【論 文 Original Article】

Technology Transfer Performance and Mindsets of TTO Staff
— Evidence from Japan and Europe —

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本研究では，大学の研究成果の商業化の担い手である産学連携実務者の意識に着目し，産学連携関連法の整備時期や技術移転市場の規模が我が国と類似している欧州の産学連携実務者を比較対象に，知的財産マネジメントの費用対効果に対する意識，大学の研究成果の商業化に対する意識，地域社会への貢献に対する意識の３つの観点から分析をおこなった．その結果，日本の産学連携実務者は，知的財産マネジメントの費用対効果に対する意識，地域社会への貢献に対する意識が欧州の産学連携実務者より低いものの，大学の研究成果の商業化のために，ビジネス視点を持つことを意識し，大学の特許の産業界への活用を強く意識している可能性が示唆された．

A comparative analysis focusing on the mindsets of technology transfer office's (TTO) staff supporting the commercialization of university-based research is presented in this paper. The study compares Japanese TTO staff with European TTO staff through which the academia-industry related laws preparation period and scale of technology transfer market resemble those of Japan. The research analyzes three mindsets: mindsets toward cost effectiveness of intellectual property management; mindsets toward commercialization of university-based research; and mindsets toward contributions to local communities. These results may suggest Japanese TTO staff leaning toward the mindset of commercialization of university-based research and have a strong mindset of utilizing from university patents. However, Japanese TTO staff exhibit a weak mindset toward cost effectiveness of intellectual property management and local social contributions.

Key Words: *intellectual property, licensing, local social contribution, marketing, motivation, patenting, technology transfer, technology transfer office*

1. Introduction

The "Patent and Trademark Law Amendments Act", also known as the Bayh−Dole Act, was enacted in the United States (US) in 1980. The enactment of the Bayh-Dole law allows universities to hold intellectual

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受付：2019 年 1 月 23 日
受理：2020 年 5 月 19 日

property rights (IPR) over the research results conducted by government funding and grant licenses for patents to enterprises. After the Bayh-dole enactment, universities began to establish technology transfer offices (TTO) all over the US. The movement triggered a significant growth in patenting and licensing by universities. Thus, raising research funds from private companies and the creations of university-based venture business became active.

Meanwhile, Japan enacted the "Act on the Promotion of Technology Transfer from Universities to Private Business Operators" (Technology Licensing Organization Act [TLO Act]) in 1998. It led to the establishment of TLOs throughout Japan. Moreover, in reference to the Bayh–Dole Act of the US, the "Law on Special Measures for Industrial Revitalization" was enacted in 1999. This law included a clause, under certain conditions, the patent rights generated by the research and development from government funds are owned by universities and private companies. In 2004, the "National University Corporation Law" was enacted, which became a major turning point for Japanese national universities. Under this law, universities became a legal personality and was allowed to invest in approved TLOs. This law also stipulates the institutional affiliation and managements of patent rights related to inventions done by university employees at national univsersities[1].

Academia-industry collaboration departments of foreign universities are generally referred to as TTO, and Japanese academia-industry collaboration departments are generally referred to as TLO. Also, many Japanese universities have IP management offices (IP Office). In Japan, TLO is an external organization and IP Office is an internal organization of university. As the roles of the IP Office and TLO overlap in some areas[2], this survey refers to Japanese TLO and IP Office collectively as TTO, hereinafter.

For an independent and sustainable economic growth, it is crucial to create an environment fostering continuous innovation. The commercialization of research results from universities, is the base of knowledge creation and an extremely important factor for the creation of continuous and sustainable innovation. Many universities in Japan have numerous superior research achievements in science and technology, unfortunately, most of them have not been commercialized.

Table 1 shows that the IP ownership produced by academic researchers is vested primarily by the inventor or the institution and indicate the years of legislative revisions in European universities. According to Geuna et al.[3], France and the UK enacted the IP ownership system in the 1980s and then granting IP ownership to universities became popular in Europe, except in Italy and Sweden.

Moreover, Denmark revised its law in the year 2000, to change the IP ownership system from individual inventors to research organizations. Following Denmark's footsteps, Germany, Austria, Norway and Finland revised their laws during 2001–2007. The revision of the IP ownership system, from individual inventors to research organizations, throughout many European nations, after 2000, developed the IP management and technology transfer by universities.

Table 1 The IP Ownerships and the Years of Legislative Revisions in European Universities

Country name	The IP ownership system to research institutions	The IP ownership system to individual inventors
Austria	◆ (2002)	
Belgium	◆ (1997/98)	
Czech Republic	◆ (1990)	
Denmark	◆ (2000)	
Finland	◆ (2007/2010)	(◇)
Germany	◆ (2002)	(◇)
Hungary	◆ (2006)	
Italy		◆ (2001/2005)
Netherlands	◆ (1995)	(◇)
Norway	◆ (2002)	
Poland	◆ (2000)	
Slovenia	◆ (2006)	
Spain	◆ (1986)	
Switzerland	◆ (1911)	
UK	◆ (1977/1985)	

◇ : The IP ownerships are granted to individual inventors under a certain condition. Refer to the Ref. 3 and list up the country names of questionnaire respondents.

The revision of the laws related to the commercialization of university research and IP management in Japan and Europe was behind that of the US. From a cultural, historical and environmental point of view, Japan and Europe differ vastly. However, investigating the mindset of the TTO staff is important to understand the commercialization process to create innovation by universities in the future.

In recent years, the commercialization of research achievements in science and technology in universities paved the way to establish theoretical models for innovation. Up until this time, the primary models for research were the National Systems of Innovation (NSI) model[4] whereby companies lead the commercialization or Triple Helix model[5] based on the industry-academia-government collaboration network. More recently, the importance of the Quadruple Helix model[6,7], that adds the public to the existing industry-academia-government collaboration model, is being discussed due to the significance of innovation created through public interaction

