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On the Historical Process of the Institutionalizing Technical Education: The Case of Weaving Districts in the Meiji Japan[1]

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<Abstract>

This paper explores the process of the institutionalizing technical education in modern Japan. In particular, this research attempts to elucidate why people in local weaving districts needed such educational institutions and how it is related with the introduction of western technology. This process is found to be much different from the government-led introduction of modern industries through establishment of technical high schools and universities to nurture engineers. In the case of traditional Japanese weaving districts, it was trade associations that voluntarily and actively established institutes for training, which were later supported by prefectural governments and the Ministry of Agriculture and Commerce and finally institutionalized as public technical schools by the Ministry of Education.

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1. Introduction

As is widely known, there was an influx of various technologies and scientific knowledge into Japan from the Western society from the end of the Tokugawa Period (1603-1868) onward. How it was spread and disseminated seems to be different from industry to industry, because there were significant differences in technical level among various domestic industries. Similarly, striking were differences in required human resources and the ways in which they could have been developed among various industries. It is also important to recognize that new technologies were introduced from the West not only to the modern sectors but also to traditional domestic industries such as the weaving industry.

There is no doubt that the traditional or indigenous industry accounted for a critical part in the development process of Japanese economy (Nakamura, 1971). Even though there was the devastating damage inflicted by the imported Western products on the traditional industries from the end of Tokugawa period to the beginning of the Meiji period, Nakaoka (2006) argues that the undue emphasis on devastating damage on the traditional industries would thwart proper understanding of the dynamic process in which the traditional industries developed through their effort in reacting to new technological possibilities and coping with the imports from the West. In fact, some traditional industries became increasingly more prosperous by the introduction of the Western technologies. For example, in the weaving industry, the use of flying-shuttle attached to power-looms introduced from the Western countries enabled it to achieve distinctly high labor productivity (Minami and Makino, 1983). The use of jacquard and some machines for

finishing process, e.g., calendar, significantly improved the design, textures and luster. The introduction of synthetic dyestuffs not only reduced cost but also made it possible to produce more vividly colored yarns and fabrics. In other words, it made Japanese weaving products more fashionable. Therefore, design of the fabrics and fashion became more critical in domestic market in Japan. For many weaving districts, production of high-quality dyed-yarn fabrics and improvement of design and fashion were the most important issues for competition with other districts. Some recent studies recognize the importance of design associated with the introduction of synthetic dyestuffs, which contributed to the development of fashion markets in Japan (Uchida, 1993; Tamura, 2004).

These studies suggest that producers in some leading districts realized the importance of new technologies which enabled product differentiation and, hence, aggressively introduced synthetic dyestuffs in the 1880s. At the same time, inferior quality of fabrics became a serious nation-wide problem in the weaving industry (Hashino, 2007a). Cheating by merchants and producers after the demise of traditional guilds has been believed to be one of the main reasons for this problem for a long time. However, it is important to recognize that the inferior quality problem was more serious in the leading weaving districts which aggressively introduced synthetic dyestuffs. Furthermore, several documents on educational history of technical schools, which offered textile-related courses, show very interesting fact that they were established to solve the inferior quality problems.[3]

[3] Technical schools or Technical high schools often edited and published the books on

In this paper, I focus on the process of institutionalizing education as a means of solving the inferior quality problem caused by introduction of new synthetic dyestuffs. In the existing literature, the relationship between the above-mentioned quality problem and introduction of synthetic dyestuffs was merely suggested (Uchida, 2004; Hashino, 2007a). Obviously further investigation is needed to fully understand why the institutionalized education was demanded in the face of the difficulties to absorb new technology. Instead of following others, guessing, and learning the knack or learning by doing, an institutionalized technical education was required to learn truly new and modern technologies. Here, focus shall be placed on the nature of higher technical schools and (ordinary) technical schools which provided courses for traditional industries. The paper shall further discuss how modern weaving districts or clusters solved this problem.[4] The development of weaving districts was also important as an objective of the industrial policies carried out by the Ministry of Agriculture and Commerce, and Ministry of Education.

