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A Review for the Mechanism of Research Productivity Enhancement in the Higher Education Institution

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ABSTRACT

The main purpose of this review is to find out the mechanism of research productivity enhancement proposed by each researcher in the papers they have published. The availability of these various mechanisms raises the desire of the authors to compare each mechanism. The focus of the review lies in the mechanism, characteristics, source of data, and evaluation methods used by each researcher. The review then jumps to the results obtained by each mechanism. The author also compares the types of data used by each researcher and the parties involved in the mechanism. There are some differences in the use of terminology between one to another mechanism, but in essence, it has the same goal, research productivity enhancement.

1. Introduction

Through this paper, the author would like to explain the results of the review related to the mechanism of research productivity optimization in higher education institutions. The mechanism discussed here focuses on the model, framework, or method. The reason the higher education institution environment was chosen is because increasing research capability in higher education institutions can increase public awareness about the importance of utilizing research results. This is evident from several studies that have been done, among them are the prevention of natural disasters [1][2] or the discovery of treatment methods for certain types of diseases [3][4]. In Indonesia, there is support from the government for research development in higher education institutions through various schemes. The determination of the scheme and the number of grants managed for research depends on the level of each institution in clusters based on its performance each year [5]. Higher education cluster membership is always evaluated and updated regularly by the government through the Ministry of Research and Technology as a Stakeholder. Other alternatives, research at universities can receive funding from institutions outside the government through joint project mechanisms or contractual agreements [6][7]. The industry is one of those that need research output produced by higher education institutions.

The main purpose of this review is to find and explain research or publications related to the mechanism of research productivity optimization in higher education institutions that have been conducted by several researchers [8][9][10][11][12]. Through this review, opinions were given about the strengths and limitations of each mechanism. The opinion given is based on the understanding obtained from various papers or journals related to the domain being discussed.

Another reason for this review is the research productivity still not optimal at the higher education institution in Indonesia. One of the increases or decreases of research productivity is explained from the comparison of the total number of academics to the number of research publications [13][14]. The following is an overall display of data on the number of higher education institutions (HEI) under the Ministry of Research, Technology and Higher Education, including public and private universities, number of lecturers, number of full professors, number of publications, and country's H-Index from 2014-2018 in Indonesia. Data was collected in November 2019, so the data probably changes or updates when this article is published.

Table 1. The publication of scientific articles in Indonesia

Year	HE Institutions [15][16][17] [18][19]	Number of Lecturers [15][16][17] [18][19]	Number of Full Professors [20][21]	Number of Publications (Articles) index in Scopus [22]	Country's H-Index (Scopus) [22]	Number of Publications index in Google Scholar [23]
2014	3,280	206,811	4,848	6,760	214	155,072
2015	3,225	227,734	5,104	8,350	214	183,364
2016	3,144	237,837	5,300	12,429	214	224,684
2017	3,276	247,269	5,463	20,459	214	275,108
2018	3,250	294,820	5,500	32,456	214	266,934

Based on the data in Table 1, it explains the gap between the number of lecturers, including the number of full professors, and the amount of research output produced. Although if viewed from 2014 to 2018 the number of publications continues to increase, the increase is still not optimal or has not yet reached the ideal conditions and this will affect the overall research productivity performance. If we look at the number of recipients of research grants and community service, in 2014 there were 3.853 recipients from private universities under the Ministry of Research, Technology, and Higher Education. In 2015 as many as 12,069 recipients for batch 1, and 381 recipients for batch 2 [24][25]. Research grantees continue to increase in the following years, an increase in the number of grant recipients should be followed by the increase in the number of research productivity. So it is hoped that this review becomes an alternative way for research managers to improve research productivity in the higher education institution environment.

2. Review Mechanism

Before further discussing the mechanism of research productivity optimization in higher education institutions, we will explain the big picture of mechanisms already published or developed related to research productivity optimization in the higher education institution environment (Table 2).

