Knowledge Mapping System Features for Supporting Researcher Mobility into Industries and SME from e-Government Perspective

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Abstract. Limitations knowledge of researcher has become an obstacle for the industry to be able to produce innovative products. Despite the fact that the government has many researchers but has not contributed optimally. For this reason, it is necessary to mobilize researcher which is one of the main problems of the low mobility into the industry, because the government has not yet provided an integrative ICT-based government service about knowledge mapping owned by institutions and individuals. Therefore, this study aims to propose a knowledge mapping system as a means of providing information that encourages the mobility of researcher in industry and SME with e-government perspective. Using qualitative methodology of CIPSODA and e-government application approach and quantitative through surveys by sampling data from three related entities (industry, government, and researchers) in Indonesia. This research has produced what functions are needed by stakeholders on the knowledge mapping system to encourage researcher mobility.

1. Introduction

Innovation in the industrial sector becomes a necessity that must be done continuously especially in the era of disruptive technology that requires an acceleration in innovation\cite{6}. The demand to produce innovative products encourages industry to conduct research and development (R \& D) conducted by HR research. Limitations of human resources research have become an obstacle for the industry to be able to produce innovative products. Despite the fact that the government has a considerable number of human resources, about 11,025 researchers and engineers in government agencies and more than 126,000 lecturers in Universities, but have not been able to contribute to the growth of innovation in the national industrial sector. One of the main problems is the low mobility of human resources of researchers to the industry, whereas in theory the mobility of researchers can improve and accelerate innovation\cite{7}, \cite{8}. This condition due to lack of the applicable regulations and also from the government which still has not provided integrative information about the capacity, competence, and field of R \& D knowledge owned by the institutions and individuals. In addition, there is no ICT-based government service that focuses on encouraging human resource mobility to the industry.

Therefore, this study aims to propose a knowledge mapping system as a means of providing information that encourages the mobility of R \& D human resources in industry and SME with e-government perspective. Using qualitative methods of CIPSODA and e-government application
approach and quantitative methods through surveys by sampling data from three related entities (industry, government, and R&D human resources). This research has produced what functions are needed by stakeholders on the knowledge mapping system to encourage researcher mobility.

2. Related Work

The use of knowledge mapping tendency is done on the implementation of knowledge management conducted by the organization, but its development is becoming more widespread. Much has been developed using knowledge mapping in various purposes and contexts. Moradi, et al. (2017) developing knowledge mapping taken from Tehran University's database of research and academic research information systems for decision deactivator dean of research and academic field[11]. It is also used in policy-making in research planning using a database at the NRF research center in Korea[12]. Another interesting study and an inspiration on this research is the use of knowledge mapping to provide keyword search services for scholar in order to obtain information to cooperate with relevant institutions on the topic or trends information in research topics based on certain keywords, where this map is generated from the NTIS source database containing the data of the research projects[13].

The use of knowledge mapping system to provide services to the public can initiate the development of these facilities to be applicable to the environment of government institutions, thus becoming part of e-government. Therefore, this research is conducted to see from the perspective of e-government on the application of knowledge mapping system.

Ramadhan(2011) take the e-government definition from Heeks (2006) is the use of Information Technology (IT) by Public sector organizations, where another definition from West (2005) is public sector use of the Internet and other digital devices to deliver services, information, and democracy itself[14]. Therefore, this research will look at the use of a knowledge map system based on e-government perspective translated in R&D context in Indonesia to encourage researcher mobility. So, in this case, it is expected to be able to propose a service that can be provided by research institutions coordinated by Ministry of Research, Technology and Higher Education of the Republic of Indonesia to encourage innovation improvement through R&D in local industry and SME in Indonesia.

3. Research Methodology

This research is done by mixed method methodology using the exploratory sequential mixed method as a design in which the researcher first begins by exploring with qualitative data and analysis and then uses the findings in a second quantitative phase[19], [20]. The first step is used to define a knowledge mapping system in the context of R & D based on e-government perspective. The approach adopted by his research Ramadhan (2011) using CIPSODA from his research Heeks (2011)[21] and e-government application approach from his research Yinbin, et al. (2009)[14], [22]. This method will produce a descriptive explanation of Capture, Input, Process, Store, Output, Decision, and Action (CIPSODA) from knowledge mapping system in e-government context and with e-government application approach method can explain the position of the system and its relationship between Citizen, Business, and Government.

The qualitative method will be performed using a randomly distributed questionnaire to the user population of the Researcher, the management of the research institute and the Industry / SME. The questioner is used to confirm the need for researcher mobility and R & D information needs to drive researcher mobility into industry and SME. The results of this questioner will be translated into the needs of features that can be provided on the knowledge mapping system.