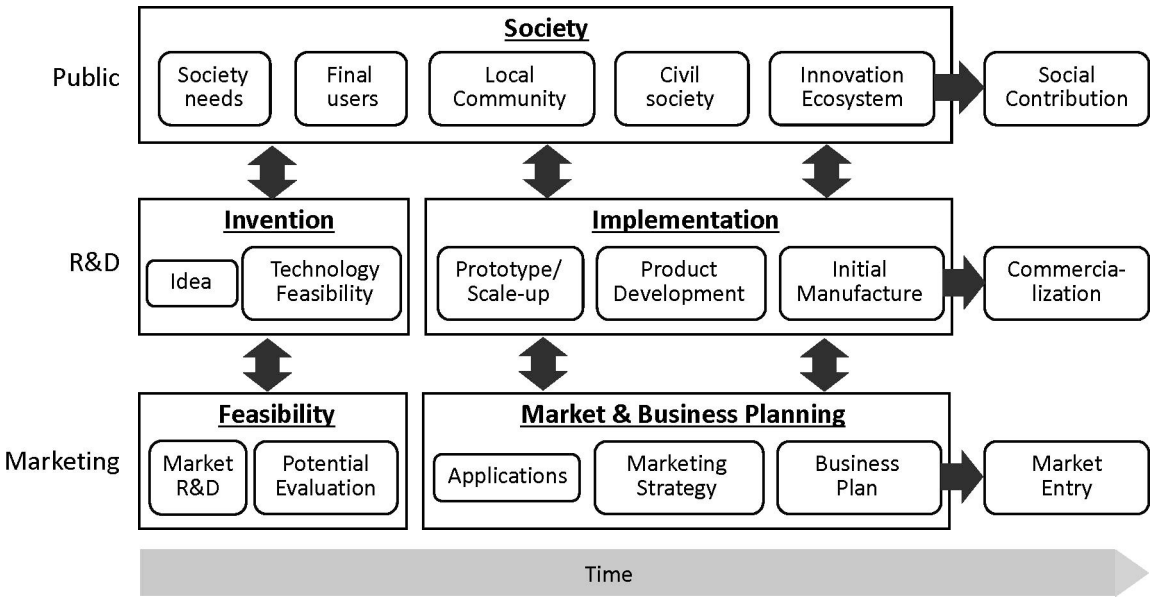

Fig. 1. The Flow of Commercialization of Scientific and Technological Seeds of Universities

that goes beyond the solutions of conventional economic issues. To integrate the public into innovation processes is vital as the role of society is major in national innovation systems (Fig. 1). Universities developed innovation processes that involve both technology push type and market pull type processes[8]. The technology push type typically achieves commercialization through basic research, applied research, prototype development, and product development. In more concrete terms, it evaluates the patentability and commercial opportunity, provision of market information to innovators, and Proof of Concept (PoC). The market pull type achieves a high level of positive social impact innovations through obtaining knowledge on social issues from public, end-users, and local communities. By feeding this knowledge back into research and development (R&D) and adopting a design-driven type model is important for the market pull type processes. Therefore, developing innovation process by universities, in either case of the technology push type or market pull type, need to accomodate a close communication with stakeholder to understand the technical aspects, client needs and social demands.

The commercialization of university-based research is vital for the creation of innovation in Japan[9]. The key to innovation creation lies in the mindsets and approaches of the TTO staff who support the commercialization of university-based research. The aim of this research is to study thoroughly the mindsets of Japanese TTO staff, in comparison with European TTO staff sharing similar academic-industrial related laws preparation period and scale of technology transfer market with Japan. This paper reviews existing leading hypotheses from three perspectives; 1) mindset toward cost-effectiveness of IP management, 2) mindset toward commercialization of university-based research, and 3) mindset toward contributions to local communities. The survey's result that is conducted on Japanese and European TTO staff are analyzed to determine the influencing factors of the TTO staff mindsets and technology transfer performance. The motive of these findings is to discover potential issues and the future prospects of the commercialization of university-based research in Japan.

2. Previous Studies

(1) The cost-effectiveness of IP management in Japanese and European universities

From the data published by the World Intellectual Property Organization, Takano and Yamashita[10] examined the number of patent applications in different countries and regions per one million population in 2013. According to their studies, Japan ranked second, Germany ranked fourth and US ranked fifth for the largest number of patent applications worldwide. While Finland, Sweden, Denmark, and Austria ranked within the top ten countries they were far behind Japan and the US. In short, the total number of patent applications in Europe, compared to Japan and the US, was relatively low.

A 10-year comparative study (from fiscal year (FY) 2004) of technology transfer performance between Japanese and UK universities by Ito et al.,[11] reported the number of invention disclosures, patent applications, and patent rights in Japanese universities, they were more than twice of UK universities. Yet, despite holding a large number of patent rights, only a limited license income of Japanese universities obtained licenses and patent maintenance fees placed immense pressure on the universities' budget.

Furthermore, in a comparative study by Walsh and

Huang[12], it showed that Japanese researchers submitted more patent applications than their US counterparts. The predominant reason for submitting patent applications was to receive public R&D grant. On the other hand, US researchers applied for patents to obtain venture capital funding and/or licensing.

Moreover, Tayanagi[13] summarized the different methods and approaches on how Japan should learn from Europe's academia-industry collaboration. Tayanagi stated that Japanese universities must learn to form strategic academia-industry collaborative alliances, conduct in long-term basic research, demand sponsorship from private companies, and not transferring the ownership of IPR to industries more than necessary. Moreover, universities need to respond to industries demand.

Debackere[14] analyzed the roles of TTO and technology transfer performance while examining the activities of the League of European Research Universities' (LERU) TTO. The analysis revealed that TTO was particularly successful in four areas of organizational management, internal operations, action guidelines, and talent development. In internal operations, TTO developed and implemented suitable IT systems for more productive management in front and back operations and effective marketing. In the areas of action guidelines, they widened technology transfer activities to the entire university, while clarifying policies on education, research, and consistent cooperation.

Takano and Yamashita[10], Ogawa and Tatsumoto[15] discussed the government-subsidized Framework Programme (FP) launched in 1984 that focus on European Union (EU) member states and other related nations. FP is an assembly of independent programs developed to respond to current social issues while providing assistance and support to basic research, talent development, technical development, and small-sized enterprises. The FP7 ran from 2007–2013. The European Research Area (ERA) is launched to conduct research activities related to FP7 and its purpose to utilize research capacities throughout Europe and assist with international joint research. FP7 provides funding and support for joint research among three or more nations, academia-industry-government, consortium joint research, and joint research involving research organizations from emerging Eastern European and BRICs nations. The Horizon 2020 programme (2014–2020) was implemented to follow the FP7 and extend support and assistance to cover an even larger framework.

According to the Japanese Ministry of Economy, Trade and Industry (METI)[16], the percentage of foreign funding received by universities in different nations, was: Japan 1% (2015), UK 15.6% (2015), Germany 4.6% (2014), France 3.5% (2014). Compared to Japan, Europe had a much larger percentage of foreign funding which lead to an expansion of academia-industry-government collaborations that utilized international networks.

