The Republic of the Union of Myanmar
Myanma Railways

Report on
Myanmar Railway Sector
Human Resource Development Course

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Japan International Cooperation Agency (JICA)

Japan International Consultants for Transportation Co., Ltd.

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1. Outline of Training Program

The objective of this training program was to provide assistance for enhancing the railway technology skills of the Myanmar Government and to strengthen the relationship between Myanmar and Japan for human resource development in the field of railway technology.
Under this program, a railway technology training course was held for personnel of the Ministry of Transport and Communications (MOTC) and Myanma Railways (MR) to introduce information including Japanese advanced railway technology and railway-related services to assist the development of the railway network in Myanmar.

1.1 Background and objectives of training program

(1) Background
Since the transition to democratic government in 2011 in Myanmar, the demand for transportation has increased along with population growth in Yangon and economic expansion. Regarding railway infrastructure, existing railway lines are deteriorating due to ageing, causing frequent problems such as train delays and accidents, including derailment and separation of trains. Therefore, there is an urgent need to repair, modify and modernize the railway facilities and infrastructure in Myanmar.

Accordingly, for the Yangon-Mandalay Railway Improvement Project, Phase I (Loan fund assistance, L/A signed in September 2014), the selection of contractor(s) and construction work are scheduled to be started in the near future. In addition, for the Yangon Circular Railway Line Upgrading Project (Loan fund assistance, L/A signed in October 2015), the detailed design work is making good progress. Through these activities, work on modernizing the railway network in Myanmar is about to start.
On the other hand, through such activities as the Project for Installation of Operation Control Center System and Safety Equipment (Gratis fund assistance, G/A concluded in March 2014) and the Project on the Improvement of Services and Safety of the Railway (Completed: technical cooperation project, May 2013–March 2016), cooperation on facility renewal and human resource development for the railway network in Myanmar are now in progress. Used Japanese diesel railcars are being imported in succession and a technical cooperation project for maintaining them will be launched soon.
Thus, the Japanese Government is actively providing assistance for the railways in Myanmar and strengthening the relationship with MOTC. It is hoped that this training program will enable the trainees to acquire beneficial and effective training experience and thus contribute to the cooperative relationship between both nations related to urban railways and intercity railways.

(2) Objectives

This training program introduced information including Japanese advanced railway technology and railway related services that may contribute to future development of the railway network in Myanmar to personnel of the MOTC and MR. Through its implementation, the training program provided assistance for enhancing the railway technology skills of the Myanmar Government.

The program covered personnel of MR ranging from executives in the Headquarters to field staff, and the counterpart organization in the Myanmar Government was MR.

1.2 Outline of tasks to be implemented

(1) Basic policy

The success of the Project on the Improvement of Services and Safety of the Railway, which is being carried out as technical assistance from Japan, will depend on Japan grasping the technology level of the Myanmar side, preparing the training program or modifying it to suit the situation, and thereby conveying Japanese technology to meet the needs of the Myanmar side.

Therefore, this program also incorporated the desires of the Myanmar side. Especially, the training program was designed so that MR staff acquire knowledge about Japan's railway policy, system and technology through the training, and better understand the Japanese railway system, which is the most advanced in the world.

In preparing the training program, we thoroughly discussed the training contents in advance with the Japan International Cooperation Agency (JICA), related organizations, etc.

(2) Outline of implementation

a) Classification of training courses

The service training (for the headquarter personnel and field staff), and the training for station development/station facilities, underground/tunnel facilities, safety issues and electric power facilities were provided.

b) Type of training courses

Each lecture was mainly provided by classroom learning (using PowerPoint slides and videos). Reference materials were distributed and workshops, exercises and drills were included as necessary. As a lecture venue, a training facility of MR near Naypyidaw Station was used. Later, during the actual course, the MR side expressed its desire to carry out service improvements more directly connected to field activities. Thus, the training was partly implemented by using Yangon Station, Lower Myanmar Office and Mandalay Station.

c) Grasp of experience and knowledge level of trainees

We endeavored to grasp the level of understanding and knowledge of trainees by identifying in

advance what level of trainees would participate in the course, asking questions, etc. during the course, and carrying out exercises and presentations.

d) Assessment of lecture and visit

A questionnaire was distributed prior to the start of the lectures and recovered after the lectures. The trainees were requested to write any issues about the lectures and future desires on the questionnaire. The contents of the questionnaire were prepared through discussion with related staff of JICA. Information from lecturers was also incorporated when considering future improvements proposed in this report to help improve the future training curriculum by MR.

1.3 Implementation procedure and schedule

In implementing this training program, it was decided that activities such as consultation with the MOTC and MR should be jointly carried out by the JICA Myanmar Office and Japan International Consultants for Transportation Co., Ltd. (JIC), and that the training courses should be implemented by JIC in Myanmar.

The schedules including preparatory meetings and results are shown in Tables 1-1 to 1-6.

Table 1-1: Results of the first training course

No.	Mon.	Date	Day	Departure	Destination	Place of stay	Remarks (visited place, etc.)
1	3	20	S	Narita	Yangon	Yangon	Travel
2	3	21	M	Yangon		Yangon	Lower Myanmar Office of MR
3	3	22	T			Yangon	Another subject
4	3	23	W			Yangon	Another subject
5	3	24	Th	Yangon	Naypyidaw	Naypyidaw	JICA Myanmar Office, Travel
6	3	25	F			Naypyidaw	MOTC
7	3	26	Sa			Naypyidaw	Preparation for training course
8	3	27	S			Naypyidaw	Preparation for training course
9	3	28	M			Naypyidaw	MR Headquarter, Workshop (GM)
10	3	29	T			Naypyidaw	MR Headquarter, Consultation on training plan
11	3	30	W			Naypyidaw	MR Headquarter, Practical training of service improvement (General manager, headquarter staff)
12	3	31	Th			Naypyidaw	MR Headquarter, Practical training of service improvement (General manager, headquarter staff)
13	4	1	F			Naypyidaw	MR Headquarter, Practical training of service improvement (General manager, headquarter staff)
14	4	2	Sa	Naypyidaw	Yangon	Yangon	Travel
15	4	3	S			Yangon	Preparation for training course
16	4	4	M			Yangon	Lower Myanmar Office of MR Information exchange with GM
17	4	5	T	Yangon		Flying overnight	Lower Myanmar Office of MR Information exchange with GM Travel
18	4	6	W		Narita		Return to Japan

Persons who made business trip: Higashi (March 23–) and Matsuo (March 20–)

Table 1-2: Results of the second training course

No.	Mon.	Date	Day	Departure	Destination	Place of stay	Remarks (visited place, etc.)
1	5	15	S	Narita	Naypyidaw	Naypyidaw	Travel
2	5	16	M			Naypyidaw	MR Headquarter
3	5	17	T			Naypyidaw	MR Headquarter, Station development training
4	5	18	W			Naypyidaw	MR Headquarter, Station facilities training
1	5	19	Th			Naypyidaw	MR Headquarter, Underground and tunnel facilities training
2	5	20	F			Naypyidaw	MR Headquarter, Underground and tunnel facilities training
3	5	21	Sa	Naypyidaw	Yangon	Flying overnight	Travel
4	5	22	S		Narita		Return to Japan

Persons who made business trip: Higashi (May 15–), Matsuo (May 15–) and Hayasaka (May 18–)

Table 1-3: Results of the third training course

No.	Mon.	Date	Day	Departure	Destination	Place of stay	Remarks (visited place, etc.)
1	6	12	S	Narita	Naypyidaw	Naypyidaw	Travel
2	6	13	M			Naypyidaw	MR Headquarter
3	6	14	T			Naypyidaw	MR Headquarter, Safety training
4	6	15	W			Naypyidaw	MR Headquarter, Safety training
5	6	16	Th	Naypyidaw	Yangon	Flying overnight	MR Headquarter, Electric power facilities training, Travel
6	6	17	F		Narita		

Persons who made business trip: Matsuo (June 12–), Wakai (6/12–) and Suzuki (June 16–)

Table 1-4: Results of the fourth training course

No.	Mon.	Date	Day	Departure	Destination	Place of stay	Remarks (visited place, etc.)
1	8	2	T	Narita	Naypyidaw	Naypyidaw	Travel
2	8	3	W			Naypyidaw	MR Headquarter, Service training
3	8	4	Th			Naypyidaw	MR Headquarter, Service training
4	8	5	F			Naypyidaw	MR Headquarter, Service training
5	8	6	Sa	Naypyidaw	Yangon	Yangon	Travel
6	8	7	S			Yangon	Preparation for training course
7	8	8	M			Yangon	Lower Myanmar Office of MR, Service training
8	8	9	T			Flying overnight	Lower Myanmar Office of MR, Service training
9	8	10	W		Narita		

Persons who made business trip: Higashi, Matsuo and Kuramochi

Table 1-5: Results of the fifth training course

No.	Mon.	Date	Day	Departure	Destination	Place of stay	Remarks (visited place, etc.)
1	10	8	Sa	Narita	Yangon	Yangon	Travel
2	10	9	S			Yangon	Preparation for service training (Yangon Station)
3	10	10	M			Yangon	Yangon Station, Service training
4	10	11	T			Yangon	Interview survey (Yangon Station) Presentation of training course (Lower Myanmar Office)
5	10	12	W	Yangon		Flying overnight	Follow-up (Yangon Station)
6	10	13	Th		Narita		

Persons who made business trip: Higashi, Kuramochi and Matsuo (joined at the site on 9th and 10th)

Table 1-6: Results of the fifth training course

No.	Mon.	Date	Day	Departure	Destination	Place of stay	Remarks (visited place, etc.)
1	1	16	M	Narita	Yangon	Yangon	Travel and preparation for Yangon
2	1	17	T			Yangon	Service training (Lower Myanmar Office) and Preparation for Mandalay
3	1	18	W			Mandalay	Service training (Mandalay Station)
4	1	19	Th			Naypyidaw	Meeting with MOTC and MR Headquarter
5	1	20	F	Naypyidaw		Flying overnight	Meeting with MR Headquarter
6	1	21	Sa		Narita		

Persons who made business trip: Higashi, Matsuo (joined on the spot) and Kuramochi (returned on 20th).

1.4 Implementation scheme

On the Myanmar side, MR mainly implemented the project and the MOTC supported the activities. To facilitate smooth operations, the project was carried out by exchanging information not only with Naypyidaw district where the Headquarter is located, but also with Yangon District where major operational departments of MR are located.
The training courses and their persons in charge are listed in the table below.

Table 1-7: Training courses and persons in charge

	Training course	Person in charge	Duration (including orientation meeting, etc.)
1	First round of service training	Mitsuo Higashi, Nobuyuki Matsuo	3/20–4/7
2	Station development and station facilities	Mitsuo Higashi, Nobuyuki Matsuo	5/15–5/22
3	Underground and tunnel facilities	Harutoshi Hayasaka	5/15–5/22
4	Safety	Nobuyuki Matsuo	6/12–6/17
5	Electric power facilities	Koichiro Suzuki	6/12–6/17
6	Second round of service training	Mitsuo Higashi, Nobuyuki Matsuo, Takahiro Kuramochi	8/2–8/10
7	Third round of service training	Mitsuo Higashi, Takahiro Kuramochi	10/8–10/13
8	Fourth round of service training	Mitsuo Higashi, Nobuyuki Matsuo, Takahiro Kuramochi	1/16–1/21

Business support: Nobuyuki Matsuo, Mari Wakai and Takahiro Kuramochi

2. Implementation of Training

2.1 Orientation

At the start of the training program, we explained the training program and exchanged opinions on its implementation in two places, MR Headquarter (March 1) and the Lower Myanmar Office (March 3).

At first, JIC presented an outline of the training program for human resource development in the railway field in Myanmar, describing that the training was designed to improve services and develop related businesses as future issues, and would cover areas where technical knowledge and experience may be insufficient.

The program was designed to cover executive staff of MR, so we proposed that MR should select up to 40 appropriate personnel for each theme. In addition, it was decided that the training courses should basically be held in Naypyidaw, and in Yangon District as necessary.

Furthermore, we explained that the opinion exchange in the day should be regarded as the Kickoff Meeting, and that the actual training courses were planned to start from the end of March. Regarding the number and contents of the training courses, it was decided that any changes to the schedule and contents could be considered in consultation with the Myanmar side, and we also asked if any additional courses, etc. were required. The proposed schedule was as follows.

a) March 28 (Mon), 29 (Tue): Railway policy and services
b) March 31 (Wed), April 1 (Thu): Passenger services
c) May 16 (Mon)–18 (Wed): Safety management
d) May 19 (Thu): Electric system
e) May 20 (Fri): Underground structures and tunnel facilities
f) June 13 (Mon) –15 (Wed): Development of station and surrounding areas

It was decided that future issues, including the contents and time of the next seminar, would be decided at each seminar. It was also decided that each training course would be mainly provided by classroom learning (using PowerPoint slides and videos), reference materials would be distributed, and workshops, exercises and drills would be included, as necessary.

As a lecture venue, it was decided to use a training facility (max. capacity: 40 people) of MR near Naypyidaw Station, and that the lectures should be provided with simultaneous interpretation from Japanese to Burmese and English textbooks should be used and distributed.

Accordingly, we requested MR to select trainees, to provide the training facility (seminar house)

and training equipment, and to support its operation.
As a result, the Japan side and MR agreed that: the training courses should start from the end of March 2016; on March 28 and 29, an executive training meeting including general managers (of MR) should be held to discuss overall subjects and to share the contents of all training courses; on March 30, 31 and April 1, a workshop should be held on measures for improving services as an urgent subject; and from April 2016, the time and people to be covered should be discussed and decided.

2.2 First round of service training (March 20–April 7)

(1) Current situation and issues in the service field

In the service field, no practical training has been provided to date. In addition, there were only a few MR personnel who could provide training on services. Therefore, although MR understands the necessity for improving services, it cannot do so at all work places. To allow MR to improve services in an integrated manner, a change of attitude at MR Headquarter is indispensable. The issue will be how to convey such changes to field staff.

(2) Method and contents of training courses according to the abovementioned issue

While service improvement requires a change in attitude among field staff, first the executive staff in the Headquarter need to understand the importance of service improvement. As an introduction, we gave a lecture for general managers (GMs) and deputy general managers (DGMs) in the Headquarter, on the following:

1. Railway policy and service
2. Passenger satisfaction
3. Service improvement (awareness and Kaizen)
4. ISO 9000 series
5. PDCA (Plan Do Check Action) cycle
6. Examples

References:

- Awareness: Intuitive “discovery” or “inspiration” originating from within
- Kaizen: Practice to improve conditions by correcting errors or deficiencies
- ISO9000 series: Generic name of standards on a quality management system specified by the International Organization for Standardization (ISO)
- PDCA cycle: A methodology to improve work by repeating the cycle of Plan (planning) → Do (execution) → Check (assessment) → Action (improvement)

In order to instill the importance of service improvement throughout the MR organization, first we endeavored to make the executive staff in MR Headquarter understand the importance. Then, a training course for 40 people (mainly headquarter staff and general managers in the areas surrounding Naypyidaw) was held in Naypyidaw. In addition to the abovementioned guidance, the training course included Kaizen techniques including Fish Bone, Logic Tree and Matrix, group discussion, and presentations. Furthermore, the training course for 20 people (mainly general managers in Yangon District) was held the following week in Yangon, with similar contents.

(3) Issues and lessons revealed by implementing the training courses

Past training programs by MR mainly used lectures and were rather passive training for trainees. Our service improvement training courses for general managers not only taught the importance of CS management, flow diagrams and cause-effect diagrams through discussion, but also used group discussions and presentations, encouraging active participation and sincere discussion.

The group discussion was carried out by gathering, arranging and summarizing opinions from every member. The trainees had almost no experience of this approach, and so may have felt some confusion at the beginning. Once some opinions were given, the room became lively with various opinions and the group leaders struggled to summarize them within the specified time.

In the presentation session, the leaders explained the contents of the discussion. Probably because of the lack of such experience, the presentations frequently exceeded the time limit, indicating the desire to eagerly convey the results of the discussions.

We had the strong impression that the policy first proposed by MR to carry out business improvement in a bottom-up manner would be supported by persons in charge and general managers.

Therefore, it was important to continue the training program by incorporating group discussion, presentations, etc. MR itself will also need to continue the program.

2.3 Training course for station development, station facilities, and underground and tunnel facilities (May 15–22)

2.3.1 Training for station development and station facilities

(1) Current situation and issues of station development and station facilities

While the station facilities of MR have the minimum equipment necessary to operate trains, they are insufficient from the viewpoint of passenger services. In part because MR lacks funds, sometimes damaged equipment such as benches in station yards is still used as is. Furthermore, some stations have no lavatory or waiting room.

MR staff consider that the inability to repair equipment or introduce new equipment due to insufficient budget is unavoidable. However, not maintaining equipment creates a vicious circle that the number of passengers does not increase and so station equipment cannot be improved, and thus the service can never be improved. Therefore, great improvement is necessary.

(2) Method and contents of training courses according to the abovementioned issue

If the Yangon–Mandalay Line and Yangon Loop Line are greatly improved, station facilities will also be improved, and the development of Yangon Station will also be started. Accordingly, we developed a lecture to enable MR staff to consider what equipment is required from the passengers' viewpoint. To do this, and introduce some examples of guide signs, etc. in Japanese stations, it is necessary to examine what passengers expect in Myanmar. The lecture contents were designed so that the trainees could consider what station facilities are required based on these matters.

In addition, since we heard that there is not enough budget to invest in station facilities, we also introduced some examples of independent efforts to increase income (by using station space, advertising income, etc.) and examined what services a railway company could provide to passengers.

Furthermore, from the perspective of station development and the future image of stations, we explained barrier-free facilities such as escalators and lifts, equipment such as platform doors to assure the safety of passengers, and equipment such as textured paving blocks and alert blocks for the physically handicapped.

(3) Issues and lessons revealed by implementing the training courses

In the case of station facilities, since measures will mainly focus on hardware assets, the current limited budget prevents prompt improvement. Therefore, to secure budget, we proposed introducing maps with advertising income in stations and new businesses using free space.

Advertising is gradually being introduced in stations to generate income for MR. However, since this is controlled by the Headquarter, the budget cannot yet be freely used under the discretion of each site. On the other hand, MR staff recently proposed installing cellular phone charging equipment. Any measures that allow the service level to be improved with limited budget should be continued.

On the other hand, since station facilities such as escalators and lifts require electric power, it will be important to secure a power source.

2.3.2 Training for underground and tunnel facilities

(1) Current situation and issues of underground structures and tunnels

Since the Yangon District of Myanmar has no subway network as transportation infrastructure for the city, people frequently use cars as a reasonable transportation means, causing congestion on roads as land traffic routes. While the utilization of railways is encouraged to alleviate the situation, the railway network currently cannot solve the root cause of road congestion. Accordingly, a subway network is planned to be constructed as a fundamental solution to road congestion.

Since Myanmar has no experience of constructing underground railway structures such as subways except for some tunnels by the mountain tunneling method, a future project that includes the planning, design and construction of underground structures will be experienced for the first time.

(2) Method and contents of training courses according to the abovementioned issue

As mentioned above, Myanmar has little experience of constructing mountain tunnels. Therefore, based on tunnels constructed by the mountain tunneling method, we gave a lecture using PowerPoint slides to allow the trainees to visually understand the contents, from the viewpoint that seeing is believing. The contents of the lecture were as follows:

1. Classification of tunnels
2. Planning and survey of tunnels
3. Design of tunnels
4. Construction of tunnels
5. Observation and measurement of tunnel face

For items 1 to 3, we gave a lecture on the fundamentals of underground structures and tunnels. For items 4 and 5, we gave a lecture focusing on some actual examples in Japan, as outlined below.

