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Author(s)	Shimbaru, Toshiki; Kai, Naoto
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A Study of Research Performance against KAKEN, using Osaka University as a Case Study

Toshiki Shimbaru ^{*}, Naoto Kai [†]

Abstract

To propose a new method of comparing performance between studies on the same subject at different institutions, we obtained information on grant amounts, keywords related to the research, and the number of achievements for all projects from Grants-in-Aid for Scientific Research (KAKEN) Database. From this database, we obtained information on research projects conducted between FY 2015 and FY 2019 and classified them into 10 groups according to their budget amounts. Therefore, we focused on 12 research institutes and compared the number of research achievements in each group. As a result, especially in the range of 1 ~ 6 million yen, there was a significant difference in the number of achievements per million yen between Tokyo Institute of Technology (Ti) and Osaka University (Os). We calculated the amount and number of achievements for each keyword for this range of projects. Results showed no significant differences for keywords common to both institutions. However, when comparing the keywords specific to each, Ti's performance clearly exceeded that of Os. In the future, it is expected that correcting the notational quirks and increasing the number of common keywords will help clarify the characteristics of keywords unique to each institution.

Keywords: KAKEN, Osaka University, Research performance

1 Introduction

Most scientists affiliated with research institutions in Japan conduct their research activities by obtaining grants, known as Grants-in-Aid for Scientific Research (KAKEN), and then publish the results to give back to society and build on their achievements. On the other hand, to grow their research capabilities, research institutions also need to understand the research achievements from each project and consider which areas they should devote their resources. For the study of such grants, Nomura et al. attempted to classify institutions based on the number of projects selected for funding [1]. Furthermore, Nomura et al. and Nishizawa et al. obtained an index of research activity for each university based on the amount allocated to each research category [2][3][4]. Yabuki used data on the number of applications and grants received for KAKEN to compare research performance between a research department and similar departments at other universities [5]. However, these studies did not extend to more detailed thematic analyses. By identifying the performance of each research theme, we will be able to develop a more detailed research strategy.

^{*} Faculty of Commerce Seinan Gakuin University, Fukuoka, Japan

[†] University Library Osaka University, Osaka, Japan

2 Data Description Analysis Method

We obtained information on grant amounts, keywords related to the research, and the number of achievements (including journal articles and presentations) for all projects from the Database of KAKEN, to support thematic studies. KAKEN is a public database that includes information on adopted projects, assessments, and research achievements from the KAKEN Program. From this database, we obtained data on research projects conducted between FY 2015 and FY 2019 and classified them into 10 groups according to their budget amounts. The range of cost in each group and examples of research categories corresponding to each group are shown in Table 1.

Table 1: Examples of research categories in each group

Group	Range of Cost (Million yen)	Examples of Research Category
X	200 ~ 600	Specially Promoted Research
IX	100 ~ 200	Scientific Research (S)
VIII	60 ~ 100	Transformative Research Areas (A)
VII	40 ~ 60	Scientific Research (A)
VI	20 ~ 40	Transformative Research Areas (B) Challenging Research (Pioneering)
V	10 ~ 20	Scientific Research (B)
IV	6 ~ 10	Challenging Research (Exploratory)
III	4 ~ 6	Scientific Research (C)
II	2 ~ 4	Early-Career Scientists Research Activity Start-up
I	1 ~ 2	JSPS Fellows

To characterize the number of achievements according to the size of the budget, we obtained the number of achievements per project and the number converted per million yen for each group (Figure 1, Figure 2). The diamond marks in Fig. 1 show the median of the achievements. In addition, the vertical error bars indicate the first and third quartiles of the achievements, and the horizontal error bars correspond to the range of the allocation amount for each group. The number of achievements per project increase with the allocation amount (Figure 1). This result can be attributed to the fact that as the size of a project increases, the project's duration tends to grow, and the number of researchers participating in the project also tends to increase. On the other hand, even if the cost of the experimental equipment were to double, the number of results would not be expected to double immediately. The number of achievements per million yen decreases as the allocation increases (Figure 2).