(2) The commercialization of science and technology by Japanese and European universities

Mizuho Research Institute Ltd.[17] conducted a survey on trends in technology transfer in Northern Europe (Finland, Sweden, Denmark and the Netherlands) and shows small nations of Northern Europe formed close alliances within their region, and engage in very close joint and commissioned research, while there was a limited technology transfer of university-based research to industries. For the number of licenses per university, the US took the lead followed by Japan and then Europe. However, the level in Europe was low compared to Japan and the US.

Ito et al,[11] conducted a 10-year comparative study (from FY 2004) on the technology transfer performance of Japanese universities and UK universities. The number of university invention disclosures, patent applications, and patent rights in Japan was nearly twice as that of the UK, however, licensing numbers were relatively equal. In contrast, UK university licensing income in FY 2012 was 86 million GBP (approx. 15 billion JPY). This was nearly five times more than the Japanese university licensing income of 2.7 billion JPY (approx. 15 million GBP) in the following FY 2013. Licensing income was drastically higher among UK universities compared to Japan (calculated as 1GBP = 180JPY).

Robin and Schubert[18] in an analysis on the influences of public research institutes and private companies' co-operation on enterprise innovation, demonstrated that co-operation between public research institutes and private companies led to a drastic increase in product innovation in enterprises. These influences were more prominent in Germany than France. One of reason for the difference between the two countries was the difference in science and technology policies.

According to the European Commission report[19], the top 10% of European universities earn 90% of the total license income earned by all universities. In the 2011–2012 study on the number of licenses per 1,000 researchers among 22 European nations, Israel ranked first (23.9) and Croatia ranked 22nd (0.0). For licensing income per 1,000 researchers (22 European nations); the Czech Republic ranked first (3,130,000 EUR); Latvia, Slovenia, and Croatia ranked 22nd (0 EUR). These figures demonstrate the large disparity in licensing income among European nations.

From the Benchmarking Scientific Research 2015, National Institute of Science and Technology Policy (NISTEP), Takano and Yamashita[10] examined the average number of research papers per year between 2011 and 2013. It was found that the US ranked first, China ranked 2nd, Germany ranked 3rd; UK 4th; Japan 5th; France 6th; Italy 7th; and Spain was 10th, and 7 other European nations ranked below 50; indicating a huge gap between nations within Europe. Moreover, patent appli-

cations overall were less than Japan and the US.

A study by Bacchiocchi and Montobbio[20] estimated the process of diffusion and decay of knowledge from patents issued by universities, public research institutes, and corporate enterprises in six countries; US, Italy, France, Germany, UK, and Japan, and investigate the differences between technical fields and nations. The paper indicates that in the chemistry, pharmaceuticals, medical and machinery fields, US universities and public research institutes patents cite the prior-arts documents listed in the patent description, more than corporate enterprise patents. The paper also suggests that there is no evidence verifying that European and Japanese university and public research institute patents are characterized by a high level of technological creativity than corporate enterprise patents.

Etzkowitz et al.[21] analyzed shifts in entrepreneurial universities in Sweden, Japan, US and Brazil. In Sweden, the IP created from research in universities is attributed to the university researchers. Moreover, Swedish universities account for the majority of industry-academia collaboration with large corporate enterprises in Sweden. In the same manner as Japan before 1998, a large portion of IP is transferred from universities to large corporate enterprises through informal collaborations between the two. Furthermore, it is suggested that the forming of joint-venture company's offshore and multinational enterprises by large Swedish enterprises have increased the gap between Swedish university research and industry needs.

(3) The contribution to local communities from the commercialization of science and technology by Japanese and European universities

In a study on European policy related to academia-industry collaboration, Takano and Yamashita[10] cited European Structural and Investment Funds (ESIF) as the most crucial programs, as well as FP including the FP7 and Horizon 2020. ESIF was formed to assist regions in Europe that were lagging behind other nations in development. During the FP7 period, the ESIF spent approximately 86 billion EUR into research and innovation projects throughout Europe. The paper demonstrates the pivotal role of ESIF in Europe while a huge disparity between nations still exists.

According to Tayanagi[13], in Europe, the academia-industry research centers are motivated to shift from conventional centers attached to universities to the establishment of systemized large-scale research parks in local communities. In Finland, 4000 Helsinki citizens cooperated with "Living lab" in social demonstration experiment projects that conducts experiments on the development of cutting-edge technologies on their daily lives. At the Torino Technical University in Italy (Politecnico di Torino), they established a new campus that is opened to the local community using factory sites adjacent to the Faculty of Engineering. The new campus aims to be "a place that is integrated into everyday life and provides new cultural stimulus to students", and that emphasis is placed on collaborations with the local community.

Research by Yoshimura and Tokunaga[22] discusses the organization of RWTH Aachen University that has been actively integrating local contribution and technology transfer since its construction, reporting that one-third of university budget is gained through industry-academia-government collaboration.

Tayanagi[23] furthers discusses the Polytechnic University of Milan. Amid the fall in external funding income from large corporations against the background of the EU integration and the hollowing out of industry, the Polytechnic University of Milan established industry-academia consortium with local small-medium sized enterprise groups. University researchers started to visit companies to promote technology transfer from the Polytechnic University of Milan to local small-medium sized enterprises.

Ranga and Etzkowitz[24] noted that the low level of research in central-eastern European university and the limited R&D of local enterprises is hindering the shift to entrepreneurial universities even when the government is providing assistance policies including programs and funding to promote technology transfer and entrepreneurship.

Ranga et al.[25] surveyed small-sized enterprises in the northern region of the Netherlands who were lagging behind other region's enterprises. The key factors of the lack in the commercialization of science and technology were because of the insufficient communication between industry-academia-governmental bodies, insufficient understanding from governmental functions on particular issues that small-medium sized enterprises face, insufficient recognition of government funding programs to small-medium sized enterprises, bureaucracy of government agency, and the doubling-up of tasks due to the conflicts in missions, culture, and language for entrepreneurial assistance provided by government agencies.

Moreover, Debackere[14] investigated the success factors of the European TTO. He revealed that the TTO staff role in venture incubation to develop local ventures and actively promoting technology transfer activities based on the Triple Helix Concept were the key factors of success. In addition, the other factors were the pursuit of best practice and how to foster mutual understanding between industry and academia. Moreover, the European TTO efforts to maintain relations with Association of University Technology Managers (AUTM) and Association of European Science & Technology Transfer Professionals (ASTP) were another success factos.

An empirical research on the Technology Advanced

Metropolitan Area (TAMA) cluster project, which was the model for the Industry Cluster Plan, Kodama[26] noted the necessity of interlocking collaborations in regions that have many small-medium enterprises that are in the process of product development. He further noted that regions which do not have such enterprises, must support startups and increase the product development in startups and small-medium sized enterprises.

