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Sustainable Management Practices of Japanese Companies in Pre-War Period from the Perspective of SDGs and ESG

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Jokichi Takamine: From Bioscience to the Intellectual Property Business

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Sustainable Management Practices of Japanese Companies in pre-war period from the perspective of SDGs and ESG

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Jokichi Takamine (1854-1922)

(Source) Sankyo Co., Ltd., “Sankyo Centennial History”, 2000

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Achievement of Jokichi Takamine and related SDGs

Economy	 	*Production of artificial fertilizer *Pharmaceutical business
Society	  	*Discovery of diastase (digestive enzyme) *Discovery of adrenaline (hemostatic agent) *Promotion of private diplomacy (Japan Society) *Regional development through traditional industries *Development of pharmaceutical manufacturers *Establishment of research institute for basic research
Environment		*Creating local industries utilizing hydropower
Governance	 	*Utilization of patent system *Creation of intellectual property business *Development of global business

1. Early life

Jokichi Takamine was born in November 1854 in Takaoka, Toyama Prefecture, as the eldest son of a Kaga clan doctor. Takamine's father, Seiichi, learned Dutch studies in Kyoto and medicine and chemistry in Edo (current Tokyo), and then he was invited by the Kaga clan to become their doctor. Jokichi's mother, Sachiko, was from the Tsuda family, a brewer in Takaoka.

Later, Takamine worked diligently to study sake brewing methods and succeeded in developing a Takamine whiskey brewing method that used koji instead of malt. His achievement was likely made possible due to his home environment. One year after Takamine's birth, his father, Seiichi, was invited to the Kaga clan's Western style military school (called Sokan Gyokan). The Kaga clan highly recognized Seiichi's knowledge on chemistry, so the Takamine family moved to Kanazawa. Later, in addition to being a doctor, he also served as translator and warship administrator.

In 1862, 8-year-old Takamine entered Meirindo, a training school for Kaga feudal lords. Meirindo educated the children of the feudal clan for three years, focusing on Chinese studies. In 1865, Takamine, who had studied at Meirindo, was selected by the clan and dispatched to Nagasaki for advanced study. In Nagasaki, he stayed at a residence of a Portuguese consular and entered a Western school of missionary Hulbecki (the founder of Meiji Gakuin University), where he received a full-fledged English education. However, with the Meiji Restoration, students of the Kaga clan moved from Nagasaki to Kyoto.

Takamine enrolled in a training school ran by Konosuke Adachi, a native of the Kaga clan who was teaching Western-style military studies in Kyoto. Takamine, who was interested in chemistry and physics instead of military science, focused on studying English at Adachi's school. The following year, Takamine enrolled in Tekijuku (school) in Osaka, headed by Ogata Koan, but Ogata Koan had already passed away at that time, and the mainstream of Western studies had moved from Dutch to English. As a result, it seems that Takamine did not absorb much from the Teki school.

In 1868, the Osaka Seimi Kyoku (Bureau) was established as a public institution to promote research, education and industrialization in the field of chemistry in Japan after the Meiji Restoration. The following year, a science school and a medical school attached to the institution were established. In later years, Takamine entered this medical school.

While Takamine was studying at the Tekijuku school in Osaka, the Kaga clan invited Brit Mr. Percival Osborn, to open an English school in Nanao (Nanao City, Ishikawa Prefecture). Then,

Takamine himself transferred to the English school, where he studied until March 1870, when Osborne's term expired. After the school closed, Takamine returned to Osaka and enrolled in the aforementioned Medical School within Osaka Seimi Kyoku (Bureau). At the medical school, he learned about chemical experiments and analysis from a German teacher, Dr. Georg Hermann Ritter. From there, Takamine's career as an applied chemist began.

However, Osaka Seimi Kyoku (Bureau) and the attached medical school were closed in 1872. Takamine had to find a new way to continue his studies. Fortunately, in November of the same year, he was accepted as a government-funded salary student of the Ministry of Industry, and in March of the following year he entered the school of engineering (called Kogaku ryo).