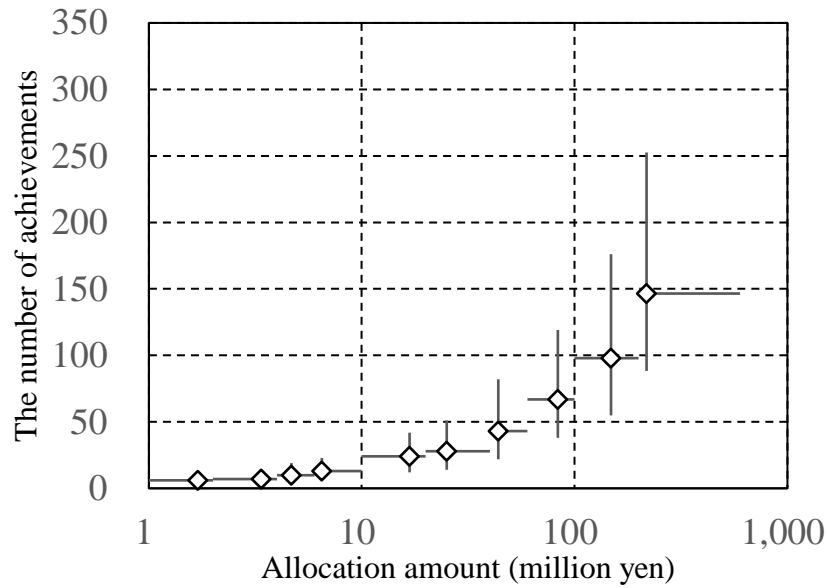


Figure 1: The number of achievements for each group

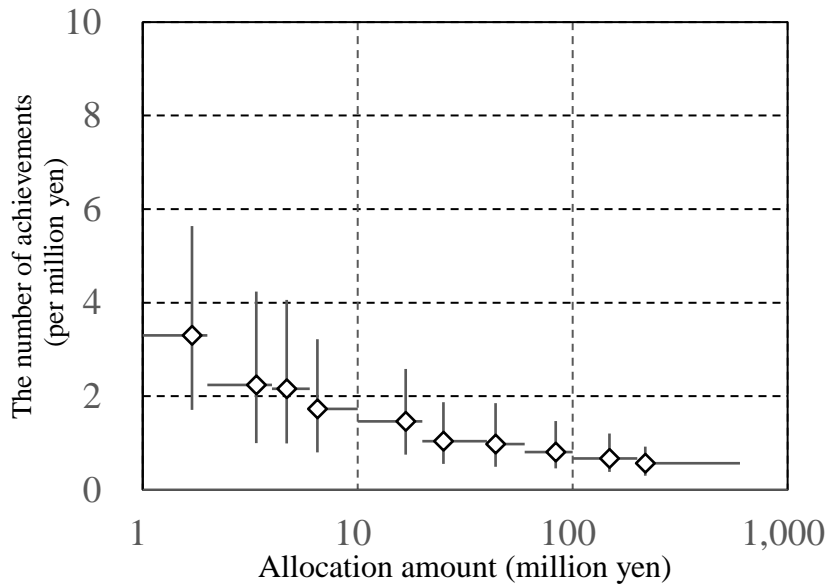


Figure 2: The number of achievements per million yen for each group

As Figure 1 and Figure 2 show, it is not appropriate to compare projects of different sizes because the scale of the number of achievements varies with the size of the project. Therefore, we focused on 12 research institutes in Japan, including Osaka University, and compared the number of research achievements in each group. Because these institutions receive a large allocation amount and their research fields are diverse, they have many areas in common. Therefore, research performance in this common area is easily comparable. Table 2 shows the average allocation amount of 12 research institutes from 2015 to 2019.