3. Hypothesis

In regard to the cost-effectiveness of IP management, previous studies showed invention disclosures, patent applications, and patent rights are higher in Japanese universities compared to European universities, although a very limited amount of licensing income has been gained from patents by Japanese universities. Also, the main purpose of patent applications by Japanese university researchers was to procure research grant rather than commercialization and technology transfer. Moreover, other studies showed that European universities were pursuing projects for the promotion of international joint research and inter-university collaboration, and utilizing IT systems for effective management of TTO operations. Based on these points, we derive the following hypothesis on Japanese and European TTO staff mindsets concerning the cost-effectiveness of IP management.

Hypothesis 1: European TTO staff mindset has a stronger focus toward IP management cost-effectiveness compared to Japan.

With respect to the commecialization of science and technology, there is a large disparity between European nations concerning invention disclosures, patent applications, and patent rights. For instance, the licensing income in the UK was approximately 5 times more than Japan. Morever, regions such as France, Germany, Italy, Finland, Sweden, and Denmark were leveraging from academia-industry collaboration with joint and commissioned research, and promotion of large enterprise innovation activities. Based on these points, we derive the following hypothesis related to the mindset of Japanese and European TTO staff concerning the commercialization of science and technology of universities.

Hypothesis 2: European TTO staff mindset has a stronger focus toward the commercialization of university science and technology than Japan.

The contributions to local communities from the commercialization of science and technology by universities in Europe, some regions exhibited a low level of university research and local enterprise development, resulting in a lack of academia-industry collaboration. On the other hand, European nations and universities implement academia-industry collaboration policies aimed to revitalize the local communities, and establish research parks and facilities that foster collaborative research integrated with people's daily lives.

In parts of Europe, university researchers are actively visiting local small-medium sized enterprises to create innovation as part of their program. Generally, among many nations, it is thought that European mindset has a stronger focus toward local social contributions than Japan. In regard to academia-industry collaboration connected to contributions to local communities from the commercialization of science and technology by universities, we derive the third hypothesis.

Hypothesis 3: European TTO staff have a stronger mindset of local social contributions than Japan.

4. Analysis Method

The key to creat innovation lies in the mindsets and approaches of the TTO staff supporting the commercialization of university-based research. The commercialization of university-based research is vital for the creation of innovation in Japan. To verify the hypotheses presented in this paper and determine the factors influencing TTO staff mindsets and technology transfer performance, a survey is implemented on Japanese and European TTO staff. The title of the survey is, "Analyzing the Science-to-Business (S2B) Marketing Practices at University Technology Transfer Office" and is prepared using a web-based survey in a document form builder function provided by Google. The survey is then sent out by email.

The survey questionnaire adopted the 6P marketing mix model (Fig.2) advocated by Prónay and Buzás[8,27]. The 4P (Product, Price, Promotion and Placement) model by McCarthy[28] was redefined by the 6P marketing mix to accommodate the university-based research commercial-

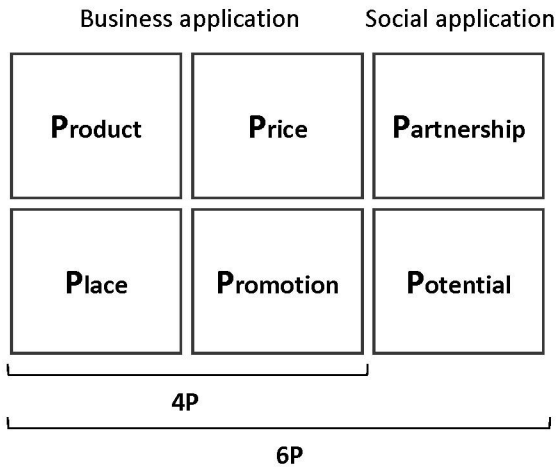

Fig. 2. Conceptual Diagram of 6P Marketing Mix Model

Table 2 Survey Questions

Question	
JPN	**EUR**
1．大学の技術に関する特許について	**1. Opinion about patenting a technology at the university**
[-2: 全くその通りではない -1: その通りではない 0: どちらとも言えない +1: その通り +2: 全くその通り]	[-2: Strongly disagree -1: Disagree 0: No opinion +1: Agree +2: Strongly agree]
特許の取得には長期的なビジョンが必要である。	Patenting requires long-term vision
大学の研究成果に関する特許は、先見性や忍耐が重要である	Patience and discretion are crucial in case of patenting.
大学は特許出願数で評価するのではなく、特許の有用性で評価するべきである。	For a university it is better to have less but more attractive patents.
3～4年間技術移転できない大学の特許は、特許を放棄するべきである。	If a university patent does not generate any interest from the industry for 3-4 years it has to be cancelled.
大きな利益を見込める技術だけ、特許を取得するべきである。	Only those technologies shall be patented that has significant business potential.
ほとんどの特許は、大学に利益を生まない。	Majority of patents does not gain financial reward to the university.
2．大学の技術移転について	**2. University technology transfer in general**
[-2: 全くその通りではない -1: その通りではない 0: どちらとも言えない +1: その通り +2: 全くその通り]	[-2: Strongly disagree -1: Disagree 0: No opinion +1: Agree +2: Strongly agree]
大学の技術に価格をつけることは困難だ。	It is hard to set the price for a university technology.
大学のイノベーションは、平均的な市場価格より安い価格で取引されている。	University innovations are usually sold for cheaper than the average market price.
産学連携を行う場合、人的ネットワークが重要である。	Acquaintance is essential for university-industry partnerhsip.
対面での商談が、大学の技術を商業化（特許の譲渡及びライセンスを含む）に結び付ける最もよい方法である。	Personal selling is the best way of commercializing university technologies.
大学の技術移転において、地域社会からの要望を考慮するべきである。	The interest of the local community should be taken into account in the university technology transfer.
大学のイノベーションプロセスは、社会的コントロールの下にあるべきである。	There should be society control over the university innovation process.
大学はオープンイノベーションプロセスに参加するべきである。	Universities should take part in open innovation processes
あなたが大学の所属である場合は、所属大学における大学産学連携部門（TLOを含む）について、あなたが企業の方である場合は連携している大学、または過去に連携したことのある大学産学連携部門（TLOを含む）について、あなたのお考えをご回答ください。	**Please think about one exact university and its technology transfer office (TTO) you had experiences before or you are most familiar with.If you are a university member, please think about your own TTO.**
あなたが選択した大学は以下である 1：国立大学 2：公立大学 3：私立大学 その他（　　）	**The university you have chosen is ...** 1:fully state owned university. 2:partially state owned university. 3:private university. Other (　　)
あなたが選択した大学の名前は何ですか	**What is the name of your university**
その大学はどこの国にありますか	**In which country is this university situated?**
※これ以降の質問（アンケートの終わりまで）への回答は、選択した大学に関する回答とみなされます。	**※ Answering the following questions (till the end of the questionnaire) always refer to this university.**
3．大学産学連携部門（TLOを含む）について	**3. Opinion about the university TTO**
[-2: 全くその通りではない -1: その通りではない 0: どちらとも言えない +1: その通り +2: 全くその通り]	[-2: Strongly disagree -1: Disagree 0: No opinion +1: Agree +2: Strongly agree]