The Kogaku ryo (the school of engineering)[1] was a six-year, educational institution established to train technical bureaucrats to be able to work for the Ministry of Industry. The school produced a large number of competent and talented graduates in both the government and the private sector. The teaching staff was composed of professors primarily from Glasgow University, the United Kingdom. Takamine was a student of the inaugural class in the applied chemistry faculty of the school. The Kogaku ryo was renamed to the Kobu Daigakko (the Imperial College of Engineering) in 1877. The school later became the Faculty of Engineering of the University of Tokyo.

The Imperial College of Engineering recruited many foreign professors; they were mainly British. The reason why British accounted for the majority of the professors was the first president of the Imperial College of Engineering, Hirofumi Ito, and other key officials had studied in the United Kingdom, and at the time, the U.K. had the world highest level of industrial technologies with the Industrial Revolution.

At the Imperial College of Engineering, Henry Dyer from the University of Glasgow was appointed the head of the college, providing a curriculum based on practical experience as well as theory. At that time, the engineering technology of the University of Glasgow was said to be the highest level in the world, so Takamine received a world-class engineering education.

In 1879, 23 of the 32 inaugural-year students enrolled with government scholarships graduated.

Takamine was among six graduates of the faculty of Applied Science. Takamine graduated at the top of his class and was selected as a government-sponsored student to study in the United Kingdom by the Ministry of Industry. In 1880, Takamine moved to the UK to study applied chemistry at Glasgow University and Andersonian University. In Newcastle, he conducted research on the

production of artificial fertilizer. This experience became a great asset to him when he established an artificial fertilizer manufacturing company after he returned to Japan.

During his three years of studying in the UK, Takamine gained world-class knowledge and skills as an applied chemist. The knowledge and skills he gained from the Kobu daigakko (The Imperial College of Engineering) and studying in the U.K. led him to later discover Takadiastase and extract crystals of adrenaline.

2. From bureaucrats to entrepreneurs : Establishment of Tokyo Artificial Fertilizer Co.

In 1883, Takamine returned to Japan from the United Kingdom and started to work for the Bureau of Industry, Ministry of Agriculture and Commerce. Takamine was interested in Japanese paper production, indigo production, and sake brewing, and promoted domestic procurement of all ingredients. He also devised a method to prevent the spoilage of sake, which was later patented as the "Liquid Preservation Method and Device"[2].

In 1884, the World Exposition was held in New Orleans, the United States, which also served as the Cotton Centennial Festival. Takamine was ordered to be a secretary of the Japanese delegation and traveled to the United States, where he stayed for about a year. During this time, he was engaged to Caroline Hitch, the eldest daughter of the Hitch family. Takamine lived at their house.

Takamine focused on the phosphate rock exhibited at the expo. He brought lime superphosphate and its raw phosphate rock back to Japan to study artificial fertilizer. When Takamine was studying in the United Kingdom, he was conducting research on the production of artificial fertilizer. He believed that the development of artificial fertilizers was urgently needed to increase Japan's agricultural productivity.

In September 1885, Takamine returned to Japan from New Orleans and became a staff member of the monopoly patent office (renamed the Patent Office in 1886) while he was concurrently holding the position in the Bureau of Industry, Ministry of Agriculture and Commerce. Takamine was involved in improving the foundation of the Japanese patent policies.

In those times, Takamine began to seriously consider setting up an artificial fertilizer manufacturing company. He knew that man-made fertilizer production was feasible, as he had mastered the method of producing artificial fertilizers when he was studying in the UK, and he had already obtained the phosphate rock used as a raw material for phosphate fertilizers. .

Takamine met Eiichi Shibusawa[3] and Takashi Masuda[4] of Mitsui & Co. who were leading players in the industrial community in japan at that time, emphasizing the need for production of artificial fertilizers for the development of Japanese agriculture. As a result, both Shibusawa and Masuda began to support Takamine's business plan.