Table 2: Average allocation amount of 12 institutes

Research Institute (Abbreviation)	Million yen	Research Institute (Abbreviation)	Million yen
Tokyo Univ. (Tk)	23,134	Hokkaido Univ. (Hk)	5,855
Kyoto Univ. (Kt)	14,522	Tokyo Institute of Technology (Ti)	4,911
Osaka Univ. (Os)	11,835	Tsukuba Univ. (Tb)	4,077
Tohoku Univ. (Th)	10,085	Keio Univ. (Ko)	3,423
Nagoya Univ. (Ng)	7,833	Kobe Univ. (Kb)	3,098
Kyushu Univ. (Ks)	7,167	Waseda Univ. (Ws)	2,846

Figure 3 ~ Figure 12 show the number of achievements of the 12 institutes for each group. These figures show the differences in the research performance of each institute for each project of roughly the same size. The vertical axis in Figure 3 ~ Figure 6 (Groups I ~ IV) shows the number of achievements per million yen. In each figure, institutions with fewer than 20 projects are not shown. Furthermore, using Wilcoxon's rank-sum test, we verified whether there was a difference between the achievements of each research institution and that of Osaka University. In Figure 3 ~ Figure 12, solid line frames are attached to institutions with significantly more achievements than Osaka University (Os), and dotted line frames are attached to institutions with fewer achievements.

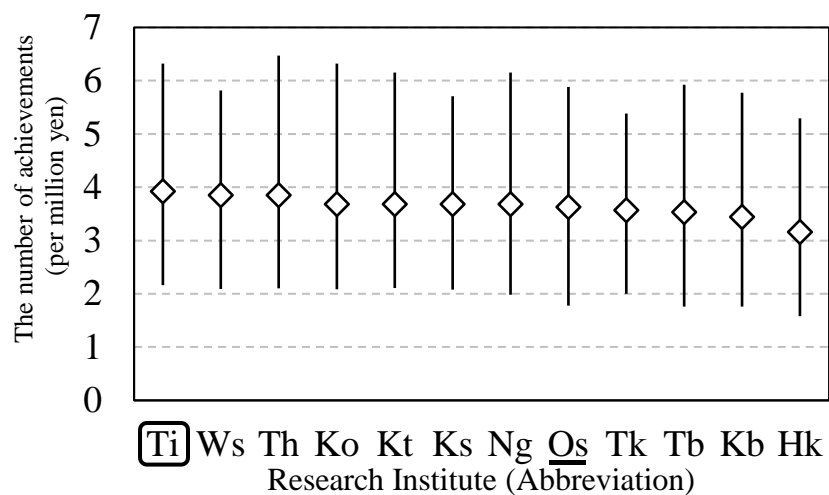


Figure 3: The number of achievements (per million yen) in Group I (1~2 million yen)

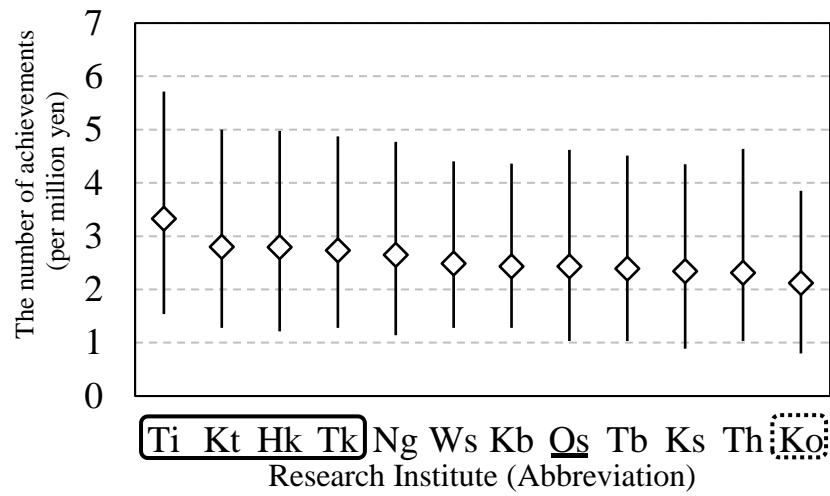


Figure 4: The number of achievements (per million yen) in Group II (2~4 million yen)