Table 2. The mechanism of research productivity optimization

Environment	Mechanism	References
Involving outsiders	Knowledge Sharing	[10][11][26][27]
	Triple-Helix Collaboration	[12][28][29][30]
Internal of Institution	Proper funding and good research facilities	[31][32]
	IT Capability Approach	[33][34][35]

At the very least, the mechanism of research productivity optimization is divided into two categories, but they can overlap with each other, involving outsiders and from the internal of

institutions, first, the example of the mechanism that involved outsiders such as knowledge sharing, and then triple-helix collaboration (Higher Education Institution-Government-Industries). Second, it only comes from internal institutions, such as proper funding and good research facilities, and an IT capability approach. Articles reviewed come from the publication of research results within the last 10 years. Each article is taken from various journals, with conditions relevant to the domain discussed. Each article is also supported by data and related research. So for the scientific quality and relevance of each article, we keep it in good sharpness. There are several publications discussed in this review, supplemented with research data used by researchers, shown in Table 3:

Table 3. The data used by researchers

Title	Research Data
How To Increase Research Productivity In Higher Education Institutions – Sims Model [8].	The data used for the study were taken from the Srinivas Institute of Management Studies (SIMS) during the last 3 years (2013 - May 2016) by 24 Faculty Members.
Increasing Research Productivity in Undergraduate Research Experiences: Exploring Predictors of Collaborative Faculty-Student Publications [9].	Data from 468 faculty members across 13 research-intensive institutions were collected using a cross-sectional survey in 2013/2014.
Improving Research Productivity through Knowledge Sharing: The Perspective of Malaysian Institutions of Higher Learning [10].	Sample data is taken randomly from instructors (tutors to professors) in Malaysia, with a total number of academics 32,516 from public universities and 24,476 from private universities (in 2015).
Knowledge sharing: Role of academics towards research productivity in higher learning education [11].	Sample data were taken from teachers (tutors to professors) in Malaysia. With a Ratio of 50:30:20 for senior lecturers: assoc. professor: professor. With a total number of academics 32,516 from public universities and 24,476 from private universities (in 2015). The total number of correspondents (who filled out the questionnaire) 542, with a total valid number of 525. The number of male correspondents was 281 and women 244.
Increasing Faculty Research Productivity via a Triple-Helix Modeled University Outreach Project: Empirical Evidence from Thailand [12].	The researcher along with eight faculty staff participated in this 12-month project, starting from June 2010 to the end of May 2011. While working on this project, the author also observed the ideas, actions and research productivity of her colleagues, as well as the perceptions of the MBS Dean, Chair of the University, two senior FTI managers and five NESAC members.

In conducting this review, the systematic mapping study method is used, where the selection of papers is not done subjectively by the author, but instead uses the protocols and filters set at the beginning of the literature review process. The steps in conducting the literature review are shown in Figure 1. The review consists of 3 main stages, pre-review, review, and post-review. Pre-review consists of collecting related publications, filtering, and sorting, review consists of constructing a matrix for literature review, finding the source of data, finding the mechanism and the characteristics, finding the evaluation and the result. The last one is the post-review, which made a summary and conclusion.

