Goals and Suggestions in Knowledge Map Development using SNA: A Literature Review

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Abstract. As a non-ministerial government institution in charge of statistics, BPS-Statistics Indonesia must be able to provide quality statistical data through integrated and international standard statistical activities. Integrated statistical activities require a process of statistical activities that does not silo thinking. This silo thinking can be detrimental to BPS-Statistics Indonesia, especially in terms of overcoming the problem of statistical activities that have actually occurred in previous statistical activities. From these problems it is necessary to identify important knowledge that is useful to be able to be accessed and used as a lesson learned by other statistical activities. In Knowledge Management there is a tool to help identify important knowledge, namely Knowledge Map, which is assisted by analysis using the Social Network Analysis (SNA) technique. To solve the problem, BPS-Statistics Indonesia needs to conduct a study on the application of this knowledge maps with SNA technique. In this study, a study literature on knowledge maps with SNA was carried out. This literature study is in the form of Systematic Literature Review (SLR). From this literature study, an overview of the fields used as research subjects on knowledge maps with SNA, description of objectives and research suggestions currently used by researchers. This study found that the most used fields of research were non-business fields, especially in the fields of education and research. Findings regarding the purpose of the study are divided into making a design / framework or analyzing a problem. From the synthesis of SLR papers it was found that research on Knowledge Map with SNA, the purpose mostly to analyzing a problem. In this study it was also found that the suggestions for most subsequent research were suggestions for modification or refinement of research methods on knowledge maps with SNA. From these findings, BPS-Statistics Indonesia is expected to be able to take advantage and can make this literature study as the basis for the implementation of knowledge maps with SNA to solve the problem of silo thinking.

1. Introduction
The BPS-Statistics Indonesia is a Non-Ministerial Government Institution that works in the statistical field. Based on the 2015-2019 Strategic Plan (Renstra), to carry out the task, BPS-Statistics Indonesia launched a vision, "The Agent of Trustworthy Statistics Data for All". To achieve this vision, BPSStatistics Indonesia formulated the mission in 2015 - 2019. The first mission was to provide quality statistical data through integrated and international standardized statistical activities.

The meaning of quality statistical data is that the data produced by BPS-Statistics Indonesia fulfilling the quality criteria in the statistics, namely: relevant, accurate, timely, coherent, accessible and interpretable. Mentioned in the BPS-Statistics Indonesia’s mission, quality statistical data can be achieved through statistical activities that meet 2 (two) criteria, namely: integrated, and international standards. In the BPS-Statistics Indonesia’s strategic plan, it was explained that integrated statistical
activities were statistical activities which carried out the need to prioritize functional approaches, and reduce silo thinking. The functional approach to statistical activities means that in every process of statistical activities ranging from data collection, data processing to data dissemination, was carried out in an integrated manner between the subject matter of the statistical fields.

To achieve the first mission described earlier, BPS-Statistics Indonesia through the Statistical Capacity Building - Change and Reform for Development of Statistics (STATCAP CERDAS) program, launched the use of Statistical Business Framework and Architecture (SBFA) as the standard of BPS-Statistics Indonesia business process framework. The statistical activities aspired by BPS-Statistics Indonesia are still lacking in terms of integration and not to silo thinking. Publications or reports on statistical activities have actually been shared and can be accessed by the subject matter of other statistical activities, but the problem of silo thinking still occurs, such as the same problem often occurs in statistical activities and both side confusion occurs to solve the problem, or the absence of lessons learned from other statistical activities before. From these problems it is necessary to identify core knowledge that is important for statistical activities. So that between statistical activities can take lessons learned from important knowledge reports from previous statistical activities.

In the knowledge management activities there are activity to identify knowledge that is a priority in an organization. This activity is knowledge mapping. Knowledge map is a knowledge representation technology that shows the basic relationship between sources of knowledge. This technology can be used to find sources of knowledge, implement knowledge creation and improve knowledge sharing. In addition, the knowledge map is also useful for several fields within the organization, including: information visualization, information retrieval, supporting strategic decision making, and business reengineering processes [1].

There are many techniques for creating knowledge map including Social Network Analysis (SNA). The SNA is a broad strategy for investigating social structures through the use of network and graph theory. SNA categorizes network structures into terms of nodes and links that connect nodes. The node referred to in this SNA is an individual or what subject or noun is the subject of knowledge. Whereas links are relationships and / or interactions between nodes [2]. From this SNA, it can be identified which are important knowledge for the organization. SNA is a powerful analytical technique for identifying important knowledge and describing knowledge maps.

To develop a knowledge map with SNA, BPS needs to conduct a study of this knowledge map with SNA. BPS needs information about the extent of the status of knowledge map development with SNA from a quality literatures. Therefore it is necessary to do a systematic literature review (SLR) to get information about developing knowledge maps with SNA. These information are:

- In what fields are knowledge maps with SNA developed?
- What goals do the researchers want to achieve before relating to the development of knowledge maps with SNA?
- What suggestions were given by previous researchers regarding the development of knowledge maps with SNA?