4. Knowledge Map in e-Government Perspective

4.1. CIPSODA Checklist Approach

4.1.1. Capture. In order to map R & D knowledge of a person or institution, data can be captured from various sources that manage scientific publications in Indonesia. The challenge is that the source of this scholarly publication is scattered in various locations of journal owners or conference organizers. However, the overall metadata of such publications can be obtained from the indexing portal, such as
Sinta (http://sinta.ristekdikti.go.id) and the garuda portal (http://portalgaruda.org), or can also use international indexers such as Scopus, Web of Science and Google Scholar [23], [24]. It can also use a database of research information systems that contain research data of researchers/lecturers [11]–[13]. In Indonesia, research data grant management has been done through Simlitabmas portal (http://simlitabmas.ristekdikti.go.id) so that this data can be used to know research interest of researcher.

4.1.2. Input. Further data can be input by each researcher, through a portal or mobile application. The data entered in the form of a profile (interest research, identification number on the indexing database, website, contact), as well as data profiles of research institutions that can be input by each research institution. In terms of industry and SME, it is necessary to input company profile data, particularly the topics and areas of research required through Knowledge Breakdown Structure (KBS) of R & D performed [25].

4.1.3. Process. Knowledge Mapping System will process the data to be able to map the field of research at each institution and person to be utilized by the industry/SME in order to build institutional research cooperation that needs to be regulated by regulation in its determination. In addition, the system will process the company profile data and the topics and research areas needed to encourage research institutions to initiate research cooperation proactively.

4.1.4. Store. Data storage can use a structural database or semi-structural database. In general, the need to do is consider 3V (Volume, Velocity, and Variety). It also needs to consider the ease of retrieval data and its processing. Data equality, either the prevention of loss by backing up or misuse of data by viewing the role and privilege of the database, becomes a consideration in the use of available database technology.

4.1.5. Output. The output of this system is expected to present researchers data, research institutions, research, industry and SME topics on a tabular and graphical basis. This output needs to be set availability in accordance with the role that the user has. It also needs to be integrated output in the form of GIS which shows the existence of the resource researcher is located.

4.1.6. Decision. The resulting information will support the decision-making of the researcher need in determining the research topic, for the institution in encouraging the focus of the research that must be done. And especially for industries and SMEs can support the determination of research cooperation that needs to be done. In the system, it is necessary to provide a recommender system for the industry in determining the needs of the research cooperation.

4.1.7. Action. Many actions can be undertaken by government and industry and SME from the resulting information, such as strengthening human resources for R&D on specific topics to support better innovation results in industry and SME and improving product innovation from industrial and SME products in Indonesia through a mechanism researcher mobility.

4.2. Knowledge Mapping System for e-Government Application Approach

The connectivity between these five entities can be described as follows:

![Figure 1. E-government application approach [14]](image)

4.2.1. Citizen to Government (C2G). Citizen's relationship with Government on Knowledge Mapping System lies in the function of consultation on community problems to be solved by researchers with a scientific approach. The general public can convey the aspirations of the problem, such as the need for clean water solutions to coastal living communities, or the need for pest-resistant rice seed on dry land and peat. The real aspirations of the problems conveyed directly by the community will greatly help the researchers to do research that has a real contribution as well as for the business to produce innovative product solutions needed by the community.
4.2.2. *Government to Citizen (G2C)*. In contrast to the number one relationship above, the government through this system can provide information to be utilized by the community. From a resolved solution of the R & D results based on the aspirations of the issues that have been submitted, it can be useful information for other communities that have similar problems, so that the solution can be reused, and avoid duplication of research on the same problem. In addition to the scientific community, such as students or journalists can easily trace who and where the institution the necessary researcher is located.

4.2.3. *Government to Government (G2G)*. Cooperation between government agencies is very important to do, with this system problem that arises in the community can encourage to conduct research collaboration between government institutions or with industry / SME. In addition, it will also facilitate the researchers to obtain useful information in seeing the state of the art in real problems and also R & D resources that can be invited to cooperate. Another thing that adds value to this system is the sharing of R & D resources so that it is expected to encourage interdisciplinary research in solving problems in society.