大学産学連携部門（TLOを含む）は、大学の有用技術のすべてを把握している。
大学産学連携部門（TLOを含む）は、企業が必要とする（投資可能な）科学的な物やサービスのすべてを把握している。
大学の研究者は、大学産学連携部門（TLOを含む）に自らの発明の運用を依頼する。
大学の研究者が自らの発明の運用を大学産学連携部門（TLOを含む）に依頼する際は明確かつ分かりやすい方法で依頼することができる。
多くの発明は、大学の部門内で良く知られている案件のみである。

４．大学産学連携部門（TLOを含む）の運営について

[-2: 全くその通りではない　-1: その通りではない　0: どちらとも言えない　+1: その通り　+2: 全くその通り]

大学産学連携部門（TLOを含む）は、大学の全ての技術についての依頼を受けることに力を入れている。
大学産学連携部門（TLOを含む）は、定期的に、定められた手順に従って、依頼を受けた技術の再評価を行っている。
大学産学連携部門（TLOを含む）は、技術の運用に関する依頼案件を受けるため、活発に研究者と交流の機会を持っている。
大学産学連携部門（TLOを含む）は、定期的に特許ポートフォリオを改良し、評価を行っている。
大学産学連携部門（TLOを含む）は、技術移転を進めるうえでビジネスだけでなく社会貢献の観点についても考慮している。
大学産学連携部門（TLOを含む）は、新しい大学の技術を地域社会に宣伝するため、活発にマスコミを利用している。

５．技術移転の連携先としての大学について

[-2: 全くその通りではない　-1: その通りではない　0: どちらとも言えない　+1: その通り　+2: 全くその通り]

大学の特許ポートフォリオを企業に公開している。
大学の産学連携の成果が、分かりやすい内容で地域社会に公開されている。
大学はナレッジマップまたは、特許ポートフォリオを、オンラインかつユーザフレンドリーな状態で提供している。
大学の特許の大多数が、企業で活用されている。（企業にライセンスまたは譲渡されている。）
大学の研究成果の大部分は、地域社会に貢献している。
大学のパンフレットは、商用的な目的でも使用できる。
大学のホームページは、商用的な目的でも使用できる。

６．あなたは大学をビジネスパートナーとして、どのように考えているか。

1. 柔軟で、企業が連携したいと思うパートナー
2. 重要であるが、どちらかと言うと理解しがたい部分があるパートナー
3. 対応が遅く、官僚的であるが、有能なパートナー
4. 商業化に対し全くのノンプロフェッショナルであり、市場回避型である。

７．あなたは大学のビジネスパートナーとしてどのようなイメージを大学に持っているか。

1. ビジネスイメージがあり、ブランド力がある。
2. 研究開発のイメージではよく知られているが、ビジネスイメージはあまりない。
3. 学術的なイメージが強く、ビジネスイメージは弱い。
4. 明確なイメージはない。

The TTO is aware of all the exploitable technologies at the university.

The TTO is aware of all the scientific services and devices that can be capitalized by industrial partners.

The researchers usually register their inventions to the TTO.

The researchers are capable of registering their inventions in a clearly understandable way.

Many inventions are only known within the department.

4. Opinion about the operation of the TTO - Please think about that exact university's TTO you previously specified above

[-2: Strongly disagree　-1: Disagree　0: No opinion　+1: Agree　+2: Strongly agree]

The university TTO put a lot of effort in administrating all the university technologies.

The university TTO regurarly reevaluates the registered innovations according to a written protocol.

The university TTO actively seeks connection with researchers in order to register their innovations.

The university TTO regularly refines and reviews the patent portfolio.

The university TTO considers not only business- but societal aspects also in the technology transfer.

The university TTO actively uses the media for informing the local community about the latest innovations of the university.

5. Opinion about the university as a technology transfer partner

[-2: Strongly disagree　-1: Disagree　0: No opinion　+1: Agree　+2: Strongly agree]

The patent portfolio of the university is transparent and accessible for business partners.

The innovation results of the university is accessible and understandable for the local community.

The university has a user-friendly online knowledge map (or patent-portfolio).

The majority of the univsersity patents are applied by the industry.

Significant amount of the university's innovation results has societal benefits for the local community.

The brochures of the university are business-conform.

The homepage of the university is business-conform.

6. How would you describe the university as a business partner?

1.Flexible partner with whom the industrial partners like to cooperate.
2.Important but rather subtle partner.
3.Slow and bureaucratic but capable partner.
4.Absolutely nonprofessional and market averse.

7. How would you describe the image of the university in the eyes of its industrial partners?

1.Business-like image, almost a brand.
2.Well-known R&D image but not really business-like.
3.Strong academic but weak business image.
4.No clear image at all.

8．あなたは、大学がマーケティング志向の研究育成を行う必要性を感じますか。（教育ではなく大学の研究に関してのみお答えください。）

1. はい、マーケティング志向の研究育成を、大学がより推進していく必要性を明らかに感じる。
2. はい、すでに大学はビジネス寄りの要素を持っているが、さらに強化する必要がある。
3. いいえ、大学はすでにマーケティング志向の研究育成を行っている。
4. いいえ、大学はマーケティング志向であるべきではない。

8. Do you see the need for fostering the market orientation at the university? (Concentrate solely on the fields of innovation within the university and not the education.)

1.Yes there is a clear need for better marketing orientation.
2.Yes it can be improved, however there are some business-like elements already.
3.No, the university is already marketing orientated.
4.No, the university shall not be marketing orientated at all.

