Importance of Inclusive Service for Corporate Use of University Research Infrastructure in Japan

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Abstract-- **Research infrastructure, especially research equipment is essential to perform R&D activities. Previous studies have shown that many researchers have used external research equipment that is not owned by their laboratories. To promote innovation, universities are increasingly expected to make their research equipment available as shared core facilities not only on campus but also to other universities or private companies. However, private companies' current utilization of Japanese universities' research equipment is very low. Therefore, this study aims to identify hidden barriers to corporate utilization of core facilities in Japan, and proposes ways to overcome them. To accomplish this, an online questionnaire survey was conducted to R&D personnel (n = 926) in 2012. Results revealed that purpose of use, respondent age, and price of research equipment in daily use, differed significantly depending on whether or not the respondent used neighboring universities' research equipment in the workplace. Further, on-site interviews with core facility management staff, indicated that corporate users often needed technological advice that facilities could not provide due to skilled staff shortages. These results indicated that universities cannot attract corporate users without provide more inclusive service according to users' needs.**

I. INTRODUCTION

R&D infrastructure, such as research facilities and equipment, is essential to creative and unique research and development activities. Consequently, R&D activities, especially, in natural sciences and engineering fields, can be very costly [19]. According to the National Science Foundation's (NSF) Science and Engineering Indicators 2012 [15], about $2.0 billion of the United States' 2009 R&D budget was spent on academic research equipment (movable items), of which 55% was paid by the federal government [15]. In Japan, 2012 intramural expenditure on research equipment (machinery, equipment, etc., valued at 100 thousand yen or more) for academic R&D was about 219.6 billion yen (approximately $2.8 billion) [18], of which 62.7% was paid by national universities [18].

University researchers who receive many research grants frequently mark equipment in their laboratories for their exclusive use. In Japanese government-funded research equipment has begun to take up space in laboratories due to the difficulty of discarding or transferring it. Furthermore, university researchers in Japan often take some time to begin work after transferring from another institution because they attempt to stock the laboratory with the necessary equipment by themselves. As such, sharing university research infrastructure could be an effective way to use research funds and space more efficiently.

In the U.S., the Human Genome Project (1990-2003) [12] (a collaborative international research project supported by the Department of Energy and the National Institutes of Health to fully sequence the human genome) is a prominent example of a major research endeavor that employs research facility with centralized equipment [11]. Another example is the National Nanotechnology Infrastructure Network (NNIN) [14]; supported by the NSF since 2003, the NNIN employs advanced shared nanotechnology user facilities at 14 universities across the U.S. to serve the needs of nanoscale science, engineering, and technology.

Given the recent economic downturn, academic R&D is not expected to increase significantly in the coming years. Universities must therefore use their R&D budgets more effectively, particularly with regard to management of core facilities – that is, the centralized sharing of research resources that provide access to equipment, technologies, and services, including expert consultation [6-8].

In Japan, many university researchers have had to use facilities and/or equipment that they or their research group did not own [10]. Indeed, the number of core facilities in Japanese universities that are open to external academic institutions is gradually increasing. For example, in 2010, MEXT (Japan's Ministry of Education, Culture, Sports, Science and Technology) established the "Kyoyo Navi" web portal, a general navigation site for the shared use of research facilities that supplies basic utilization information (location, utilization fields, usable time, etc.) to promote shared use. In 2013, the web site reported 34 shared core facilities across the country.

While one might expect private companies to take advantage of these shared core facilities to conduct R&D activities, private companies in Japan are actually unlikely to use such facilities, as they are not well known outside of the academic community [5]. As such, academic-corporate research partnerships could promote innovation and contribution to local and national economies [9].

Therefore, this paper examines barriers to corporate utilization of core facilities at universities, and proposes ways to resolve them.

II. LITERATURE REVIEW

One barrier to academia-corporate partnerships is their differing R&D needs. Such differences, including the orientation of the university and its researcher(s), and the attitudes and behavior of the university administration and technology transfer office, can represent serious obstacles to academia-corporate collaboration [3].

However, a survey of individual determinants of university researchers working with private companies, has

suggested that a wide range of traditional academic activities, roles, and interactions work synergistically with the private sector [2]. Further, it has been reported that inter-organizational trust is one of the most important mechanisms for lowering the barriers to academic-corporate interaction [3]. Building this trust requires a long-term relationship; such a long-term relationship could be initiated through the corporate use of a university's research infrastructure (i.e., a shared core facility).

Meanwhile, in the U.S., the Indiana Clinical Translational Sciences Institute (CTSI) in the Indiana University attempted to improve clinical research infrastructure through a partnership with Indiana University School of Business [17].