4.2.4. *Business to Government (B2G)*. This section is the main focus of the use of knowledge mapping systems, where limited R & D human resources and low product innovation can be encouraged to mobilize the researcher. In this position, the industry and SME provide the profile data and identification of the needs of the research fields required in product innovation. Through this data can be identified by system recommendations by providing researcher advice in accordance with the field of research and also institutions that need to be explored to conduct research cooperation to improve the innovation of products produced. The other side of the data can be utilized by research institutions to be encouraged to offer themselves to cooperate in research that is being done by industry or SME.

4.2.5. *Government to Business (G2B)*. The government in this position provides researcher knowledge map information scattered in each institution and college to be utilized by industry and SME in order to build research cooperation. The government can arrange R & D cooperation mechanism with industry and SME with regulation and policy that need to be made, so as to build conducive and comfortable cooperation between entities. The government, in this case, can be represented if the Ministry of Research, Technology and Higher Education of the Republic of Indonesia become a facilitator of the implementation of e-government for researchers mobility who must be represented by each agency's management.

5. Questionnaire Result

Based on the results of the identification in the previous section, compiled questionnaires to identify the needs of functions and information from the knowledge mapping system required. Furthermore, this questionnaire was distributed online to several groups of researchers, lecturers and industry / SME, until this paper was prepared to get feedback data as much as 31 respondents who have filled out the questionnaire.

| Categories | Percentage | Categories | Percentage | Categories | Percentage |
|------------|------------|------------|------------|------------|------------|
| Age        |            | Gender     |            | Job Background |          |
| 31-40 Years| 22.6%      | Men        | 61.3%      | Researcher at a government institution | 48.4%     |
| 41-50 Years| 41.9%      | Women      | 38.7%      | Lecturers of university | 25.8%     |
| > 50 Years | 35.5%      | Length of work |         | Non-researcher of civil servant | 12.9%     |
| Education  |            | < 10 Years | 9.7%       | Privat college lecturers | 12.9%     |
|            |            | 10-20 Years| 38.7%      |              |            |
|            |            | 21-30 Years| 32.2%      |              |            |
|            |            | > 30 Years | 19.4%      |              |            |

5.1. Profile of Respondent

The following is presented information of the respondent's profile regarding gender, age, last education, occupation.
5.2. The Results of the Questionnaires

To identify respondents' perceptions of information and knowledge mapping functions in the researcher mobility, e-government services, and e-government context, the authors divide into three parts of the question to know the respondent's perception of the three items. The first part and second part is shown in Table 2 and the third part in Table 3 and 4.

Table 2: The result of the questioner for researcher mobility and e-Government services

| No. | Questionnaire                  | Result                      |
|-----|-------------------------------|-----------------------------|
|     |                               | Yes (%) | No (%) | Unknown (%) |
| 1   | Is researchers mobility required in local industries and SMEs in Indonesia to improve product innovation | 96.8     | 3.2     | -            |
| 2   | Is government support needed in terms of programs and policies to regulate the mechanisms of researchers' mobility in local industries and SMEs | 87.1     | 12.9    | -            |
| 3   | Does the government need to provide e-government tools or services for researcher mobility in local industries and SMEs? | 80.6     | 12.9    | 6.5          |
| 4   | Is the researcher's knowledge mapping scattered throughout the territory of Indonesia necessary to use e-government facilities or services? | 93.5     | 6.5     | -            |
| 5   | Will the integration of information that will result from researcher knowledge mapping will help and stimulate research collaboration and encourage the mobilization of researchers with local industries and SMEs? | 90.3     | 3.2     | 6.5          |
| 6   | What institutions do you think of in Indonesia need to provide e-government tools or services for researcher mobility in local industries and SMEs? | • The Ministry of Research, Technology and Higher Education of the Republic of Indonesia (RISTEKDIKTI)-32.3 • Indonesian Institute of Sciences (LIPI) - 25.8 |

Third, e-government context, table 3 and table 4 consist the information and functional needs of e-government facilities or services to support researchers' mobility in local industries and SMEs as e-government context apart.

Table 3. Information required

| No | Information required                                    | (%) |
|----|--------------------------------------------------------|-----|
| 1  | Information on research results of each institution     | 74.2 |
| 2  | Expert information and research area of researchers     | 74.2 |
| 3  | Expertise and research institution research information | 64.5 |
| 4  | Map information distribution of researchers based on institutions | 64.5 |
| 5  | Information on the research needs of Industry and SMEs (Small and Medium Industries) | 71.0 |
| 6  | Problem information suggested by a citizen to do research | 61.3 |
| 7  | Expert information is completed with a successful story of collaborative practice that has been done | 3.2 |
| 8  | Patented research                                      | 3.2 |
| 9  | Information about SMEs Problem                          | 3.2 |