For item 1, we visually presented the classification and procedure of tunnel construction methods (mountain tunneling method, shield method and excavation method) and introduced actual examples by showing color photographs.

For item 2, we presented the procedure for planning and survey by using flow charts and various tables, considering a detailed and careful explanation.

For item 3, we explained the types of design methodologies and the functions of tunnel support members by using various figures and tables.

For item 4, we prepared several color photographs according to the procedure and explained the

construction procedure including excavation, muck loading, shotcrete and rock bolts by using several color photographs in an efficient and detailed manner.
For item 5, we explained construction work based on geological information obtained from tunnel face observation upon completion of tunnel excavation.
We provided time for questions and answers at suitable points and confirmed the trainees' understanding of the lecture contents.

(3) Issues and lessons revealed by implementing the training courses
Since the lecture contents were generic due to the limited time, questions and answers are important throughout. However, the questions from trainees suggested that they strongly wanted to fully understand the contents. For example, in the questions and answers on the design of tunnels in item 3, a question was asked on the method of fixing rock bolts as one of the support members of tunnels, reflecting the strong desire to understand the lecture.
In future, contents that are more suitable for the current situation in Myanmar regarding the theory and practice for underground structures should be arranged, such as the following: introduction of NATM theory; various construction methods against spring water specific to underground structures and introduction of examples; introduction of construction methods and auxiliary construction methods against various types of bedrock (soft rock, soil, etc.) and extraordinary bedrock (expansive, high pressure, large amount of spring water, high geothermal flux, hot spring, toxic gas, high-pressure compressed gas, etc.); construction methods in narrow urban areas; and construction methods while assuring surface traffic.
In addition, construction methods focusing on safety should also be explained, such as KY (Kiken-Yochi: risk prediction) activities at construction sites.

2.4 Training for safety and electric power facilities (June 12–17)

2.4.1 Safety training

(1) Current situation and issues of each field

MR has experienced about 650 accidents such as derailment per year as of 2011, and there are serious issues regarding safety and stable transportation by railway. There are various causes including track, cars and operation handling. Comprehensive enhancement of safety is needed.

Although MR staff consider that their mission is safe transportation, they have almost no experience of safety training and have not discussed what actual measures may enhance or improve safety.

(2) Method and contents of training courses according to the abovementioned issue

Railway safety covers all fields and is related to a wide range of personnel. Therefore, the training course was designed to cover the whole of railway safety.

MR Headquarter requested an explanation on safety measures at crossings. These have two aspects, namely hardware measures and software measures, such as increasing the safety awareness of people near the crossing. We introduced Japanese examples and some examples of a crossing completed last year in Myanmar.

In addition, as full-scale improvement of the Yangon–Mandalay Line and Yangon Loop Line is starting, cases of construction work being carried out near commercial lines will increase. We introduced safety measures and rules for such cases and encouraged MR staff to consider what safety measures could be taken by the Myanmar side.

The contents of the lecture were designed not only as a one-way presentation, but also introduced Japanese examples with videos followed by discussions on the videos, to encourage active participation on safety by the trainees.

Furthermore, since a lecture alone might lead to a one-way presentation, group discussions were carried out. The contents were designed so that the staff of all systems could speak based on the video examples on the theme, “How to make trains safe for passengers”.

(3) Issues and lessons revealed by implementing the training courses

In Japan, there are various safety rules. The lecture revealed that in Myanmar, while there are no detailed rules, safety could be assured through some simple procedures (not relying on systems but intensively using manpower) which do not exist in Japan. Thus, we felt that the concept of safe train operation can be shared between both nations.

Since safety covers all systems, various safety measures including those of each respective

system, those of all systems, and safety awareness mainly by the Headquarter through media are required. Although it would be difficult to take hardware measures promptly due to limited budget, there are easy safety confirmation measures such as pointing and calling attention which could be promptly taken.

From now on, in order to enhance the safety awareness of field staff, back-up or follow-up by the Headquarter and executive staff will be required.

2.4.2 Training for electric power facilities

(1) Current situation and issues of the electric power field

Since the railway network in Myanmar has not been electrified, few people have expertise in electric power. However, since electric power facilities will be indispensable for modernization of the railway network in Myanmar, the development of human resources having expertise in electric power is required.

(2) Method and contents of training courses according to the abovementioned issue

We gave a lecture with Microsoft PowerPoint slides focusing on basic matters to allow even beginners to learn the expertise required for electrification of the railway network. The lecture included:

1. Outline of electricity
2. Electric power supply
3. Transformation of electric energy
4. Train conductor system
5. Distribution of electric energy
6. Overhead contact line and battery driven electric car
7. Three major accidents in electric power facilities

For items 1 to 5, we explained the fundamentals of electrification of a railway network. For item 6, we introduced the latest technology of cars without overhead contact lines (energy accumulating vehicle, known as “ACCUM” from the word “accumulator”) now in commercial operation in Japan. For item 7, we gave a lecture using video materials and additional explanations. Together with learning about electric power facilities, item 7 taught the trainees about the three major kinds of accidents (electric shock, fall and contact with train) specific to electricity which could occur in the construction and maintenance of electric power facilities. In addition, we inserted item 7 among items 1 to 5 to avoid a one-way presentation and to keep the trainees motivated to learn by alternating visual presentation with lecture.

(3) Issues and lessons revealed by implementing the training courses

Each topic was taught for two hours in the morning and two hours in the afternoon, i.e., four hours in total per day. Since most of the trainees were beginners with little background knowledge, the contents and time allocated seemed suitable. In addition, since MR has almost no high voltage facilities and cannot give trainees experience, it was desirable to give the trainees on-the-job training at a site, or a tour to electric power facilities. Furthermore, if lectures on electric power technology will be held for similar trainees in future, we suggest that

they should focus on substation facilities and power distribution facilities for electric railways. In addition, the three major accidents of electricity should continue to be taught together with electric facilities.

2.5 Second round of service training (August 2–10)

(1) Current situation and issues of each field

In Myanmar, various new policies including the "100 days plan" have been launched following the change of government in 2016. Among them, also for MR, business management that considers services for passengers is desired, including enhancing services by staff.

In order to improve services, it is important to hear the opinions of users and reflect them. In addition to measures by management, measures by field staff will be important.

However, to date MR has had almost no sense of passenger service, and field staff have not been required to carry out their work with initiative.

Therefore, field staff must also be made aware that they should take the initiative in measures, make improvements through small actions, obtain results, and relate them to the larger issue of improving service.

(2) Method and contents of training courses according to the abovementioned issue

This training program constituted the start of measures for field staff to improve services. First, we gathered executive staff of stations from all 11 districts in Myanmar to Naypyidaw and provided the training course.

The participants were seven persons from the Headquarter, 13 station masters and 20 managers of stations (40 persons in total).

We emphasized that in addition to safety, a railway company should attach greatest importance to customer satisfaction, grasp the needs of passengers, and address them.

The lecture introduced ideas such as "awareness" and "Kaizen", which have been emphasized in the process of improving service over 30 years since the privatization of Japanese National Railways in 1987. Accordingly, we introduced some actual examples in Japan. The curriculum was designed so that Japanese methods would not be applied simply without modification, but so that MR staff could identify issues in their respective station by themselves, identify points that can be improved by field staff, and establish an implementation plan.

In particular, we explained this training program and the roles that the 40 trainees from the whole of Myanmar should play. Namely, first, we asked the trainees to consider the position of service for a railway company. Then, we explained that this training program would be the first trial to improve the services in MR and that the trainees would be the first members to implement it.

The lecturers requested them to return to their respective work places with their own ideas, and to discuss and disseminate the importance of improving service in the company. We explained this desire and emphasized that safety should be paramount through cooperation between

lecturers and trainees.
We encouraged the trainees to tackle the training course with a sense of ownership and awareness of issues through these actions.

First, we set the familiar theme of “How to increase customers of a restaurant” and conducted brainstorming by free discussion.

Then, the trainees were divided into six groups and each group imagined a model station. They discussed the matter using approaches such as the fish bone method to identify issues, a logic tree to analyze the issues and an option matrix to examine solutions.

> Fish bone: This figure is sometimes called a cause-and-effect diagram and is created to analyze the causes of results. The figure allows a visually understandable analysis by focusing on a problem and issue, entering possible causes and entering more detailed causes in a branching manner. The name originates from its final shape like fish bones. We used this fish bone to visualize the issues concerning services in stations and their causes.
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> Logic tree: Like the fish bone, this figure helps visualize the thinking process. There are “Why Tree” and “How Tree”. In this case, the Why Tree was used, which derives the causes by repeating the question “Why?” for a problem. As a result, we could analyze why the causes inferred by the fish bone would occur.
>
> Option matrix: This is a matrix diagram, which is obvious from its name. The matrix indicates solutions as options for the issues analyzed by the fish bone and the logic tree. Then, criteria are set, each item is assessed and ranked, and the solutions to be carried out are selected.

Mong Len, Mandalay, Pyinmana, Bago, Hinthada and Bagan Stations were selected as model stations. Each group considered the issues concerning services in each station, the results of their detailed analysis and the solutions that could be implemented by the trainees after returning to their respective work places, and then gave a presentation.

On the other hand, in Yangon, a training course was held in the Lower Myanmar Office for 25 staff who newly participated from the stations around Yangon and four staff who had participated in the seminar in Naypyidaw from Yangon District.

Like the example in Naypyidaw, the five stations of Yangon, Mingaladon, Danyingon, Insein and Bago were selected as model stations, and a workshop to identify the issues of each station, examine solutions and present results was held.

The staff who had already attended the seminar in Naypyidaw participated in each group and guided the process of discussion, identifying issues and considering solutions, thus facilitating smooth discussions.

In the Yangon case, MR invited the media including the national broadcasting company MRTV to the opening ceremony on the first day. The media covered the ceremony and the beginning of the lectures.

On the second day of the training course in Yangon, the undersecretary of the MOTC visited the training place, listened to the presentations on issues in the field by the staff and exchanged opinions.

(3) Opinions from participants and the contents of discussion

As some examples, the following figures show the products created by a group in Yangon and their corresponding English translations, for Yangon Station.

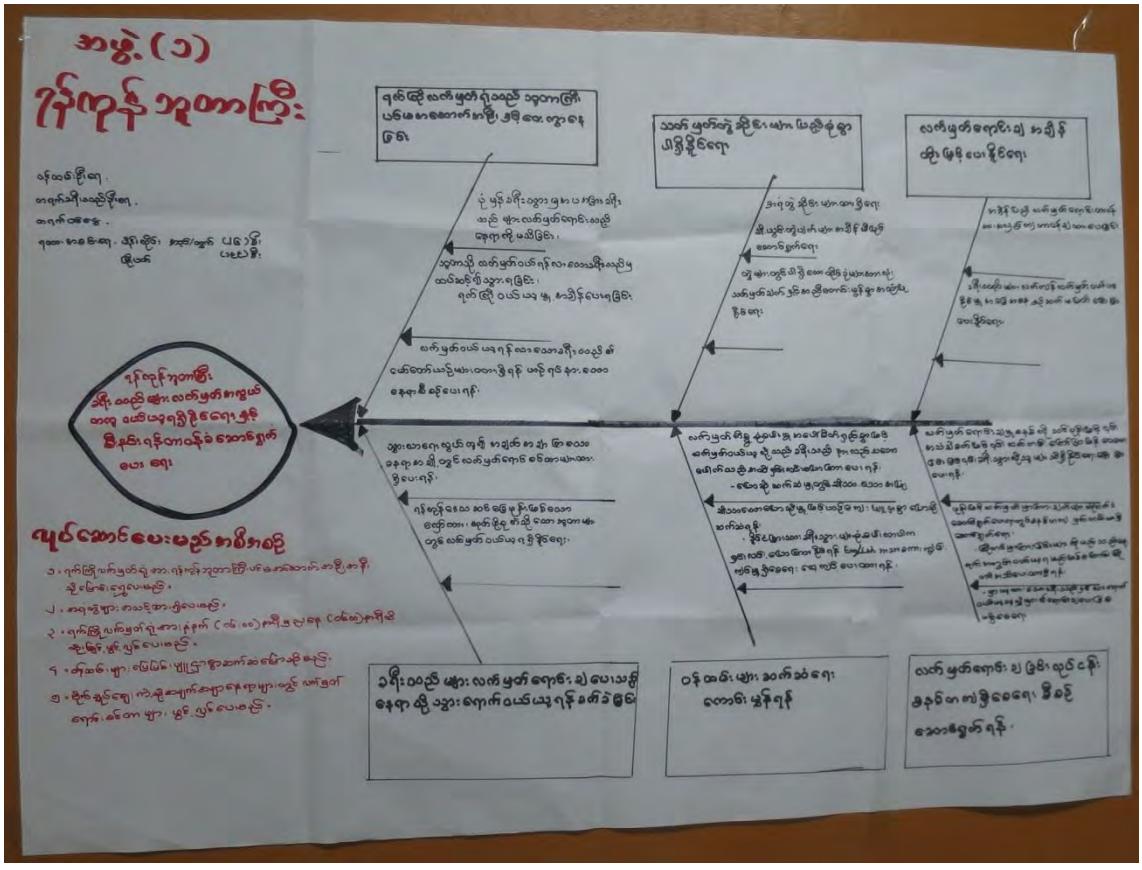


Figure 2.5.1: Fish bone

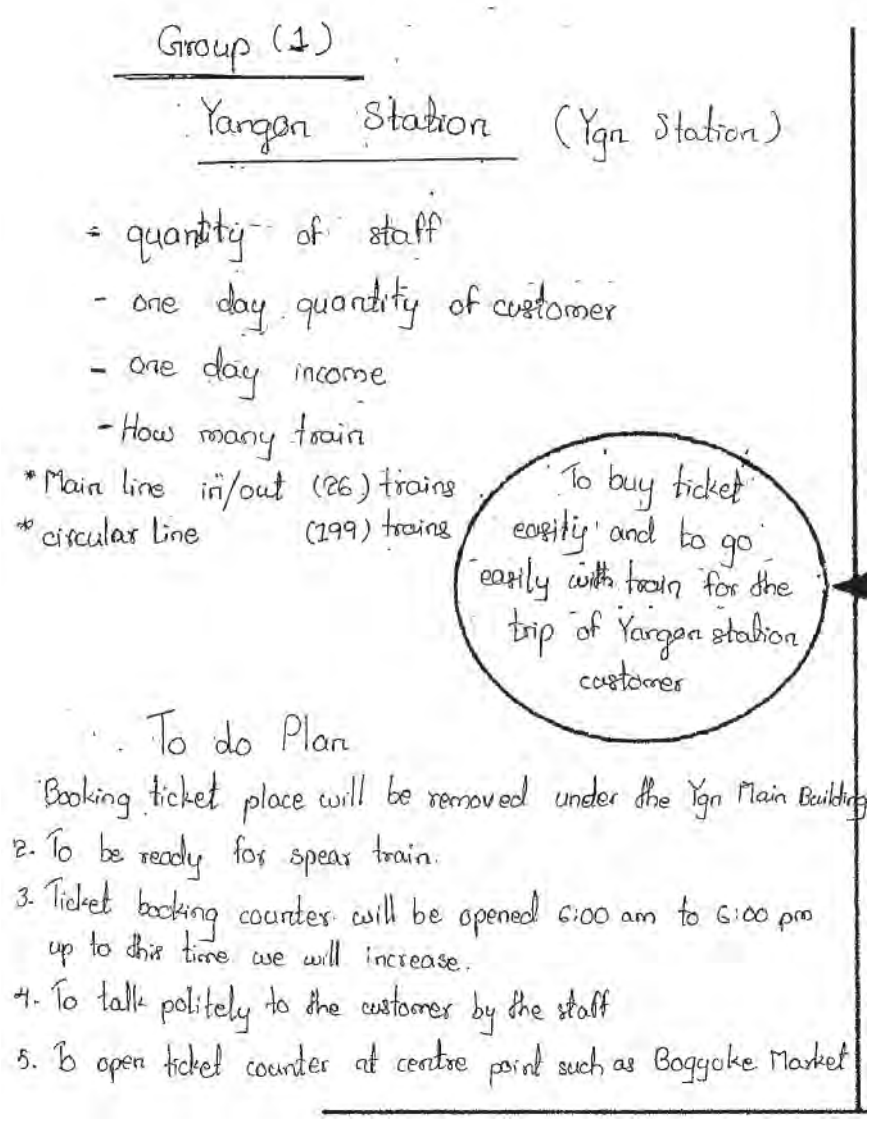


Figure 2.5.2: Fish bone

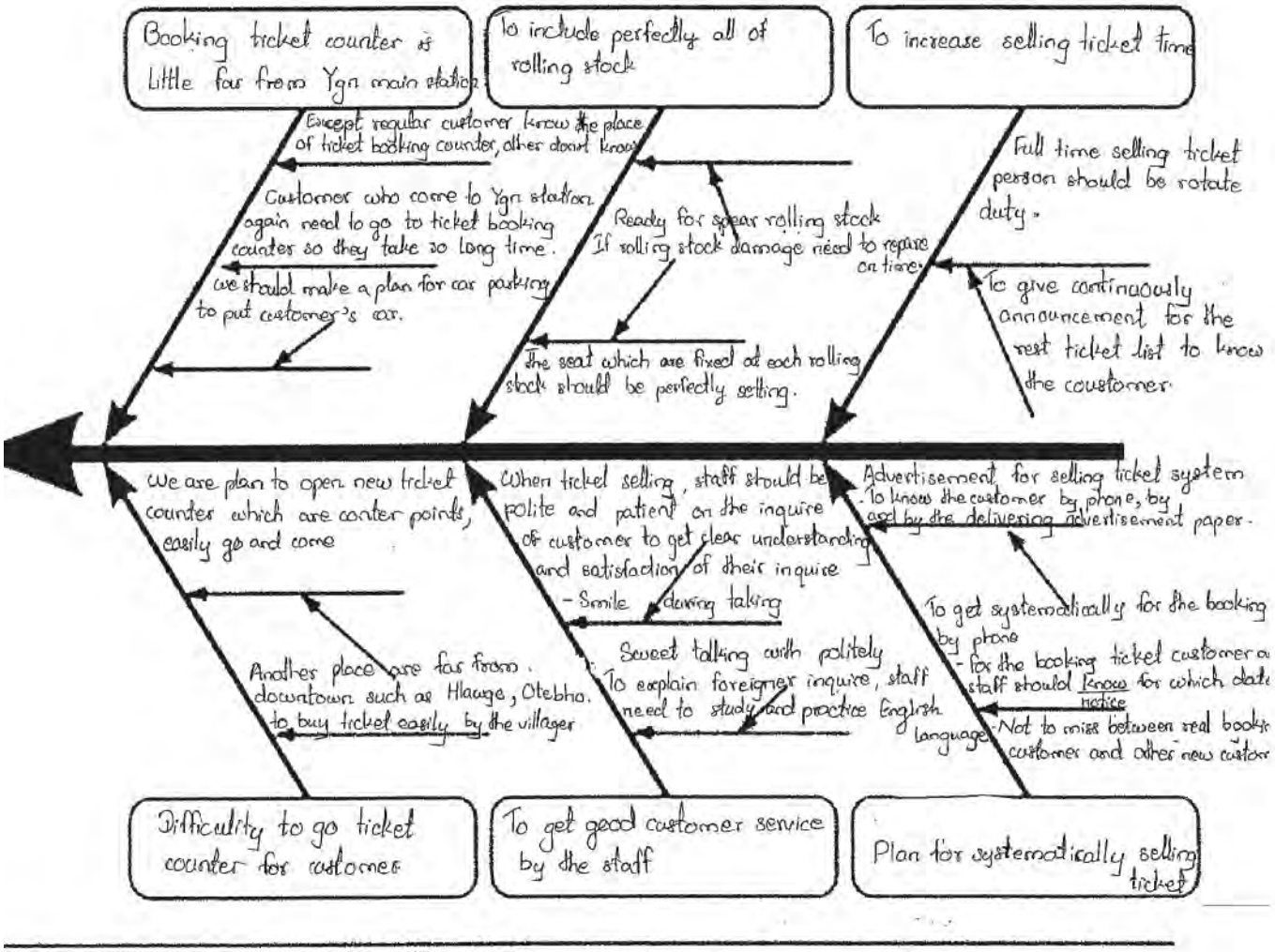


Figure 2.5.3: Fish bone

In this case, the theme “A passenger in Yangon Station can purchase a ticket easily and promptly catch a train” was set and discussed using the fish bone method. In the process, the analysis was that “the ticket counter is far from the main building of Yangon Station (station building)” and a detailed analysis was that “while some passengers using the station usually know the location of the counter, other passengers do not”.

