A Scientometric Analysis: Big Picture of Innovation Process in Merger & Acquisition

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Abstract

Fast-growing number of research of Innovation Studies especially innovation process, had been main concerns in many research funding organizations. Recent studies on innovation process during merger & acquisition (M&A) present information overload that may burden effective academic research and collaboration. Scientometric analysis has a possibility for an accurate quantitative analyze and visualize the database into extensive landmark of research trend using suitable software tools. This study adopted scientometric analysis on innovation process during M&A using VOS Viewer software. Bibliographic data was taken from Scopus database ranged from 2003 to 2022. There were 275 documents to be compared and analyzed. Scientometric evaluations described density and network of authors, contributing countries & affiliations, and keywords. Number of documents by type and by year were analyzed by using data tables and graphics. The results showed that innovation process during M&A was still wide open to be discussed in terms of public organizations. Innovation process during M&A was strongly linked to open innovation. Meanwhile, to achieve deeper understanding of innovation process, several aspects (such as market and managerial challeges) were needed to be discussed carefully. Finally, this study also suggested further research in terms of innovation process during M&A

Keywords
Innovation Process, Innovation Performance, Mergers & Acquisitions, Scientometric Analysis, VOS Viewer.

1. Introduction

For many years, merger & acquisition (M&A) in several terms had been discussed by scholars. Implementation of merger and acquisition could affect a highly complex innovation process. Until today, there are still many debatable multidimension in the analysis of M&A-innovation connections. The allegation of M&A as a barrier to innovation process seemed not fully correct. It can be seen by the results of previous researches that discussed the positive impacts of innovation process among some aspects relating to firm size, technology level, organizational fit, and many more (Cheah & Ho, 2021; Contreras & Lozano, 2022; Kang & Liu, 2021; Wang & He, 2021). An empirical study in China showed that improvement of innovation during M&A between state-owned and private enterprises was related to trust mechanism (Kang & Liu, 2021; Xiong et al., 2022). Innovation process also described in the societal change such as transition in the socio-technical systems and socio-ecological systems (Scaliza et al., 2021; Selviaridis, 2020). On the other side, horizontal M&A among pharmaceutical firms caused the falling numbers of patents and R&D. M&A activities in hard disk companies focused on increasing rates of sales rather than intensity of R&D. Innovation process of an open innovation could be influenced by clan, adhocracy, hierarchy, and market culture (Heller-Schuh et al., 2020; Stipp et al., 2018). Meanwhile during transformation from current regime to a modern regime in governance bureaucracy, innovation process was divided into strategic, tactical, and operational level which support by polycentric governance approach (Haucap et al., 2019). Today, government sectors involved in e-government innovation that often failed due to knowledge vacuum and least support from stakeholders. In last decade, innovation process was examined in the scope of commercial firm's M&A and rarely discussed in the context of non-profit or government organizations. Meanwhile, today's agendas in public higher education institutions implemented M&A strategy to lean the educational and research systems, which eventually generated gaining number of joint researches and publications (Bennato et al., 2021; Berkhout et al., 2006; Kong, 2010). Yet, there is still gaps to fill the theoretical model of innovation process during M&A especially in public institutions since most studies focused only on commercial companies. This research is intended to present a scientometric analysis of the bibliographic data from 2003 to 2022 on innovation process during M&A. The purpose of this research is to capture scientific visualization and links of co-occurrence or co-citations relate to innovation process during M&A in the modern research. The final section of this research will explain theoretical gaps in the recent studies and proposed further research.

2. Significance of Present Research

Several previous research about innovation process during M&A were examined from commercial firm point of views, governmental case studies are still least discussed. Moreover, many review studies had been conducted using traditional review methods which might present a knowledge burden to scholar's academic collaboration and joint research effort. Therefore, scientometric is a best fit method to facilitate the scholars to extract and review important data from the most certified sources (Li et al., 2021). This study applies a scientometric examination on a broad bibliographic data of innovation process that obtained from Scopus database. Focus of current research is to assess important information and model developments related to innovation process during M&A in public organization by using a scientometric analysis approach. Scientists can take advantages from the current scientometric analysis in terms of building joint ventures, research partnerships, new concepts for more strategic developments that relate to innovation process during M&A. This study shows critical topics and gaps on implementation of innovation process especially during M&A. Finally, new directions for next studies are offered.

3. Methods

In this research, a scientometric analysis of bibliometric data (ranged from 2003 to 2022) on innovation process is performed. Using links and maps in the bibliometric data, this study measures development of research as well as quantitative evaluation of scientometric analysis. The articles on Innovation Process were selected and taken from Scopus in February 2022. The keywords that used to search related articles were ("innovation process" OR "process of innovation") AND ("merger" OR "acquisition"). Moreover, data refinement was utilized by selecting document type as "review" manuscripts. Additionally, the language was also limited to "English". "Publishing Year" was restricted from 2003 to 2022. There are only 275 documents available that related to the topics. Scopus data were retrieved as Comma Separated Values (CSV) files and then CSV files were proceeded to be analyzed using VOSViewer (Visualization of Similarities). VOSViewer -as a new emerging tool for scientometric mapping- has special features that captures unified approach of mapping research networks and applies the scientometric network analysis that will dentify such as co-author networks, citation networks, and co-citation networks. Research steps as seen in Figure 1.