In February 1887, a preparatory organization for the establishment of Tokyo Fertilizer Co., Ltd. was started. Eiichi Shibusawa was appointed as president, and Jokichi Takamine was appointed as chief engineer and production manager. In March of the same year, Takamine traveled to Europe and the United States to purchase machines and raw materials for the production of artificial fertilizer. During his trip, he officially married Caroline Hitch in New Orleans.

In December 1887, the Tokyo Fertilizer Co., Ltd. was officially established, and full-scale production of artificial fertilizer began in September of the following year. The company is now the Nissan Chemical Industry Co., Ltd. In March 1888, after working for about five years, Takamine resigned from the Ministry of Agriculture and Commerce, and started to take a path as a researcher and entrepreneur. Eiichi Shibusawa highly valued Takamine's ability as an entrepreneur, saying, "He is originally a scholar, but he also has the talent to handle the business."

3. R & D activities and Entrepreneurship in U.S: Discovery of Takadiastase and Adrenaline-

3.1 Development of the Takamine brewing method

With the establishment of the Tokyo Fertilizer Co., Ltd., Takamine took the first step as an entrepreneur. He opened a private laboratory adjacent to the factory and began researching alcohol fermentation. He first attempted to replace malt with rice koji (rice mold) as the raw material for whiskey production. Rice koji was used for sake brewing. Brewing sake and distilled whiskey had completely different production methods. Takamine noted that alcohol fermentation in the early stages of the manufacturing process is common to both sake and whisky.

In the production of whiskey, malt obtained by germinating barley is used, and saccharifying enzymes such as diastase contained in the malt degrade barley starch to sugar. When yeast is added and fermented, the sugar changes to alcohol.

Although koji (rice mold) used for sake brewing had a lower saccharification ability than malt, it had the advantage that saccharification and alcohol fermentation could be processed in parallel, and it had higher alcohol fermentation ability than yeast. Furthermore, Takamine's method utilized husk

as a raw material for fermentation. The husk was disposed of as waste in the traditional whiskey manufacturing process. Takamine's method made it possible to significantly reduce manufacturing costs compared to conventional methods.

Whiskey Trust, which had a 95% share of the U.S. whiskey brewing industry, payed attention to Takamine's production method. The company offered Takamine an experimental facility, and Takamine accepted the offer. However, many people, including Shibusawa, expressed opposition against Takamine’s will to resign from the Tokyo Fertilizer Co., Ltd. as the company was just established and Takamine was playing the central role.

Eventually, the mediation efforts of Mitsui & Co.'s Masuda Takashi and others succeeded so in 1890, Takamine successfully left Tokyo Artificial Fertilizer Company and moved to the United States. The following year, Takamine succeeded in experimenting with a distillation method using koji, and he applied for patents in the United States and the United Kingdom.[5]

Whiskey Trust's president, Joseph Greenhut, strongly supported the Takamine method. However, he faced strong opposition from the company's shareholders who felt threatened by the Takamine method. Most of the shareholders were the owners of malt-based brewing companies.

Opponents held a shareholders' meeting and resolved the dissolution of Whiskey Trust, as the ultimate means of preventing the Takamine method. As a result, commercialization of the whiskey manufacturing business using the Takamine method was abandoned.

Losing the way to commercialize the whiskey production with his new method, Takamine established the Takamine Ferment Company in Chicago. The company aimed at utilizing the patent rights that Takamine acquired through his R&D efforts to obtain royalties. Takamine obtained a license of the U.S. patent attorney and applied numerous patents for his research findings.

3.2 Discovery of Takadiastase

With the strong opposition from malt-based brewing companies, the whiskey manufacturing business was abandoned. As a result, Takamine shifted his research focus from brewing to pharmaceutical manufacturing. In the course of his research on whiskey brewing with koji (rice mold), he discovered a rice mold that secreted an enzyme (diastase) that had a much stronger starch digestibility.

Diastase is a digestive enzyme that promotes the breakdown of starch and glycogen into sugars.

In 1833, Anselme Payen (1795-1871) and Jean François Persoz (1805-68) of France first successfully separated diastase from malt.