The acceleration of university research has increased the importance of effective, proactive, and strategic management of core facilities [7]. To maximize return on resource use during the economic downturn, institutions may market their core facility services outside of the university, especially to private industry, to generate additional revenue [8]. Furthermore, it has been suggested that the core facility is itself an ambassador of the university, acting as a service provider or potential collaborator with external commercial customers, which provides an opportunity to demonstrate the university's strength to private clients [9].

III. METHODOLOGY

An online questionnaire targeting private company experts among monitors engaged in R&D (13,812 people as of October 2011) was conducted in cooperation with SpiRE, Inc. from September 24 to October 5, 2012. The questionnaire comprised 20 items covering areas such as respondent characteristics (age, specialty, seniority, and occupation), affiliation characteristics (organization type and size), and attitudes (purpose, mindset etc.) toward using equipment (Table 1). Of 13,812 total possible respondents completed questionnaires were collected from 926 (response rate: 6.7%) monitors who were engaged in R&D at private companies and used equipment in the workplace.

To better understand core facility management issue in Japan, on-site interviews were conducted from January to March 2013 with 16 people engaged in management of core facilities at five universities (four public and one private university) in Japan. Participants were interviewed regarding each core facility's management system, aim, external user, strengths, and weaknesses.

III. RESULTS

Mann-Whitney U test (Table 2) showed significant differences in the responses to five survey items: "purpose," "purchase," "price," "collaboration," and "age."

In response to the question "Have you ever used neighboring universities' equipment," 17.5% (n = 162) answered affirmatively and 82.5% (n = 764) answered negatively. While this disparity may seem unusual, a relatively common answer for why respondents did not use such equipment was lack of information about or absence of a relationship with a neighboring university.

Respondents who used neighboring universities' equipment at their workplace identified most of their R&D activity as applied research. Conversely, respondents, who did not use neighboring universities' equipment tended to favor trial manufacture. Further, respondents who used neighboring universities' equipment found it easy to purchase equipment and frequently used slightly higher-priced equipment at work. Such respondents also had more collaborative experience with external organizations, and

TABLE 1 DEFINITION OF VARIABLES

Variables	Description
Organization	Universities or colleges, companies, public research institutes, local municipalities, medical institutions, and other.
Preferences	Latest model available, short distance to access, cheap to use, good service, availability of acquaintance, and other.
Purpose	Basic research, applied research, trial manufacture, clinical research, and other.
Purchase	Easy to purchase, difficult to purchase, and impossible to purchase.
Price	Less than 5 million yen ($50,000), or 5 million yen or more.
Collaboration	Has collaboration been initiated with external organizations through equipment sharing? (Yes or No.)
Neighboring Universities	Has your organization used equipment belonging to neighboring universities? (Yes or No.)
Occupation	Engineering, information systems, research and development, manufacture and design, management, and other.
R&D Fields	Natural sciences, engineering, agriculture, health, other health, and other.
Age	Respondent's age.
Seniority	Years of service at current workplace.
Company Size	Number of employees at current workplace.

were older than respondents who did not use neighboring universities' equipment. This suggests that these respondents were likely in charge of making decisions about R&D activities at their organization, and therefore might have more opportunities to use neighboring universities' equipment than would less senior employees.

Table 3 summarizes the responses to the on-site interviews with 16 managers of five reputable core facilities. The results generally indicated that most of the core facilities were mainly available for on-campus collaboration, while only one core facility had the goal of promoting academic-corporate partnership.

Additionally, survey results identify a need to foster human resources at core facilities for engagement with corporate users. In interviews, many core facility staff indicated that, although corporate users often needed technological advices or extra help, these requests were seldom fulfilled due to skilled staff shortages.