2. Literature Study

2.1. Knowledge Map in Knowledge Management

Dalkir (2011), in his book entitled "Knowledge Management in Theory and Practice", proposes a cycle of activities in knowledge management. Figure 1 follows a knowledge management activity cycle proposed by Dalkir [3].
Dalkir (2011) classifies the knowledge management cycle into three major processes, namely:

1. Knowledge Capture and/or Creation,
2. Knowledge Sharing and Dissemination, and
3. Knowledge Acquisition and Application.

The field of knowledge management has received much attention from many researchers and practitioners over the past few decades. Continuous efforts have been made by researchers and practitioners towards the progress of this field. In particular, attention is paid to the development of tools that can support or facilitate knowledge management activities. Among these tools, special attention is given to the Knowledge Map [4].

Knowledge Map is a technology in representing knowledge that displays the basic relationship between sources of knowledge [1]. Many benefits provided by Knowledge Map in supporting and facilitating activities in knowledge management. In knowledge activities capture and/or creation knowledge map can help knowledge workers to identify important knowledge of the organization [4] and seek expert (expert finding) [5]. In the process of knowledge sharing and dissemination, the knowledge map can help to describe the knowledge path in the organization and the search for knowledge gaps to identify what knowledge is necessary and not necessary for the sharing process [4]. In knowledge acquisition and application activities, knowledge maps can help accelerate the knowledge acquisition process, especially for new users of knowledge or who have little understanding of certain knowledge objects, by visualizing knowledge objects to facilitate the process of browsing knowledge [1].

2.2. Social Network Analysis (SNA)

The SNA, also referred to as 'structural analysis', is not a formal theory, but a strategy that is widely used to investigate social structures [2]. In SNA a subject is described as a node / node that has a relationship with other nodes so that a network / map is formed. Indicators of analysis on SNA are:

2.2.1. Density

Density is an indicator of the level of connectedness of a network / map. Density of a map is defined as the number of relationships divided by the number of nodes in a complete map with the same number of nodes. For G maps not directed by the number of nodes, density D is defined as follows:

\[
D = \frac{2 \times \#L(G)}{N(N - 1)}
\]  

(1)

\#L(G) is the number of relationships between nodes in map G [2].
2.2.2. Centrality
Centrality has three important measures in SNA, namely degree centrality, closeness centrality, and betweenness centrality. The degree centrality of a node is defined as the number of relationships that the node has. Closeness centrality of a node is defined as the total distance (shortest path) of the node with all nodes in the map. Betweenness centrality of a node is the shortest total path used by another node that passes through the node [2].

3. Methodology
This study was conducted using the Systematic Literature Review (SLR) method, which is an iterative process that documents all available studies that are relevant to a particular topic or research question [6]. The methodology of this study adopted the Kitchenham and Charters guidelines [6]. Activities carried out in the study, namely: formulating research questions; planning search strategy; identify inclusion and exclusion criteria; carry out the selection process; carry out quality testing; do data extraction and synthesis.

3.1. Formulating Research Question
The following are the research questions from this study:
1. In what fields are knowledge maps with SNA developed?
2. What goals do the researchers want to achieve before relating to the development of knowledge maps with SNA?
3. What suggestions were given by previous researchers regarding the development of knowledge maps with SNA?

3.2. Planning Research Strategy
Literature search is done by searching two literature search sites, IEEE Xplore and Scopus. The keywords used are “Social Network Analysis Knowledge Mapping”. The year of publication used in this study is 2014-2019. The sources of literature taken are journals and conference works. The following is the boolean search of this study based on the Scopus format:

| TITLE-ABS-KEY (social AND network AND analysis AND knowledge AND mapping) AND (LIMIT-TO (SRCTYPE, "j") OR LIMIT-TO (SRCTYPE, "p")) AND (LIMIT-TO (PUBYEAR, 2019) OR LIMIT-TO (PUBYEAR, 2018) OR LIMIT-TO (PUBYEAR, 2017) OR LIMIT-TO (PUBYEAR, 2016) OR LIMIT-TO (PUBYEAR, 2015) OR LIMIT-TO (PUBYEAR, 2014)) AND (LIMIT-TO (LANGUAGE, "English")) AND (LIMIT-TO (SUBJAREA, "COMP")) |

3.3. Identify Inclusion and Exclusion Criteria
The inclusion and exclusion criteria used in this study can be seen in Table 1 below.