Until then, it was believed there was only one type of diastase, but the discovery of Takamine revealed the existence of another type of diastase which had higher saccharification ability. In 1894, Takamine succeeded in extracting this enzyme and named it Taka-diastase. And he obtained patents for the Takadiastase manufacturing method in the United States and the United Kingdom.

While obtaining a patent for Takadiastase, Takamine was also thinking about commercializing it. In 1897, the Detroit-based Park Davis Company acquired the right to manufacture Takadiastase and market it globally except in Japan, making it a worldwide brand.

Takadiastase was widely used as a component of stomachic drugs because of its digestive promoting effect. In Japan, pharmaceutical companies such as Sankyo Co., Ltd. launched Takadiastase as a gastric drug.

Figure 1　Taka-diastase

(Source) Daiichi Sankyo Co., Ltd.

3.3 Extraction of crystal of adrenaline

In the 1890s, the Western medical community was focusing on the effects of animal adrenal glands. It was long known that the animal's adrenal gland had an effect of increasing hemostasis and increasing blood pressure. Extracting crystalline substances of adrenal hormone was the largest research theme in medical and pharmaceutical communities. At the time, the leading researchers in this field were Otto von Fürth (1867-1938) in Germany and John Jacob Abel (1857-1938) in the United States, and each of them announced substances with completely different chemical structures. There was no definitive conclusion in the academic community about which claim was correct.

In 1897, the Park Davis Company, which partnered with Takamine to manufacture and sell Takadiastase, commissioned Thomas Bell Aldrich (1861-1938), Abel's assistant, and Takamine to conduct an experiment to extract crystalline substance of adrenal hormone. Takamine's research was conducted at the Takamine Research Laboratory in New York, but had no success for the first two years. Takamine's specialty was in the field of fermentation; he was not necessarily a specialist in crystallization.

In 1899, Keizo Uenaka (1876-1960), who graduated from the Department of Pharmacy, the University of Tokyo medical school, came to the Takamine Research Institute as an assistant. Uenaka greatly contributed to breaking this stalemate. He left an experimental notebook (July 20 to November 15, 1900) detailing the experiment for extracting crystal materials of adrenal hormone.

The crystalline material obtained from his experiments had a completely different chemical structure than that of Fürth or Abel mentioned earlier. Takamine named this crystalline substance adrenaline and filed a patent application in the United States on November 5, 1900. He also filed a patent application in the UK on January 22 of the following year.

The discovery of Uenaka's experimental notes proved that the successful extraction of adrenaline was substantially Uenaka's achievement. Takamine introduced Uenaka as a research collaborator in some English papers and oral presentations in the United States, but when Takamine submitted his Ph.D. dissertation to the University of Tokyo in 1906, he did not mention Uenaka's name. In addition, all of the adrenaline patent applications mentioned above were filed under Takamine's sole name and the presence of Uenaka was completely erased.

Uenaka retired as an auditor of the Sankyo Co., Ltd.[6] as his last job in 1933. He did not publish his notebook while he was alive and never expressed any complaint against Takamine. The extraction of adrenaline crystals was a joint achievement between Takamine and Uenaka. If Takamine intentionally erased Uenaka's name from his research work, it would not have been appropriate.

In Japan, the adrenaline Takamine and Uenaka successfully crystallized was officially named epinephrine. The same name was adopted in the United States, and the name of adrenaline was used only in Europe. Epinephrine is the name of a substance announced by US chemist Abel as a crystalline substance of adrenaline prior to Takamine.[7]

In 1927, Abel claimed in his reminiscence that Takamine and Uenaka plagiarized his research findings on adrenaline. At this time, Takamine passed away, and Uenaka's experimental notebook

was not yet disclosed. With the influence of Abel's reminiscence, the name of adrenaline disappeared in the United States, and epinephrine became a common name.

It is now clear that Abel's claim is completely groundless, given the discovery of Uenaka's experimental notebook. Under the amended Japanese Pharmacy Act announced in 2006, epinephrine was changed to epinephrine adrenaline. Takamine and Uenaka's achievements, which were allegedly suspected, were finally able to regain their honor 107 years after their discovery.