The group summarized the analysis through the discussion into the following plans:

“The ticket counter should be relocated to the main building of Yangon Station.”

“A spare train should be arranged.”

“The business hours of the ticket counter should be extended to 6:00 am to 6:00 pm.”

“Staff should serve passengers politely.”

“The ticket counter should be located in a town center such as Bojo Market.”

Figures 2.5.4 to 2.5.6 show the logic tree created by the group and its corresponding English translation, respectively.

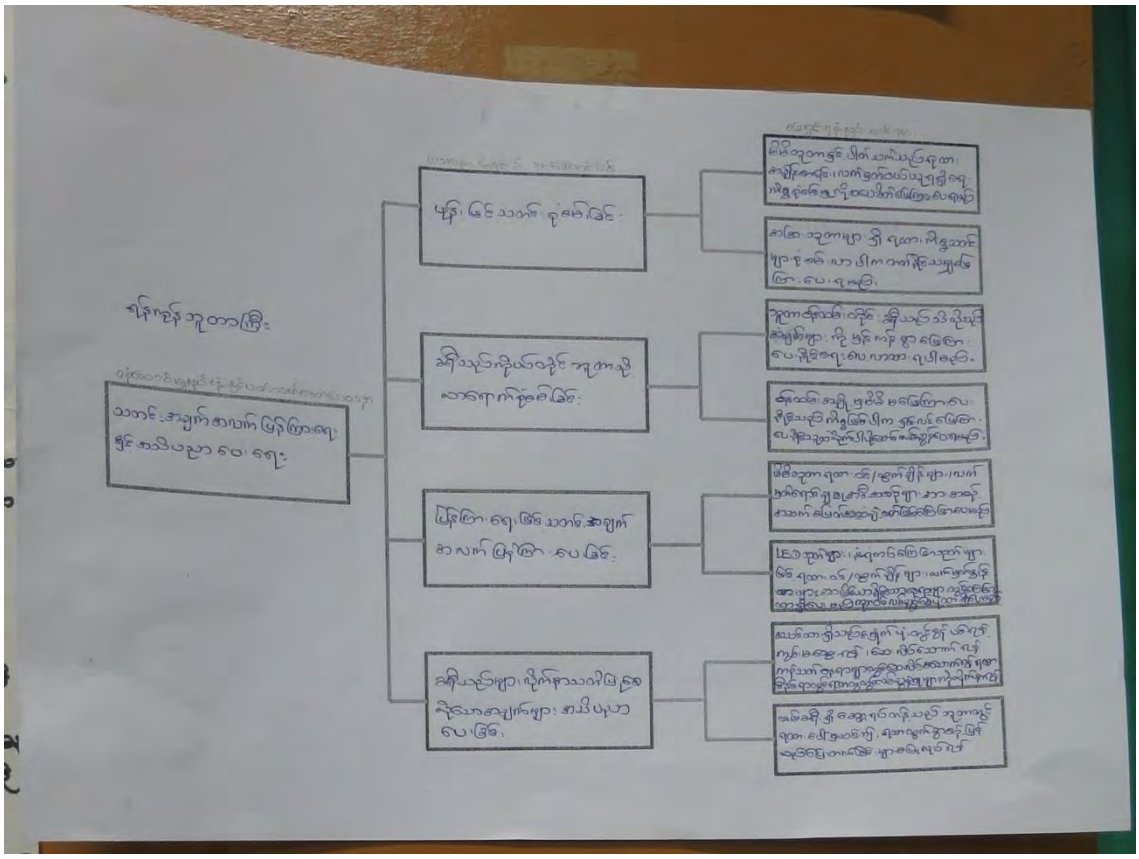


Figure 2.5.4: Logic tree

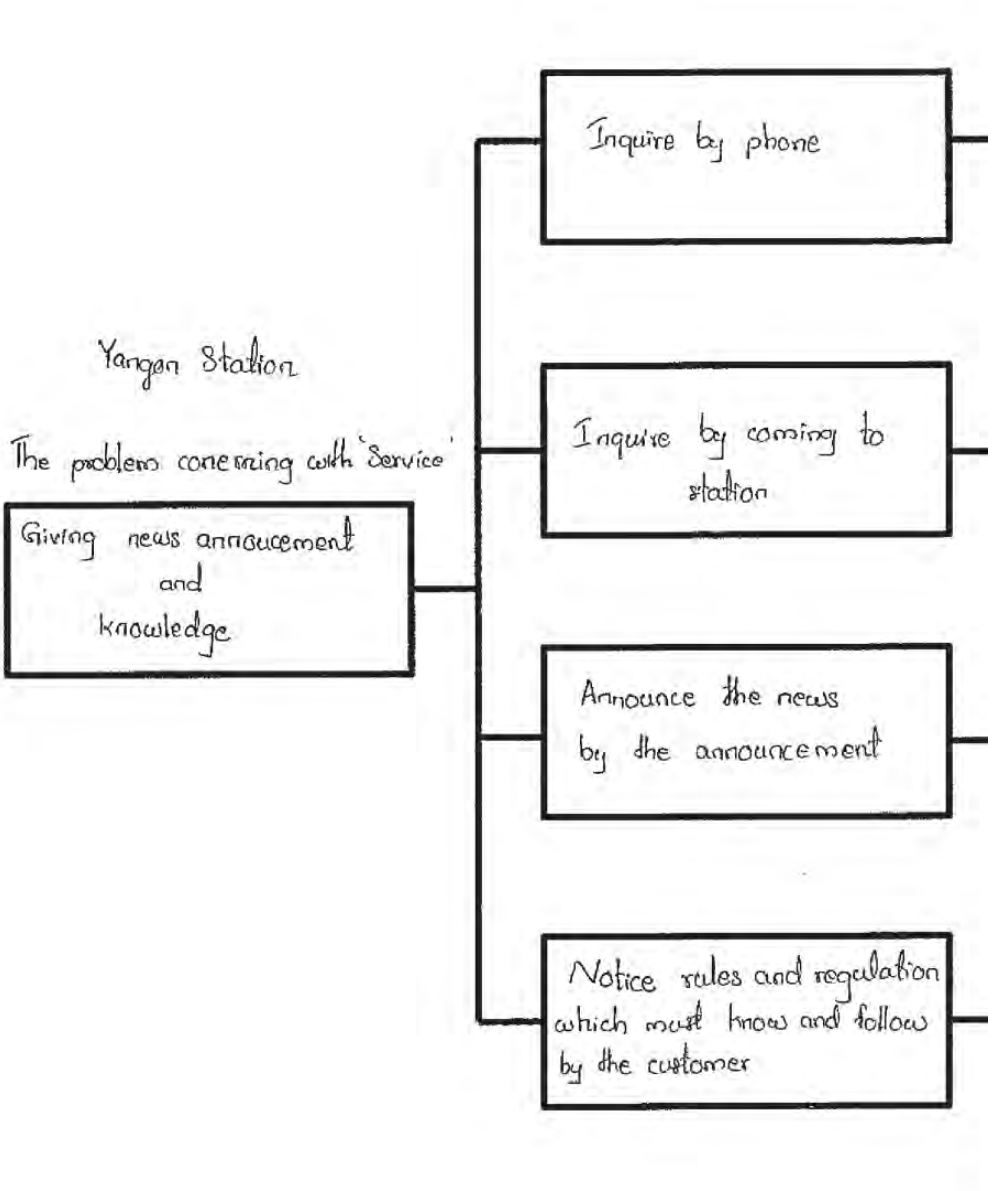


Figure 2.5.5: Logic tree

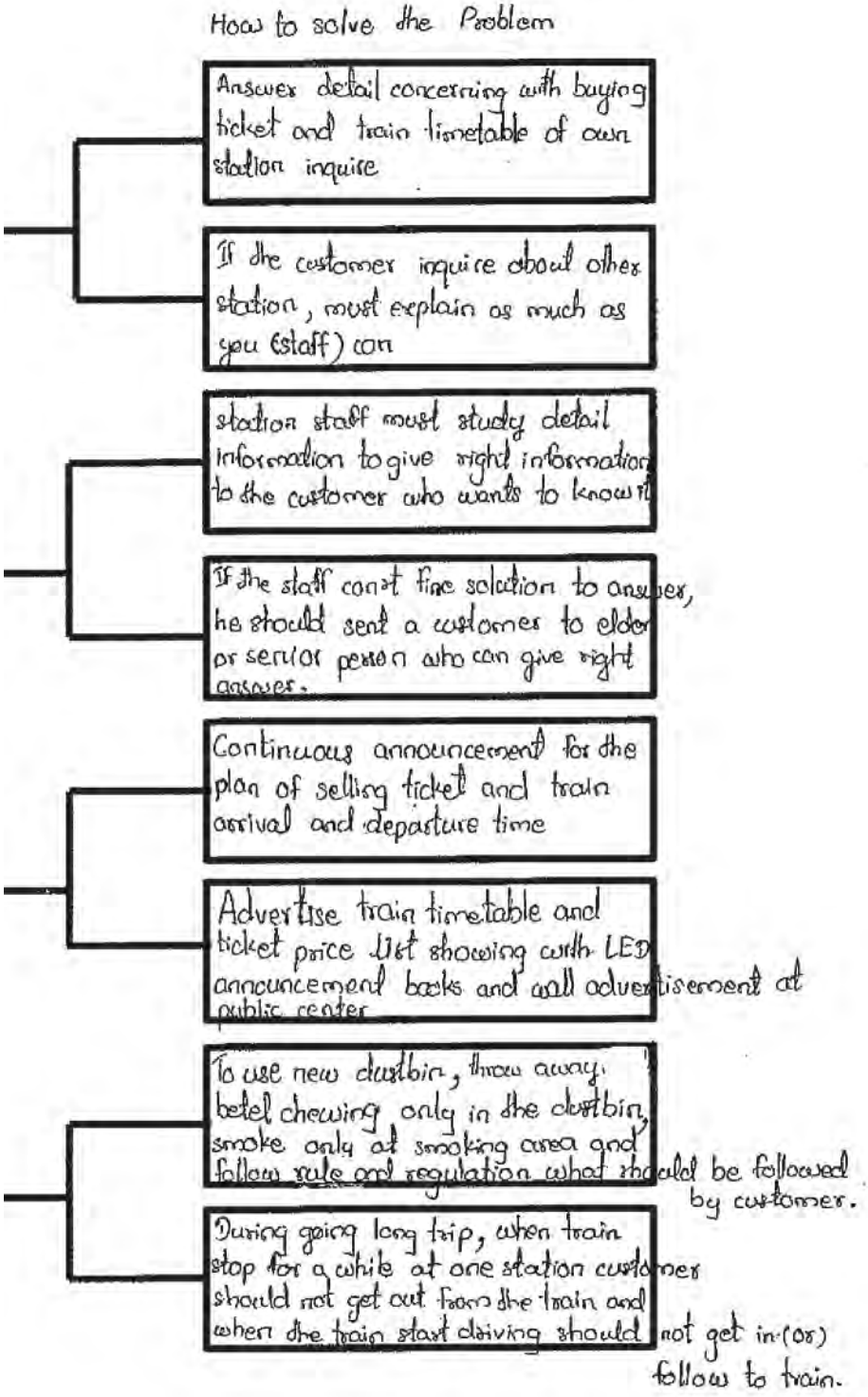
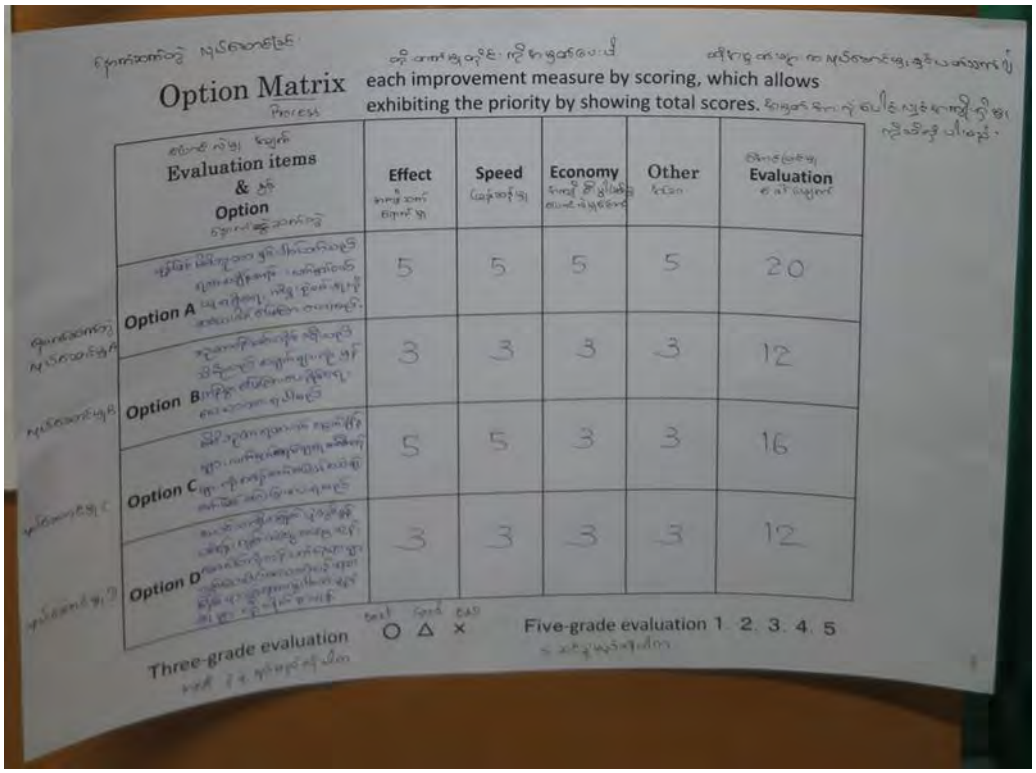


Figure 2.5.6: Logic tree

The group discussed the provision of information to passengers in Yangon Station. The matters "inquiry by phone", "inquiry at a station", "guide by announcement" and "notification of rules and regulations which must be known and followed by customers" were discussed.

Figure 2.5.7 and 2.5.8 show the option matrix and its corresponding English translation, respectively.



Option Matrix

each improvement measure by scoring, which allows exhibiting the priority by showing total scores.

Evaluation items & Option	Effect	Speed	Economy	Other	Evaluation
Option A	5	5	5	5	20
Option B	3	3	3	3	12
Option C	5	5	3	3	16
Option D	3	3	3	3	12

Three-grade evaluation ○ △ ×

Five-grade evaluation 1. 2. 3. 4. 5

Figure 2.5.7: Option matrix

Option Matrix each improvement measure by scoring, which allows exhibiting the priority by showing total scores.

Evaluation items & Option	Effect	Speed	Economy	Other	Evaluation
Option A Answer detail concerning with buying ticket and train timetable of own station inquire by phone.	5	5	5	5	20
Option B Station staff must study detail information to give right answer to the customer who wants to know it.	3	3	3	3	12
Option C Continuous announcement for the plan of selling ticket and train arrival and departure time.	5	5	3	3	16
Option D To use new dustbin, throw away betel chewing only in the dust bin, smoke only at smoking area and follow rule and regulation what should be followed by customer.	3	3	3	3	12

3

Figure 2.5.8: Option matrix

From the options analyzed by the logic tree, the group assessed them based on factors such as “effect”, “speediness” and “economic efficiency”.

As seen from the analyzed results, MR staff have many ideas, whether attainable or not by their own efforts. In the lecture, they gave many opinions, including that even if they propose simple things, they don’t know whether to carry them out.
It is necessary to help realize ideas through continuous support. In addition, this case suggested that it is important to create a support structure by the whole of MR to allow the staff to carry out an improvement proposal themselves without hesitation.

(4) Issues and lessons revealed by implementing the training courses
Since this training program was for front-line station staff, their responses were generally better than the lecturers had expected. In particular, we found that each staff understood the issues in their respective work places very well, not only issues for staff, but also that the current situation of MR is not ideal for passengers. In addition, regarding actual solutions, while at the start of the training they tended to identify easy solutions, they proposed various opinions by repeating the discussion.
We strongly considered it is necessary to consider how this case should be made ongoing and effective. That is, as described above, it is necessary to establish a system that a) accepts proposals from staff; b) implements proposals; c) explicitly improves services for passengers; d) enhances the motivation of staff; and e) provides feed-back to the next improvement.

In addition, this seminar in Yangon attracted much media attention. The national broadcasting company MRTV reported on it in a long news program and a local newspaper also reported it. These responses suggest the whole country is keenly interested in the ongoing efforts by MR to improve services.

Furthermore, the lectures of this program had the principal objective of encouraging respective staff to identify things they could do to improve services and consider improvement methods, mainly through group discussion. We found that several staff are aware of the issues also for items beyond their scope, for example, improving reserved seat management which is currently paper based, making it easier to purchase tickets, attracting facilities to the surroundings of a station, etc. In addition, they strongly wish to improve services for passengers by resolving such issues.
As pointed out by the staff, the matters to be handled by MR Headquarter, such as issuing tickets and lack of basic passenger infrastructure such as lavatories, should be steadily improved.

The same applies to matters requiring coordination with others, such as the development of secondary transportation measures; the field staff are broadly aware of such matters.
While promoting the improvements proposed by field staff, the executive of the Headquarter should also be committed to improving services and tackling the matter.

Another issue is future continuation. Like JR which has improved services for almost 30 years since its privatization, service improvement by MR will take a long time.
It is necessary to create a system allowing the whole of MR ranging from executives to field staff to share a sense of service and tackle the matter.
To do this, support should continue to be provided and several measures including assisting the preparation of a service manual suitable for local conditions and dispatching experts on cleaning and announcement depending on local requests should be examined.

2.6 Third round of service training (October 8–13)

(1) Current situation and issues of each field

We held the service training courses in Naypyidaw and Yangon in August and endeavored to disseminate the action policies such as “Awareness”, “Kaizen” and “Think for yourself and then act” to allow the field staff to take action to improve services. However, the current situation is at the level of “Plan” or even earlier in the PDCA cycle; further follow-up is required.

In addition, together with measures on site, the understanding and active assistance of executive staff for measures to improve services is needed.

(2) Method and contents of training courses according to the abovementioned issue

We had held a training course in Naypyidaw for the staff from all districts and a training course in Yangon District. This time, we held a training course using Yangon Station itself as a training site and focused on improving services at Yangon Station as a pilot study for service improvement by MR.

The contents consisted of lectures, interviews with passengers, discussion and presentation.

First, to the 20 staff gathered from every department of the site, the concept of customer-first and some Japanese examples of measures for improving services on site were explained.

Then, both the field staff and MR executives carried out interviews with passengers. They gathered opinions and comments from a wide variety of passengers on the platforms for long-distance trains and circular lines, and within the trains. The scene was reported in local TV stations, newspapers and Japan NHK’s Yangon bureau.