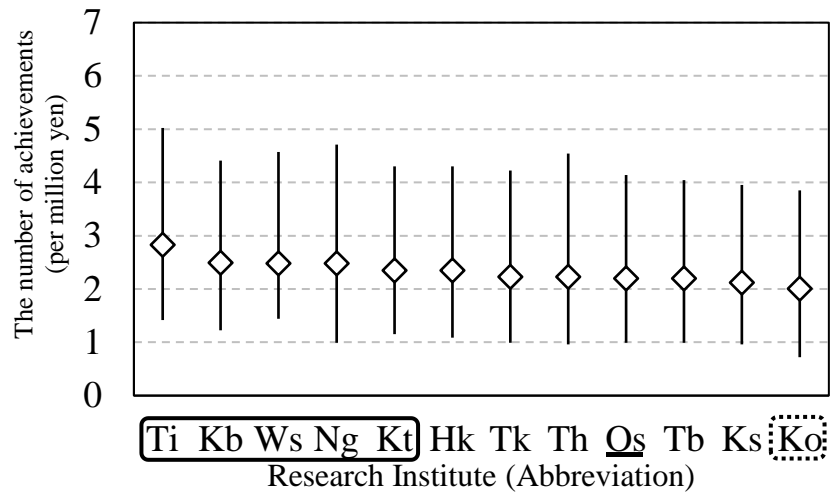


Figure 5: The number of achievements (per million yen) in Group III (4~6 million yen)

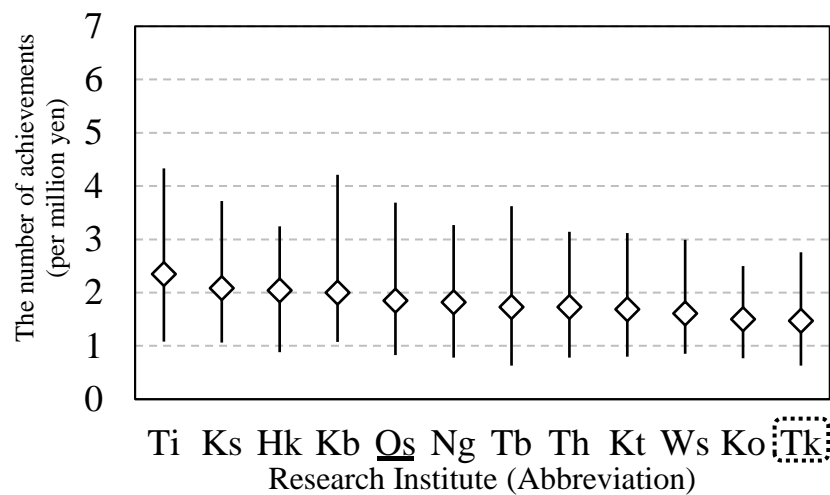


Figure 6: The number of achievements (per million yen) in Group IV (6~10 million yen)

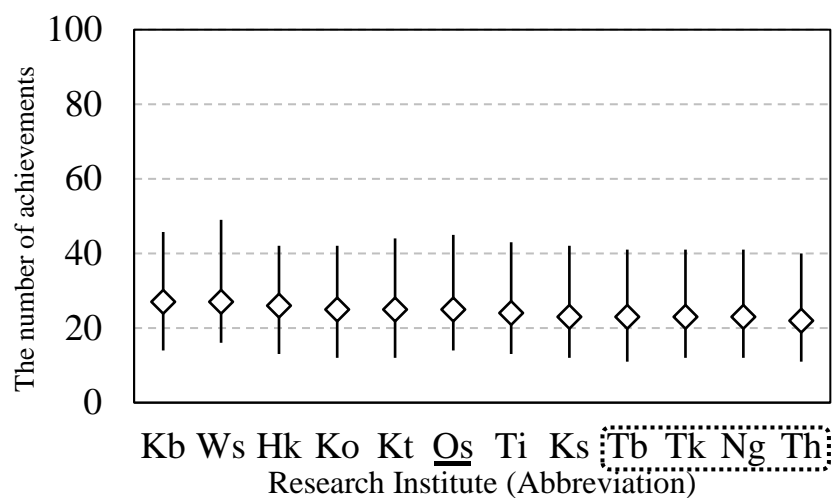


Figure 7: The number of achievements in Group V (10~20 million yen)