9．あなたは下記の対象者、大学、企業に対する大学産学連携部門（TLOを含む）の人的ネットワークについて、どのように考えていますか。

1. 弱い関係またはつながりがない	2. 稀で形式的な関係	3. 協力な連携関係	4. 親密なパートナー	5.わからない
学内の研究者				
国内の他大学				
外国の大学				
多国籍企業				
国内の大企業				
地域の中小企業				
地域社会				
マスコミ				

9. How would you describe the university TTO's connection to the following actors?

1. Weak or no connection	2. Few formal connections	3. Intensive collaboration	4. Close partners	5. I don't know
Own researchers				
Other domestic universities				
Foreign universities				
Multinational companies				
Large domestic firms				
Local SME's				
Local community				
Media				

10．あなたの知っている範囲で、大学の知的所有権が商業化（特許の譲渡及びライセンスを含む。）に結び付いている件数（年間）をお答えください。

10. According to your knowledge how many intellectual properties are commercialized by the university annually? (Patent selling and licensing combined.)

11．あなたの知っている範囲で、大学産学連携部門（TLOを含む）が、技術移転関連の国際イベントに参加している件数（年間）をお答えください。

11. According to your knowledge how many international partnering event does the members of the university TTO visit annually?

12．あなたは、ビジネスの観点から大学産学連携部門（TLOを含む）をどのように評価しますか。

【全く成功していない　1 2 3 4 5 6 7　非常に成功している】

12. How would you describe the success rate of the university TTO from a business point of view?

【Absolutely unsuccessful　1 2 3 4 5 6 7　Very successful】

あなたの所属する組織が当てはまるものを１つ選択してください。

1. 大学
2. 企業
3. 研究所
その他（　　）

What type of organisation are you working for?

1.University
2.Business company
3.Research Institute
Other （　　）

あなたの役職で当てはまるものを１つ選択してください。

1. 組織の長／責任者
2. 管理職
3. 学者または研究者
その他（　　）

What is your position at your organization?

1.Head/Director
2.Administrative employee
3.Scholar or Researcher
Other （　　）

あなたは大学産学連携部門（TLO含まない）のメンバーですか？それともTLOのメンバーですか？

私はTLOのメンバーです。
私は大学産学連携部門（TLO含まない）のメンバーです。
私はTLOまたは大学産学連携部門（TLO含まない）のメンバーではありません。
その他（　　）

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研究開発または技術移転の分野でのあなたの業務経験年数をご回答ください。

How long have you been working on the field of R&D or Technology Transfer?

ization process. The social contribution was taken into consideration and the Partnership and Potential indexes[8,27] were included. The survey questionnaire contains 52 questions and predominately use the 5 point Likert scale, 10 related to Product, 3 related to Price, 8 related to Promotion, 5 related to Place, 9 related to Partnership, and 6 related to Potential, and 11 were related to other areas (7 of which were connected to the institute that the respondent belonged to).

The survey respondents were TTO staff working in the commercialization of science and technology in Japanese and European universities. To expunge concerns surrounding changing mindsets in the period following the enactment of industry-academia related laws, a comparison of European TTO staff with similar law enactment period[3] and technology transfer market was selected. According to the European commission report[19], there is a large disparity in university-based licensing income among various European nations and regions. Therfore, the survey was carried out across west, east, north and south European nations to account for variations across regions and university sizes. The survey was conducted April 2015 (approx. over one month) in Europe, and September 2015 (approx. over one month) in Japan. The main languages used were English (for Europe) and Japanese (for Japan). The contents of the survey are shown in Table 2.

The total number of survey respondents were 137 people. 77 respondents belonged to 18 European countries (Austria, Belgium, Croatia, Czech Republic, Denmark, Finland, German, Hungary, Ireland, Italy, The Netherlands, Norway, Poland, Portugal, Slovenia, Spain, Switzerland, and UK), and 60 respondents belonged to Japan. The number of affiliated universities was over 18 universities in Europe and over 16 in Japan (14 national universities and 2 private universities). Inquiring the name of the affiliated university was optional in our survey. The respondents' working experience percentage for 0～9 years, 10～19 years and over 20 years were 55%, 27% and 18% in Europe (n＝77), and 62%, 32% and 7% in Japan (n＝60) respectively (Total was not 100% because the data were rounded to integers). The average working experience were 10.3 years in Europe and 8.3 years in Japan.

To verify the hypotheses derived from the prior literature, we analyzed and considered the characteristic of each answer to its designated question. Depending on the question, it is expected that answers will be similar for each affiliated institution. However, in this survey the answers were not obtained as an organizational achievement and obtained independently by individual self-report on the TTO staff supporting the industry-academia collaboration.

5. Analysis of Results and Examination

(1) Hypothesis 1: European TTO staff mindset has a higher focus toward IP management cost-effectiveness compared to Japan

The chi-square test in Table 3 indicates that the differences in the answers obtained from European and Japanese TTO staff about university IP management are statistically significant. According to the survey result, European TTO staff have a higher tendency to think that a patent should be disclaimed if it cannot be transferred to corporate enterprise (industry) within 3–4 years ($P < 0.01$, Table 3: Q1). Moreover, European TTO staff also showed a tendency to think that research results with significant business potential should be patented ($P < 0.01$, Table 3: Q2). Compared to Japanese TTO staff, European TTO staff are quite strong-minded about the need to regularly review and reevaluate patents obtained by the university ($P < 0.01$, Table 3: Q3).

In respect to the survey on promotional activities, 72% of European TTO staff (n＝77) and 75% of Japanese TTO staff (n＝60) agreed (Agree＋strongly Agree) with the following statement "Personal selling is the best way of commercializing university technologies" (not shown in the tables). Moreover, 82% of European TTO staff (n＝77) and 92% of Japanese TTO staff (n＝60) agreed (Agree＋strongly Agree) with the statement "Acquaintance is essential for university-industry partnership" (not shown in the tables). The result shows that both European and Japanese TTO staff strongly supported the personal selling, and they consider that human networks are an effective marketing method.

Table 3 Answers to the IP Management of University Related Questions

	Question	JPN	EUR	Significant Difference
Q1	If a university patent does not generate any interest from the industry for 3–4 years, it has to be cancelled. Answer: Strongly Agree and Agree	25%	51%	**
Q2	Only those technologies shall be patented that has significant business potential. Answer: Strongly Agree and Agree	18%	73%	**
Q3	The university TTO regularly refines and reviews the patent portfolio. Answer: Strongly Agree＋Agree	42%	70%	**

JPN: n＝60, EUR: n＝77, **: $p < 0.01$

Table 4 Answers to the Promotions Related Questions

Question		JPN	EUR	Significant Difference
Q1	The homepage of the university is business-confirming. Answer: Strongly Agree and Agree	18%	44%	**
Q2	The brochures of the university are business-confirming. Answer: Strongly Agree and Agree	13%	44%	**
Q3	The patent portfolio of the university is transparent and accessible for business partners. Answer: Strongly Agree and Agree	35%	51%	*
Q4	The university has user-friendly online knowledge map (or patent portfolio). Answer: Strongly Agree and Agree	15%	44%	**