This paper is structured as follows. In section 2, I will review the process of institutionalizing technical education in the Meiji period. Based on it, Section 3 will consider for what purposes the weaving industry and weaving districts demanded education, while Section 4 will examine how

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their school history for their anniversary of the establishment.

[4] Through the solution of the problem, local people in the weaving area became more tightly structured than before. In other words, modern weaving district was formed by making local brand as 'public goods' and infrastructures like institute for training and school. Chapter 1 in Hashino (2007a) discusses the difference between industrial area and industrial district or cluster in detail. In this paper, however, I will not distinguish between them for simplification. Hashino and Saito (2004) also surveys the formation process of weaving districts in the Meiji Japan.

significant the institutionalized technical education was in absorbing new knowledge. Further, it will be pointed out that the policy set including the industrial policy of the Ministry of Agriculture and Commerce was important in supporting the educational programs for the weaving industry, in addition to the educational policy of the Ministry of Education. Institutionalized education also offered opportunities not only to learn how to use new technologies but also to acquire the knowledge of business management and skills. Finally, in section 5 the conclusion and implication for developing economies from this issue will be drawn.

2. Formation of the Institutionalized Technical Education in the Meiji period

In this section I will outline how the institutionalized technical education including universities, higher technical schools and technical schools was organized and developed in the context of development of the traditional industries in the Meiji Period.[5] Amano (1997) asserts that these educational organizations fostered high-, middle- and low-level engineers, respectively. It is important to note that the higher technical schools and technical schools were concerned with indigenous or traditional industries.

The Imperial College of Engineering was an institution for technical education established as a part of the early industrial policy by the Ministry of Public Works (1870-1885). It was a boarding school that offered

[5] Description here is excerpts from Hashino (2001) and from the History of Science Society of Japan ed. (2007) in sections "Higher Technical School" and "Apprentice's School" written by the author, unless specified. See Hashino (2001) for the related literature.

specialized education, emulating the European polytechnics, with the goal of so-called transplantation of the modern industry. The schooling was for a six-year term and all lectures were offered in English. It had eight departments including civil engineering, machinery, housing construction (architecture), telegraphy, chemistry, metallurgy, mining and shipbuilding, where theoretical and advanced technical courses were offered. It offered quite unique education including internship at government enterprises of the Ministry of Public Works in the final two school years. The College of Science of the Imperial University had civil engineering, chemistry, electricity, mining and machinery departments. The Imperial College of Engineering was integrated into the Imperial University, together with various engineering departments of the University of Science, and was reorganized as College of Science and Engineering of the Imperial University in 1886. It should be also noted that Kyoto, Kyushu and Tohoku Imperial Universities had the Faculty of Engineering since their establishment. Setting up a faculty of engineering in universities and issuing diploma to the graduates is a unique feature of Japan as a latecomer that distinguishes itself from Europe with a long tradition of university. It was an educational innovation in Japan.

On the other hand, higher technical schools seem to have been contrived to offer education in a different field from universities. Tokyo School of Mechanics founded in 1881 is the first such case. It was later renamed as Tokyo Technical School (1890), and renamed again as Tokyo Higher Technical School (1898).[6] Tokyo School of Mechanics was designed

[6] This is Tokyo Institute of Technology today.

to develop talents for shop floor foremen in modern factories that could digest the transplanted technology from Europe and United States, but in reality it offered engineering education. Osaka Technical School was established in 1897, and was later reorganized as Osaka Higher Technical School (1898). In 1902, Kyoto College of Technology was also established. Based on the Specialized School Order of 1903, Nagoya Higher Technical School, Kumamoto Higher Technical School, and Sendai Higher Technical School were also opened in the same year, and, and Akita School of Mining and Yonezawa Higher Technical School were newly established in 1910.