The interviews not only gathered various opinions and comments on improving services, but also showcased MR’s willingness to do so, both inside and outside the country.

For details of the interview results, please refer to Section 3.4.

In addition, a discussion on creating a draft improvement plan allowing field staff to carry out tasks by themselves was held. Using the fish bone technique, the participants identified the following topics for improving Yangon Station and created a logic tree based on it.

1. A clean and beautiful station
2. A station that is easy to use and provides necessary information that is easy to understand
3. A station that helps passengers when in trouble
4. A comfortable and convenient station

Lastly, a presentation session was held and the improvement plan was reported to Mr. Htun Aung Thin, General Manager of the Lower Myanmar Office and Mr. Kyi Win, Station Master of

Yangon Station. The draft report was submitted to the station master.

(3) Opinions from participants and the contents of discussion

Representative opinions and comments obtained from the discussion are as follows.

"Clean station"

- I want repairs to buildings, maintenance and keeping of buildings, cleaning of the first floor, and cleaning of the track and surroundings.
- Besides cleaning of rubbish, I propose planting flowers between tracks, making flower beds, or planting some trees around the station to create shade.

"Easy to understand guidance"

- Since there are no reliable signs at entrances and exits, I propose posting bilingual maps and signs at the entrance of the station and signposts to bus stops in station areas.
- Departure times and platforms of long-distance trains should be posted in both English and Burmese, and any delays and cancellations of trains should be announced and posted on a sign board.
- Signposts to ticket counters.
- While there are lavatories and shops, there are no signposts for them. Signposts should be installed where they are easy to see.

"Response to troubles"

- Back-up trains should be prepared.
- Refunds should be provided in case of train delays.
- In order to allow passengers to wait for delayed trains, appropriate rest spaces should be provided, and drinks or water should be provided.
- Estimated times of arrival should be announced.
- In order to allow passengers to continue their trip in case of trouble, passengers should be transferred.
- For assuring safety, there should be more patrols by railway police.

"Comfortable and convenient station"

- To create a good, relaxing station, cleaning should be improved. Passengers in trouble should be helped.
- Chairs and TV sets should be provided to allow passengers to relax comfortably. A campaign on manners should be carried out using visual materials.

- A medical office should be provided for first-aid cases. An ambulance should be on stand-by.
- A reliable left-luggage office should be provided.

While there were a great variety of proposals ranging from urgent actions to those requiring a long-term response including the Headquarter, all proposals have been carefully considered from the viewpoint of passengers. Some of them, such as “signs that are easy to understand”, have been promptly carried out. While the site is taking actions to implement items, the Headquarter, etc. should steadily tackle some issues by incorporating the opinions and comments from the site.

In addition, the day after the interviews by general staff, we asked them about the interviews and some said they had gained strong impressions. Some examples of comments from MR staff are as follows.

- When I asked some questions about passenger satisfaction, some people passed me by without answering. Some people gave negative answers, complaining about things we thought were sufficient, which was shocking.
- Until now, I had had almost no opportunity to hear customers’ opinions, and could hear only things which I wanted to hear. Finally, I could hear true opinions.
- I heard the comment, “Trains have become more punctual and our commuting has become more comfortable, since the bus route is congested.”
- Although I was self-confident…
- If we correct things based on passengers’ opinions, we can make improvements and satisfy passengers’ expectations.
- This kind of activity on the last day was the first time. I think it was excellent and I was very happy.
- From a teacher using the railway for commuting every day, I heard the comment, “Trains have become more punctual and easier to use for commuting.”
- I received a request for an active campaign by the MOTC against passengers throwing rubbish out of the train or smoking. I was startled.
- I heard a comment, “Trains towed by locomotive still run on the circular line even now. It should be stopped; circular operation should be like in Japan.”
- In my interview on the last day, when I told a customer I was interviewing in order to enhance passenger satisfaction, I received the positive response, “That’s great.”
- I heard a comment, “I want you to repair the track. Lines under JICA projects allow us to

ride trains comfortably. Hence, other lines should be upgraded similarly."

- I heard the view, "Although Yangon Station has some seats, there are too few. I sit on the floor on a rug. It must be tough for the elderly."

Many positive opinions and expectations for improvement by MR were received. But, although the staff think they are trying to improve services, passengers don't think so. Such awareness is a valuable result from this activity. On the other hand, although many positive opinions and comments were obtained from passengers, it merely reflects that MR has just begun to launch service improvements. Therefore, without future efforts by MR to steadily improve services, passengers' evaluation will change soon.

(4) Issues and lessons revealed by implementing the training courses

By gathering the participants who had attend the training courses in Naypyidaw and Yangon in August, smooth discussions were carried out.

Also at that time, following the previous training courses, we explained the ideas of "Awareness" and "Kaizen" and the concept of the PDCA cycle. Then, we introduced some topics of "three modernizations", i.e., the modernization of infrastructure, people and systems, and explained that passengers' expectations toward MR and its staff would rise by reinforcing the infrastructure promoted by Japanese assistance in future. Finally, we emphasized the need to reinforce services and the importance of launching the necessary measures from now.

In addition, we introduced and explained in detail some examples of field staff's proposals for improvements, implementation by themselves, and the results obtained, in a Japanese railway for improving services. These examples revealed how Japanese staff analyze passengers' opinions and the things that station staff might think to be insufficient, examined possible pilot cases and resolved them. We introduced the case of field staff making a noticeboard for passengers and attaching it by themselves, and a case which led to actual improvement. We thus guided MR staff on the process of doing things that they thought necessary.

In addition, we asked the trainees about the interviews of passengers by the field staff. As described above, they realized what is possible only through field interviews. The results suggested that service awareness and further actions can be expected.

On the other hand, as in the previous training courses, in the discussion many trainees said they didn't know the extent to which they should take measures.

Thus, continuous support by the organization is required in order to make good use of the valuable improvement proposals.

Furthermore, as described in the previous section, currently MR has many issues to be improved which cannot be resolved promptly by field staff alone, even though the site is aware of their

importance. To enhance staff motivation, the issues and improvement proposals should be steadily addressed.

2.7 Fourth round of service training (January 16–21)

(1) Current situation and issues of each field

Previously, we held the training course in Naypyidaw for the staff from all districts and then the training course in Yangon District. Even in Yangon where improvement measures are most advanced, the progress remained at the stages of "Plan" and "Do" in the PDCA cycle.

In every place other than Yangon, the situation remained at the level of the group training course held in Naypyidaw in August and no further progress was achieved.

Hence, this time, we planned to hold a training course to teach the participants the "Check" process in Yangon Station and, as a new trial, a training course to allow the participants to learn the "Plan" or "Do" process in Mandalay Station.

(2) Method and contents of training courses according to the abovementioned issue

The previous training course in October used Yangon Station as a training place and included lectures, interviews with passengers, and discussion and presentation of service improvement plans focusing on improving services in the station as a pilot case of improving services in MR.

In this training course, as the "Check" stage in contrast with the preceding training, we asked the trainees to discuss and present "things actually attained" and "things not yet actually attained" during the three months from October to the time of the training course.

Prior to the process, we emphasized that "Check" is not the same as "Inspection", but rather, it means looking back at actions taken by themselves, not assessing them through a simple pass or fail.

Therefore, an important point is discussion rather than assessment. Since service improvement in MR has only just begun even in Yangon Station, such discussion is difficult for field staff to do on their own. Hence, not only the results of improvement actions, but also things prevented from happening due to various reasons, provide useful lessons for future improvements. We endeavored to make each staff aware of this.

We explained some examples of measures for improving services in various departments of a Japanese railway company with the assistance from the OJT trainees visiting Yangon from various departments of East Japan Railway Company. In particular, we introduced such measures in the areas of "crew", "civil engineering", "signal and communication" and "Headquarter of Operation of Shin-Kansen (System Division)" and asked the person in charge of JIC to introduce the measures for "station".

In the lecture, we explained that services are provided not only by customer related divisions such as stations, but by every division in their respective ways. After the lecture, the trainees

discussed and presented their plans for tackling service improvement based on their activities for three months.

In Mandalay, through discussion with the trainees at the start, we found that none of them had participated in the service training course in Naypyidaw in August. Therefore, we extracted the essential contents from the three-day training course in Naypyidaw and taught them the fundamentals of service improvement.
The trainees were asked to consider the importance of service for a railway company, and we explained the fundamentals of improvement methodologies including the PDCA cycle, fish bone, logic tree and option matrix.
Then, like the training course in Yangon Station, OJT trainees from JR East Japan Railway Company and the persons in charge of JIC explained examples of service improvement activities in various departments of the Japanese railway company.
Finally, like in the first training course in Yangon Station, the trainees discussed and identified issues.

(3) Opinions from participants and the contents of discussion
Representative opinions and comments obtained in the discussion in Yangon Station are as follows.

The main “things actually attained” described by participants were:

- Arrival and departure of trains are announced in the station and transfer is guided.
- The train sets are as specified. Cases such as although a train should be 11 cars, a train of 10 cars arrives due to car troubles, for example, are prevented.
- Signposts to lavatories and restaurants, and guidance on passenger fares, are provided and easy to understand.
- Accidents and train delays are announced.
- When a transport trouble occurs, passengers are transferred.
- Estimated delays are announced.
- Routes to ticket offices and platforms on the Yangon Circular Line are signposted.
- Staff are more polite to passengers.
- Ticket sales can be bought using electronic money.

In contrast, the main “things not yet actually attained” described by participants were:

- Preparation and distribution of a guide map to various facilities in station areas
- A bilingual guide should be posted at the entrance of the station.

- Trains should start after passengers have completed getting on and off.
- Prohibition of riding on the roof and the spaces between cars.
- Preparation of a route map.
- Better connections to bus routes.
- Increase in the number of lavatories.
- It should be possible to purchase advance tickets not in the current place which is far from the station building, but in a near place.
- Although we want to extend the hours of selling tickets, it was not possible due to a staff shortage.
- Communication facilities to operate trains on time are insufficient.
- Signposts written in both English and Burmese are yet not popular.

In Mandalay Station, the situation is at a very early stage of service improvement. Thus, we emphasized that trainees should be aware of more fundamental points, i.e., “not top-down, but identifying things that can be attained by each section”. Compared to the case in Yangon Station, the staff came from various sections not just the customer division. We introduced some examples of how staff from various divisions in a railway company in Japan helped to improve services, which may be useful for future activities.

Then, we set the topics of “facility”, “train”, “track”, “staff”, “information/guide” and “safety” and discussed how each division could contribute to service practices.

(4) Issues and lessons revealed by implementing the training courses

We felt that in Yangon Station, awareness of service improvement will steadily increase. The issues they can resolve by themselves have been clearly proposed, and even if they cannot attain some suggestions by themselves, many of them can be resolved someday.

Indeed, during the period from the previous training course to this training course, guide panels written in both English and Burmese were posted in the station area, as shown in Photographs 2.7.1 to 2.7.3. For example, a hand-made board indicates the platforms often used by foreign tourists and guides long-distance trains to various destinations together with their train numbers on the circular line. Another large panel shows a detailed guide including the destinations of tracks of the circular line. Tourists walking through the station area often look at these notice boards.

However, although announcements have been improved, they are only given in Burmese, and as pointed out in the past, the tourist information guides are still difficult to understand. Although improvements are being made step-by-step, they will take time. We told them that the problem is not whether a thing will be tackled or not, but whether appropriate targets are set.

One factor determining the future direction of service improvement is whether services can be sufficiently improved by securing enough budget under the discretion of the station master or district general manager.
Also, a measure to be realized by the wishes and efforts of field staff without money should be made official someday. Hand-made paper signs are an example. Such issues should not be left forever. Also, various proposals have been made for improvements that go beyond the efforts of field staff alone. Hence, a system for dealing with them step by step should be realized.

In Mandalay Station, through discussion with the trainees, we had to run the training course from the beginner's level as a pre-stage rather than "Plan" or "Do", like the training course in Naypyidaw in August 2016. Partly because none of the staff who had participated in the training course in Naypyidaw attended the present course, we felt that while they were interested in service, the awareness of field staff will grow.

In order to improve services overall, rather than just here and there, regardless of whether the training course is held at a station or in Naypyidaw, a long and sustained effort is required.

Photo 2.7.1: A signpost in a concourse at Yangon Station

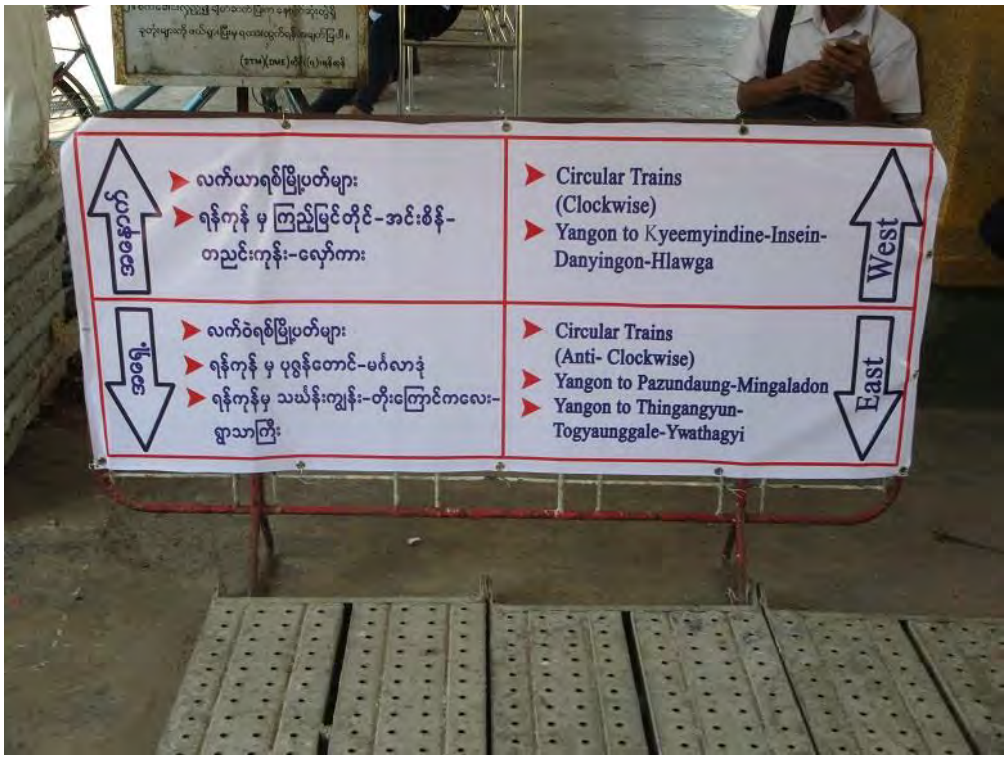


Photo 2.7.2: A signpost on a circular line platform at Yangon Station


Photo 2.7.3: Passengers looking at notice boards on a circular line platform at Yangon Station

3. A Review of the Training Program

3.1 Upon completion of the training program

We held various training courses including service training for MR staff from March 2016 to January 2017. While the program was originally launched using a training facility in Naypyidaw, through discussions with MR, it was considered that the training program should be implemented on site. Therefore, in the latter half of the program, the meeting room of the Lower Myanmar Office in Yangon and Yangon Station was increasingly used.
We consider that holding the training program in this way was good not only for carrying out lectures, but also for practical activities. In particular, the service training course was expanded to include Yangon Station and the training course in Mandalay, at the strong request from MR.

Thus far the training courses by MR have been implemented mainly by lectures in Meiktila and the Headquarter, etc. In this program, focusing on MR Headquarter, we emphasized the need to change the awareness of the executives of the Headquarter. The objective of the training program is not simply to implement it by Japan for MR, but rather to improve the current situation by relating the training course to actual practice.

The training program was reported in various media both in Myanmar and Japan. TV stations broadcast scenes of the GM of the Lower Myanmar Office directly interviewing passengers, and a newspaper carried an article about the training program. Hence, this six-month training program encouraged a change in attitude of MR in Myanmar.
MR should continue to make improvements through a bottom-up training program by themselves. If requested, we will continue to help MR improve their business through coordination with related organizations.

Reference: Media which reported the training program
TV stations in Myanmar: MRTV, MRTV-4 and MITV
Newspapers in Myanmar: New Light of Myanmar, a local newspaper
Japanese TV station: NHK
Japanese media: International Development Journal

3.2 Impressions of the Trainees (Extracts)

We requested the trainees to complete a questionnaire in each training course. This section summarizes representative opinions and comments on the courses.

The questions were as follows.

1. Points well understood
2. Points wanted to learn further
3. Current issues in your job
4. Your future vision for the organizational management of Myanma Railways
5. How will you implement your vision after returning to Myanma Railways?
6. What course you want to attend in future?

3.2.1 Service training

1. Points well understood
I learned how to analyze issues in my current workplace. It was very good training and I could obtain knowledge. It was very good training, etc.
2. Points wanted to learn further
I hope it will be held again in the future. If I am invited to another seminar, I will participate. I want to learn how to improve the skills and thoughts of the staff. I want to learn more about things relating to MR. Leadership training. I want to participate in some foreign-language lessons including English and Japanese and to provide service to not only local customers, but also foreign customers. I want to take a training course for customer service. I want to attend service training courses in future too. I want to learn about management. I want to attend training courses on signaling and transportation.
3. Current issues in your job
MR has various weak points. MR staff must take responsibility for them. Accidents must not occur. Each staff must work to prevent accidents. Improve skills and staff. The process of maintenance should be improved. MT has many weak points. The attitude of staff must be changed. The poor quality of communication lines causes difficulties. There is no restroom. Perfect service is not provided. At Insein Station, there are trains every night in the station yard, which cause delays. When inspecting tickets, sometimes I see passengers who are struggling to get on and off trains, so I help them. There is a dangerous hole in the floor of the entrance/exit in the station area. Since there is no lavatory, passengers struggle.
4. Your future vision for the organizational management of Myanma Railways
All staff should confirm the completion of their job. Management should reliably grasp the issues occurring on site. MR will be modernized through technical and economic assistance from advanced nations including Japan.

We should endeavor to carry out smooth communication to prevent accidents. We need a training course on it. Training courses should be improved in a discussion style. The system of MR should be changed to modern management style. By changing management methods, we want to provide perfect service. Managers should take responsibility at respective stages. The executives of MR should teach duty and responsibility to subordinates. Under professionals, I want to change the management of MR. Various engineers will be required in many fields. I want MR to include measures for on-time train operation into future management plans.
5. How will you implement your vision after returning to Myanma Railways?
I want to reduce accidents. Safety is the most important matter for passengers. I try to understand fundamental facilities. I will continuously enhance construction technology. I will carry out daily inspection and maintenance. The supervision and management for all MR staff should be changed. I try to disseminate the things I learned in my own workplace. I want to provide a sense of security to customers. I want to convey the things I learned to subordinates and fellow workers and provide service to customers. Together with subordinates, I want to aim at perfect work to make customers satisfied with the service. The first objective is to relax customers and not to expose them to danger. The thinking of staff is changing and they are tackling their duties and responsibilities in a reliable manner. To enhance the service by MR, I want to share this lecture and make efforts together with my colleagues. I want to take action to enhance customer service.
6. What course you want to attend in future?
I want to learn about management in order. I was happy to learn how to resolve problems. Workshop to enhance technology and the skills and thinking of staff. Training program which can change the supervision and management by all MR staff. Workshop on transportation. I want to attend a course on the growth of MR. I want to learn about computerized train control. I want to learn computing, English, Japanese and Chinese.

If another training course on customer service is held, I want to participate.
Various languages.
Training course on customer service and management.