| Table 1. Inclusion and Exclusion Criteria. |
|------------------------------------------|
| **Steps**                  | **Inclusion Criteria**                                                                 | **Exclusion Criteria**                                                                 |
| Initiation Step            | - literature comes from journal or conference                                           |                                                                                         |
|                           | - 2014-2018 publication year                                                           |                                                                                         |
|                           | - check duplication with mendeley app                                                   |                                                                                         |
| Step 1 (Title and Abstract Selection) | - relevance of the topic of the paper to the research question and study title (knowledge map using SNA) | - literature review                                                                      |
|                           | - closed access fulltext to Universitas Indonesia                                       |                                                                                         |
Step 2 (Full-Text Selection) - Making Knowledge Map with SNA in his research
- Describe Research methodology
- Describe research goals and or limitation or suggestion for future research

3.4. Selection Process
In the research search process found 88 studies from searches through IEEE Xplore and 56 from Scopus. However, when included in the Mendeley application for duplication checking it turned out that in total at this stage of the search this study received 141 studies.
Step 1, the selection process through title and abstract was only obtained 19 studies that were relevant to the topic of this study. And after stage 2 selection through the contents of the study only 15 studies were found that could answer the study's research questions. The following is a list of studies that are relevant to the topic and research questions of this study.

| Ref | Papers | Title |
|-----|--------|-------|
| [7] | Birjali M, Beni-Hssane A, & Erritali M (2018) | A novel adaptive e-learning model based on Big Data by using competence-based knowledge and social learner activities |
| [5] | Rafiei M, & Kardan A A (2015) | A novel method for expert finding in online communities based on concept map and PageRank |
| [8] | Li Y M, Lin L F, & Lin Y H (2014) | A recommender mechanism for social knowledge navigation in an online encyclopedia |
| [9] | Grandjean M (2016) | A social network analysis of Twitter: Mapping the digital humanities community |
| [10] | Chiu C, & Su H (2014) | Analysis of patent portfolio and knowledge flow of the global semiconductor industry |
| [11] | Su H (2016) | Analyzing scientific structure of Digital Humanity |
| [12] | Wang H C, Chiang Y H, & Huang Y T (2018) | Considering social information in constructing research topic maps |
| [1] | Hao J, Yan Y, Gong L, Wang G, & Lin J (2014) | Knowledge map-based method for domain knowledge browsing |
| [13] | Zhang Q, Wang Q, Hao J, & Yu Y (2016) | Mapping smart tourism research in China: A semantic and social network analysis using CiteSpace |
| [14] | Ye C, Liu D, Chen N, & Lin L (2015) | Mapping the topic evolution using citation-topic model and social network analysis |
| [15] | Krishnamurthy M, Marcinek P, Malik K M, & Afzal M (2018) | Representing Social Network Patient Data as Evidence-Based Knowledge to Support Decision Making in Disease Progression for Comorbidities |
| [16] | Kim J, & Hastak M (2018) | Social network analysis: Characteristics of online social networks after a disaster |
| [17] | Cheng F F, Huang Y W, Tsaih, D C, & Wu C S. (2018) | Trend analysis of co-authorship network in Library Hi Tech |
3.5. Quality Assessment
In conducting a quality assessment this study examines selected studies on 7 criteria. The following is a checklist for quality considerations in this study.

**Table 3. Checklist for Quality Assessment.**

| Checklist Question | Checklist |
|--------------------|-----------|
| C1 Does the article describe the research objectives clearly? | ✓ ✓ ✓ ✓ ✓ ✓ ✓ |
| C2 Does the article write a literature review, background and research context? | ✓ ✓ ✓ ✓ ✓ ✓ ✓ |
| C3 Does the article display related work from previous research in order to show the main contribution of the research? | ✓ ✓ ✓ ✓ ✓ ✓ ✓ |
| C4 Does the article describe the proposed architecture or the methodology used? | ✓ ✓ ✓ ✓ ✓ ✓ ✓ |
| C5 Does the article have research results? | ✓ ✓ ✓ ✓ ✓ ✓ ✓ |
| C6 Does the article show conclusions relevant to the research objectives / problems? | ✓ ✓ ✓ ✓ ✓ ✓ ✓ |
| C7 Does the article recommend future work or improvements for the future? | ✓ ✓ ✓ ✓ ✓ ✓ ✓ |

**Table 4. Quality Assessment Checklist Result.**

| Literature | Criteria | C1 | C2 | C3 | C4 | C5 | C6 | C7 |
|------------|----------|----|----|----|----|----|----|----|
| [7]        |          | ✓  |    | ✓  |    | ✓  |    | ✓  |
| [5]        |          | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  |
| [8]        |          | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  |
| [9]        |          | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  |
| [10]       |          | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  |
| [11]       |          | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  |
| [12]       |          | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  |
| [13]       |          | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  |
| [14]       |          | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  |
| [15]       |          | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  |
| [16]       |          | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  |
| [17]       |          | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  |
| [18]       |          | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  |
| [19]       |          | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  | ✓  |

From quality assessment, only the literature "A novel adaptive e-learning model based on Big Data by using competence-based knowledge and social learning activities" and "Analysis of patent portfolios and knowledge flow of the global semiconductor industry" that does not meet future recommendation
criteria work. So that it can be ascertained that overall the research used in this study fulfills the quality required.