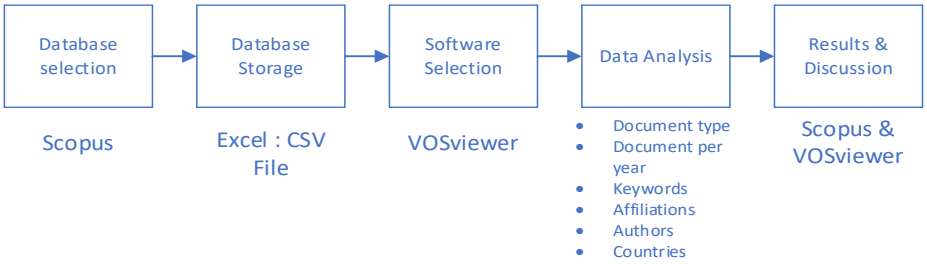


Figure 1. Recent Study Phase for Scientometric Analysis

4. Results & Discussion

This research aims to perform scientometric analysis on Innovation Process especially during M&A. The results of current study not only capture holistic historical perspectives on scientific progress related to innovation process but also explain the emerging trends in research as well as prospective partner to collaborate.

4.1 Scientific Mapping of Document Numbers by Type and By Year

The number of documents by year had been fluctuated, and it ranged from 3 until 21 documents per year. The least document counts were in 2003 or just around 1% of total documents to 2022. There was time that the topic less discussed among scholars such as year 2005 and 2008. Higher Education Institutions in Europe were urged to merge immediately in accordance to achieve 'economies of scale' (Sułkowski et al., 2019). Process of Innovation topics were recent trending themes, it can be figured from 2020 to 2021 with 21 documents (or peaked at 8%). Details of document numbers by year was appeared in Table 1.

Table 1. Number of Documents by Year

Year	Document Number (Proportion in %)	Year	Document Number (Proportion in %)
2022	3 (1%)	2012	13 (5%)
2021	21 (8%)	2011	12 (4%)
2020	21 (8%)	2010	16 (6%)
2019	18 (7%)	2009	12 (4%)
2018	14 (5%)	2008	9 (3%)
2017	16 (6%)	2007	12 (4%)
2016	19 (7%)	2006	16 (6%)
2015	13 (5%)	2005	8 (3%)
2014	19 (7%)	2004	15 (5%)
2013	15 (5%)	2003	3 (1%)

Furthermore, detailed data explained 7 (seven) types of documents which mention consecutively: articles (157 documents); conference papers (74 documents); book chapters (19 documents); reviews (14 documents); conference reviews (6 documents); books (4 documents); and note (1 document). It depicted that articles (in journals) and conference papers were more preferred to be the means to exchange ideas among scholar since both journal and conference papers made scholars being acknowledged globally and more credit points in scholar's portfolios.

4.2 Scientific Clustering of Contributing Affiliations, Authors, and Countries

Keywords played the most important research elements as it reflected the study domain's underlying area. To analyze the keywords, the least number of occurrences for a keyword had been limited to 25. The results found 86 of the 4178 keywords met the criterion. Co-occurrence in the network visualization of keywords can be seen in Figure 2. Size of keyword circle represented its frequency, and position of keyword circle indicated its co-occurrence in papers. The bigger size of the circles, the more significant keyword in the study of innovation process (Zhang et al., 2022).

Meanwhile, colors of circles indicated different clusters of keywords. From clustered colors analysis, such as the red one, studies on innovation process during M&A often correlate with 'open innovation', 'challenge', 'management', and 'case study'. Rigorous examination on previous research showed that case study method dominated the research methodology.

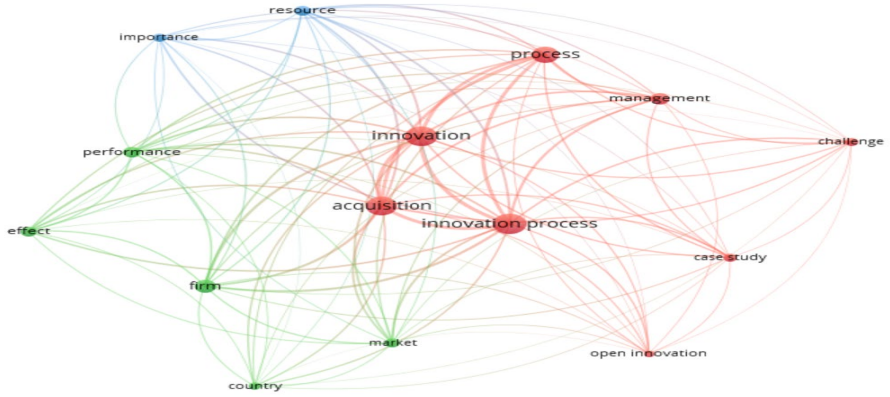


Figure 2. Network Visualization of Keywords Scientific Mapping

The innovation process keyword located closely to the market keyword, although 'market' was grouped into green color. The green color indicated that 'market', 'performance', 'firm', and 'country' were linked to each other when the scholar discussed about innovation process during M&A. On the other hand, 'resource importance' was stood alone and worth to be deeply discussed as one special issue in the innovation process topics. Density visualization of keywords depicted the most discussed keywords among scholars. Yellow color explained greater density of keyword. The keywords with low level of yellow color and placed on the edge of density distribution, indicated that the keywords were less discussed or still new to the topics. As can be seen in Figure 3., it explained that 'open innovation'-'resource importance'-'effect on performance'-'management challenge' could be seriously reviewed when conducting the study of innovation process during M&A. The overlay visualization described from the oldest keywords (indicated by dark blue colors) to most updated keywords (represented by yellow ones). There were several keywords to dig in overlay visualization -according to the density visualization- such as: 'innovation process'; 'case study'; 'performance'; and 'process'. Figure 4 (a-b) revealed that innovation process mostly examined in case studies whether country or firm comparison, furthermore it involved careful examination about process management and market competition (challenge). This study also showed that process performance in the innovation process was urged to focusing on resource importance, as described by Figure 4 (c-d).