3.2.2 Training for station development and station facilities

1. Points well understood
What is TOD? Definition of a station and its functions. Development and how to change methods of quality control. I could understand the contents completely. I could understand the contents sufficiently and was satisfied with the good lecture and interpretation. I could understand the contents.
2. Points wanted to learn further
Design concept of stations. Japanese circular railway and stations. Investigation and bridges. Inspection of railways. Construction of bridges and generic civil engineering technology. “Awareness” and “Kaizen”.
3. Current issues in your job
Mismatch between supply and demand. Lack of facilities. No problem. No problem. Staff have little interest in customers.
4. Your future vision for the organizational management of Myanma Railways
I want many nations to assist our new government. Facility management of MR should be enhanced. We require advanced technology and equipment for inspection and measurement. I want to improve the project with advanced technology and machines. We should improve management.
5. How will you implement your vision after returning to Myanma Railways?
I want to change the process of station development. I will confirm and investigate bridges and buildings. When returning to my workplace, I will try to improve conditions. Safety. On-time train operation. Customer satisfaction.
6. What course you want to attend in future?
How to design and construct an example station. I want to attend a workshop on civil engineering by MR. I want to attend a lecture or training on civil engineering. Subways.

3.2.3 Training for underground and tunnel facilities

1. Points well understood
I could learn fundamental knowledge on the planning, investigation, design and construction of tunnels. I could learn fundamental knowledge on tunnels, and the planning, design and construction. I could understand well. I could learn each step of construction work, planning and work control of tunnels.
2. Points wanted to learn further
How we should reflect the investigation results from mechanical and physical techniques to actual design parameters, namely, the design of shotcrete mortar, rock bolt and lining. I want to learn about detailed analysis and the design of underground tunnels in urban areas. This course was held for two days and was very short. In one week we would learn more. I think a longer schedule is better. I want to learn about details and examples.
3. Current issues in your job
MR has 12 old tunnels. I want to investigate them and learn investigation methods. In addition, how the subway in Yangon will be planned. A knowledge of tunnel engineering may be insufficient. I have encountered problems handling concrete equipment on site, but I could resolve it. The reinforcement of technical support and staff. Preparation of required equipment.
4. Your future vision for the organizational management of Myanma Railways
Urban traffic also plays an important role in the economy. Public Private Partnership (PPP) in railways should be used. If MR could improve technically, the whole of MR would be better. If the advancement of technology contributes to the growth of the nation, MR will also be able to grow.
5. How will you implement your vision after returning to Myanma Railways?
I will learn things required for urban traffic. I will create a draft development plan for railway transportation. I will learn about underground transportation, including subways. I will tackle underground traffic systems. I want to alleviate the congestion in Yangon with tunnels. I want to work on constructing high-speed railways. I want to share knowledge with superiors and subordinates. I want to do my best in MR.
6. What course you want to attend in future?
I want to learn about subways and the construction of infrastructure required for subways. I want to learn about infrastructure for public urban traffic.

Construction of steel girder bridges. Infrastructure for railways.

3.2.4 Safety training

1. Points well understood
I could understand the basic policy for safety of the JR East Japan Group and “Four Columns” in “Group Safety Plan 2018”. I could obtain good ideas for safety. I could understand Japanese safety control and acquire much knowledge. I could understand well, etc.
2. Points wanted to learn further
How we should create a plan for safety. I want to learn more about the commercial aspects of railways. I want to learn more than was provided in this program. For example, a system by which car doors and platform doors open automatically when a train stops in a station. How to construct track and bridges that can withstand earthquakes.
3. Current issues in your job
Facilities for safety and knowledge on safety may be insufficient. Lack of track maintenance is a serious problem. All infrastructure is old. Although I have no problem in my job, MR has several issues: most locomotives and RBE are very old.
4. Your future vision for the organizational management of Myanma Railways
Enhancement of facilities for safety and knowledge of safety. Promotion of sustainable development of transportation facilities. The lack of knowledge may be a problem. I believe that the organizational management of MR will improve in the future with assistance from JICA.
5. How will you implement your vision after returning to Myanma Railways?
I want to guide locomotive operators. I want them to become good, safe operators. I want to reduce accidents in a reliable manner based on the results of this seminar. I will try to establish a culture of safety in our organization. I want to give priority to renewing safety-related equipment. I want to work honestly like Mr. Matsuo. I want to develop the necessary environment. I want to think of ways to improve MR and my work.
6. What course you want to attend in future?
I want to learn much knowledge and about safety management. The modernization of MR. Workshop to enhance the organizational management of MR.

Workshops on civil engineering, mechanical engineering and operation.

3.2.5 Training for electric power facilities

1. Points well understood
The three major accidents in electric power facilities. Electric power facilities and electric power distribution. Electric power supply, transformation of electric energy, electric power distribution, overhead contact line and hybrid cars. Major accidents in electric power facilities etc. I could understand all contents well and everything was interesting.
2. Points wanted to learn further
I want to learn about the technology of electric power supply facilities and control of electricity. Electric power facilities and overhead contact line. Facilities for electrification, power distribution and the safety system of electric power facilities for railways. Substations.
3. Current issues in your job
Test facility relating to electricity, spare parts, etc. In my workplace, safety facilities are insufficient. Shortage of experienced engineers. Regardless of OJT or OFF-JT, we require more training on electricity. Shortage of experienced staff and safety facilities.
4. Your future vision for the organizational management of Myanma Railways
Future realization of electric operation should be examined. More electric engineers will be required. MR is currently upgrading all sectors. We require knowledge and experience on modern railways and training for management will also be required. It may be better to restructure MR into separate organizations such as an operational division and a car maintenance shop.
5. How will you implement your vision after returning to Myanma Railways?
I want to learn more about technologies of electric power facilities and transformation of electric energy. I want to share knowledge and provide advice. To use electricity safely, I want to continue strictly following the safety-first principle. I want to share knowledge and experience with subordinates. I want to make utmost effort to make our railways better. I want to disseminate safety as top priority for all of us, and such policy on the correct use of

safety facilities.
6. What course you want to attend in future?
I want to learn about maintenance of overhead conductor lines. I hope that each state and district will hold a workshop on electricity. I want to attend workshops on the electrification of railways and electric power distribution. I want to learn about modern safety facilities for usage of electricity.

3.2.9 Analysis

On “Points well understood,” several participants responded that they could understand the explanations lecturers gave very well. Many staff described what they could understand in detail. It was frequently noted that the schedule would be too short, and participants expressed their desire to attend training programs in the future.

On the other hand, in response to, “Points wanted to learn further,” participants offered various opinions and comments; for example, methods to improve participant skill and thinking, station design, technical details of tunnel construction, how to create designs for safety and platform doors in Japan, safety system of electrified railway, leadership and service for foreign tourists, etc. All ideas would be indispensable for the future growth of railway industry in Myanmar. Many participants would hope to realize these ideas in the future.

Looking at responses to, “Current issues in your job,” we found that many participants have individual opinions on issues that MR and sites have. For example, several participants pointed out the shortage of knowledge, facilities and experienced engineers, issues of service, safety, ageing and so on. It is worth mentioning that participants serving as technical staff also pointed out a tendency toward indifference to customers. Furthermore, in the service training course, in addition to the above-mentioned items, the poor quality of the communication network, possibly pointed out by a person in charge of transportation, and a comment on the discrepancy between the higher floor of RBE and lower platform, might be remarkable.
On the other hand, some participants indicated that there were no problems.

Similarly, responses to, “Your future vision for the organizational management of Myanma Railways” revealed that many participants were aware of current MR management issues. Some participants requested implementation of training programs for the grasping of issues occurring at sites, the desired configuration of organizations, and communication. Some participants noted that training courses on modern railways, and experience and management should be held. Other participants requested the introduction of advanced technology and equipment.

In response to, “How will you implement your vision after returning to Myanma Railways?,” participants expressed the desire to transmit knowledge to fellow workers and subordinates after returning to their workplace or to endeavor to establish a culture of safety. These comments suggest the desire to make MR better. Many in the categories not limited to the service training

course referred to customers. Some pointed out that the mindset of MR staff would change. An awareness of the issues related to urban traffic in Yangon was also evident.

As for the final item, “What course you want to attend in future?,” some indicated the desire to learn computer technology, foreign language and transport issues, as well as management, civil engineering and electrification. Many comments indicated that participants earnestly wish to continue learning service practice.

In addition, in the service training course mainly for the MR sales department staff, there were many requests for implementation of a training course in transportation. In particular, transportation-related jobs, including station signal handling would be indistinguishable from on-time and safe train operations. Hence, the implementation of such a training course may need further consideration to contribute to the enhancement of the service level.

3.3 Results from passenger interviews

3.3.1 Passenger interview

In the third service training course at Yangon Station, to incorporate passenger voices into service improvement and to highlight the attitude of MR toward service improvement, passenger interviews were conducted in the Yangon Station yard.

Firstly, on the afternoon of Monday, October 10, the general staff of Yangon Station conducted interviews. Pairs conducted interviews at various locations in the station yard, including the platform of track No.1 for long-distance trains, tracks No. 6 and 7 of the circular line, and inside cars on the circular line. They interviewed 39 passengers in total.

On Tuesday, October 11, the following day, the executive staff, including Mr. Htun Aung Thin, the General Manager of the Lower Myanmar Office of MR, and Mr. Kyi Win, the Station Master of Yangon Station, conducted interviews. They placed a desk and chairs on the concourse next to track No.1 and interviewed a total of 18 passengers.

This instance of executive staff listening directly to passengers was a first for MR. Both MR staff and executives actively gathered passenger voices while posting ”Listening to customer comments” both in English and Burmese on notice boards. These postings remain in Yangon Station yard as this report is being written, and they continue to highlight the attitude of MR to passengers.

Implementation of interviews and the direct gathering of various passenger voices was reported by domestic TV stations, newspapers, Japan’s NHK and the International Development Journal, and showed MR’s active attitude toward service improvement inside and outside the country.

The questionnaire used is shown in the attachment. The sheet translated to Burmese was used.

3.3.2 Passenger interviews: Analysis 1

"About yourself"

The first question asked information about passengers.

The distribution of sex and age may suggest that we gathered responses from the full range of passengers.

In addition, interviews were conducted during the 15:00 to 16:00 time slot on the first day and at about 10:00 in the second day. Hence, more passengers from the suburbs who may be users of mid- to long-distance trains than city passengers were covered. On the second day in particular, the interview was conducted near track No.1 only. This is where long-distance trains depart and arrive. Also such a location might influence results.

While occupation was sometimes left blank, various occupations were entered; and hence, a wide range of passengers was covered.

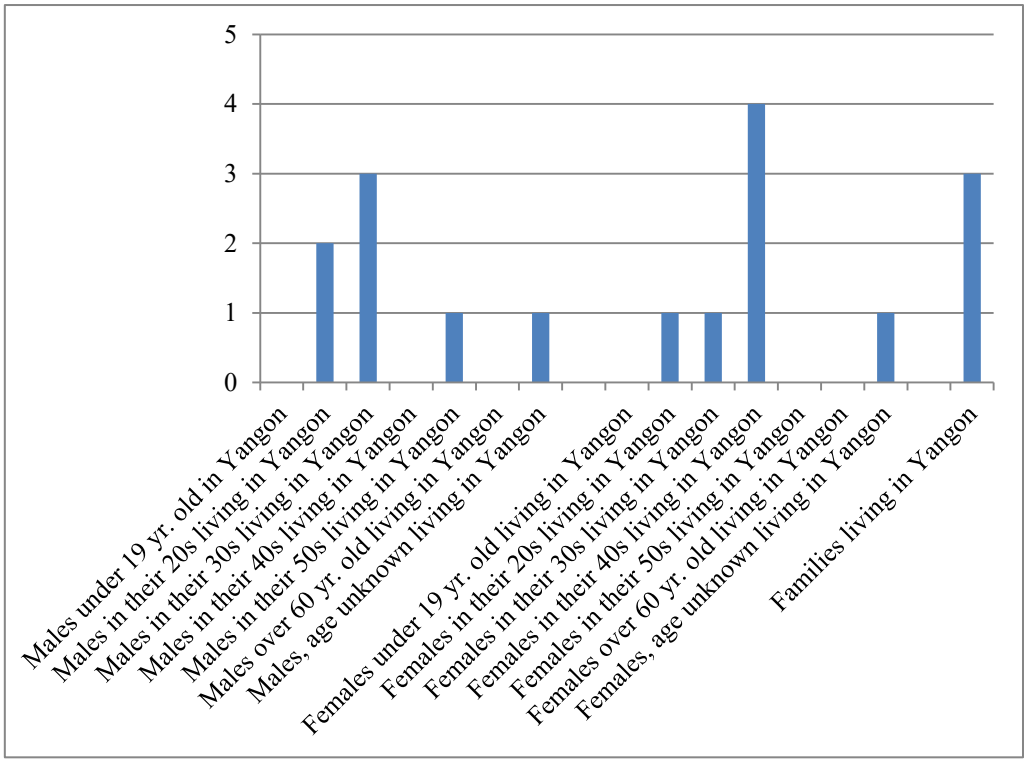


Figure 3.3.2.1: Distribution of respondents: Residents in Yangon City
(17 people and groups in total, on October 10 and 11, 2016)

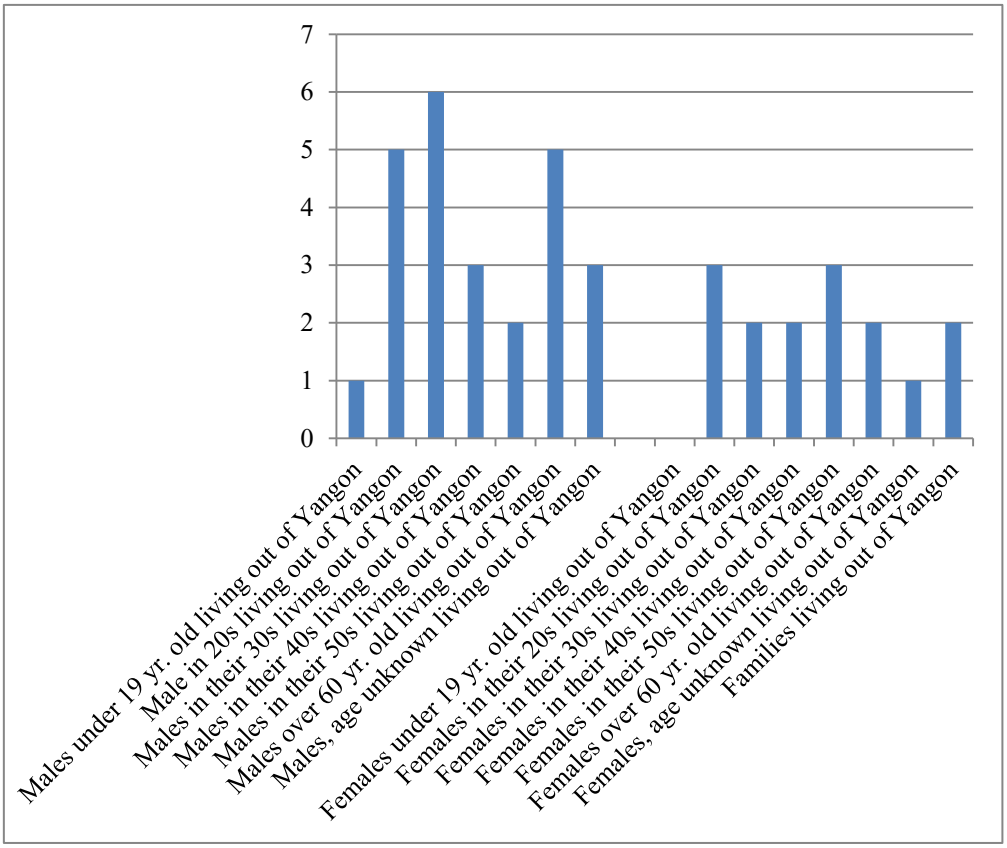


Figure 3.3.2.2: Distribution of respondents: Suburbanites

(40 people and groups in total, on October 10 and 11, 2016)

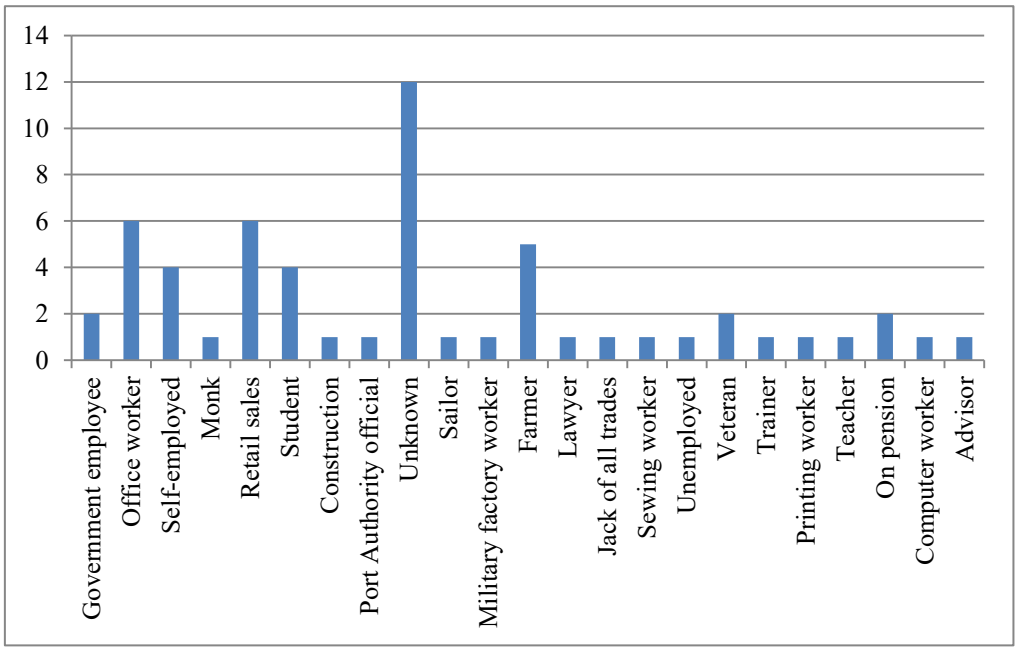


Figure 3.3.2.3: Distribution of respondents: Occupation

(On October 10 and 11, 2016)

3.3.3 Passenger interviews: Analysis 2

“The purpose of coming to Yangon Station today”

Question No. 2 was on the purpose of coming to Yangon Station.

Since the questions in this subsection and later requested written and multiple answers, or answers may not have been provided, the number of answers is not necessarily equal to the number of respondents.

In part because rush hour periods were not included, the response, “commuting,” accounted for approximately 10%; and many passengers indicated “something to do” (including “business etc.”).

Since several responses were gathered on the platform for long-distance trains, a relatively large number of respondents indicated “travel.” In parallel, a large number of respondents indicated “hospital-related.” Some respondents indicated “visit to a hospital etc.”

Remarkably, respondents indicating “driver license” accounted for approximately 10%.

An issue to be reconsidered for this question would be that since the aim of the question was vague and the translation to Burmese could not necessarily catch its correct aim, various answers to the questions with various potential meanings were intermingled. For example, the question might be understood as follows: “For what purpose do you take the train?” “Why do you use train instead of other transport?” “What is the reason you came to the station?” Hence, although some answers such as “Because it is fast and inexpensive,” “It is better than the bus” or “Because of congestion” were provided. Future interviews should set a separate question for “What is the reason you use the train?”