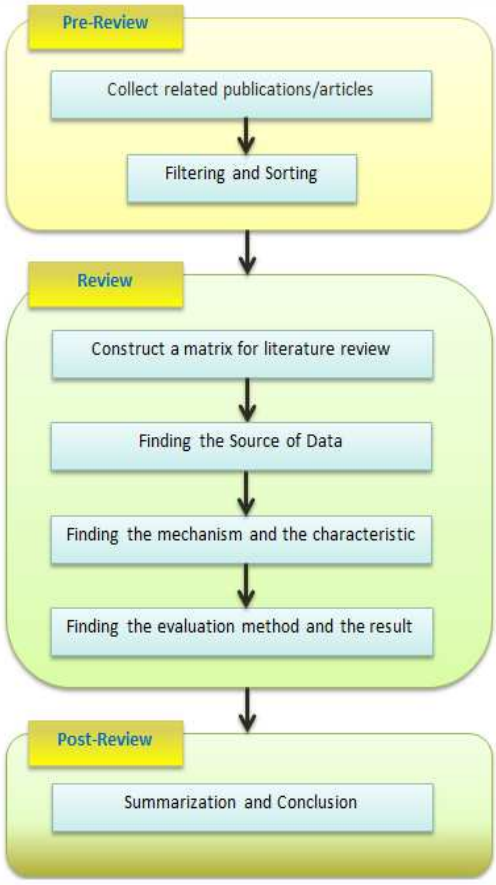

Fig 1. The systematic mapping study

3. Results and Discussion

The review is carried out based on the steps in Figure 1, the first stage id the comparison of mechanisms used by each researcher. Each mechanism has a different construct than the other mechanism. The selection of constructs is based on needs and where the mechanism is implemented. Comparisons are also accompanied by the characteristics of each mechanism (Table 4).

Table 4. The comparison of the mechanism used by the researcher

Author(s)	Mechanism	Characteristics	Comments
S. Aithal [8]	Sims - Model (Model of improving higher education research productivity)	1. Research is not only conducted by professors /lecturers. 2. Involving student and faculty members in improving HEI research performance. 3. Design a curriculum that focuses on research involved in industry projects every semester, with the synergy of the industries, students and faculty members. 4. Professors, students, faculty	Involving students in research has a positive impact on students themselves, the performance of the institution and the continuity of research at the institution.

		members can get additional project funding from various industry agencies.	
D.X. Morales, S.E. Grineski, T.W. Collins [9]	The results of the generalized estimating equation (GEE) model analysis using the normal distribution.	The analysis shows the significance of variables related to research productivity based on faculty-student collaboration.	Has not shown an analysis of the significance of the number of faculty members and the number of students collaborating with each other.
M.A. Fauzi, C.N. Tan, R. Thurasamy [10]	A framework of research productivity of academicians consisting of 3 main indicators: individual, organizational, and technological aspects.	The proposed framework successfully integrates 3 models: TPB (planned behavior), social capital (SC) theory and the Triandis model (TM).	Authors have not shown the testing results of the proposed framework.
M.A. Fauzi, C.N. Tan, R. Thurasamy, A.O. Ojo [11]	Knowledge Sharing framework model with 12 constructs	The 13 constructs used are commitments, social network, management support, social media, attitude toward KS, subjective norm toward KS, KS intention, KS behavior, perceived behavior control, facilitating conditions, trust, research productivity.	Continuing from previous research, the authors have shown the testing results of the proposed framework.
S. Chanthes [12]	Triple-helix model (government-university-industry)	Explain empirical evidence about the important role of the triple-helix in improving faculty research productivity. In its implementation, the authors make triple-helix modeling (government-university-industry) used in joint projects, research collaboration, and funding.	A detailed explanation of the proposed triple-helix model is needed so it can be implemented in other higher education institutions.

The first mechanism proposed by Aithal [8], Sims - Model (Model of improving higher education research productivity). Involving students in research has a positive impact; however, the impact of involving faculty members is unknown. Who are the faculty members here? The model has not yet explained the extent of the involvement of faculty members in research activities. The model already has researcher leveling but has not demonstrated the ability to measure the performance of each individual involved in research (only HEI's overall performance). Next, we will discuss the source data vs the evaluation method used by each researcher. The second mechanism proposed by Morales, et al. [9], The results of the generalized estimating equation (GEE) model analysis using the normal distribution show average duration = Statistically Significant ($p < 0.001$) for duration > one year. For a short duration (one summer or less), $p = 0.004$ less productive in terms of

collaborative faculty-student publications. Faculty members who teach students about research publications have a significance of p = 0.006. Faculty members who guide African-American student research projects have a significance of p = 0.009. Other variables significantly influenced are faculty members with good H-index scores (p <0.001), faculty members with years of research experience (p = 0.025), and faculty who get more research grants (p = 0.001). Gender and race/ethnicity do not have a statistically significant effect on the model. The author needs to clarify the high H-index (which according to researchers has a significant effect) whether pure-citation or self-citation. The experience used as a variable is actually very difficult to measure. It is necessary to explain the values used as indicators to measure the significance of the experience.