Table 4. Function Requirement

| No | Function Requirement                                                                 | (%) |
|----|--------------------------------------------------------------------------------------|-----|
| 1  | Data search function profile of the researcher                                       | 61.3 |
| 2  | Data search functionality based on accurate keyword field/research interest           | 80.6 |
| 3  | The function of knowledge mapping owned by researchers based on the results of research that has been done | 64.5 |
| 4  | The function of knowledge mapping based on a research collaboration                   | 58.1 |
| 5  | Search function institution data profiles                                              | 58.1 |
| 6  | Function profile field of expertise and research owned by the institution              | 61.3 |
| 7  | The function of confronting the concrete problems facing the community and suggestions for research | 64.5 |
| 8  | Profile function and requirement of research field on Industry and IKM (Small and Medium Industry) | 74.2 |
| 9  | The function of successful and failed SMEs profile                                    | 3.2 |

In Table 3 there are six choices of information needs, of which more than 50% (majority) state that information is required on e-government services and there is an additional information suggestion, which is: expert information is supplemented by a successful collaborative story ever undertaken by one respondent, patented research and Information about SMEs Problem. Whereas in Table 4 for functional requirements there are eight functions of choice, which on average over 50% of respondents stated that those functions are required in e-government services. There is one additional information suggestion, namely The function of successful and failed SMEs profile.
6. Discussion and Future Works

This research can contribute new approaches to the knowledge mapping approach of researchers on the perspective of e-government, most of which previously still focus on the disclosure of knowledge possessed by individual institutions and utilized in their internal management, such as decision-making in the academic context[11] and research planning[12].

Therefore, by exploring the utilization of knowledge mapping on e-government, it will be able to identify the inter-linkage between entities and the features required in the knowledge mapping system. To know the features, we can use mapping through the functions and information that has been identified based on user needs. In Table 5 there is a feature analysis and its relationship with the functions and features of the identification result.

| No | Features                                           | Functions                                                                 | Information                                                                 |
|----|---------------------------------------------------|---------------------------------------------------------------------------|----------------------------------------------------------------------------|
| 1  | Mapping the knowledge of researchers & Institutions| • The function of mapping knowledge owned by the researchers based on the results of research that has been done.  
• Knowledge mapping function based on a research collaboration  
• Function profile field of expertise and research owned by the institution | • Information research results of each institution  
• Information expertise and research areas of researchers  
• Information on the distribution of the researcher based on the institution  
• Information expertise and research field of research institutions |
| 2  | Research Cooperation                              | • Profile function and requirement of the research field in Industry and SME (Small and Medium Industry) | • Expert information completed with success story of cooperative practice ever done |
| 3  | Community reports                                 | • Concrete confronting functions are facing communities and suggestions for research. | • Citizen-recommended problem information for research |
| 4  | Mapping the field of research on Industry and SMEs | • Profile and needs function of the research field in Industry and SME (Small and Medium Industry) | • Information on the research needs of Industry and SME (Small and Medium Industry) |

From these features can be described more clearly with the use case diagram as in Figure 2. Figure 3 illustrates the knowledge mapping system architecture in the e-government perspective. With this architecture can be more clearly known patterns of interconnection between entities in the application system.

This research is initial research that will be followed up with further research. Therefore, many things need to be further identified, such as technology, regulation, and human aspects. However, this preliminary study will become a justification for conducting further research in a more comprehensive manner by involving experts who are competent sources in the field.
7. Conclusion

Current knowledge mapping domains are no longer limited only in the context of implementing knowledge management but can be used more broadly into e-government-based public services. In the context of the state of Indonesia, e-government facilities and services with respect to knowledge mapping systems to encourage researcher mobility in industries and SMEs should be encouraged and implemented by the Ministry of Research, Technology and Higher Education of the Republic of Indonesia, which has the task of coordinating R&D in research institutions in government and universities.

Based on this research, some great features of the knowledge mapping system for the researcher's mobility in industry and SME are mapping knowledge of researchers and institutions, mapping the field of research on industry and SME, research cooperation and report problems from the citizen or people.

This research begins to examine the possibilities of utilizing the knowledge mapping system on public services, many things that need to be explored comprehensively with regard to it. Therefore, further research on knowledge mapping system model in R & D context is needed to support the researcher's mobility in industry and SME in order to encourage product innovation in Indonesia.