JPN: n = 60, EUR: n = 77, **: $p<0.01$, *: $p< 0.05$

Table 5 Answers to the Partnership Related Questions

Question		JPN	EUR	Significant Difference
Q1	How would you describe the university TTO's connection to multinational companies? Answer: Weak and No connection	40%	17%	*
Q2	How would you describe the university TTO's connection to foreign universities? Answer: Intensive collaboration and Close partners	10%	43%	**

JPN: n = 60, EUR: n = 77, **: $p<0.01$, *: $p<0.05$

The survey results in Table 4 (about promotional activities outside of personal selling) shows that university websites and brochures are frequently used to communicate university research results to industries to facilitate the commercialization of university-based research among European TTO staff compared to their Japanese counterpart (Table 4: Q1, Q2). Furthermore, European TTO staff are more likely to offer IP obtained by universities to industries via online sources and in a user-friendly way than Japanese TTO staff (Table 4: Q3, Q4). In line with Debackere[12], our results also revealed that European TTO staff were using IT systems for more effective marketing.

The chi-square test in Table 5 indicates that the differences in the answers obtained from European and Japanese TTO staff about human networks are statistically significant. According to the results, compared to Japan, European TTO staff tend to have a stronger tendency toward multinational enterprise collaboration ($P<0.05$, Table 5: Q1). At the same time, they also have a stronger tendency toward collaboration with foreign researchers than TTO staff in Japan ($P<0.01$, Table 5: Q2). Regarding the networks between TTO staff and large domestic firms or local small and medium-sized enterprises, no significant difference between Japanese and European TTO staff was observed in the chi-square test result (not shown in the tables).

As inferred in the survey results by Takano and Yamashita[10], Ogawa and Tatsumoto[15] and international collaborative research assistance programs aimed at European member nations, such as FP and the Horizon 2020, led to formation of international networks.

Findings from comparisons on university IP management, promotional activities, and human networking, show that European TTO staff exhibit a stronger consideration and mindset of the cost-effectiveness of IP management than TTO staff in Japan. At the same time as showing a strong mindset of the importance of personal selling, European TTO staff were also highly conscious of utilizing IT systems for effective marketing. Findings inferred that European TTO staff also utilize national assistance programs to expand human networks more than Japanese TTO staff. These findings confirmed hypothesis 1: "European TTO staff mindset has a stronger focus toward IP management cost-effectiveness compared to Japan".

(2) Hypothesis 2: European TTO staff mindset has a stronger focus toward the commercialization of university science and technology than Japan

Table 6 relates to questions on cases of commercialization of university science and technology. The table indicates the number of cases (per year) where the IP of

Table 6 Answers to the Commercialization Case Number Related Questions

Commercialization Case Number	JPN	EUR
0–10	33%	54%
11–20	31%	26%
21–30	12%	14%
31–40	6%	2%
41<	18%	4%

JPN: n = 60, EUR: n = 77

the university leads to commercialization (patent selling and licensing combined). The survey results revealed that the number of cases of commercialization of university IP was higher for TTO staff in Japan than in Europe. These findings, as demonstrated in studies on licenses per university by Mizuho Research Institute Ltd.[17], show that while US, Japan, and Europe rank in order with, the US being at the lead, Japan has more licenses than Europe. And, while this supports claims by Ito et. al.[11], that the number of licenses between Japan and UK is relatively equal, it should be noted that this research looks at indexes on the number of licenses, as opposed to licensing income (which would reap differing results). In the European Commission report[19], the number of licenses and licensing income of European universities differ drastically between western, eastern, northern and southern nations and regions. Therefore it is necessary to consider this situation in regard to license numbers.

The chi-square test in Table 7 indicates that the differences in the answers obtained from European and Japanese TTO staff about the value of IP are statistically significant. According to the survey results, compared to Japanese TTO staff, European TTO staff tend to think that the majority of patents maintained by universities will not have financial reward for the university ($P<0.01$, Table 7: Q1). There is also a tendency among European TTO staff to think that it is hard to set the price for a university technology ($P<0.01$, Table 7: Q2). On the other hand, compared to European TTO staff, Japanese TTO staff tend to think that university innovations are usually sold for less than the average market price. ($P<0.05$, Table 7: Q3).

In order to clarify the factors affecting the mindsets of TTO staff and technology transfer performance, we focused on the question about "According to your knowledge, how many intellectual properties are commercialized by the university annually? (patent selling and licensing combined)" (Table 6). Table 8 shows the results obtaining correlation coefficient, that have significant differences, between this question and other questions.

Our research results found that the number of cases of commercialization of university science and technology by Japanese TTO staff correlate weakly with the following questions "The university TTO actively seeks connection with researchers in order to register their innovations" and "How would you discribe the university TTO's connection to large domestic firms" ($P<0.01$, Table 8: Q2, Q4). As the number of cases (per year) where the IP of the university leads to commercialization (patent selling and licensing combined) was higher for Japanese TTO staff than in Europe. This may show that Japanese TTO staff mindset possess a stronger focus toward active communication with university researchers as a means of

Table 7 Answers to the Price Related Questions

Question		JPN	EUR	Significant Difference
Q1	Majority of patents does not gain financial reward to the university. Answer: Strongly Agree and Agree	22%	79%	**
Q2	It is hard to set the price for a university technology. Answer: Strongly Agree and Agree	42%	86%	**
Q3	University innovations are usually sold for cheaper than the average market price. Answer: Strongly Agree and Agree	70%	54%	*

JPN: n = 60, EUR: n = 77, **: $p<0.01$, *: $p<0.05$

Table 8 The Correlation Coefficient between Commercialization Case Number of Intellectual Properties and Other Questions

Question		Correlation Coefficient	
		JPN	EUR
Q1	The researchers are capable of registering their inventions in a clearly understandable way.	.355 *	.068 ns
Q2	The university TTO actively seeks connection with researchers in order to register their innovations.	.424 **	.042 ns
Q3	The university TTO regularly reevaluates the registered innovations according to a written protocol.	.288 *	−.303 ns
Q4	How would you describe the university TTO's connection to Large domestic firms.	.387 **	.253 *
Q5	How would you describe the university TTO's connection to Multinational companies.	.322 *	.290 *
Q6	How would you describe the university TTO's connection to Foreign universities.	.313 *	−.141 ns
Q7	The university TTO considers not only business but societal aspects also in the technology transfer.	.350 *	.317 *
Q8	The interest of the local community should be taken into account in the university technology transfer.	−.320 *	.096 ns

JPN: n = 60, EUR: n = 77, **: $p<0.01$, *: $p<0.05$, ns: Non-significant

discovering inventions. It is possible that strengthening networks with large domestic firms will mitigiate the gap between researchers and industries. This is one possibility attributing to the larger number of cases of commercialization of university science and technology in Japan compared to European TTO staff. As a result, hypothesis 2: "European TTO staff mindset has a stronger focus toward the commercialization of university science and technology than Japan" has been rejected.