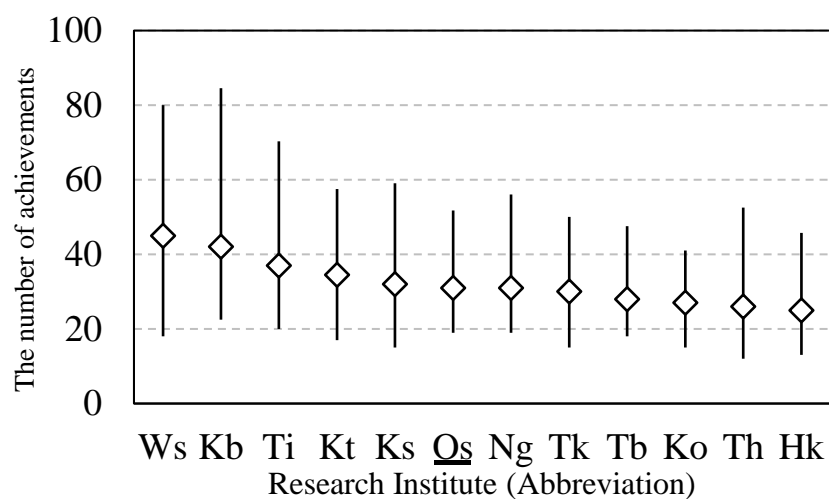


Figure 8: The number of achievements in Group VI (20~40 million yen)

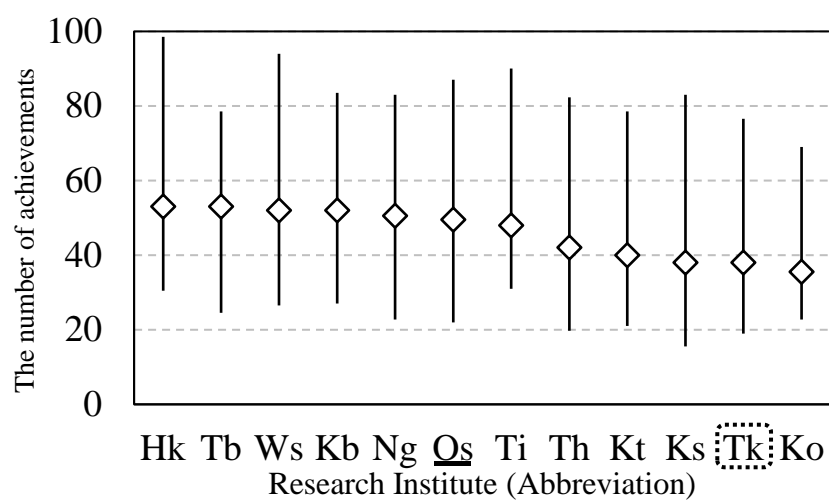


Figure 9: The number of achievements in Group VII (40~60 million yen)

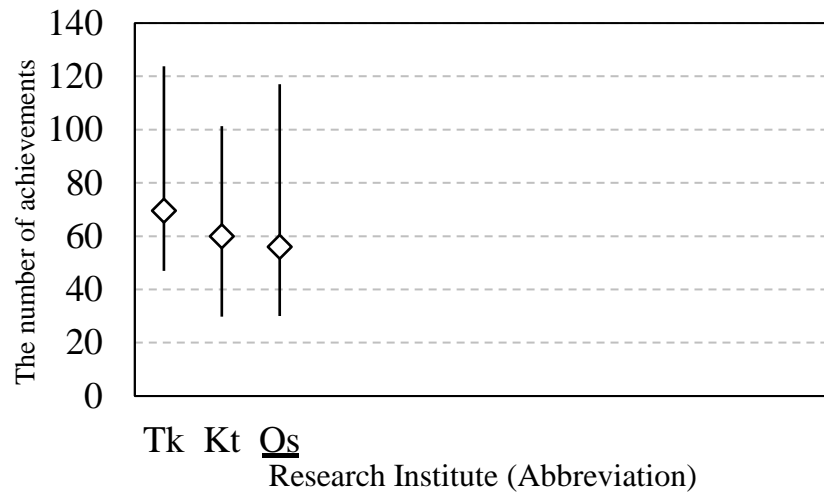


Figure 10: The number of achievements in Group VIII (60~100 million yen)