TABLE 2 RESPONDENTS' SHARED EQUIPMENT USE AND CORRESPONDING VARIABLES

		Utilization of neighboring universities' equipment		Mann-Whitney U	*P*-value
		Yes (n = 162) (%)	No (n = 764) (%)		
Organization	Universities or colleges	3.1	0.5	Z = -1.079	
	Companies	88.3	90.6		
	Public research institutes	2.5	1.3		
	Local municipalities	3.7	3.5		
	Medical institutions	0.6	0.1		
	Other	1.9	3.9		
Preference	Latest model	50.0	37.7	Z = -1.813	
	Short distance toaccess	8.6	12.0		
	Cheap to use	14.2	25.7		
	Good service	20.4	16.8		
	Acquaintance has used the facility	2.5	2.6		
	Other	4.3	5.2		
Purpose	Basic research	23.5	20.8	Z = -4.033	***
	Applied research	38.9	20.4		
	Trial manufacture	34.6	51.8		
	Clinical research	1.9	1.4		
	Other	1.2	5.5		
Purchase	Easy to purchase	17.3	8.1	Z = -3.302	**
	Difficult to purchase	61.7	62.6		
	Impossible to purchase	21.0	29.3		
Price	< 5 million yen	34.6	58.1	Z = -5.314	***
	5 million to < 10 million yen	30.2	19.2		
	10 million to < 30 million yen	16.7	13.1		
	30 million to < 100 million yen	11.7	5.6		
	> 100 million yen	4.3	2.1		
	Other	2.5	1.8		
Collaboration	Yes	62.3	9.6	Z = -15.615	***
	No	37.7	90.4		
Occupation	Engineering	16.7	26.2	Z = -1.052	
	Information systems	10.5	9.6		
	Research and development	53.1	39.3		
	Manufacture and design	15.4	23.6		
	Management	3.7	0.8		
	Other	3.1	0.7		
R&D Fields	Natural sciences	3.1	6.4	Z = -0.240	
	Engineering	79.0	73.8		
	Agriculture	6.2	2.0		
	Health	6.2	2.7		
	Other health (except medical, dental, and pharmacological)	0.6	0.1		
	Other	4.9	14.9		
Age	20s	4.3	3.0	Z = -3.531	***
	30s	14.2	19.8		
	40s	31.5	42.3		
	50s	33.3	28.4		
	60s	11.7	6.0		
	70s and above	4.9	0.5		
Seniority	Less than 1 year	5.6	4.3	Z = -0.961	
	1 to 4 years	14.2	11.8		
	5 to 9 years	18.5	15.2		
	10 to 19 years	22.2	27.7		
	20 to 29 years	28.4	30.8		
	30 years or more	11.1	10.2		
Company size	20 or less employees	11.1	12.4	Z = -0.557	
	21 to 100 employees	17.9	14.8		
	101 to 300 employees	14.2	13.6		
	301 to 1000 employees	15.4	15.2		
	More than 1000 employees	41.4	43.3		
	Unknown	0.0	0.7		

TABLE 3 RESULTS OF ON-SITE INTERVIEWS WITH CORE FACILITY MANAGER

	University	System	Aim	External user	Merit	Issue
A	Public	Centralized	Promotion of academia-corporate partnership	University or private company	Encouragement of collaboration with company	Need for skilled staff to engage with corporate users
B	Public	Scattered	Shared use	Mainly on campus	Utilization without hesitation by newly appointed faculty	Increased use
C	Public	Scattered	Rennovation of laboratory eqipment	Mainly on campus	Effective utilization of equipment	Increasing users
D	Public	Scattered	Shared use on campus	No	Reducing disparities between laboratories	Difficulties with centralization because of space
E	Private	Centralized	Shared use	Based on collaborative research	Effective utilization of space and resource (including human resources)	Grasp of utilization rate for evaluation

IV. DISCUSSION AND IMPLICATIONS

Based on the above results, this study suggests three main barriers to shared academic-corporate use of core facilities: (i) absence of designated corporate employee to arrange shared use of core facilities with universities; (ii) lack of information about utilization of core facilities at universities; and (iii) limited relationship between universities and companies.

These results suggest a large gap between universities and companies in Japan. In contrast, in the U.S., 15% of total NNIN users in 2009 were from corporations [13, 14].

In light of increasing academic-corporate partnerships in Germany (e.g. the mission of the Fraunhofer Institute to perform applied research to promote economic development) and the U.S. [20], Japanese research institutes, including universities, should consider opening the ivory tower of academic to corporate collaboration. Universities' core facilities may play a key role in closing the distance between universities and private companies by facilitating the use of shared research equipment.

To ensure core facilities are best placed to occupy this role, such facilities should maintain a high profile and ensure important information, such as facility access rules, policies, and processes to neighboring companies.

However, as identified by this study, the most important change core facilities can make is to provide inclusive service for corporate users. Such service is considered to include: (i) general consultation, such as user training, general technological advice, and referral to experts at the university; (ii) specific consultation, including highly technological advice (at the research level); and (iii) analytical assistance. The realization of these services is definitely required introduction of new framework, which conceptualizes the relationship between service entities and their users' well-being, to core facilities. The conceptual framework could be useful for improvement of services in each core facility, by application of service research [1, 16].

With that said, proper training and education of staff at universities' core facilities is still poorly understood. In the U.S., Indiana University arranged a partnership between one of its research institutes (including a core facility) and their business school, which introduced concepts such as, cost controlling and business acumen to the research institute [4, 17]. It might be helpful to consider this example as a development or education model for human resources tasked with corporate engagement at university core facilities.

There are some limitations to this study. The study revealed hidden barriers to corporate utilization of core facilities at universities. However, we could not fully examine it as compared between successful cases and unsuccessful cases, because the successful cases are seldom in Japan. It is hoped this study can be starting basis for research topic about integration of research infrastructure and service. The future study addresses social impact provided by corporate utilization of core facilities at universities through a survey, and finds a way of the facilitation.

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