3.6. Data Extraction and Analysis
After the quality assessment of the selected research, extraction and synthesis of data from the contents of the selected studies were carried out. Data extracted and synthesized in this study are data related to research questions, namely:
  - Research field,
  - Research objectives, and
  - Research suggestions for further research.
After extraction and synthesis, the data is processed into information reports to answer research questions.

4. Result and Discussion
4.1. Literature Study General Report
In this literature study, it was found that from the 15 studies examined below, the distribution of research according to several general indicators such as the year of publication and the continent of the first researcher.

![Figure 2. Chosen Literature Count in SLR by Publication Year](image)

![Figure 3. Chosen Research Percentage in SLR by First Author Continent](image)

From the data on the number of studies based on the year, Knowledge Map research using SNA has the highest number in 2018. This indicates that research on Knowledge Map using SNA is still popular among researchers.
From the data on the number of studies based on the continent where the first researcher conducted the study, it was found that the Asian continent had the highest number of studies. This indicates that many Asian researchers are interested in developing this Knowledge Map with SNA.

4.2. Research Field Extraction and Synthesis Result
In the step to the six methodologies of this study, extraction and synthesis of data from research have been carried out to answer the research questions. The first research question is "In what fields are knowledge maps with SNA developed?" To answer this question this study categorizes the subject of research into relevant fields for the interests of BPS-Statistics Indonesia as a government institution. The field categorization used in this study are business and non-business categories. Included in business category are fields of business-related fields, both profit-oriented individuals and companies. Whereas the fields included in the non-business category are those related to activities carried out by the community, organizations, and government institutions that are not profit-oriented. The following are the results of the research field extraction and the number of studies based on this study category.

![Research Field Extraction and Synthesis Result](image)

**Figure 4.** Research Percentage of Research Field by Business or Non-Business Category.

From knowledge map research using SNA, non-business research category outnumber business category. From the non-business category the most dominating is research in the field of education.

4.3. Research Goal Extraction and Synthesis Result
In the process of extracting and synthesizing the research data in this literature study, the research goals of knowledge map with SNA is divided into two categories, namely the development of knowledge map frameworks / models with SNA and analysis of problems with the help of knowledge maps with SNA. The following are the results of the extraction and categorization of the results of this study.

![Research Goal Extraction and Synthesis Result](image)

**Figure 5.** Research Percentage of Research Goal Category by Analysis or Framework.
From the results of extraction and synthesis of the research data, it was found that knowledge map research using this SNA was 60% in the form of problem solving analysis with the help of knowledge maps and SNA. Besides that, the creation of a knowledge map framework / model with SNA.

4.4. Research Suggestion Extraction and Synthesis Result
In the process of extracting and synthesizing research suggestions, this study categorized suggestions into suggestion about the subject of research, research methods, research subjects and methods, out of the topic of knowledge maps and SNA, and others. The following are the results of the extraction process and the synthesis of the research suggestion in this study.

Based on the results of extraction and synthesis of research suggestion data, it was found that research on knowledge maps with SNA for the last 5 years focused more on suggestions for improving research methods.

5. Conclusion and Suggestion
5.1. Conclusion
Based on the literature study that has been done, it can be concluded that in the last 5 years of research on knowledge maps with SNA, knowledge map research using SNA was mostly carried out in nonbusiness fields, especially in the field of education. Knowledge map research using SNA also focuses a lot on developing knowledge map frameworks / models with SNA. In addition, from the literature study process, it was also found that the future work recommendations / research suggestions given by previous researchers focused mostly on developing research methods regarding this knowledge map with SNA.

From this literature study process, BPS gets an overview of knowledge map studies with SNA, especially regarding current research and future research, both in terms of fields, research objectives and suggestions for future research. From this description, BPS is expected to be able to involve itself in knowledge map research with SNA and can enrich the study of the research. BPS can provide new colors, especially for government research or in the field of statistical education. Improvement methods from previous studies are also still widely recommended to be filled out by BPS, both the analysis method and the framework / model development.

5.2. Suggestion
This literature study is the first step for BPS in conducting further research on knowledge maps with SNA. This research is expected to be able to provide an initial picture needed by BPS in further research regarding the implementation of knowledge maps. Further research is expected in addition to the
implementation of the knowledge map as well as evaluating whether this knowledge map can effectively overcome the problem of thinking silos in BPS.

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Acknowledgments
This research was supported by PIT 9 Grants, Universitas Indonesia (NKB-0007/UN2.R3.1/HKP.05.00/2019).