Contributing affiliations was also one of scientometric analysis units in this research. Table 2 depicted affiliations with contribution of more than 2 documents on Innovation Process studies. ETH Zurich placed as the most contributing affiliation. These contributing affiliations were dominated by European institutions, mostly from management and engineering majors. From Table 3, it explained that top 10 contributing authors had H-Index ranged from 2 to 45. Such as Lichtenthaler, U. had the highest number of contributed documents on innovation process studies (6 documents), but only had 52 average citation count (lower than Cassiman, B. who had 134 average citation count). Moreover, contributing authors analysis will be proceed into clustering and mapping visualization. Contributing authors were clustered into 4 (four) groups that indicated by colors such as green, red, yellow, and blue. It can be detailed in Figure 5. Further analysis was presented by Figure 6, the density visualization. There was a separated group consisted of Hitt, M.A.-Ireland, R.D.-Hoskisson, R.E that can also considered as newcomer authors in the studies of innovation process during M&A.

Table 2. Contributing Affiliations on Process of Innovation during M&A

Affiliation	Number of Documents
ETH Zürich	5
Università degli Studi di Padova; WHU - Otto Beisheim School of Management; Fraunhofer Institute for Industrial Engineering IAO; IESE Business School	4
Delft University of Technology; Luleå tekniska Universitet; Universidade de São Paulo; CNRS Centre National de la Recherche Scientifique; Politecnico di Torino; Göteborgs	3

Affiliation	Number of Documents
Universitet; Georgia Institute of Technology; Russian Academy of Sciences; Högskolan i Halmstad; Universidad de Antioquia; Aalto University; Universite Paris-Saclay	

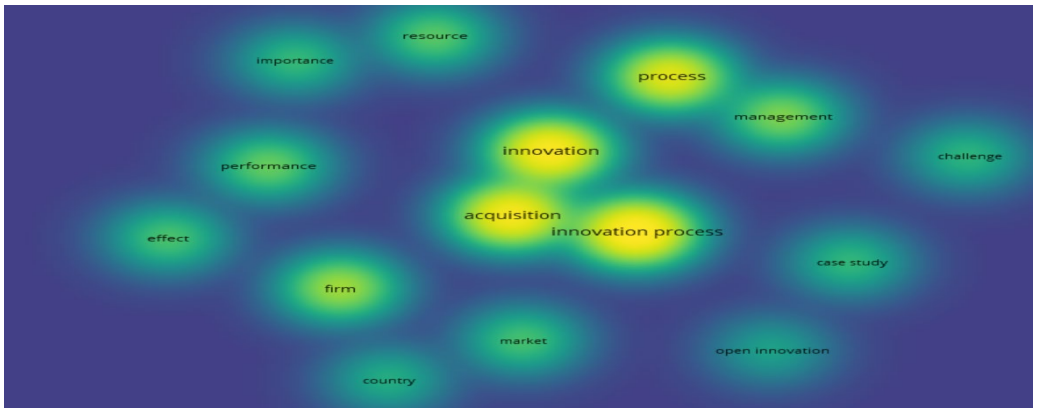
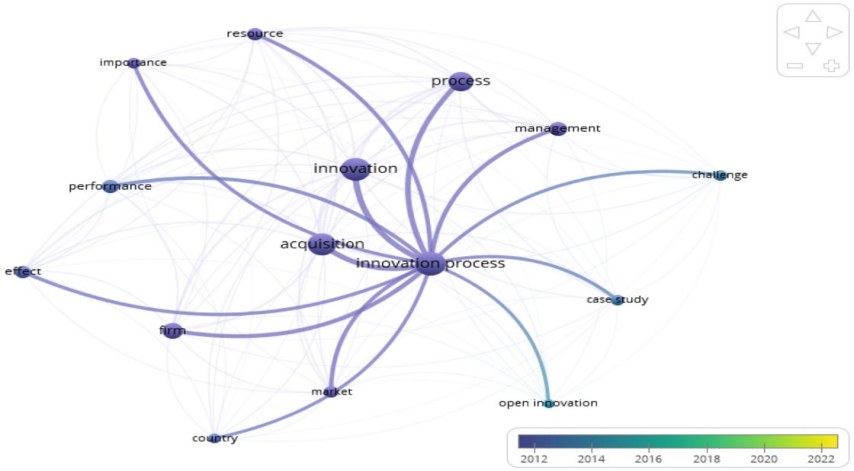
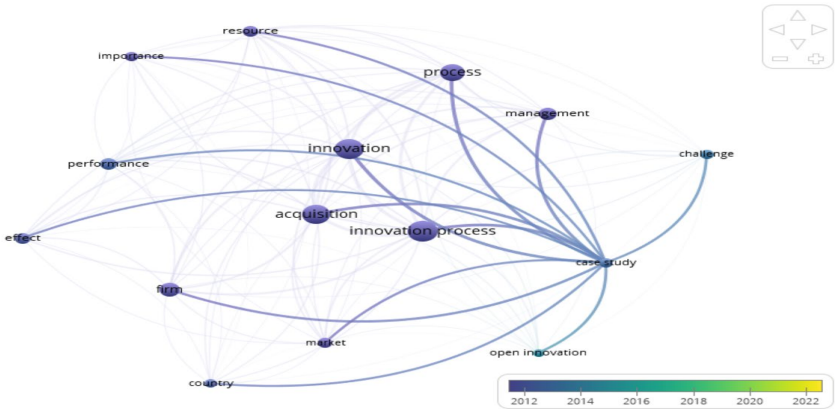