Furthermore, the third mechanism proposed by Fauzi, et al. [10], the integration of three models showing academics engaging each other in Knowledge Sharing (KS) activities. The selection of PLS-SEM as a method for analyzing and testing hypotheses is very appropriate because (1) it involves a non-normal dataset, which will increase the goodness of fit. (2) PLS-SEM can accept small sample sizes, while SEM-based covariant cannot be implemented for small data sizes. The authors have not shown the testing results of the proposed framework, still unknown how many hypotheses were accepted and how many hypotheses were rejected, so it is unknown whether the proposed framework is valid/acceptable or not. The next papers [11] are still related to the papers discussed earlier, so the data used remains the same but with different contributions: Through the KS framework model proposed by the authors, the role of academics (with 13 constructs) has a positive effect (substantial impact) on research productivity. The 13 constructs used are commitments, social network, management support, social media, attitude toward KS, and subjective norm toward KS, KS intention, KS behavior, perceived behavior control, facilitating conditions, trust, and research productivity. Research productivity is used to determine the position/ranking of an HEI (Higher Education Institution) on a national or international scale. So the authors need a mechanism (a model framework or method) to increase research productivity. The last mechanism proposed by Chanthes [12], these papers discusses increasing faculty research productivity via a Triple-Helix Modeled (government-university-industry). We also display the results obtained by each researcher shown in Table 5.

Table 5. The comparison of the source data vs evaluation method

Author(s)	Source of Data	Evaluation Method	Results Obtained
S. Aithal [8]	Survey	the ABC model of institutional performance measurement	The idea of this model is to involve students and faculty members in intensive research through curriculum design focused on research. To enable students and faculty members to participate in research projects sponsored by the industrial agencies.
D.X. Morales, S.E. Grineski, T.W. Collins [9]	Web Survey	Statistical Analysis	The results of the analysis of the researchers concluded there should be collaboration between faculty mentors and undergraduate students in conducting research with collaboration time > 1 year, mentoring activities, teaching about research, and faculty members who are experienced with high H-index. It must be seen the similarity of character and interest between each researcher. From the results of this collaboration, the author stated they could increase research productivity.

M.A. Fauzi, C.N. Tan, R. Thurasamy [10]	Questionnaires	Not tested yet	The contribution given by researchers is to create a framework of research productivity of academicians consisting of 3 main indicators: individual, organizational, and technological aspects. The idea is how to increase research productivity through well-managed KS so academicians are able to perform interdisciplinary research. The proposed framework has a conceptually good formula but has not shown the results of testing the hypothesis.
M.A. Fauzi, C.N. Tan, R. Thurasamy, A.O. Ojo [11]	Questionnaires	Variance-based PLS-SEM (Structural Equation Modeling) analysis	The results showed academic productivity explained the variance of 22.6 percent. This shows that KS academic behavior has a large impact on research productivity. The factors of academic attitude, academics commitment, trust, and social network explain the variance of 36.4 percent. Management support has a variance of 38.7 percent of subjective norms while facilitating conditions and social media have a variance of 26.5 percent of perceived behavioral control (PBC). Academics KS intention and KS behavior explain the variance respectively 62.1 and 47.1 percent.
S. Chanthes [12]	Observation	Grounded theory approach	The final result of this research is the implementation of triple-helix modeling which was carried out after the proposed strategic plan with the title "The development of strategic approach to the building of Thai-Lao economic partnership" was accepted by the Council of Ministers (council of ministers) in July 2011, which means a collaboration between triple-helix (university-industry-government) established, which is named MBS-FTI-NESAC.