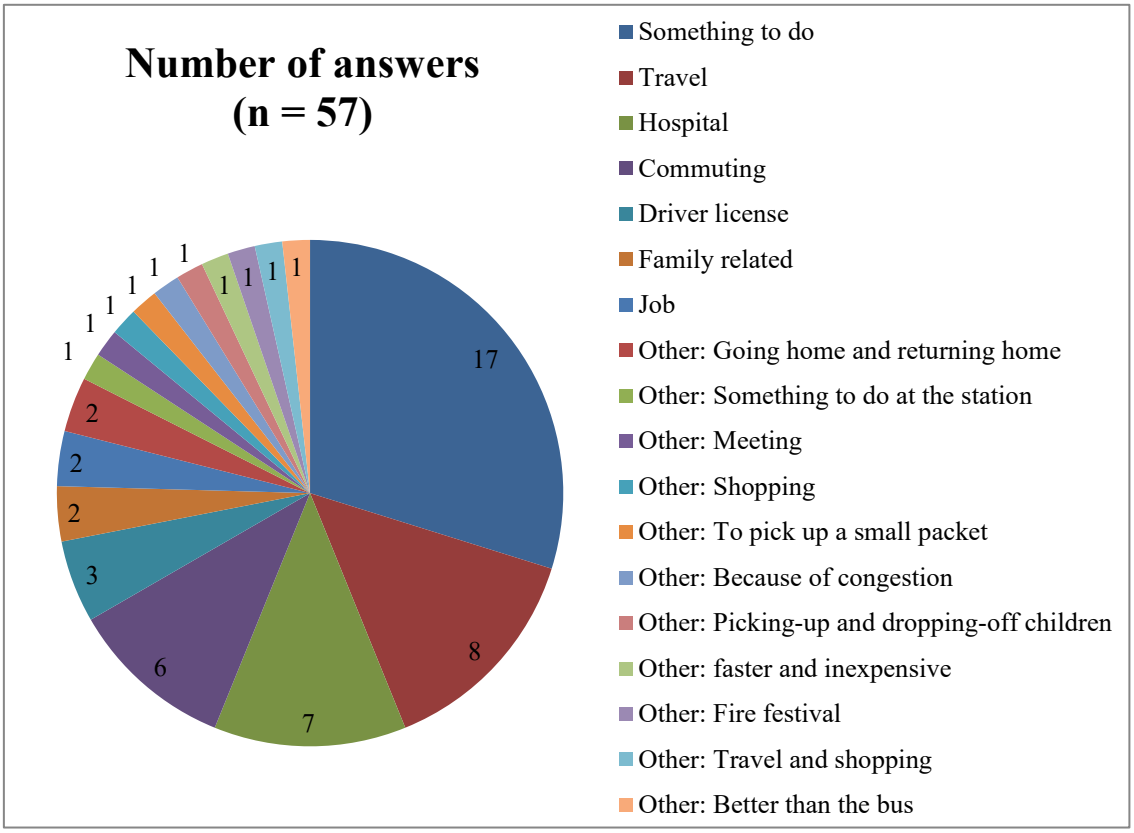


Figure 3.3.3.1: “The purpose of coming to Yangon Station today”
(On October 10 and 11, 2016)

3.3.4 Passenger interviews: Analysis 3

"How often do you use Yangon Station and Myanma Railways?"

Question No. 3 was on the frequency of train use.

As with the preceding question, since the time window of interview did not overlap busy hours, the percentage of passengers using the train every day accounted for 20% or less. Furthermore, the percentage of passengers using the train once to twice per month accounted for nearly 30%; and the fraction summed with that of the responses indicating train use three to four times per month reached 35%. In other words, most passengers who currently use MR trains would use MR regularly regardless of frequency.

In contrast, two passengers indicated using MR for the first time. Even though the fraction is small, future measures to encourage such passengers to use trains as customers from now should be required to increase passengers.

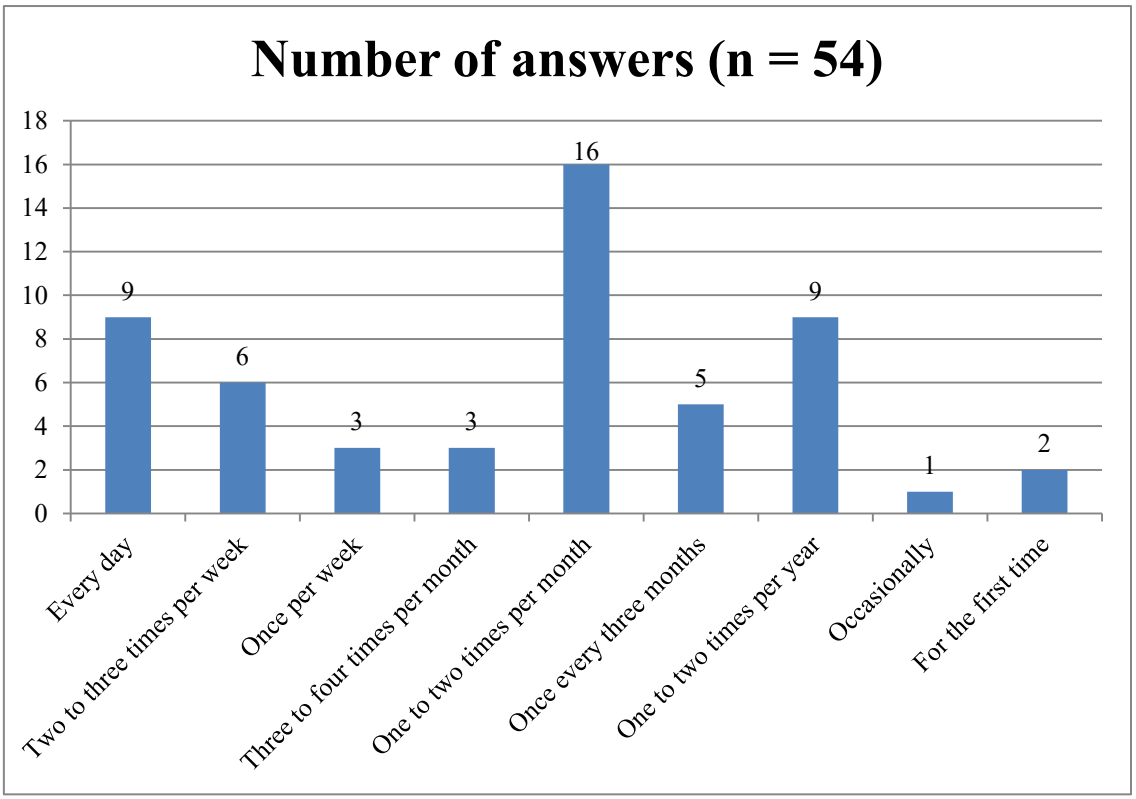


Figure 3.3.4.1 "How often do you use Yangon Station and Myanma Railways?"
(On October 10 and 11, 2016)

3.3.5 Passenger interviews: Analysis 4

"What transport are you using to *commute* from your house to your place of work?"

Question No. 4 was on the transportation for the commute to the workplace.

Twenty passengers indicated that they use the train, and these passengers accounted for approximately half. To question No.3, nine passengers responded that they use the train every day. It could, however, be inferred that even if passengers do not use the train every day, a relatively large number of passengers would use train for the commute to their workplaces.

While there were few examples of transit between train and bus, the number of cases in which a bus was utilized was fewer than the train; and the fraction was comparable to that of a car.

While motorcycles are prohibited in Yangon City, a relatively large number of people use motorcycles, probably since many passengers live in the suburbs.

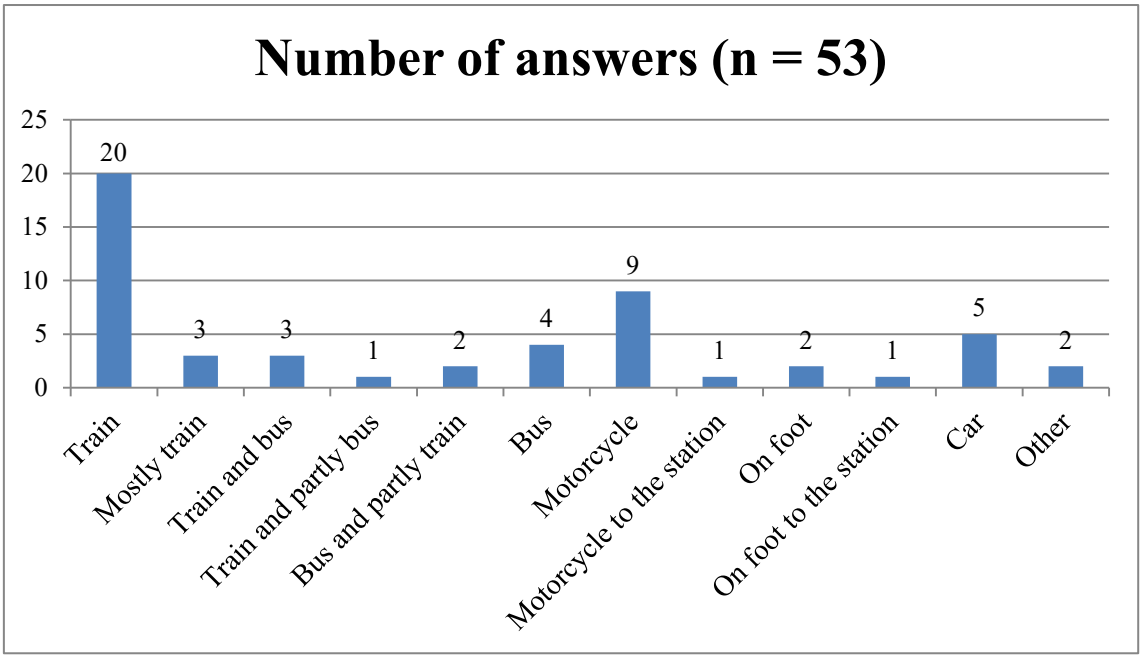


Figure 3.3.5.1: "What transport are you using to *commute* from your house to the workplace?" (On October 10 and 11, 2016)

3.3.6 Passenger interviews: Analysis 5

"What transport do you use to *travel*?"

Question No. 5 was on transportation used for travel.

At first glance, the cases of train use account for the majority. There also were responses such as "Train when moving long-distance" and "Train when accompanying family." Train use accounted for approximately 70%. Given that the majority of respondents to the questionnaire would be passengers who use medium- to long-distance trains, it may be required to ask the same question during morning and evening busy hours to identify any difference between them.

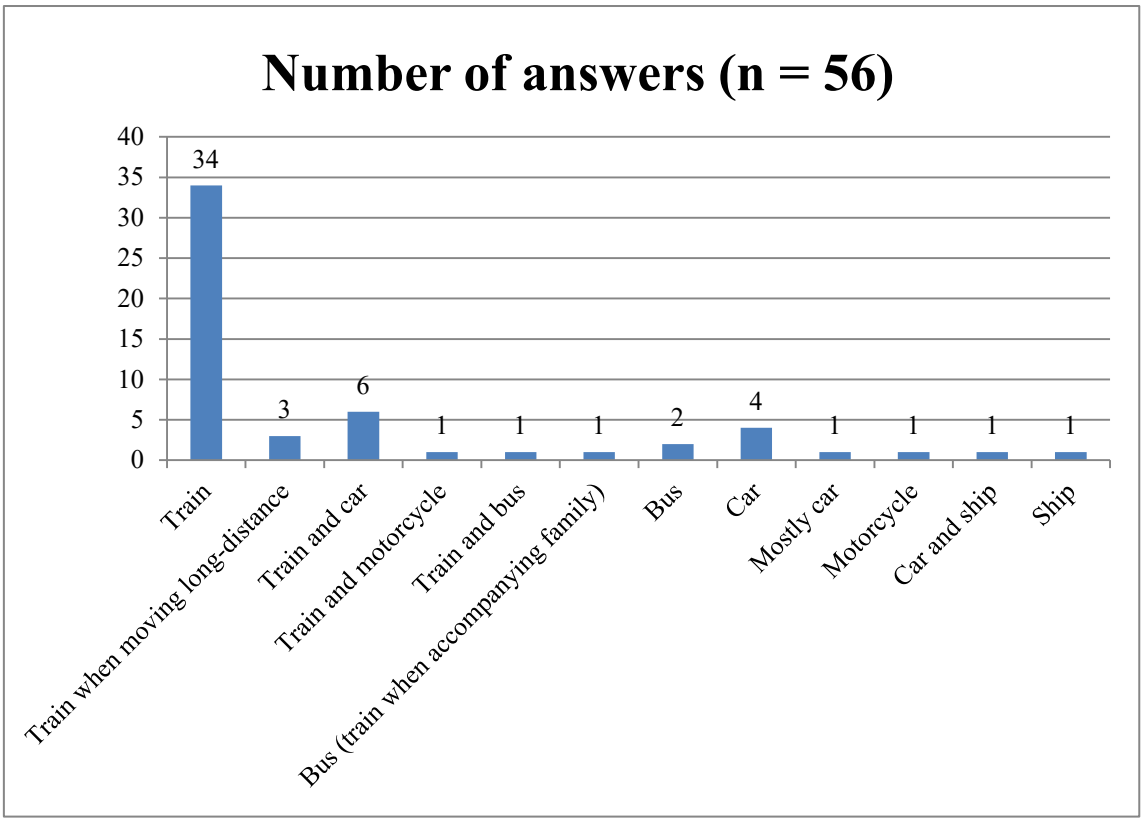


Figure 3.3.6.1: "What transport are you using to *travel*?"
(On October 10 and 11, 2016)

3.3.7 Passenger interviews: Analysis 6

"How do you evaluate the service of Yangon Station and Myanma Railways?"

Question No. 6 was on the level of service provided by Yangon Station and MR. At first glance, the number of responses indicating "Good" was remarkably large. Among these, the positive comments on recent changes such as "The situation is recently becoming better than before," "Cleaning in Yangon Station is being improved," "The environment in trains is becoming better than before," "I'm surprised by service improvement activities" and "I'm happy to see changing conditions" were given.

Then, as comments on train operation, some desires such as "I hope that passenger cars will be abolished on the circular line and that all trains will be operated in a circular manner," "I hope for an increase in the number of trains during busy hours" and "I hope to have six trains every 30 minutes (five minutes head)" were given. In contrast, some responses indicated that "Train operation is becoming on-time" were given

Remarkably, several issues regarding passenger manners were pointed out. Related to the answers to succeeding questions, comments included "Cars are comfortable, but I want passengers to take more care," "Smoking in cars is unpleasant," "Cars are not comfortable since luggage is placed on passenger seats" and "I want passengers to use manners."

Among the comments on cars, one passenger "is thankful that RBE cars are being operated also on local lines, such as the section between Mandalay and Kawlinn." RBE trains were newly introduced in July 2016 to improve convenience. The opinions suggested that the improvement in hardware is steadily being infiltrated among passengers, even if at a slow pace. Similarly, while some praised air-conditioning and toilets in cars, others requested further improvement.

On cleanliness and cleaning, some commented that the situation is becoming better than before, and others commented that cleanliness at mid-stations is insufficient or that some cars are good but others are not."

Several comments on stations referred to seating. While some requested an increase in the amount, others pointed out the damaged condition.

On the other hand, trains and booking clerks at Yangon Station received high evaluation. Some, however, pointed out that since passengers must stand in line, better line control should be required.

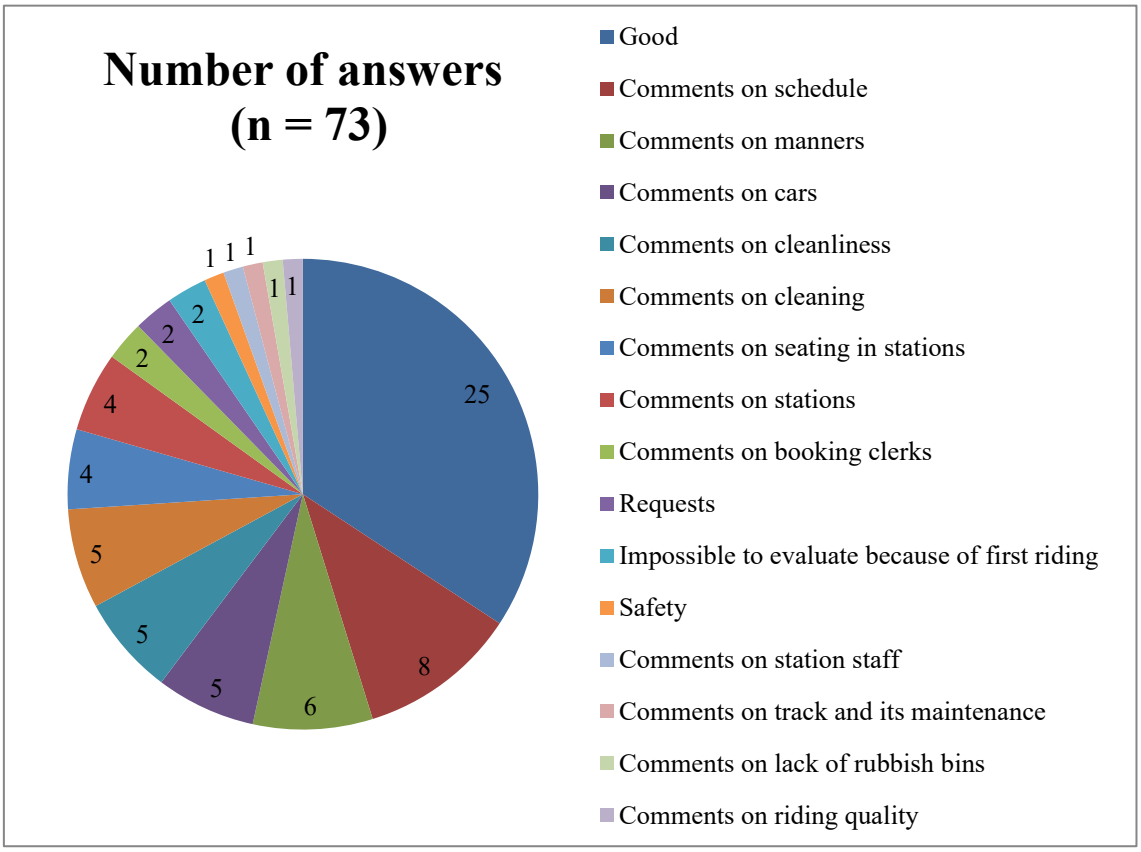


Figure 3.3.7.1: “How do you evaluate the service of Yangon Station and Myanma Railways?”
(On October 10 and 11, 2016)

3.3.8 Passenger interviews: Analysis 7

"How do you evaluate the attitude of Yangon Station staff?"

Question No. 7 was on the evaluation of the attitude of Yangon Station staff toward passengers. Multiple equivalent answers were consolidated into the category of "Other."

Twenty-eight positive evaluations and six evaluations in particular for good hospitality to passengers were given. Hence, a relatively high evaluation was given. Some respondents noted the attitude toward service improvement and others pointed out a change from before.

In contrast, some said that "Since staff are national civil servants, this is the level of service that can be expected" and others pointed out insufficient cleaning in cars. Some also requested an increase in the seating.

We received one severe comment regarding a booking clerk for the circular line station that was playing with his phone and did not respond to the passenger properly.