The rights to sell Takadiastase and Adrenaline globally were owned by the Park Davis Company with the exception of Japan. The reason for excluding Japan was Takamine's desire that sales of Takadiastase and Adrenaline in Japan were to be conducted by Japanese. In fact, the right to sell in Japan was acquired by Sankyo (currently Daiichi Sankyo Co., Ltd.), which was founded by Matasaku Shiobara and others. Sankyo Shoten was reorganized into a joint-stock company in 1913, and Takamine was appointed as the first president, and Takadiastase and adrenaline were fully manufactured in Japan.

Figure 2　Adrenaline

(Source) Daiichi Sankyo Co., Ltd.

4. Later life

Takamine established a business model that transformed discoveries and inventions acquired through research activities into intellectual property with the patent system. Also, he actively made policy recommendations about the development of medicine and chemistry and industrial promotion.

One example is the recommendation of the establishment of the National Science Institute in 1913 as a national research institution for fostering scientists and promoting industry. This proposal was

supported by many businesspeople, including Eiichi Shibusawa. As a result, RIKEN was founded in 1917 with Shibusawa as the founder's representative. Today, the Institute is the only natural science research institute in Japan that conducts research in a wide range of fields, including physics, engineering, chemistry, biology, and medicine.

Takamine also proposed the commercialization of aluminum production using casting technology, a traditional local industry in his hometown of Toyama Prefecture. He made this recommendation because Toyama Prefecture had many rapid rivers therefore was suitable for hydropower generation. At present, Takaoka City, Toyama Prefecture, is a major base of the Japanese aluminum industry.

Takamine also focused on developing Japan-US friendship, because of his success as a chemist and entrepreneur in the United States. At the World Exposition in St. Louis in 1904, when the Russo-Japanese War broke out, he hosted a party and invited U.S influential figures. The following year, in 1905, he helped the establishment of the Japan Society in New York, making it a base for celebrities' interaction between the United States and Japan. Takamine's efforts to promote friendship between Japan and the United States played an important role in deepening American society's understanding of Japan.

Finally, we would like to look back on Takamine's life from the perspective of an R & D venture. In the first half of Takamine's life, he succeeded in commercializing his research findings as intellectual properties. On the other hand, in the latter half of his life, he struggled to find new technology seeds due to a decline in R & D capabilities because of lack of human resources.

Takamine strongly recognized that fostering scientists and developing science and technology were indispensable for promoting industry. However, Takamine Laboratories, which served as a research and development center in his later life, had no breakthrough achievements since the discovery of adrenaline. This may be due to the shift of Takamine's focus to social activities, but the direct cause of the slump in research results was that he could not attract young capable researchers such as Uenaka.

Takamine died in New York in 1922. He was 67 years old. His body was buried in the Woodlawn Cemetery in New York. His achievements were praised as follows: "In 1896, Dr. Takamine developed a starch-degrading enzyme and was admired as the "father of modern biotechnology." In 1900, he separated adrenaline for the first time in the world. In 1912, he donated cherry trees beautifying the banks of Washington, D.C."

Takamine's philosophy was succeeded to Matasaku Shiobara who founded the pharmaceutical company, Sankyo Company. Shiobara offered the opportunity for commercialization to Japanese scientists who made good discoveries but were not recognized. He also actively promoted the transfer of intellectual property obtained from medical and chemistry research to industry.