Most of the data collection methods used are through surveys and questionnaires. Aithal [8] took research publication data (from 2013-2016). Morales, et al. [9] through a web survey involving 468 faculty members across 13 research-intensive institutions. Fauzi, et al. [10][11] distributing questionnaires in the form of questions involving sample data taken randomly from instructors (tutors to professors) in Malaysia. Chanthes [12] made observations to obtain research data. The author of this paper along with eight staff faculty participated in a project, starting in June 2010 and ending in May 2011. While working on this project, the author observed the actions, ideas, and research productivity of her colleagues. Comparisons were also made with the types of data used by each researcher, divided into two types, primary data, and secondary data (Table 6). Furthermore, involvement in the mechanism, we divide into three groups namely academics, government, and industries.

Table 6. The comparison of the type of data and involvement in the mechanism

Author(s)	Type of Data		Involvement in Mechanism		
	Primary	Secondary	Academics	Government	Industries
[8]		√	√		√
[9]	√		√		
[10]	√		√		
[11]	√		√		
[12]	√		√	√	√

After conducting a literature review of several articles discussing the mechanism of research productivity optimization in higher education institutions and understanding the results, the author tried to make an initial model by combining some of the advantages of the mechanism discussed earlier. This initial model consists of 13 constructs, for indicators still not determined, while the number of hypotheses is 12. Furthermore, based on several constructs that are considered to have an effect on increasing research productivity, hypothesis testing is carried out to find out and re-inform the truth of influence between one and the other.

The hypothesis is a provisional estimate of the positive effect of the construct on the enhancement of research productivity.

H1: Social network has a positive effect on academics' knowledge sharing behavior towards enhancement of research productivity.

H2: Teamwork has a positive effect on academics' knowledge sharing behavior towards enhancement of research productivity.

H3: Competition has a positive effect on academics' knowledge sharing behavior towards enhancement of research productivity.

H4: Points and bonuses have a positive effect on academics' motivation towards the enhancement of research productivity.

H5: Leveling up has a positive effect on academics' motivation towards the enhancement of research productivity.

H6: Appropriate research funds have a positive effect on academics capability towards the enhancement of research productivity.

H7: Research based on Goals has a positive effect on academics capability towards the enhancement of research productivity.

H8: Good research facilities have a positive effect on academics capability towards the enhancement of research productivity.

H9: Join Project (government-university-industry) has a positive effect on academics' capability towards the enhancement of research productivity.

H10: Knowledge sharing behavior among academics' will have a positive effect on the enhancement of research productivity.

H11: High motivation for academics' will have a positive effect on the enhancement of research productivity.

H12: Academics' capabilities will have a positive effect on the enhancement of research productivity.

So based on the constructs and hypotheses already explained, and then the initial model proposed is shown in Figure 2:

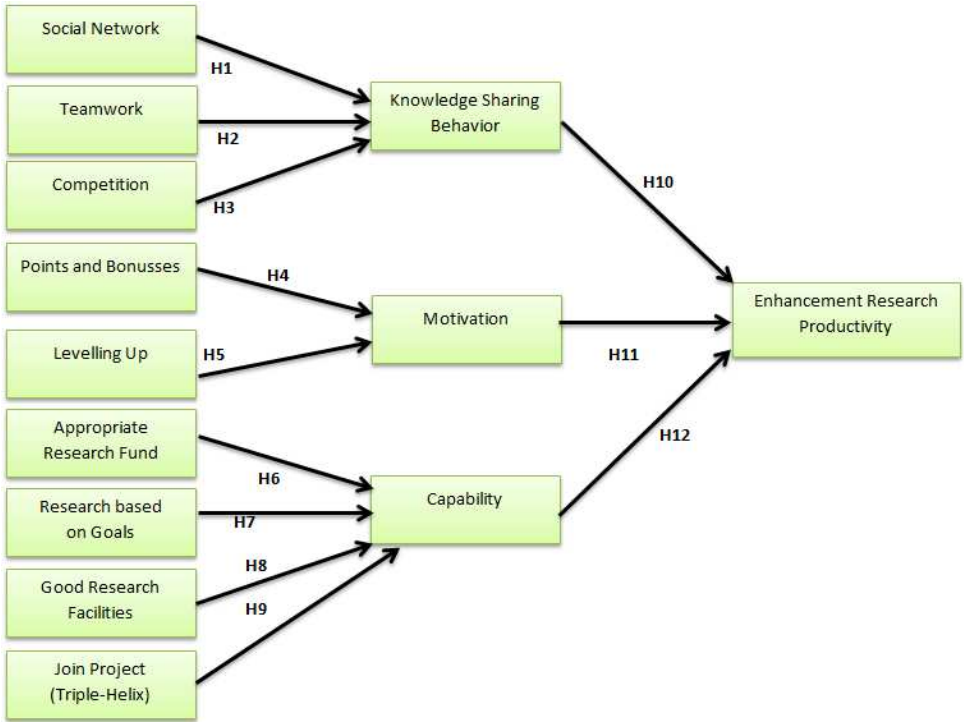

Fig 2. Conceptual Model

This framework model is a combination of the knowledge sharing model proposed by Fauzi, et al. [10] [11], the triple-helix model [12], Sims-Model [8], and some elements we took from gamification [36][37][38]. This conceptual model is also an adaptation of the model that has been proposed previously [39]. This framework model consists of 9 independent variables and 4 dependent variables. The independent variables used are social networks, teamwork, competition, points, and bonuses, leveling up, appropriate research funds, research-based on goals, good research facilities, and joint projects (triple-helix). The dependent variable used is knowledge sharing behavior, motivation, capability, and enhancement of research productivity. The following are references that we use in selecting the gamification element used in the framework model (Table 7).

Table 7. The relevant elements from gamification

Game Elements	References
Points, Bonuses, Progress Bar, Badges	[40][41][42]
Competition, Teamwork	[36][43][44]
User Status, Ability/Capability	[36][45]
Leaderboards, Mission, Virality, Countdowns	[36][37][38]

In future work, the author will conduct a pilot test of the proposed framework model. For testing and analysis of the proposed model, PLS-SEM (Partial Least Square - Structural Equation Modeling) is used. The reason for choosing the SEM method is because it supports complex modeling constructs with minor correspondents. SEM is powerful in modeling latent variables, measuring error correction, and estimating simultaneous parameters for the whole theories [46]. PLS-SEM is an alternative structure equation modeling method used to explain relationships between constructs, emphasizing the theory of the value of these relationships with a small sample

data size. Some common reasons for choosing PLS-SEM as a method for testing the proposed method are as follows:

1. The PLS algorithm is not limited only to the relationship between indicators and their latent constructs which are reflective, but the PLS algorithm is also used for formative relationships.
2. PLS can be used to estimate the path model with a small sample size.
3. PLS-SEM can be used for very complex models (consisting of many latent variables and manifests) without experiencing problems in estimating data.
2. PLS can still be used when the data distribution is skewed.

4. Conclusion

In this article, the authors review the mechanism of research productivity enhancement of publications contained in several reputable journals. Broadly speaking, the discussion on research productivity enhancement mechanisms is very dynamic. The authors focus on the mechanism, characteristics, sources of data, and evaluation methods used by each researcher. The review then jumps to the results obtained by each mechanism. Next, the comparison of the types of data used by each researcher and the parties involved in the mechanism. An indicator of the number of publications in the form of articles and the amount of industry-funded research still dominates the measurement of the success of research productivity enhancement. There are some differences in the use of terminology between one mechanism to another, but in essence, it has the same goal, research productivity enhancement. The evaluation method for each mechanism is adjusted to the level of complexity of the problem and the source of data used. Based on the summarization of the review, the author proposes a conceptual model which is a combination of several mechanisms already discussed. This framework model consists of 12 constructs and 11 hypotheses. Over the initial hypothesis, the model proposed is expected to be better than some of the mechanisms already discussed. The indicators for each construct have not been determined. In future work, the author will conduct a pilot test of the proposed model by involving academics' in the higher education institution.

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