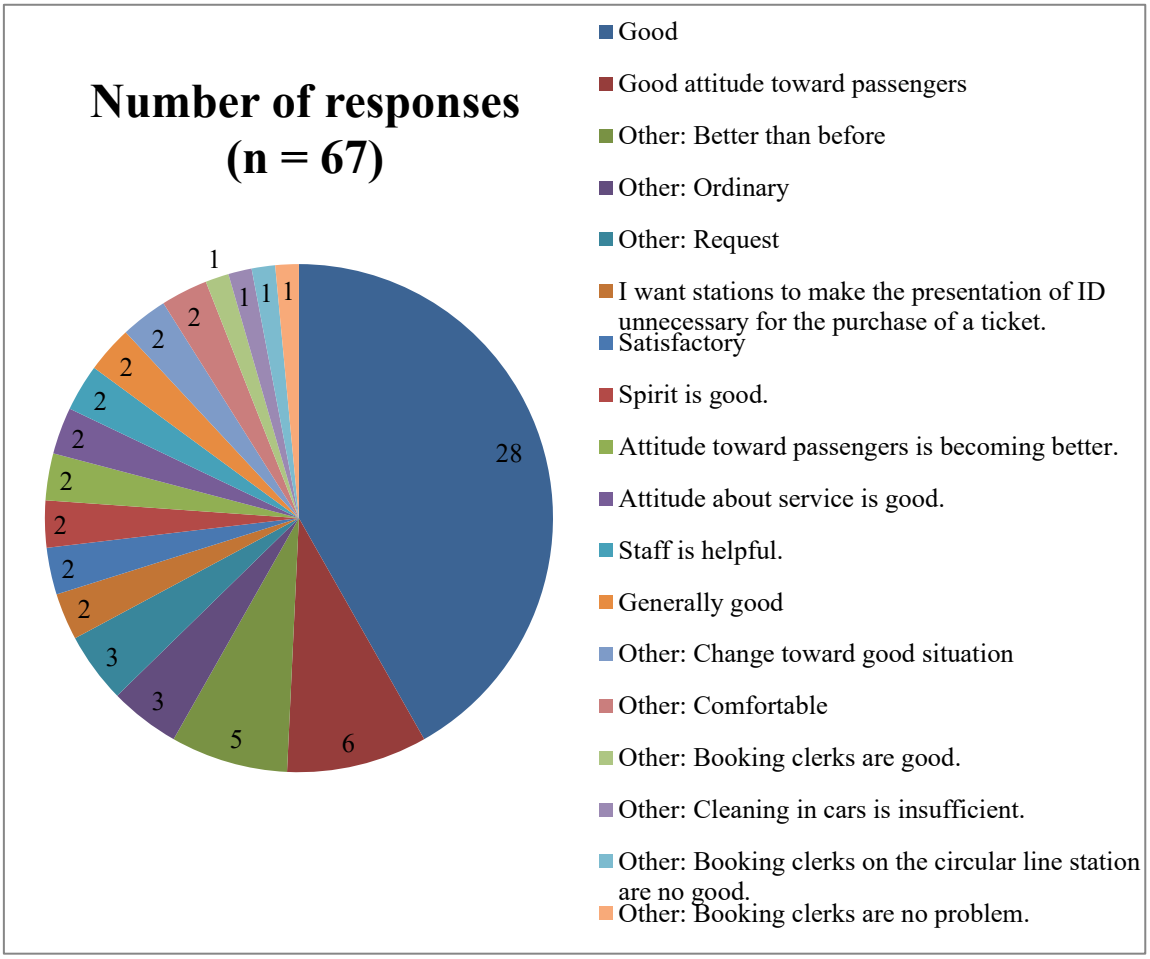


Figure 3.3.8.1: "How do you evaluate the attitude of Yangon Station staff?"
(On October 10 and 11, 2016)

3.3.9 Passenger interviews: Analysis 8

"How do you evaluate the cleanness of Yangon Station?"

Question No. 8 was on cleanliness in Yangon Station.

Half of respondents indicated "Clean," "Clean and good," "Environment is becoming cleaner," or "Good," "Becoming better," or "Good but could be better." However, some indicated, "I want the station to increase the number of rubbish bins," "Should clean" and "I want the station to make the environment as clean as Bagan Station".

Also in response to this item, some pointed out that "Together with the staff, passengers should also obey the rules" and "Some passengers do not pay attention to manners on the platform or in cars."

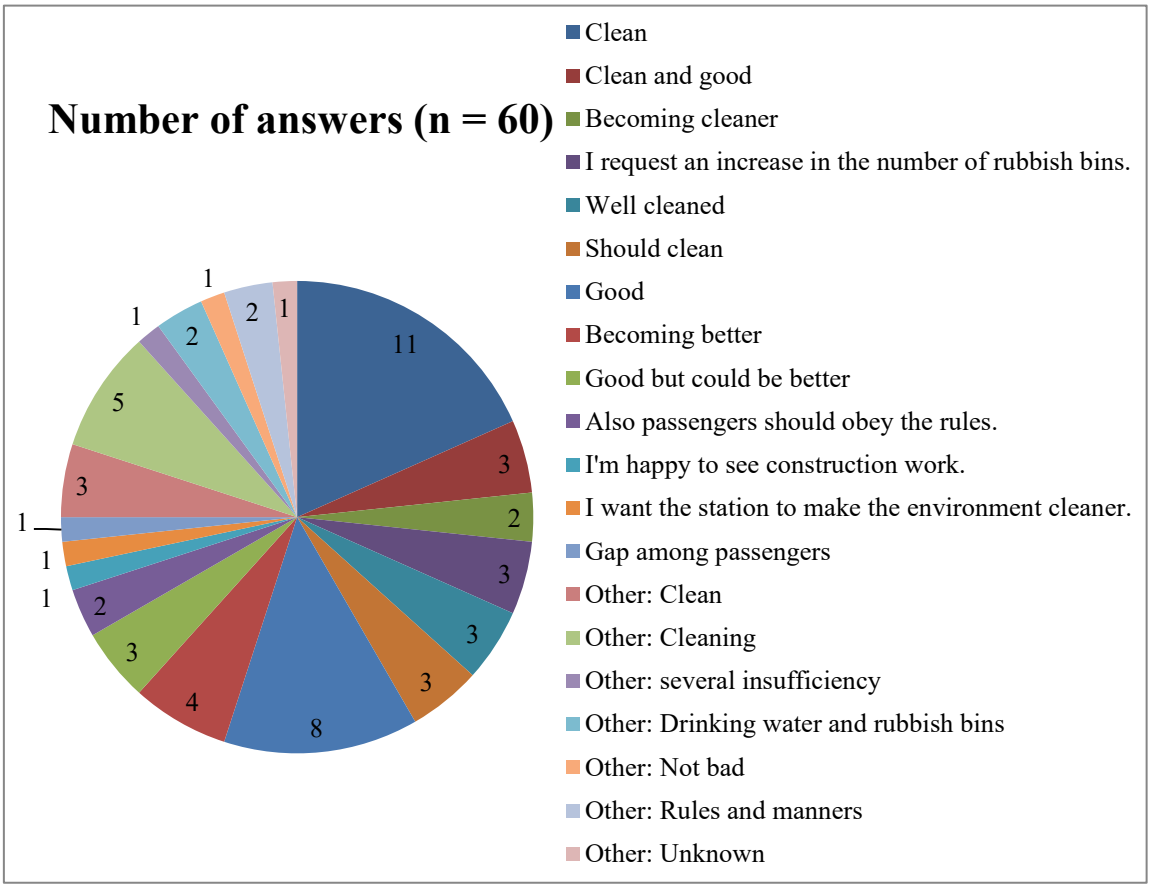


Figure 3.3.9.1: "How do you evaluate the cleanness of Yangon Station?"
(On October 10 and 11, 2016)

3.3.10 Passenger interviews: Analysis 9

"How do you evaluate the waiting facilities at Yangon Station?"

Question No.9 was on the waiting facilities in Yangon Station.

One fourth of responses were positive. However, a comparable number of respondents pointed out the lack of seating on the circular line. It can be inferred that although the amount of seating in the concourse of the long-distance trains may be generally sufficient, seating on the circular line platforms may be significantly insufficient.

Also, some requested announcements on manners and luggage placed on seats.

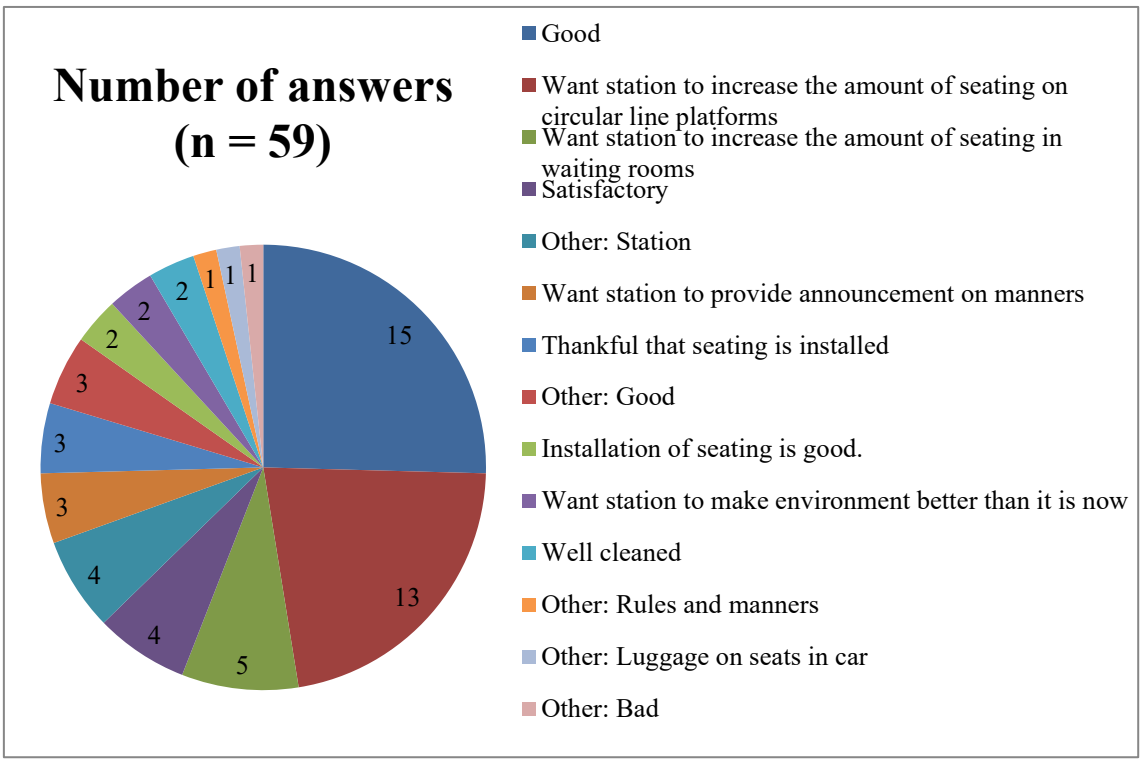


Figure 3.3.10.1: "How are you evaluating the waiting facilities at Yangon Station?"
(On October 10 and 11, 2016)

3.3.11 Passenger interviews: Analysis 10

"What are the "Good Points" of Yangon Station and Myanma Railways?"

Question No. 10 was on the "Good points" of Yangon Station and MR.

The largest number of responses was "Trains run on-time during busy times," and the second largest was "Convenient facilities including Wi-Fi, electric fans, TV, charger equipment, bookshelves, water supply, clocks and lavatories." Some passengers pointed out that promptness has improved in recent years. Including Wi-Fi and charger equipment, these comments reveal the steady positive evaluation of passengers regarding recent improvements.

Similarly, some indicated that "Modernization is being promoted," "I am satisfied with RBE cars" and comments on tickets included "Tickets have become easier to purchase" and "No black-market for tickets now exists." As for negative responses, some passengers pointed out that even if passengers request information, staff do not provide reliable answers.

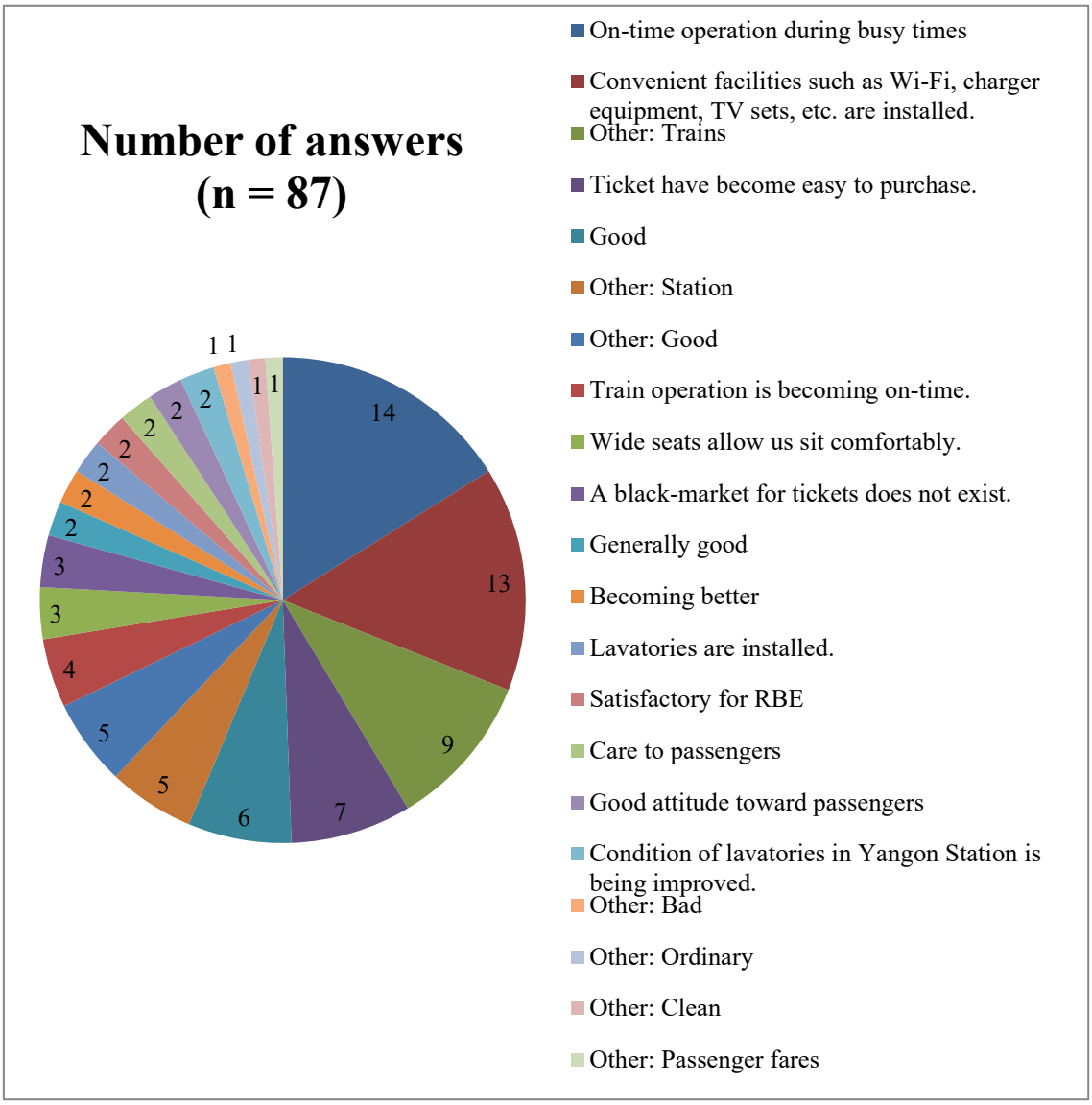


Figure 3.3.11.1: "What is the "Good Point" of Yangon Station and Myanma Railways?"
(On October 10 and 11, 2016)

3.3.12 Passenger interviews: Analysis 11

“What would you like to see improved at Yangon Station and Myanma Railways?”

Various respondents pointed out items they would like see improved at Yangon Station and MR. Even for stations, the requests covered a very wide extent of items ranging from software, such as “If a passenger requests information, the staff could respond” and “I want the staff to enhance their skills,” to hardware, such as “I want stations to introduce automatic ticket machines,” “I want stations to install slopes along stairs for wheelchairs” and “I want stations to improve entrances/exits.”

Besides these, requests for the operation of extra trains on the circular line and some strong complaints that “Not enough comfortable cars come to the nearest station” or “Stations should increase the allotment of reserved seat tickets to the nearest station” were heard. The issue of the allotment of reserved seat tickets originates from the practice of reserved seat tickets being controlled not by a computer system, but by an account book at stations. This issue is made worse by the fact the passengers are not able to buy reserved seat tickets until a few days prior to use. Hardware improvement should be carried out from now.

Among common comments from respondents, the largest number was “Request for the introduction of better cars.” Following this, some asked “Myanma Railways to improve all lines” and for “on-time train operation.”

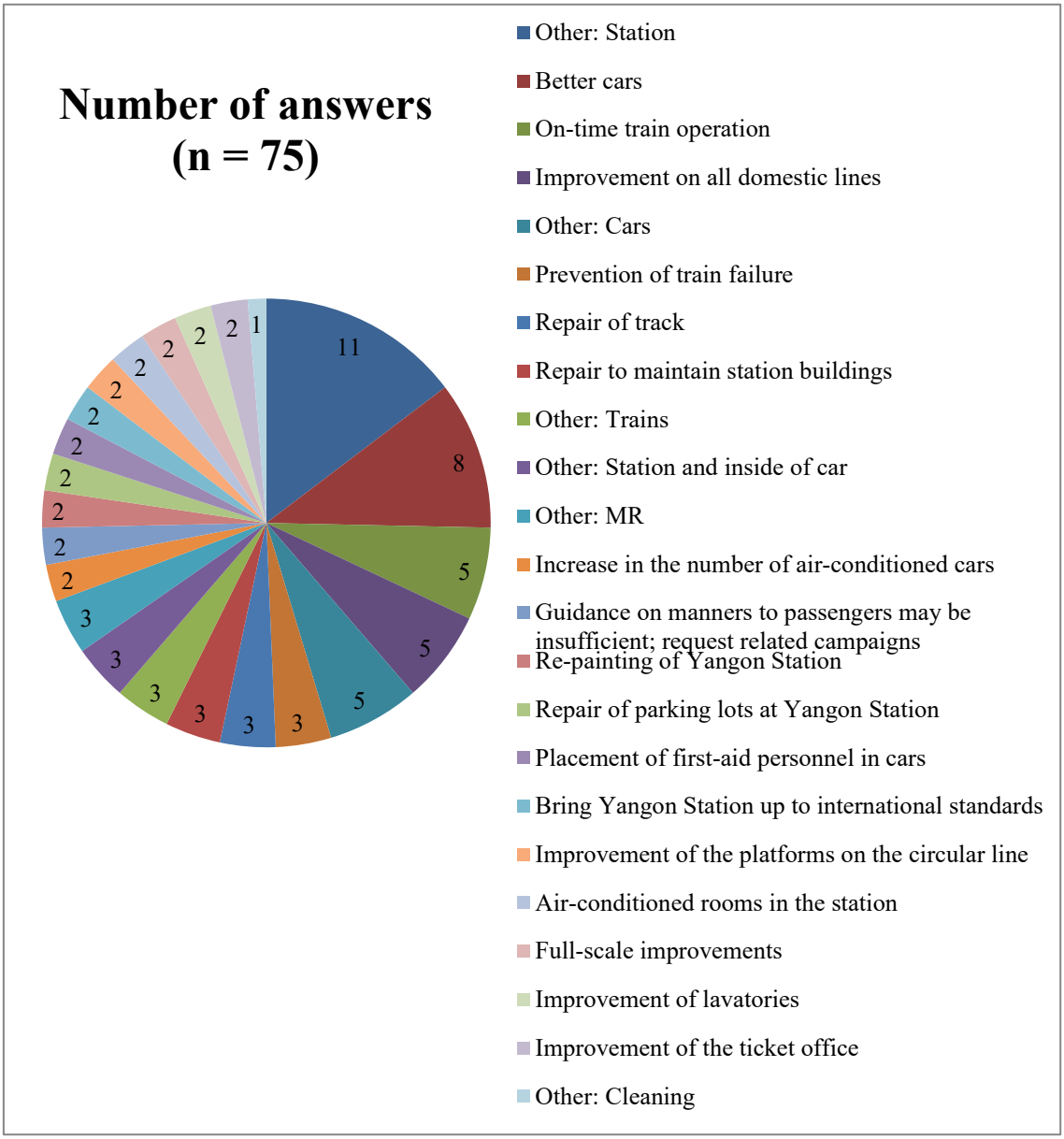


Figure 3.3.12.1: “What is the point which you want to improve of Yangon Station and Myanma Railways?”
(On October 10 and 11, 2016)

3.3.13 Passenger interviews: Analysis 12

"Yangon Station and Myanma Railways are now trying to improve service for passengers. Would you please give us your opinion about these efforts?"