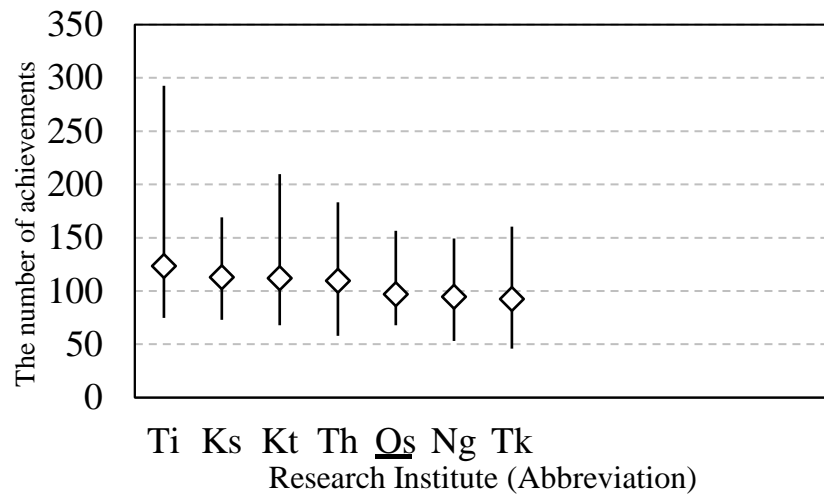


Figure 11: The number of achievements in Group IX (100~200 million yen)

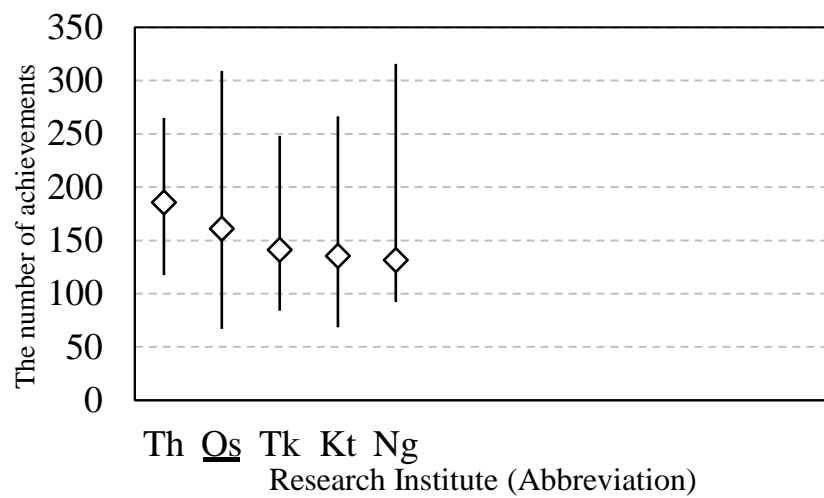



Figure 12: The number of achievements in Group X (200~600 million yen)

Figure 3 ~ Figure 5 show a significant difference in the number of achievements per million yen between Tokyo Institute of Technology (Ti) and Osaka University (Os), especially in Group I ~ III projects. Therefore, for Group I ~ III projects, we compare the allocation amount and the number of achievements for each keyword related to the project.

Typically, a single project contains several keywords related to its content. In this study, we prorated the allocation amount according to the number of keywords. Table 3 shows an example. Since the project listed in Table 3 includes five keywords, the amounts for each year are divided by five and allocated to each keyword. Similarly, the number of journal articles and presentations should be divided by 5 for each keyword. We performed this calculation for all projects and recounted the allocated amount and number of achievements for each keyword.

Table 3: How to distribute the amount for each keyword

Project	Budget Amount		Journal Articles	Presentations
	FY2018	FY2019		
Novel spin filter function using graphene nanoribbon	5,200,000	1,300,000	15	60



Keywords	Budget Amount		Journal Articles	Presentations
	FY2019	FY2020		
Graphene	1,040,000	260,000	3	12
Nanoribbon	1,040,000	260,000	3	12
Topology	1,040,000	260,000	3	12
Spin filter	1,040,000	260,000	3	12
Spintronics	1,040,000	260,000	3	12
Total	5,200,000	1,300,000	15	60

3 Result of Analysis

The number of keywords common to the Ti and Os projects and the number of unique keywords are shown in Table 4. We created histograms for common and unique keywords, classified by the number of results per million yen (Figure 13, Figure 14). The diamond mark in each figure shows the median of the achievements, and the horizontal error bar indicates the first and third quartiles of the achievements. As shown in Figure 13, there were no significant differences between the two institutions for common keywords. Statistically, there was no difference in the performance of either institution for common keywords. However, a comparison of the number of achievements obtained from studies on unique keywords shows that Ti results exceeded those of Os (Figure 14). The research related to unique keywords is valuable in differentiating the institution from others. On the other hand, if their performance is inferior, it can be an opportunity to reconsider their necessity.