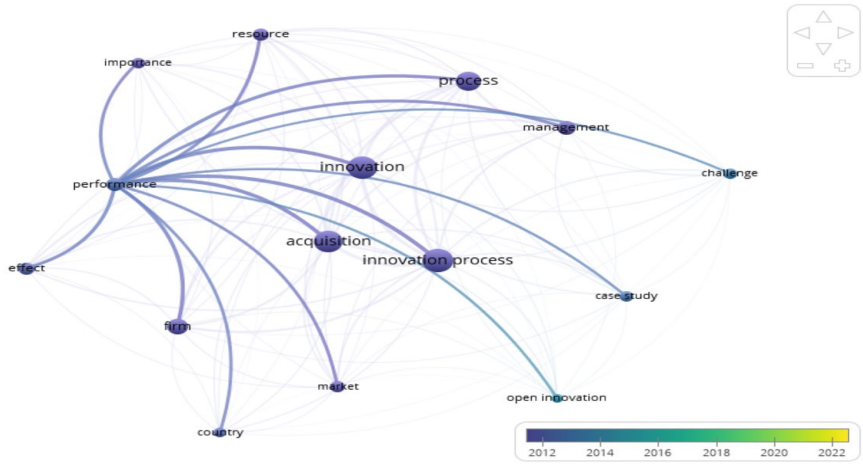
Figure 3. Density Visualization of Keywords Scientific Mapping



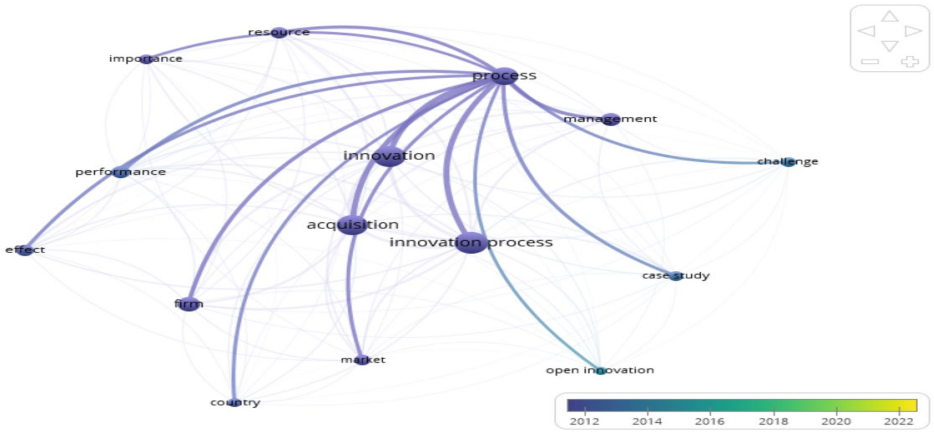
(a)



(b)



(c)



(d)

Figure 4. Overlay Visualization related to:
(a) Innovation Process; (b) Case Study; (c) Performance; (d) Process

This paragraph discussed about scientific mapping analysis of contributing countries. The scientific mapping divided into 5 (five) clusters as depicted in Table 4 and Figure 7. As can be seen from the network visualization, Portugal and Brazil were closed to each other. It explained strong bonds between their innovation process studies. Size of the circles in network visualization explained the most intensive countries that studied on innovation process. There were 3 (three) countries with the biggest circle sizes: United States, Italy, and China. China had become advance country since globalization era and intensified its research and development sector especially through alliance strategies. The closeness of the countries indicated their relationship. European countries paid intensive attention to innovation process studies. The United States was still the benchmark of innovation process research. On the other hand, several countries (such as Russia, Norway, Sweden, and Switzerland) appeared less involved in the studies of innovation process. Previous studies showed that Norway, Sweden, and Switzerland played role as main contributors in Hospitality Management. The overlay visualization of contributing countries showed countries that just entered the scope of innovation process study. The brighter color (such as yellow), the more recent involvement of a country. From Figure 8, it depicted that several countries (China, France, Russia, and Norway) were newcomer in this topic. The Figure 9 implied that most of countries that appeared in the picture had the same intensity (showed by the size of yellow circles) to involve in innovation process except Russia as the new one in innovation topics. As can be seen in Table 5, research related to process of innovation are mostly published in Technological Forecasting & Social Change and from the main journals, there are 12 methods applied in recent studies. The most applied method is literature review and the least utilized are experiment, abductive research, kruskall-wallis test, dynamic system, action research,

critical analysis, and bibliometric study. This study will add new prospect in innovation process topis through bibliometric study or scientometric analysis.