A notable feature of the higher technical schools was their emphasis on dyeing, ceramic engineering and brewing courses, which were not taught in faculties of engineering in the universities. However, courses offered by the higher schools and universities are complimentary to each other, even though only the former are relevant for the traditional industries that had been developed before Meiji Period. Many sons of entrepreneurs in the traditional industries learned at higher technical schools, and some graduates were hired as technical officials by the Ministry of Agriculture and Commerce or the prefectures, and as instructors at industrial research institutes or at technical schools. The significance of the higher technical schools can be inferred from the role it played in facilitating the understanding of the imported Western technology and grafting it to the existing technology of the traditional industries. At that time, however, such educational institutions were set up as experiments for the future. For example, memories of the graduates appeared in *Kuramae Journal* (Volume *Infancy of Kuramae*) (1931) testified that the *raison d'être* of the school itself

was not fully understood by the general public at the beginning, and as a result, graduate did not acquire useful practical knowledge and, hence, had dismal job prospects[7].

In the technical school, the courses were designed to assist the traditional industries from the viewpoint of the regional economy by teaching such subjects as dyeing, dyeing and weaving, woodworking, metalwork, and craftwork. Originally the technical school was regarded as an institution to foster self-employed craftsmen in dyeing and craftwork. In 1894, vocational schools and apprentice schools including technical schools became entitled to an annual grant of 150,000 yen out of state budget based on National Governmental Defrayment Act for Technical and Vocational Education. When Vocational School Act was issued in 1899,[8] there were 18 technical schools throughout Japan. Seven of them had dyeing-related courses, which were resulted from the history that the private institutes for training in dyeing had been established in weaving districts before these schools. Among class A public technical schools that existed in 1940, 35 of them had dyeing-related courses, and seven of them originated from various private

[7] In spite of such dismal job prospects, it seems that the graduates from this school who majored in chemistry contributed the rise of Japanese synthetic dyestuff industry during the WWI as the stock of experts. The number of graduates of this school majoring in chemistry was 1220 until the end of 1917. (Hashino, 2007b).

[8] The promulgation of Vocational School Act prompted a comprehensive institutionalization of vocational schools including technical schools, commercial schools and agricultural schools. It categorized the technical school as Class A (three-year education, the enrollment age of 14 years or older, with graduation from four-year higher elementary school, or having an equivalent or higher academic achievements). The conventional apprentice's schools categorized as the Class B (the enrollment age of 10 years or older, graduate of higher elementary school with four-year education, or having an equivalent or higher academic achievements). See the History of Science Society of Japan ed. (2007). The qualification for enrollment in the academic course included an age range of 14 to 24, graduation from primary school or equivalent academic achievement, and correctitude. The academic course offered three-year education as will be mentioned in detail in the section 3 of this paper.

institutes for training, namely, Yonezawa Technical School, Ashikaga Technical School, Isesaki Technical School, Hachioji Prefectural School of Dyeing and Weaving, Kawagoe Technical School, Gose Technical School, and Kyoto Municipal Dai-Ichi Technical School (Hashino, 2007a, Chapter 4). This can be understood as regional industry-driven institutionalization of education prior to the promotion of vocational education by the Ministry of Education.

3. Technical Education for the Weaving Industry in the Early Meiji Period

3.1. Problems in the weaving districts

How did the awareness that education and training were necessary for the absorption of Western technologies come about in the first place? When one hears the words of education and training for the weaving industry, what comes to the mind may be the apprenticeship practiced in the weaving or on-the-job training. In reality, however, prior to designing the institutionalized technical education, the request from the weaving districts had been materialized in the form of institutes for training on dyeing.

What is deeply related to the establishment of institutions for training was so-called *'Sosei-ranzo'* in Japanese, i.e., the problem of inferior quality. There are two possible sources of this problem in the weaving industry. One is moral hazard in business transaction after the demise of traditional guilds such as cheating by producers or distributors, and the other is the insufficient understanding of technology amid the introduction of the western synthetic dyestuffs (Hashino, 2007a, Chapter 4). The moral hazard, however, is likely to be resolved, if the business transactions are repeated.

Thus, the latter perspective will be examined in depth to find a key to grasping the relationships between the institutionalized technical education and industrial development.