Table 4: Number of keywords in Ti and Os projects

	Osaka Univ. (Os)	Tokyo Institute of Technology (Ti)
Projects	4,166	1,460
Common keywords	1,999	
Unique keywords	20,889	7,337
Total keywords	22,888	9,336

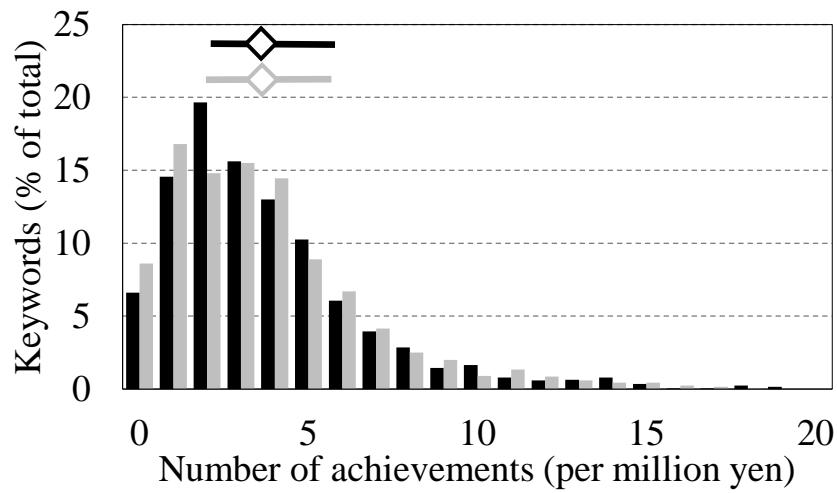


Figure 13: Histogram for common keywords

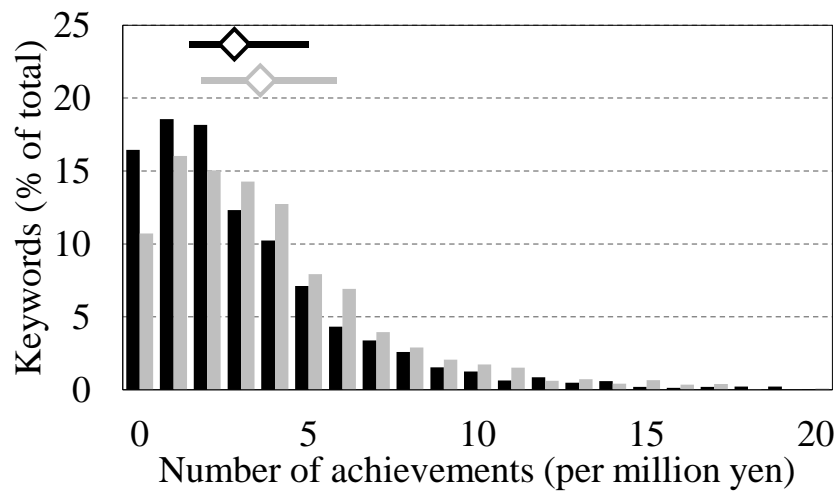


Figure 14: Histogram for unique keywords

4 Future Work

In this study, there were only 1,999 keywords in common between the two institutions because we did not correct the orthographical variants of the keywords. In the future, it is expected that correcting the variants and increasing the number of common keywords will help clarify the characteristics of keywords unique to each institution. For this problem, we are considering judging by the cosine similarity between keywords [6][7]. In this study, the allocation amount is prorated by keyword. However, the number of keywords varies from project to project, and the first keyword's importance may differ from the last one. We need to consider how to divide the allocated amount to each keyword more carefully.

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