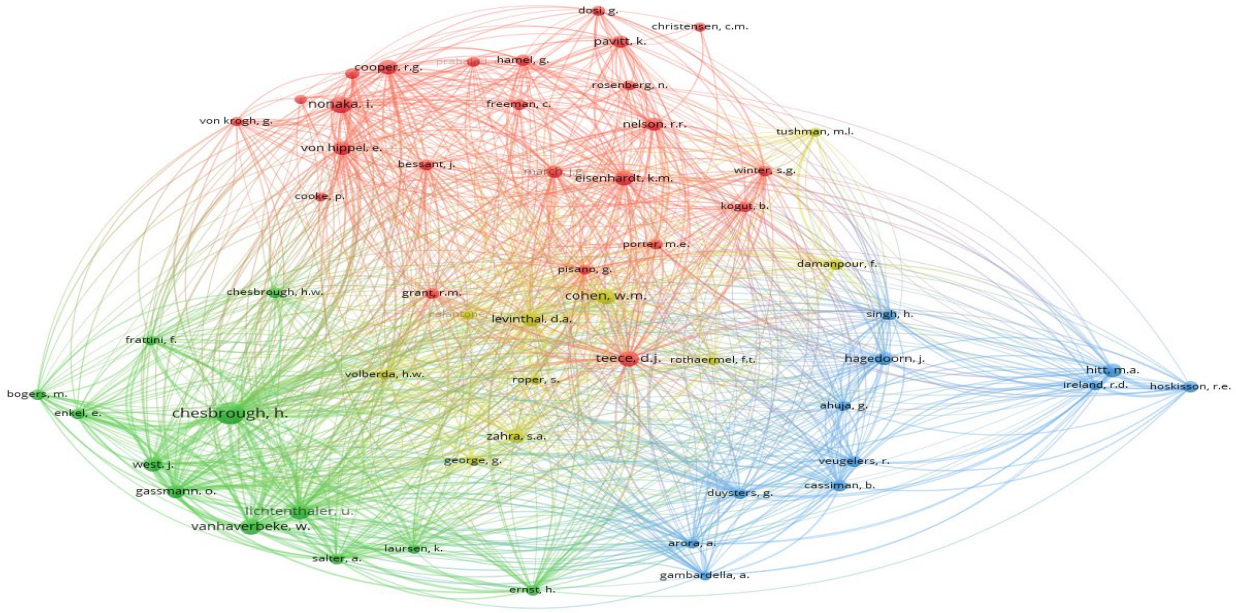


Figure 5. Network Visualization of Contributing Authors

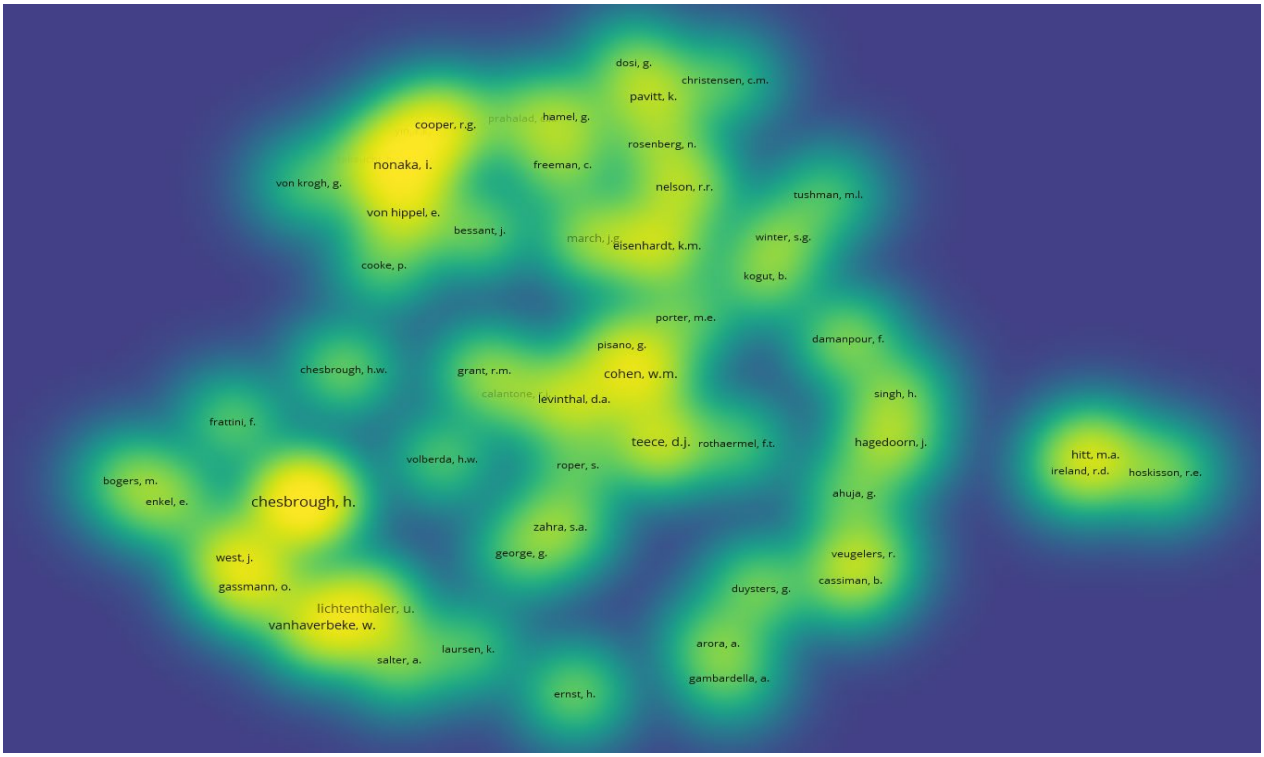


Figure 6. Density Visualization of Contributing Authors

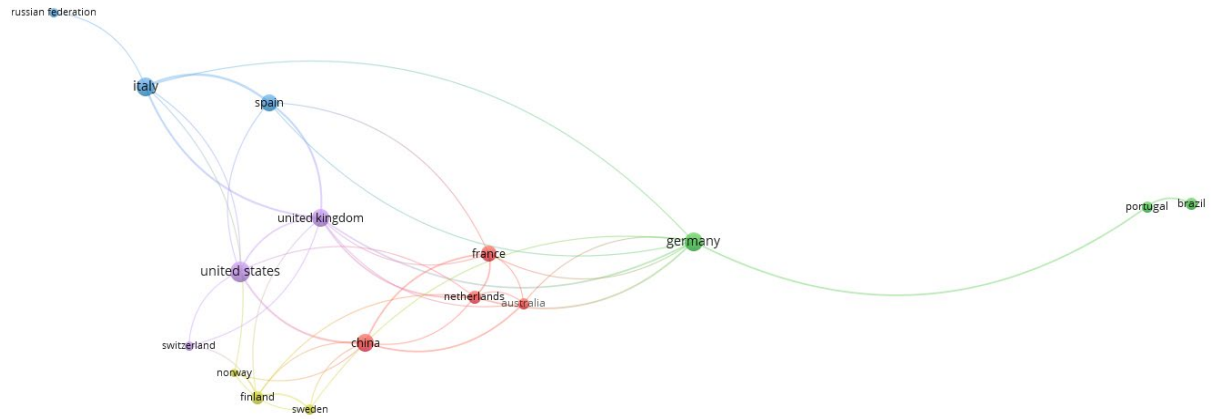


Figure 7. Network Visualization of Contributing Countries