The exposition (*Hakurankai*) and the competitive exhibition (*Kyoshinkai*), which were held in line with the industrial promotion policy of the Meiji Government, exemplified the technical problem of inferior quality. The exhibits must have been carefully prepared for the prestige of winning an award at such special events; nevertheless, the quality problems of exhibits often occurred. The Competitive Exhibition on Silk and Cocoon, Textile, Ceramics and Lacquer-ware (hereafter abbreviated as 'the Competitive Exhibition') in 1885 is a good example, in which a number of low-quality products were presented. It is therefore relevant to examine the problem of the dyeing technology in the weaving industry at that time by reviewing the evaluation of the exhibits and comments from the jurors (Tamura, 2004). The Competitive Exhibition accepted textile exhibits from various weaving districts in various prefectures. Most technical issues pointed out were concerned with (1) dyeing defect, (2) cheated method of inflating weight of yarn, and (3) the flaws in dimension and weight. Especially dyeing defect was more conspicuous in silk-weaving districts than cotton-weaving districts, and more so in the eastern than the western Japan. Above all, the products from traditionally advanced weaving districts producing fabric with pre-dyed yarn received particularly harsh criticisms.

What kind of dyeing technology was actually used in the castigated producing areas? *Kogyo Shisatsu Kiyo [The Industrial Inspection Report]* (1896) is an interesting literature that recorded how the dyeing methods were

misapplied.[9] In what follows are excerpts of descriptions on the introduction of European synthetic dyestuffs.

Hachioji Textile (Tokyo): As European dyestuff was imported increasingly, the textile producers competed to use it for the beauty of colors while disregarding the quality, so that the color of some products faded away in a short time (*The Industrial Inspection Report, Volume 1*, p. 2).

Mekura-jima (Saitama prefecture): Everyone used such dyestuffs as aniline to fake up royal blue (*Volume 1*, p. 31).[10]

Isesaki-jima (Gunma prefecture): As soon as aniline dyestuff was imported, the producers competed to use it for its brighter color while ignored its characteristics, result of which was color change or discoloration of products (*Volume 1*, p. 49).

Ashikaga Textile (Tochigi prefecture): As the European artificial dyestuff was imported, textile manufacturers carelessly use it without considering its applicability, so that not a few of the products ended up with color fading (*Volume 1*, p. 55).

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[9] *The Industrial Inspection Report* is a collection of reports on inspection trips of important industrial districts by officials of Section of Industry, Bureau of Commerce and Industry, the Ministry of Agriculture and Commerce. Not only local governments including prefectures, counties, cities, towns, and villages but also chambers of commerce and industry and business associations helped the officials with collecting data and information on the industry.

[10] This means the dyeing method for dark colors with inferior color fastness by mixing synthetic dyes and dyeing agents (Tamura, 2004, p.135).

Mino-jima (Gifu prefecture): As the European dyestuff was used inappropriately for the cost reduction, weaving tended to become rough, thereby temporarily lowering their reputation (*Volume 2*, p. 43).

Iyo-jima and Iyo Gasuri (Ehime prefecture): A fake royal blue dye was used to deceive the consumers (*Volume* 2, p. 93).

As can be seen above, *The Industrial Inspection Report* shows how the European synthetic dyestuff, which was described as 'European dyestuff', 'artificial dyestuff from Europe' and 'aniline dyestuff", was introduced and used in wrong ways. Textile manufacturers, who had never been involved in the dyeing process, used the Western synthetic dyestuff for the purpose of imparting brighter color and reducing production cost without considering its applicability and effect on the quality.

The traditional natural dyeing requires complicated process, its color forming is dull, and its cost is higher (Hashino, 2007a). Uchida (2004) argues that many of the issues of inferior quality were a result of misuse of imported dyestuff, because the producers did not understand the difference between the imported and the well-understood traditional dyes. In addition, many kinds of dyestuffs were imported without classification of organic, mineral, and synthetic (i.e. chemical) dyestuffs. Because importers lacked enough information on dyestuffs, the textile manufacturers used them through a trial-and-error process, which is supposedly the cause of various problems.