Table 1 Trend in profit and capital during the founding period of Sankyo Co., Ltd. (Unit: yen)

Year		Profit	Capital
1899	1st half	1,000	859
	2nd half	1,060	1,500
1900	1st half	1,495	1,950
	2nd half	1,615	3,000
1901	1st half	2,111	3,000
	2nd half	3,918	3,000
1902	1st half	5,830	3,000
	2nd half	4,698	15,000
1903	1st half	2,191	18,000
	2nd half	3,996	30,000
1904	1st half	2,789	30,000
	2nd half	3,360	30,000
1905	1st half	4,106	30,000
	2nd half	11,134	100,000
1906	1st half	10,557	120,000
	2nd half	18,293	300,000
1907	1st half	32,541	300,000
	2nd half	14,555	187,500
1908	1st half	41,727	250,000
	2nd half	51,650	312,500
1909	1st half	42,552	375,000
	2nd half	34,790	500,000
1910	1st half	35,643	500,000
	2nd half	38,580	500,000
1911	1st half	96,583	1,000,000
	2nd half	50,914	1,000,000

Note: Takadiastase launched (1899), adrenaline launched (1902)

Source: author created based on Sankyo Co., Ltd. (1960), "Sankyo 60 Years History" pages 38

5. Conclusion

Jokichi Takamine was a first-generation applied chemist who received state-of-the-art European and American education right after the Meiji Restoration which began in 1868. He was highly skilled in the discovery of Takadiastase and crystallization of adrenaline. In addition, he succeeded as an entrepreneur by commercializing these scientific achievements. Even today, Takamine is highly regarded as the first bio-venture entrepreneur in Japan.

Takamine was an outstanding chemist before becoming an excellent entrepreneur. The most important thing for an R & D type venture is the innovative discoveries and invention that forms the core of the business. In the case of Takamine, discoveries of Takadiastase and adrenaline through R&D became the core competence of his business. Even if one has good entrepreneurial qualities, it is difficult to succeed in an R & D venture business unless he or she can grasp the innovative seeds.

R & D investment plays an important role in increasing corporate value through the creation of innovation. To achieve this, it is important to commercialize the seeds acquired through R & D.

In this regard, Takamine's histories of entrepreneurial activities give us many valuable lessons .

One of the hallmarks of Takamine's entrepreneurial activities was his deep understanding about the importance of intellectual property (knowledge). He was fully aware of the importance of intellectual property in business from his experience working at the Patent Office. Therefore, by turning his discoveries and inventions into intellectual property, he succeeded in establishing a business model with knowledge as its core competence.

The purpose of Takamine's active use of patents was not to obtain a huge amount of wealth by earning huge royalties, but to secure the funds needed for the next R & D. For Takamine, making money was not a purpose, but merely a means to promote research and development.

Finally, we need to add the difficulties of succession of a R & D type venture company. Takamine was not blessed with a successor. Successors who are expected to further develop the R & D venture companies must have the qualities of both excellent researchers and entrepreneurs. However, there are very few people who have both research ability and entrepreneurial qualities. Therefore, to date, Takamine has been the role model of R & D venture entrepreneurs.

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[1] The Kogaku ryo was renamed to the Imperial College of Engineering in 1877. It was the predecessor of the Faculty of Engineering at the University of Tokyo.
[2] Takamine's mother's family ran the brewing business.
[3] Shibusawa Eiichi (1840-1931) was a leading figure in the development of Japan's modern society. In the late Edo period, Shibusawa served the Tokugawa shogunate and was acquainted with the socio-economic situation of advanced European countries. After the Meiji Restoration which began in 1868, he worked for the Ministry of Finance and was involved in the establishment of the Daiichi (first) National Bank, and focused on the creation and development of stock companies. He was involved in establishing about 500 enterprises and 600 organizations for social welfare, education.
[4] Takashi Masuda (1848-1938) became the first president of Mitsui & Co. when he was 29 years old. He created a new business form called a general trading company. He also launched Chugai Price Shimpo, the predecessor company of the Nihon Keizai Shimbun(Nikkei, Inc.)
[5]Takamine obtained patents in the United Kingdom in 1887, France and Belgium in 1888, and the United States in 1889.
[6] Sankyo Co., Ltd. later became Daiichi Sankyo Co., Ltd., one of the major pharmaceutical companies in Japan.
[7] Epinephrine discovered by Abel is a substance with a different molecular structure from adrenaline, and it was found that epinephrine cannot be extracted by the Abel's method.

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