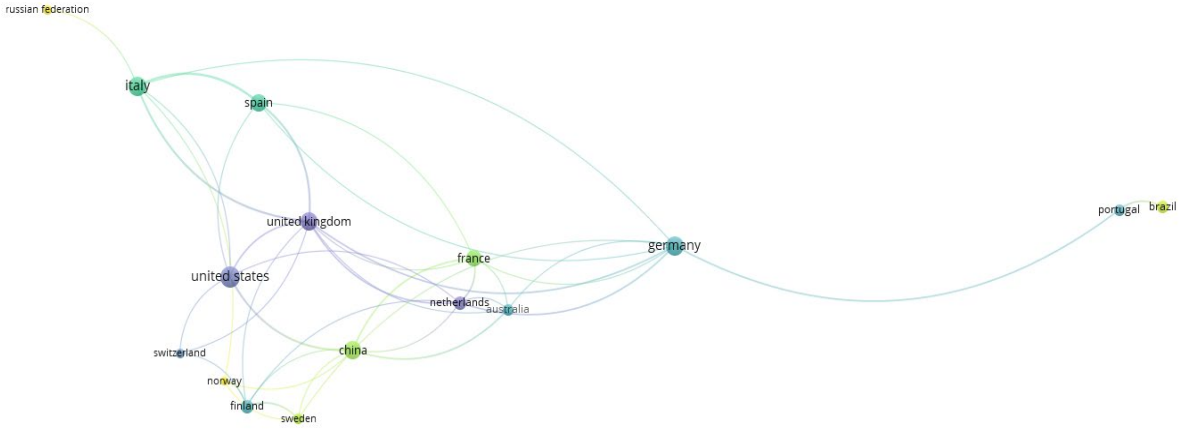


Figure 8. Overlay Visualization of Contributing Countries

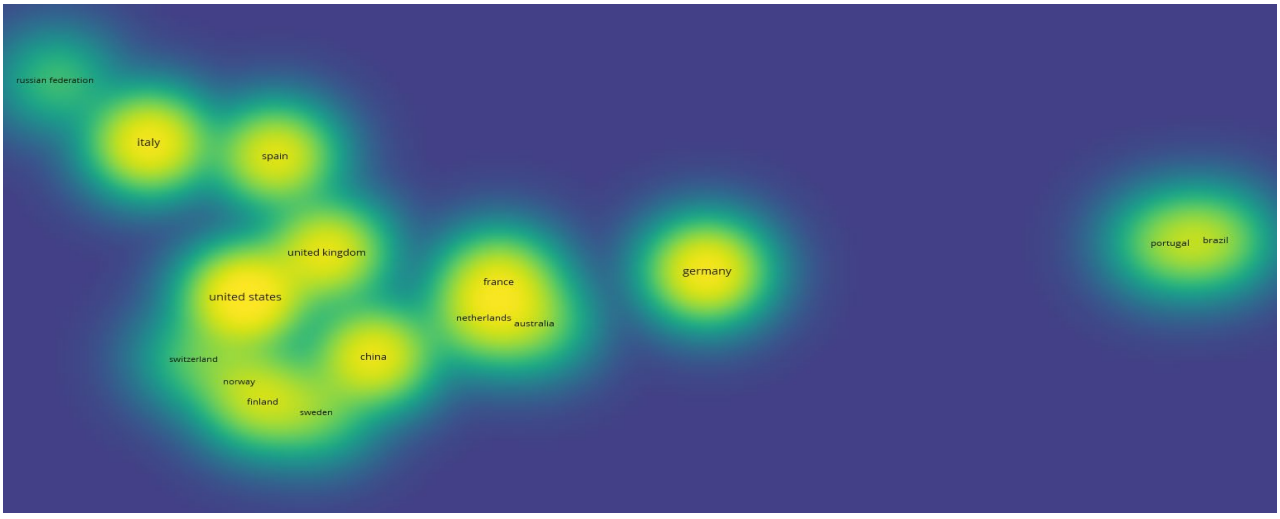


Figure 9. Density Visualization of Contributing Countries

Table 3. Top 10 Authors (with more than 2 documents) on Process of Innovation during M&A