According to Tamura (2004) who investigates the cause of defective

dyed products, dyeing problem was identified to be caused by the use of synthetic dyestuffs without technological improvement in scouring and bleaching. At the same time, producers attempted to reduce production cost of fabrics (Tamura, 2004). The appropriate scouring process to remove protein and impurities from the yarn is the key to successful dyeing with synthetic dyestuff. He mentions that the dyeing technology itself and the development of the peripheral technologies were mutually complementary.

In fact, the jurors summarized the faults of the exhibits at the Competitive Exhibition in an examination report (Nomu-kyoku and Komu-kyoku eds., 1885). The root causes of defective dyeing were discussed in detail in the commentary session which was held immediately after the Competitive exhibition.[11] It was Dr. Yoshimi Hiraga and Jiro Yamaoka who served as jurors of the fabrics. They were both specialists employed by the Ministry of Agriculture and Commerce, and were leading modern chemists in Japan and working as dyeing engineers who had learned the dyestuff chemistry and modern dyeing method in the West (*Op. cit*, p. 151). Both specialists diagnosed the situation to be very serious, where the introduced new technology was misapplied to the conventional technology.

3.2. An attempt to initiate technical education by private sector

Institutes for training provided a place for technical guidance concerning the dyeing-related issues. According to Yui's (1964, pp. 27-29) pioneering work, the number of weaving districts where the Ministry of

[11] The detail of the examination reports is given in Chapter 4 of Hashino (2007a) and discussion at the commentary session is found in Chapter 3 of Tamura (2004).

Agriculture and Commerce was involved in technical improvement of the traditional weaving industry in the five-year period between 1885 and 1889 totaled 26. Among them, Tsuru (Yamanashi prefecture), Wakayama (Wakayama prefecture), Ashikaga (Tochigi prefecture), Kiryu (Gunma prefecture), Hachioji (then Kanagawa prefecture), Isesaki (Gunma prefecture) and Matsuzaka (Mie prefecture) established institutes for training or industrial research institute under the guidance of the Ministry of Agriculture and Commerce.

In the mid-1880s, the traditional industries in various regions were troubled by dumping of inferior products that started out in the early Meiji Period. As a result, these districts keenly felt the need to voluntarily explore new distribution channels and regulate the sale of the inferior quality products (*Op. cit.*, p. 26). In Ashikaga, for example, its Chamber of Commerce and Industry, which was an effectively textile manufacturer's association, established the Institute for Training on Weaving. Likewise, the trade associations of Tsuru, Kiryu, Isesaki and Wakayama also established institutes for training. Many of these institutions for training applied for subsidy for facility and operating expenses to the prefectural governments, and requested the Ministry of Agriculture and Commerce through the prefectural governments to send specialists of dyestuffs for technical guidance (*Ibid*). It is easy to imagine that the harsh criticism received at the Competitive Exhibition must have invigorated such moves.

Let us take the Isesaki Institute for Training on Dyeing as an example.[12] Since the beginning of the Meiji Period, Isesaki Textile lost their

[12] The description here is basically cited from Gunma-ken Isesaki Kogyo Gakko Soritsu

reputation in the markets due to infestation of products of inferior quality. The industrial promotion section in the prefectural government tried to recommend them various measures for regulation. During the business downturn after *the Seinan War*, a riot by former samurais in 1877, the local producers and traders finally set up a trade association. In 1886, a year after the disgrace of castigation at the Competitive Exhibition, the association organized an institute for training on dyeing. Upon its establishment, it sought guidance from Jiro Yamaoka of the Ministry of Agriculture and Commerce, and invited Kin'ichiro Okamoto who was one of the first graduates from Tokyo School of Mechanics.