(3) Hypothesis 3: European TTO staff mindset has a stronger focus toward local social contributions than Japan

The chi-square test in Table 9 indicates that the differences in the answers obtained from European and Japanese TTO staff are statistically significant. Table 9 shows the answers to the question about the contributions offered by university-based research to local community. According to the survey's results, European TTO staff have a higher understanding toward the importance of university-based research that plays in benefiting the local community ($P<0.01$, Table 9). These findings coincide with Takano and Yamashita[9] findings; science and technology exchange policies of the ESIF and small-medium enterprise R&D assistance are one of the primary factors for accelerating joint-project between research institutes, including universities, and increasing employment rate.

To predict the influencing factors on mindset toward local social contribution, the response in Table 10 showed unique significance on the correlation between the question displayed in Table 9 "Significant amount of the university's innovation results has societal benefits for the local community." and other questions.

It was found that the mindset of Japan TTO staff concerning local social contributions correlates with the following survey question, "The majority of the university patents are applied by the industry." ($P<0.01$, Table 10: Q6). Japanese TTO staff expressed a weaker mindset toward local social contributions (Table 9), but a strong mindset of utilizing from university patent in the industry. It is possible that such mindset is a primary factor leading to the high number of commercialization cases of university technology by Japanese TTO staff (Table 6).

On the other hand, the European TTO staff mindset toward local social contributions expressed a weak correlation with the following survey question, "How would you describe the success rate of the university TTO from a business point of views?" ($P<0.01$, Table 10: Q5). European TTO staff tend to think that the majority of university-based research will benefit the local community. These results suggest that they have a business-perspective and a strong mindset toward utilizing the commercialization of university-based research to benefit the local community.

These results align with Debackere's[14] report that European TTO staff play a major role of local venture incubator. This situation, as noted by Tayanagi[13], has influenced local social contributions such as opening research facilities including the community-based research parks in various regions throughout Europe. These points thus confirmed the hypothesis 3: "European TTO staff mindset has a stronger focus toward local social contributions than Japan".

Table 9 Answers to the Contribution to Local Community Related Questions

	Question	JPN	EUR	Significant Difference
Q1	Significant amount of the university's innovation results has societal benefits for the local community. Answer: Strongly Agree + Agree	8%	33%	**

JPN: n = 60, EUR: n = 77, **: $p<0.01$

Table 10 The Correlation Coefficient between Questions about Contribution to Local Community and Other Questions

Question	Correlation Coefficient	
	JPN	EUR
Q1 How would you describe the university TTO's connection to the local community?	.069 ns	.237 ns
Q2 How would you describe the university TTO's connection to local SME's?	.194 ns	.205 ns
Q3 How would you describe the university TTO's connection to large domestic firms?	.235 ns	.296 *
Q4 How would you describe the university TTO's connection to multinational companies?	−.056 ns	.308 *
Q5 How would you describe the success rate of the university TTO from a business point of view?	.373 **	.478 **
Q6 The majority of the university patents are applied by the industry.	.764 **	.335 *

JPN: n = 60, EUR: n = 77, **: $p<0.01$, *: $p<0.05$, ns: Non-significant

6. Conclusions and Implications

The commercialization of university-based research is considered vital for driving forward innovation in Japan. This paper examined the importance of the TTO staff's mindsets and approaches to support the commercialization of university-based research. We applied a comparitive analysis between Japanese TTO staff and European TTO staff sharing similar academia-industry related law preparation period and scale of technology transfer market.

The construction of our research hypotheses was based on three varying mindsets; mindsets toward the cost-effectiveness of IP management, mindsets toward commercialization of university-based research, and mindsets toward contributions to regional communities. The hypotheses were tested and verified to reveal the potential influencing factors of TTO staff mindsets and technology transfer performance. Concerning mindsets toward IP management cost-effectiveness, research results confirmed the first hypothesis: "European TTO staff mindset has a stronger focus toward IP management cost-effectiveness compared to Japan". For mindsets toward the commercialization of university-based research, research results rejected the second hypothesis: "European TTO staff mindset has a stronger focus toward commercialization of university science and technology than Japan". Finally, in terms of mindsets toward contributions to local communities our research confirmed the third hypothesis: "European TTO staff mindset has a stronger focus toward local social contributions than Japan".

These results may suggest the Japanese TTO staff leaning toward the mindset of commercialization of university-based research and have a strong mindset of utilizing from university patents. However, Japanese TTO staff exhibit a weak mindset toward cost effectiveness of intellectual property management and local social contributions.

To improve the performance of technology transfer, we suggest that TTO staff (1) adopt a mindset of improving cost-effectiveness by utilizing IP management while using market evaluations and the practical application of IT systems to enhance work efficiency, (2) adopt a mindset of actively networking to act as a bridge between universities and industries, and (3) adopt a mindset toward the commercialization of university-based research and strives to contribute to the local community.

From the innovation creation perspective, MEXT[29] indicates that IP management in Japan shows (1) "Universities cannot independently manage IP on their own." and (2) "The number of universities implementing commercially aware technology transfer activities is limited". The analysis of our research results suggests that reforming the mindset of TTO staff toward commercialization will increase the potential to improve the performance of technology transfer and the creation of industry innovation.

Moreover, regional universities are being leveraged as regional "knowledge hubs", and by circulating IP from regional universities into the local community and producing high-value-added products and services, it is expected that these "knowledge hubs" will become hubs for innovation[30]. The analysis results of this research infer that there is great potential for TTO staff with a business-oriented mindset, a drive for commercialization of the university-based research, and a mindset that focuses on local social contribution. It will be the source and the drive of building-up regional university to "knowledge hubs".

The answers to the questionnaire survey were obtained using random selection. The data samples were taken from Japan's main universities and across different (west, east, north and south) regions of Europe. The quality of the data sample from Europe varies among regions and nations. Therefore, by comparing Japan with different regions and nations of Europe, we consider the possibility to gain insights regarding the factors that influence TTO mindsets and technology transfer performance.

Acknowledgment

This work was supported by JSPS KAKENHI Grant Numbers JP18K01754, JP20K01937.

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