No. Document that Most Contributed	H-Index	Author	Articles	Citation Count	Average Citation Count
6	32	Lichtenthaler, U.	100	5137	52
4	12	Nunes, F.D.	98	657	7
3	21	Cassiman, B.	39	5234	134
3	3	Engelbach, W.	20	33	1
3	2	Laufs, U.	10	10	1
3	45	McCann, P.	217	8540	39
3	10	Norese, M.F.	33	293	9
3	6	Simonen, J.	13	285	22
3	13	Valentini, G.	30	1155	38
3	8	Zibuschka, J.	48	197	4

Table 4. Clustered Contributing Countries

Cluster	Country	Document
1 (Red)	Australia	10
	China	26
	France	21
	Netherlands	14
2 (Green)	Brazil	13
	Germany	30
	Portugal	11
3 (Blue)	Italy	29
	Russia	7
	Spain	24
4 (Yellow)	Finland	15
	Norway	6
	Sweden	9
5 (Purple)	Switzerland	7
	United Kingdom	25
	United States	36

Table 5. Number of Journals as Model Development Basis

Journal	Number of Journal	Journal	Number of Journal
MIT Sloan Management Review	1	Industrial Marketing Management	1
Water Policy	1	Sustainability	1
Chinese Management Studies	1	Research Policy	2
Technological Forecasting & Social Change	3	Virtual Economics	1
International Journal of Industrial Organization	2	Advances in Mergers and Acquisitions	1
Procedia Computer Science	1	International Journal of Managing Projects in Business	1
Science, Technology and Society	1	Management Decision	2
Industrial Marketing Management	1	Journal of Knowledge Management	2
British Food Journal	1	Team Performance Management	2
Kybernetes	1	The Academy of Management Annals	1
Research Evaluation	1	International Journal of Innovation	1
Higher Education Policy	1	Journal of Intellectual Capital	1
European Journal of Higher Education	1	Innovation & Management Review	1
Zentrum für Europäische Wirtschaftsforschung (ZEW)	1	International Journal of Innovation Science	1
J. Eng. Technol. Mgt	1	Management Research Review	1
Journal of Retailing and Consumer Services	1	Econstor	1
International Journal of Organizational Analysis	1	Organization Science	1

4.3 Organizational and Individual Antecedents of Innovation Process during M&A

Public research organizations (PRO) had missions to conduct research and development (R&D) activities. Previous studies often confused between PRO and universities since both institutions were having public fundings. Major differences between PRO and universities were the research output quality and substantial resources. PRO mostly consumed all substantial resources for research and development, meanwhile universities had to balance substantial

resources usages for research and education activities. Moreover, most researchers in PRO were graduate degrees and expected to produce more appropriate research activities and outputs rather than in the universities. Merger & acquisition in public research organizations is still less examined, since then it is important to discuss the innovation process during M&A of PRO. In previous researches, resource managements were linked with commercialization projects, construction management, and supply chain management (Cheah & Ho, 2021; Scaliza et al., 2021; Stipp et al., 2018). In line with Figure 3., resource management still a recent discussed variable in innovation process. Culture is seemed to be the core of organizational factors related to knowledge, innovation management, organizational development, and many more. Previous researches explained that organizational culture were shaped by management support through human resource development programs as well as individual interaction within the organization (Salehi & Veitch, 2020). Culture is composed of shared values, attitudes and meanings that influenced the way of thinking and behavior of the people in organization. We found that culture plays role to succeed innovation performance in relation with the level of technology acceptance within the firms or among the market. Culture can be the orchestrator to improve success level of innovation process both directly and indirectly.

Cultures with a strong rules-based guidance could disrupt employee's autonomy to innovate. On the opposite side, an adequate strategic knowledge management could enable the process of innovation effectively (Thouret et al., 2022). Since knowledge considered as core resources in public research organizations, it needed a proper allocation to minimize the failures of innovation process (Colombo & Rabbiosi, 2014). This statement is in-line with current keywords scientific mapping. Other studies explained that technological distinctive competencies and organizational learning, which including into type of managerial challenges during M&A, also had effects on innovation process in terms of improving firm performance (van Assche et al., 2021). Moreover, organizational learning which consisted of exploitative learning and exploratory learning that could influence imitation and innovation strategies to create an organizational sustained competitive advantage. Many previous studies also involved knowledge-based view (KBV), capability-based view (CBV), and resource-based view (RBV) when examining organizational innovations. KBV indicated that firms must elaborate intangible resources and capabilities such as knowledges and values to sustain competitive advantages. Meanwhile, RBV highlighted exploitations of unique tangible resources to support creations of valuable and non-substitutable outputs. CBV was utilized to balance the implementation of KBV and RBV which can overcome hardships of tangible and intangible measurements (Agolla & Van Lill, 2017; Singh et al., 2020). Stated phenomena was clearly described that managing resource importance and internal-external challenges were the primary activities on innovation process during re-arranging the organizational structures.