The 15 articles in bylaw of the institution for training show its role as an organization within Isesaki Weaving Trade Association. Their five roles are as follows: (1) education and development of engineers, (2) dyeing on commission, (3) research and testing on dyeing, (4) determination of the specific and appropriate dyeing method for the Isesaki Weaving Trade Association, and (5) examination of dyed products and dyeing method. In addition to the guidance on the dyeing process, interestingly it also offered an academic course to 'provide essential academic knowledge on the textile profession to the youngsters who intend to engage themselves in the weaving industry in the future'. The qualification for enrollment in the academic course included age range of 14 to 24, graduation from primary school or equivalent academic achievement, and the possession of clear motivation. The academic course consisted of a three-year curricula; mathematics, physics, chemistry and English in the first year; algebra, chemistry,

60 Shunen Kinenshi Henshu Iinkai ed. (1969), where it is not otherwise specified.

introduction to weaving, design and color combination, applied dye chemistry, fabric testing and English in the second year; and applied dye chemistry, textile design, color combination and arrangement, fabric testing and English in the third year. Students at Ashikaga Institute for Training on Weaving also consisted of those having studied in the academic course for 'acquiring principles and theories, and receiving vocational training', as well as and the vocational course to 'learn simple and combined Japanese and Western dyeing methods and run business on their own'. The curriculum for its academic course was almost similar to that at Isesaki (Ashikaga Kogyo Hyakunenshi Henshu Iinkai ed., 1995).

The academic course in Isesaki Institute for Training on Dyeing had an enrollment limit of 50 trainees, and required monthly tuition of 0.50 yen. An additional testing fee was collected for the dyeing and fabric testing in the second and third grades. Although the first batch of students (entrants) in 1886 was merely five for the three-year regular course and five for the one-year vocational course, the enrollment grew to 28 trainees and graduates to 12 in 1891. The Institute for Training on Dyeing Method with Synthetic Dyes was founded by the Isesaki Weaving Trade Association. In 1887, the synthetic dyestuffs used to attain as many as 11 colors (red, silver gray, yellow, sky-blue, yellow-green, white brown, black, dusky green, brown gold and dark grayish blue) were specified.

The establishment of informal institutes for training can be understood as an effort by the weaving districts, which recognized the need for acquiring the know-how on the dyeing method with the use of synthetic dyestuff, to solve technical issues. This is clearly indicated by the history of

trade association described by *the Industrial Inspection Report* and other literature. The institutes for training in different areas received consultation from engineers sent by the Ministry of Agriculture and Commerce, and training by the graduates of Tokyo School of Mechanics (later renamed as Tokyo Higher Technical School) as lecturers. It is well-known that these institutes contributed to the improvement of product quality. Although they suffered from the lack of fund, they formed a basis for the institutionalized technical schools organized by the Ministry of Education.

4. Institutionalization of Technical Education and Policy Sets

4.1. Problem of inferior quality and formation of waving districts

According to my observation, the most advanced and middle-standing weaving areas suffered from the synthetic dye-driven problem more than other minor areas. The pioneering studies of this point are Uchida (1993) and Tamura (2004). I also once discussed the problem of inferior quality from the standpoint of dyeing technology, which was formerly seen from the conventional perspective of the confusion of trading caused by the dissolution of cartel organization of wholesalers (Hashino, 2000). Uchida and Tamura also emphasize the effects of product innovations on the quality of product in the leading weaving districts from the end of Tokugawa Regime to Meiji period. They point out that synthetic dyestuff was indispensable for the development of new products with highly sophisticated and fashionable designs.

Such technical improvement required organized effort of the local area. Meanwhile the weaving areas attempted to establish their own local

brands and started to act as if a group of producers had been a single seller in the market. As new products were developed with lots of new ideas and designs, the required new technical knowledge had to be shared among the members of the producing district, because the local brand became a 'local public goods'. The association was obliged to strive to eliminate free riders, who produced and sold fake brand-name products, by setting up inspection systems. It also monitored the business moral in trading throughout the weaving area. This process has led to the formation of the weaving 'districts' or 'clusters' in the traditional weaving areas. Consequently, a weaving district was recognized as a single participant in the market and it served as a target of various policies.

