technology Innovation Performance of Photovoltaic Enterprises-- Based on Mediating Effect of Technology Capability and Moderating Effect of Government Behaviors," presented at the 2013 International Conference on Management Science & Engineering(20th), Harbin, P.R.China, 2013.
16. L. Karadsheh, E. Mansour, S. Alhawari, G. Azar, and N. El-Bathy, "A Theoretical Framework for Knowledge Management Process: Towards Improving Knowledge Performance," *Communications of the IBIMA*, vol. 7, pp. 67-79, 2009.
17. Kim, Song, and Nerkar, "Learning and innovation: Exploitation and exploration trade-offs," *Journal of Business Research*, vol. 65, pp. 1189-1194, 2012.
18. M. Kondratiuk-Nierodzińska, "Innovation capabilities in EU countries: have Central and Eastern European countries been catching up?," *Journal of Business Economics and Management*, vol. 17, pp. 765-779, 2016.
19. W.-I. Lee, "The Relationship between Technology Planning Capability Enhancement, the Technology Roadmap, and Innovation," *International Journal of Innovation, Management and Technolog*, vol. 6, pp. 26-29, 2015.
20. S. Marinković, J. Rakićević, and M. L. Jakšić, "Government performance in technology and innovation management – the case of serbia " presented at the symorg 2014 New Business Model and Sustainable Competitive Belgrade, Serbia, 2014.
21. M. Martin, "Effectiveness of Business Innovation and R&D in Emerging Economies: The Evidence from Panel Data Analysis," *Journal of Economics, Business and Management*, vol. 4, pp. 440-446, 2015.
22. A. A. A. Morales, J. Nielsen, H. A. Bacarini, S. I. Martinelli, S. T. Kofuji, and J. F. G. Díaz, "Technology and Innovation Management in Higher Education—Cases from Latin America and Europe," *Administrative Science*, vol. 8, pp. 2-34, 2018.
23. OECD, "Innovation and Growth rationale for an Innovation strategy " 2007.

24. M. Pellens, B. Peters, C. Rammer, and G. Licht, "Public investment in r&d in reaction to economic crises – a longitudinal study for oecd countries," Instituto Valenciano de Investigaciones Económicas, S.A., Valencia , Spain2016.
25. G. Pisano and H. Figgie, "Toward a prescriptive theory of dynamic capabilities: connecting strategic choice, learning, and competition," *Industrial and Corporate Change*, vol. 26, pp. 747-762, 2016.
26. A. Potgieter, T. Dube, and C. Rensleigh, "Knowledge management awareness in a research and development facility: Investigating employee perceptions," *SA Journal of Information Management*, vol. 15, p. 592, 2013.
27. Rizzi, Ponte, and Bonifacio, "A new institutional reading of knowledge management technology adoption.," *Journal of Knowledge Management*, vol. 13, pp. 75-85, 2009.
28. J. Rodriguez and F. Wiengarten, "The role of process innovativeness in the development of environmental innovativeness capability," *Journal of Cleaner Production*, vol. 142, pp. 2423-2434, 2017.
29. Spender, "Knowledge management: Origins, history, and development," *Advances in Knowledge Management*, pp. 3-23, 2015.
30. Swan and Scarbrough, "Knowledge management: Concepts and controversies," *Journal of Management Studies*, vol. 38, pp. 913-921, 2001.
31. E. Unsal and D. Cetindamar, "Technology management capability: Definition and its measurement," *European International Journal of Science and Technology*, vol. 4, pp. 181-196, 2015.
32. I. M. a. R. A. R. Yaacob, "Perceptions of knowledge creation, knowledge management processes, technology and applications in military organisations," *Malaysian Journal of Library & Information Science*, vol. 16, pp. 73-85, 2011.
33. E. Žemaitis, "Knowledge management in open innovation paradigm context: high tech sector perspective " *Procedia - Social and Behavioral Sciences*, vol. 110 pp. 164 – 173, 2014.

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