Proposition 1. There is a crosslinked between resource-based view and knowledge-based view in innovation process during organizational transition

During the process of M&A, knowledges that required and were available seemed to be intertwined with the innovation process. These knowledges can be confusing to employees. In addition, with tensions of new structural and behavioral organization, this situation was likely to generate a loss of knowledge. There were differences between knowledge gap and knowledge vacuum or loss. Knowledge gap took place for a short-term period, meanwhile loss of knowledge happened for a longer time. Complexity of workloads that increased beyond employee's absorptive capacity can caused the knowledge vacuum. One innovation created a knowledge gap but more than one innovation that happened sequentially may enable a knowledge loss (Choi & Chandler, 2020). Another form of knowledge vacuum can be found when someone did not fully understand how to strategize even, he/she was positioned as an expert or a strategist and already well trained, the knowledge was loss during the thinking process. Until today, knowledge vacuum only explored as fragmented activities rather than consecutive events in innovation process and it is rarely discussed among the public research organizations. Meanwhile, absorptive capability is defined as capability to enable resource base and adjust to changing market environment in terms of achieving a competitive advantage through innovation process. Adaptive and absorptive capability facilitate combination of existing and newly acquired knowledge during organizational M&A. A proposed conceptual model for future research is served in Figure 10.

Proposition 2. Unclear bureaucracy leads to knowledge loss which can harm the distinctive competencies and adaptive capability

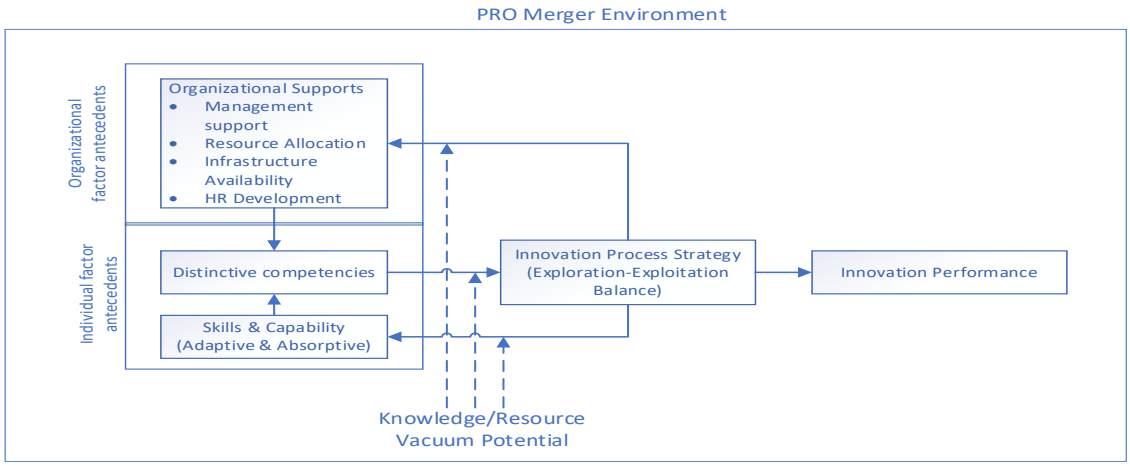


Figure 10. A Conceptual Model of Innovation Process and Its Antecedents during M&A in PRO

5. Conclusion

Potential future research is also being discussed by this study, and indicates that innovation process still needs to be assessed from the point of view of management challenges-resource allocation importance-and effect on performance (particularly relates to organizational and market performance). The result of this research may be useful for policy makers and academia who will explore innovation process theory especially in coping with organizational condition during merger and acquisition, to minimize cultural frictions as well as gaining market and organizational performances.

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Elisa Anggraeni is graduated from Gadjah Mada University and received her bachelor's degree in Agro-industrial Technology. She received STUNED scholarship to study at Delft University of Technology in 2001 and received her Master of Science degree on System Engineering and Policy Analysis from Faculty of Technology, Policy and Analysis in 2003. She also obtained her Doctoral degree on Innovation Studies from the Department of Economics of Innovation and Technology, Delft University of Technology. She found the complexity in the intersection between technology, society and environment to be interesting. This translates into her research interests in innovation studies: technopreneurship in bringing technology into practice, fuzzy front end of new product development, open innovation, the role of network and social capital as sources of competitive advantages, learning and managing knowledge. Continuing this body of knowledge, she pursues her passion in managing innovation at organization and actively participates in developing concepts and programs aiming at improving innovation capability, nurturing student's innovative and technopreneurial capabilities. Implementing engaged scholarship as a framework and design thinking as mindsets and tools, she aims at integrating teaching, research and community empowerment through action research and experiential learning to improve the health of innovation ecosystem.

Machfud is a professor at Agroindustrial Engineering in IPB University. He achieved his master's degree at Industrial Management & Engineering in Bandung Institute of Technology (1987) and his doctoral degree at Agroindustrial Engineering in IPB University (2001). His expert is also in Industrial Engineering and Systems. He wrote many scopus-indexed articles as well as posed as keynote speech in many national and international syposiums. His research interests are agorindustrial production and management systems, system modelling and optimization, and strategy for developing innovation in agroindustries.

Nurul Taufiqu Rochman is a professor in National Research and Innovation Agency. He obtained his doctoral degree in Kagoshima University (Material Process & Engineering-2000) and IPB University (Management & Business-2011). Both of his bachelor (1995) and master (1997) degree were also from Mechanical Engineering, Kagoshima University. He won several medals for innovators since 2005, which recently received BJ Habibie Technology Award (2014) and WIPO Medal (2016). His role in Nanotech Indonesia Group as co-founder is quite impactful that guiding business management for many scientists. He actively poses as delegations in many scientific activities both national and international as leader and member. His research interests include metallurgical and material such as nanobubble technology as well as business and management scopes. He holds many intellectual property rights until today.