4.2. Policy responses

Since the existing weaving districts attempted to strengthen ties among the fellow producers as an entity and to solve their common problems through establishment of institutes for training, the Ministry of Education's infrastructure development projects to establish the vocational education system were timely. The enactment of Rules for Enforcement of National Subsidy for Vocational Education Law (1894) upgraded informal institutes for training as prefectural technical schools. Eligible vocational schools received annually 150,000 yen as subsidy for a period of five years, which was renewable. As I will mention later, like Yonezawa weaving district, people did not have their own institute for training but knew the benefit of such school very well through exhibitions. In such area the movement to establish a formal technical school became an important challenge (Hashino,

2004a).

The fact that the period of education, qualification, subjects and hours of instruction were defined by the Regulation of Technical School in line with the promulgation of the Vocation School Act (1899) signifies that the district-specific schools were transformed into public ones. These educational institutions had been originally created to accommodate the request of the local people, but they now adopted courses which had little to do with the traditional industry of the district, and adjusted to the requirements of centers for the institutionalized technical education, such as mechanics and architecture courses. This opened a possibility for the technical schools to function as conduits for the development of industries in other areas, as graduates found jobs in other areas (Hashino, 2007a, Chapter 5).

On the other hand, it can be said that organizing the production districts was strongly supported by the concerned Ministry of Agriculture and Commerce to supplement the activity of the local trade associations. The Ministry issued a regulation for trade associations in 1884 and gave the prefectural authorities the right to promulgate the Trade Association Regulation Rules in 1891, pending permission by the Ministry. This right was restricted to the key export items and products. As a result, 78 associations of compulsory membership in 18 industrial sectors acquired the permit (Suzuki, et al., 2007). As previously discussed, the Ministry encouraged understanding and dissemination of the modern chemical knowledge-based dyeing method by sending lecturers to the institutes for training that had been set up by trade associations.

Apart from serving as instructors at the institutes for training, the engineers sent by the Ministry often published illuminating books on the dyeing method. For instance, Jiro Yamaoka, who was respected experts on the modern chemistry, wrote *Introduction to Dyeing Method* (1888) that discusses, in plain expression, the way of using synthetic dyes and gives cautions in their use for the shop floors. In addition, the Ministry was also active in dispatching jurors to the competitive exhibitions. Their role at the events was to make objective assessment of the quality of exhibits, to suggest improvement of methods based on their expertise in chemistry, to compare the performance between the districts, and also to offer a platform to exchange information.

Kiyokawa (1995) positively evaluates the function of the competitive exhibition and its advertising effect, but it should be also emphasized that the contribution of the competent jurors who could assess the exhibits properly was another success factor. The competitive exhibition and exposition also worked as a forum for presenting the benefits of education together with the benefits of the encouragement of competition. The Fourth Exposition in 1896 was a good example: The jurors there highly evaluated products from Kiryu, Ashikaga, Hachioji and Isesaki, and found that education had a significant effect on the improvement of product quality. This gave a significant stimulus to the weavers in Yonezawa (Hashino, 2004). The core of the action by the Ministry of Agriculture and Commerce can be considered as presenting the 'best practice' of *Kogyo Iken* (*Commentary of Promotion of Industry*), as Sugihara (1994) points out. The Ministry of Agriculture and Commerce planted the seeds for mechanization by supporting the technical

and quality improvement activities that was realized later. The close relationship between the Ministry of Agriculture and Commerce and Tokyo Higher Technical School should be also mentioned, because the document of Tokyo Koto Kogyo Gakko (1906) shows how the Ministry of Agriculture and Commerce contracted out various textile-related tests to the school, such as dyeing and scouring tests.