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References

[1] M. F. Wiersema, H. P. Bowen, M. F. Wiersema, and H. P. Bowen, “Corporate Diversification: The Impact of Foreign Competition, Industry Globalization, and Product Diversification,” vol. 29, no. 2, pp. 115–132, 2008.
[2] I. Report, “Competing in the global economy : the innovation challenge,” no. December, 2003.
[3] J. S. Dietz and B. Bozeman, “Academic careers, patents, and productivity: Industry experience as scientific and technical human capital,” Res. Policy, vol. 34, no. 3, pp. 349–367, 2005.
[4] S. K. Zsuzsanna and E. Herman, “Innovative Entrepreneurship for Economic Development in EU,” Procedia - Soc. Behav. Sci., vol. 3, no. 12, pp. 268–275, 2012.
[5] OECD, “Innovation and Growth: Rationale for an Innovation Strategy,” 2007.
[6] K. Still and G. Satell, “Accelerating Research Innovation by Adopting the Lean Startup Paradigm,” vol. 7, no. 5, pp. 32–44, 2017.
[7] U. Kaiser, H. C. Kongsted, and T. Rønde, “Labor Mobility, Social Network Effects, and Innovative Activity,” IZA Discuss. Pap., no. 5654, pp. 1–37, 2011.
[8] J. Moen, “Is Mobility of Technical Personnel a Source of R&D Spillovers?,” J. Labor Econ., vol. 23, no. 1, pp. 81–114, 2005.
[9] R. H. A. Mostafa Jafari, Peyman Akhavan, Atieh Bourouni, “A Framework For The Selection Of Knowledge Mapping Techniques,” J. Knowl. Manag. Pract., vol. 10, no. 1, pp. 1–8, 2009.
[10] K. W. Lee, K. L. Wu, H. P. Kuo, and P. L. Yuan, “Design and validation of a knowledge map system—the case of construction industry in Taiwan,” Hum. Factors Ergon. Manuf., vol. 27, no. 1, pp. 30–44, 2017.
[11] R. Moradi, K. Taheri, and M. S. Mirian, “Data-Driven Methods to Create Knowledge Maps for Decision Making in Academic Contexts,” J. Inf. Knowl. Manag., vol. 16, no. 01, p. 1750008, 2017.
[12] B. Yoon, S. Lee, and G. Lee, “Development and application of a keyword-based knowledge map for effective R&D planning,” Scientometrics, vol. 85, no. 3, pp. 803–820, 2010.
[13] M. S. Yang, W. K. Joo, K. S. Choi, Y. K. Kim, and Y. J. Kim, “Development of Platform-Based...
Knowledge Map Service to get Data Insights of R&D Institution on User-Interested Subjects,”
*Wirel. Pers. Commun.*, pp. 1–21, 2017.

[14] A. Ramadhan and D. I. Sensuse, “e-Livestock as a New Paradigm in e-Government,” no. July, pp. 1–4, 2011.

[15] R. Hishiyama and T. Ishida, “An e-procurement Model with Specification Description Improvement.”

[16] J. Hwang and A. B. Mohammed, “Approaching e-democracy : A Case Study Analysis from Jordan,” pp. 932–939, 2008.

[17] L. Berntzen, “Enhanced e-Services through Partnerships,” pp. 0–4, 2007.

[18] L. Sommer and R. Cullen, “Participation 2 : 0 : a Case Study of e-Participation within the New Zealand Government New Zealand Abstract,” 2009.

[19] V. Venkatesh and S. A. Brown, “Bridging The Qualitative-Quantitative Divide: Guidelines for Conducting Mixed Methods Research in Information System,” *MIS Q.*, vol. 37, no. 1, pp. 21–54, 2013.

[20] Jhon W. Rreswell, *Research Design: Quantitative, Qualitative and Mixed Methods Approaches*. SAGE Publication, 2014.

[21] R. Heeks, *Implementing and Managing eGovernment An International Text*, First Edit. SAGE Publication, 2011.

[22] L. Yinbin, “Current Practices of Shanghai E-Government : A Framework and Case Study,” pp. 0–3, 2009.

[23] X. He and P. Liu, “Knowledge mapping of community research in China based on CSSCI (2006-2015),” *2017 2nd IEEE Int. Conf. Cloud Comput. Big Data Anal. ICCCBDA 2017*, pp. 454–459, 2017.

[24] J. Watthananon and A. Mingkhwan, “Optimizing knowledge management using knowledge map,” *Procedia Eng.*, vol. 32, pp. 1169–1177, 2012.

[25] B. Karimi and M. Saedikia, “Building a Knowledge Map Based on Process Mapping for R & D Centers,” *Aust. J. Basic Appl. Sci.*, vol. 3, no. 3, pp. 2405–2409, 2009.