4.3. Two types of technical schools

While the establishment of higher technical schools was regarded as a strategic investment for the future, the establishment of a large number of (ordinary) technical schools for dyeing represented the immediate response to the request from the local region to cope with real problems as seen in Section 2. The breakdown of careers by the 216 graduates from the dyeing course at Tokyo Higher Technical School (surveyed in February 1906) enumerates 90 workers in the textile industry, 62 teachers, 37 technical officials, 13 soldiers, 8 workers in dyeing business, 5 studying abroad, and one research student. Because private enterprises did not have their employment policy for formally educated workers yet, many graduates had to find their job at school or central and local governments. Indeed, Uchida's study (1982) on "employment of early graduates from dyeing course at Kuramae Higher Technical School in the traditional weaving districts[13]" shows that so many of them were engaged in jobs at institutes for training, technical schools and factories in their traditional weaving districts. By becoming teachers for

[13] People often called Tokyo Technical High School "Kuramae" after its name of the place.

technical schools, graduates from higher technical schools are expected to play their part in developing human resources and disseminating the knowledge in a digestible way. In addition, the network of personal contacts among the local industrial research institutions, technical schools and trade associations in the weaving districts played a crucial role in linking the current and future leaders of the industry.

In higher technical schools, they offered advanced education and testing methods. While the dyeing industry did not separate dyeing and weaving processes at that time, Tokyo Higher Technical School was forward-looking and offered the dyeing and weaving sub-courses under the dyeing and weaving course. In this school, printing machines, power looms and related preparatory machinery were imported, and its level of testing was also leading in the Japanese dyeing industry as a whole. Examples are the dyeing method using synthetic dyestuff, mercerization test, comparative test of Japanese and Indian indigo, testing of khaki, refinement of silk, applied weaving testing of Tussah silk yarn and wild silk yarn, testing of weaving of umbrella cloth and fabric for female students' *hakama* (divided skirt), and applied testing of power loom on *habutae* silk weaving. It was the undeniable fact that the graduates who studied in such an advanced environment played an important role in the institutes for training, technical schools and factories in the weaving districts. In particular, they played an important role for the introduction, adaptation, and dissemination of various novel technologies including the Western synthetic dyestuff. They were the drivers of application of the modern Western technologies to satisfy domestic demand and to promote exports mainly to the Asian market. Established as

a foresighted investment, these higher technical schools became indispensable to the development of a large number of the technical schools.

5. Conclusions

In this study I found that the institutes for training had been gradually institutionalized in the development process of industrial districts in an effort to solve the problem of inferior quality. Initially the practical know-how on the Western dyeing method was taught effectively at institute for training under the guidance of outstanding technical officials, which was further applied to the curriculum of technical schools (Uchida, 2004). Later the informal institutes were later transformed to formal technical schools managed by the Ministry of Education. These technical schools served as a forum for human resource development within the respective producing area. Actually, however, the institutionalization by the Ministry of Education, especially founding of technical schools, took place rather late from the viewpoint of accommodating the demand for education and training in the industrial districts. It can be said that the Ministry of Education was forced to institutionalize the informal institutes for training that attempted to cope with highly practical problems from the shop floor.

Such sequence of events makes a lot of sense. Since the trade associations consisting of local producers possess accurate knowledge of what technology and management know-how is demanded at the grass-root level, it is natural for them to take initiative to set up the informal institutions for training on production technology and management. Associations, however, lack financial resources and knowledge of appropriate training programs.

Thus, they requested the support of prefectural governments and the Ministry of Agriculture and Commerce. In this way, training institutes have developed and made invaluable contributions to the development of traditional industrial districts. Finally, such training institutes were formalized by the Ministry of Education, which has meager knowledge of actual demand for technological and managerial knowledge but has command of ample financial resources. In my view it is this evolutionary process in which local, prefectural, and national organizations/governments play roles in areas with their respective comparative advantages that brought about initially revitalization and later respectable development of traditional industrial districts in the modernizing process of Meiji Japan.

Such experiences in the Japan's early industrialization process indicates that even small institution for training initiated by local private sector can immensely facilitate the introduction of new technologies and learning scientific knowledge and basic business practices. At the same time, better governments, both central and local, are also needed to support their activities by appropriate policies like sending instructors, subsidizing funds, and facilitating institutionalization.

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