Question No. 12 was on the improvement of service. The largest number of responses referred to overall MR operations, and the next largest referred to stations.

Among the responses consolidated into the category of "Other: MR," some positive comments included "As the items mentioned now are improved, the situation will become better," and some comments such as "I want MR to bring the staff up to international standards" and "I want MR's attitude toward passengers to be kinder" were given. On the other hand, the strong request that "MR should carry out appropriate maintenance and control" was also given.

Among the responses consolidated into the item of "Other: Station," besides comments such as "Stations should be made cleaner" and "MR should modernize Yangon Station," the comment that "Announcement of arrivals and departures in stations was unclear. Stations should repeat it" was provided.

About trains, some comments such as "Reinforcement of cleaning," "I want MR to install TVs in trains," "I want MR to prohibit peddlers in cars," and "While operation time is becoming more accurate than before, I request further improvement" were given.

Among responses from passengers, many indicated that "Passengers and staff should conduct a manner enhancement campaign in a cooperative manner," "Service by the staff is becoming better," "I'm happy to see efforts to enhance service" and "I want MR to continue such efforts." These results generally suggest an explicit expectation among passengers of service improvement.

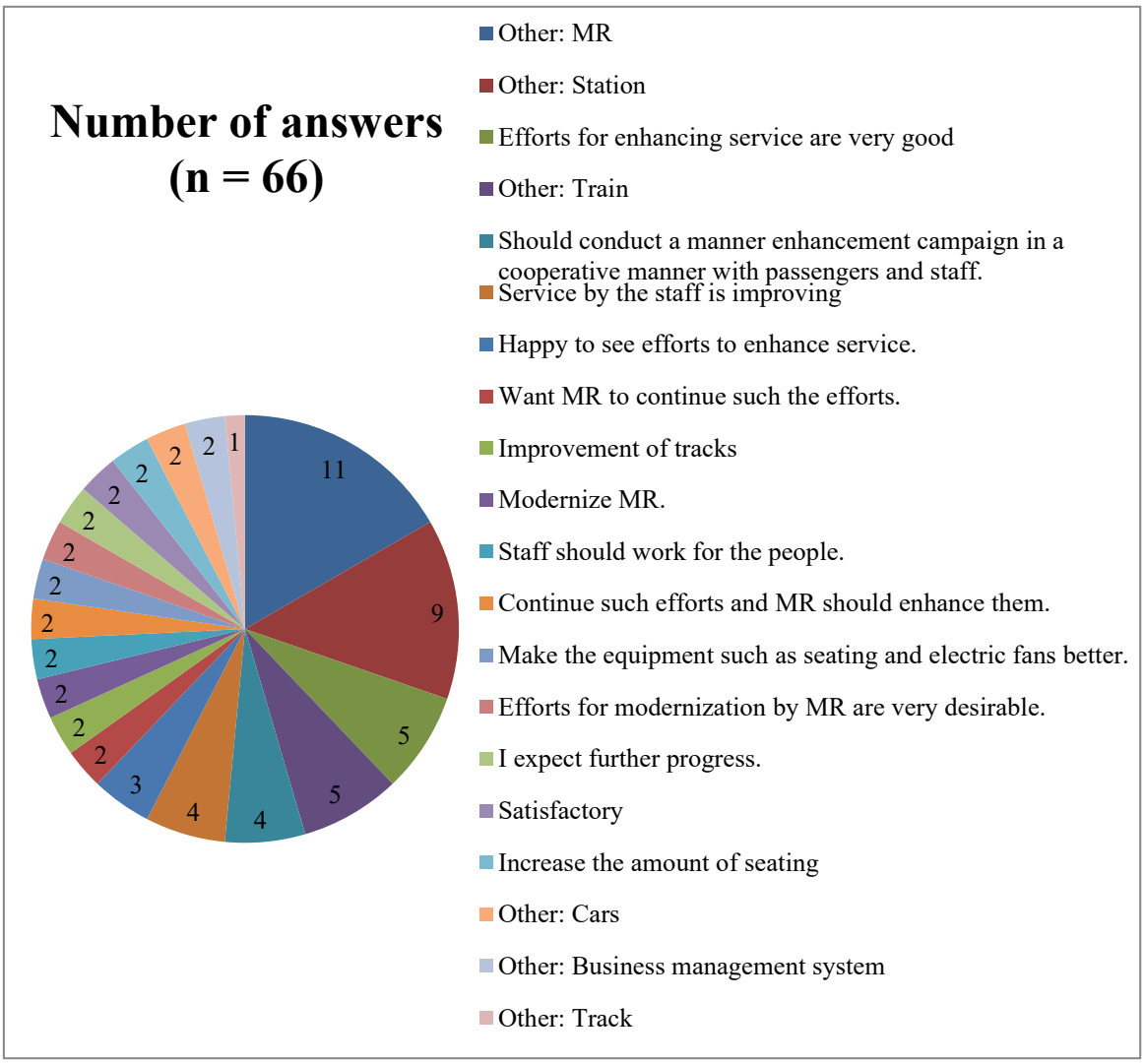


Figure 3.3.13.1: “Yangon Station and Myanma Railways are now trying to improve service for passengers. Would you please give us your opinion about these efforts?”
(On October 10 and 11, 2016)

3.3.14 Analysis of Passenger Interviews: General Remarks

General impressions would be that frank opinions and comments were provided, and that passengers see MR very favorably.
Several responses pointed out the efforts for Wi-Fi and charger equipment, and recent gradual changes by MR.
Some responses referred to the reinforcement of track maintenance through JICA projects and the resulting improvement of quality. These responses clearly suggest that RBE cars from Japan receive high evaluation
Among these, remarkable responses from passengers would be a comment that pointed out the lack of seating on the platforms on the circular line and a comment that pointed out passenger manners.

- Seating on the platform of circular line and transformation of the transport system

Indeed, in Yangon Station a sufficient amount of seating has been installed in the concourse for long-distance trains, and they are being used frequently. In contrast, on circular line platforms there is almost no seating for passengers waiting for trains. This is probably a legacy of the times when the transportation by long-distance trains accounted for a major segment.
Also in Japan, Japan National Railways had mainly operated long-distance trains for a long period of time, operated only few trains even in urban areas, and responded to transportation demand with an operation diagram and facilities mainly for intercity transportation. In the last years of Japan National Railways in the 1980's, several factors caused the company to commence intra-city transportation and regional transportation. Japan National Railways carried implemented various improvements in a manner that surpassed their previous concepts and transformed it into the current JR, a company that expresses community-based operation. Improvement of transportation and improvement of facilities form two sides of the same coin together with the improvement of service.
In the future, if MR wants to hold a position in not only the conventional transportation area of long-distance trains, but also intra-city transportation in Yangon City and its suburbs, comprehensive improvement of service and improvement of the transportation scheme and facilities should be clear requirements.
The responses from passengers on seating on the platforms on the circular line would clearly suggest such movement; and as MR steadily improves such situations, the activity will become a pilot case of the transformation of MR to a city railway company.

- Comments on passenger manners

More comments on manners than expected were provided.
Among these, an especially large number of passengers asked that luggage not be placed on seats in car. Besides these, several comments pointed out smoking related issues and that passengers should not throw rubbish from windows. Some requested that MR staff and passengers enhance manners in a cooperative manner.
These are very appropriate comments and provide information important to future service improvement.
For measures to enhance service, the understanding of passengers is indispensable. We introduced examples of Japanese service improvement in the third round of service improvement training. For example, measures to alleviate congestion may be a typical case requiring assistance from passengers; and even if appealing to passengers for improvement of manners in cars, such activity cannot be advanced without the understanding of passengers.
Also in Japan, for example, several posters placed in stations and information displayed on monitors in cars appeal to passengers for their cooperation. These measures suggest it.
Under the circumstances, active voices from passengers on the improvement of manners may be regarded as suggesting such a direction toward future improvement.

As described in Section 2.6, the results provided a strong impact on the MR staff who conducted the interviews, and these were widely reported by the media.
The interview provided an indispensable opportunity for future service improvement. We hope that gathering the voice of passengers will exceed the simple position of interviews, leave a strong impression on personnel, from site staff to MR executives, and play a significant role in the process of developing MR not only as an intra-city railway company, but also as an inter-city railway company.

3.4 Conclusions

In the Myanmar Railway Sector Human Resource Development Course, service training received the greatest response and was the central issue in the latter part of the course.

In Myanmar generally, not just MR, the concept of service is still relatively uncommon. For this reason, explaining the idea of passenger services and offering training to improve those services were both well received, particularly as the issue was also backed by the changing of the government administration, and was widely picked up by local television programs and newspapers.

Consequently, the training course was not limited to introducing Japan's advanced railway technologies and railway-related services to MR. Through the publicity via TV and newspapers, the impression was given that improvements to passenger services largely depend on the efforts of the MR employees themselves. By focusing on the efforts of employees, we believe that this led to an improvement in the motivation of people connected with MR.

As for the improvement of services, the ideas from MR employees were all inevitable in improving passenger services for the future. During group training in Naypyidaw in August 2016, the initial ideas from the employees all depended on someone else's efforts. However, the ideas they proposed by the end of the training course were all well-thought out. Supported by ongoing follow-up, we consider that these efforts will surely lead to further progress.

However, the main issue that needs to be addressed is how we can realize these ideas. As mentioned earlier, for full-scale improvement of services, back-up with financial support is required. To proceed with the ongoing necessary improvement, a range of measures will be required, such as transferring authority related to the budget to GMs and station masters and establishing a service promotion committee at head office to create a system to consider situations and ideas from field sites.

Continued efforts to follow up the measures at field sites and to support the establishment of the necessary structures in MR as a whole will be needed.

At the same time, training on station development, station facilities, electricity, underground facilities, and tunnels are all areas that need to be learned through on-the-job training. Accordingly, most of the training contents seem to have been new for MR employees. Among

the trainees, some had experience of studying abroad, and we had feedback from these trainees that they have seen or heard about some of the contents we introduced in the course. For these areas, after clarifying the targets for MR, and by setting targets to take actions within set periods of time, it is recommended that the basic knowledge among employees will be increased during the set periods.

The training course was planned to include curricula for the areas mentioned above along with case studies from Japan. However, in future training courses, it would be better to include examples from other countries similar to Myanmar so that MR employees can introduce examples relevant to their own situations in addition to those of Japan to further improve training outcomes.

Regarding safety-related issues, the contents need to be deepened. Safety is the top priority in any railway business, and this is common across all areas of activity.

However, the GMs at head office and employees at field sites all seemed to be unclear about what exactly needs to be done.

For this reason, because group discussions on the causes of and measures for past accidents were relatively popular in the 'Project on the Improvement of Services and Safety of the Railway', which was organized previously, to consider dangerous incidents at MR, we watched videos, discussed issues and thought about possible countermeasures. Through group discussions, the opinions of each individual on safety were revealed and this led to an improvement in mutual awareness about safety. As a next step, it will be important to direct this awareness toward actual countermeasures at field sites.

Regarding individual safety in each area of operation, in most cases, the safety rules were not clear, and MR employees seemed to encounter difficulties in improving safety. This is considered to be because of the old culture, where they only needed to do what they were told to do. Hence the first step will be to clarify the rules related to safety in each area of activity and follow those rules on an ongoing basis. To achieve this, it would be better to formulate the safety plans of MR at head office, plan specific measures for each area and take actions accordingly. Based on the above, as specific efforts, it is recommended that safety rules are stipulated for each area (e.g. railway operations, level crossings, wayside construction work, etc.) and that the execution of the relevant actions is followed up.

We have offered the Myanmar Railway Sector Human Resource Development Course for the past year. As infrastructure improvement at MR progresses, we expect that the necessary structures will be established so that new facilities will be operated by employees who have acquired the required knowledge by utilizing the experiences gained through this training course.

Appendix

1. Material for preparation meeting

Challenges for Modernization of Myanma Railways

Three Challenges for Modernization

- Modernization of infrastructure
- Modernization of human resources
- Modernization of state organization and system

- **Two Challenges for Privatization**
- Establish a clear target of reformation and establish the system to carry reformation
- Establish the clear mission of government and private enterprise

Presented by Mr. Mitsuo Higashi, Railways Policy Advisor for Myanmar

Key Elements of Draft Road Map

(1)Phased modernization program

i. Phase 1 (- 2015) : Preparation
ii. Phase 2 : 10 year Incremental improvement
iii. Phase 3 (2025 -): Full-scale improvement

(2)MR Management improvement

(3)Business improvement (passenger and freight)

(4)Infrastructure – rehabilitation and modernization of MR facilities

(5)Human Resource Development

(6)Introduction of modern technology

2

- **For activate railway**
- **Reform of Myanmar Railway organization**
- **Diversity of business system and clear regulation and Operating Structure and promotion of competition of railway company**
- **Clear regulation of fare system and Royalty for Track Use system**

- **For Secure safety of operation of railway**
- **Establishment of clear and flexible rules and regulations, standards and restriction(Technical Standards on Railway Facilities, System and Operation)**

Support for railway technique and improving service throughout holding Workshop by JICA

- 1. Purpose Strengthening of relations on the Cultivation of human resources in the field of Myanma Railways
- 2. Attendance Management staff in MR（Ministry of rail transportation staff by consultation）
- 3.Japan International Consultants for Transportation Co., Ltd.(JIC) carries out Cultivation of human resources Workshop for Myanma Railways at Nay Pyi Taw.
- 4.JICA Myanmar Office and JIC conduct discussion with Ministry of rail transportation and Myanma Railways.

We are planning that Kick off meeting holds on end of February and first workshop holds on end of March.

Contents and number of times of workshop are scheduled as below. We will consider change of schedule and contents by consultation with Myanmar side.

- **①28th and 29th in March Railway policy and service**
- **②31st in March and 1st in April Passenger service**
- ③16th～18th in May Safety Management
- ④19th in May Electric System
- ⑤20th in May Underground Structure and Tunnel
- ⑥13th～15th in June Station development

* **Work Shop at Yangon Lower Myanmar Office**

Contents（Plan)

①28th and 29th in March Railway policy and service

Modernization program is proceeding from short-term to middle-term now. Railway policy is very important item for the next phase. In addition to this, we are planning new workshop about railway service including railway management.

The purpose of this course is raising the level of management class.

②31st in March and 1st in April Passenger service

*** Work Shop at Yangon Low Myanmar Office**

We will introduce examples of service improvement in Japan and consider how to tackle passenger service in Myanmar practically .

Eligible persons are station master and section of service, etc.

③16th～18th in May Safety Management

Safety is 1st priority in railway management. Range of safety in railway management is very wide not only passengers but also each technical field. We are planning safety management workshop summarized these.

The purpose of this workshop is raising the level of safety for every class and field.

④19th in May Electric System

Electrification on commercial line has just begun at Strand road. We are planning electric system and electric management. The purpose of this workshop is raising the level for electric staffs.

⑤20th in May Underground Structure and Tunnel

Subway is planning in Yangon. But there are no experience of tunnel except mountain area in Myanmar. We are planning basic workshop of tunnel and underground structure. The purpose of this workshop is the raising the level of civil staffs.

⑥13th～15th in June Station development

Station development is very important item for Myanma Railways. We will introduce improvement of station and around station. Transit Oriented Development and smart mobility will be introduced in this workshop. The purpose of this workshop is to get knowledge of town planning for railway planner.

Short-term	
Phase 1	**Phase 2**
Up to 2015	**2016-2020**
(Build up the basis for modernization) Implementation of rework and acquisition of basic skills to recover essential functions	**(Level up towards modernization)** Improvement of the levels of safety/services by strengthening/improving functions of equipment/facilities and maintenance levels
Acquisition of basic skill to improve the technical capabilities of an on-site level Improvement of safety and service level of operation and maintenance .	Implementation of large scale project trigger for mordernization of Myanma Railway. Promotion of steady improvement and planning drastic improvement
○Discussion for the modernization railway law and rules ○Make amendment as the frisrt step ○Discussion for regulations of railway by Ministry	○ Discussion role and function about centra goverment and local goverment ○Study for New PPP & BOT system for new project and Railway opeation ○Implementation New Railway Act step by step ○Discussion for financial framework of transportation
○Discussion for organization of Myanma Railway	○Introduction of new organization of Mranma Railway State-owned enterprise (SOE) owner of land and rail asset and all stock ,established by MORT (Owner of SOE is MORT) ○Establishment of Subsidiary company as Yangon Urban Railway Service (YURS) Intercity Passenger Service (ICPS) Freight Rail & Logistics Service(FRLS) Nationwide Railway operation Service(NROS)

Field/Items			
	Management	○Awereness of Raising of safty and service ○Trainning program on Manegement & Marketing	○Establishment new railway tecnical standards ○Introdution of new railway policy on fare system, new bussiness system of railway for operation and maintenance
	Rolling stock	○Trial of maintenance training and rehabilitation support for RBE ○Injection DMU from Japan into Yangon circular line commuter service	○ Establishment of an appropriate method for maintenance of RBE and new DEMU ○ Rehabilitation of RBEs ○ Introduction of express type DEMU into Yangon-Mandalay line and commuter type DEMU into Yangon circular line ○Discussion for Local Manufacturing of Rolling stock
	Traks	○Improvement of skill and method for track maintenance	○Training of Mechanization of track maintenance work ○Introduction of a database of track/civil engineering structures ○Outsourcing of track maintenance work
	Railway structures	○Grasping of the status (performance) of civil engineering structures(surveys of bridge soundness) ○Compiling of the asset drawing of civil engineering structures (preparation of drawings)	○Establishment of the standards for the maintenance and control of civil engineering structures ○Rework on structures in an urgency priority order ○Introduction of civil engineering structure inspection machines/tools
	Signals/ telecommunications	○ Start on Project of the operation control center (OCC) and electronic interlocking systems ○Rework, repair and remodeling of signal systems	○Installation of an operation control center (OCC), full-scale introduction of electronic interlocking systems ○Improvement of the security of crossings (introduction of alarms and barriers) ○Improvement of train-operation-related systems (Introduction of train protection devices and a centralized train control system)
	PassengersService	○Strat operation of Spceal train by charter contract ○New commuter services in the Yangon by DMU	○ Introduction of express type DEMU into Yangon-Mandaley line ○Purchasing of New Passenger Coaches ○Establishment of marketing organizations and Implementation of marketing activity (Homepage, reservation, sightseeing campaign, package tour, travel service agency.)
	Yangon Urban Railway Network	○Discussion of the Yangonn Urban railway systems ○Strat operation of Strand road electrification Tram line	○ Introduction of commuter type DEMU into Yangon circular line ○ Starting Yangon circle Line Improvement Project ○Discussion for organization of urbun transportiaon and integrate fare system
	Freight	○Trial implementation of container transport ○Improvement of Yangon area and Mandalay freight station ○Study of Dry Port of Yangon and Mynnge ○ Implementation of Private Freight rail operator for container and heavy cargo	○ Improvement of Thilawa station and port freight facility ○ Establishment of Private owner system of Freight car and container ○ Improvement of equipment/facilities for freight handling work ○ Discussion of feeder line and freight facility used for specific goods
	TOD/Station Development	○Preparation of a development plan for the Yangon central station ○Discussion on vitalization of Railway asset of Yangon Urban area	○Into action of development of the Yangon central station ○Vitalization of local hub stations ○Introduction of PPP for stastuon development
	Trainnig of human resouces	○Improvement of the maintenance skill and management ablity for civil deparatment ○Improvement of the maintenance skill for DMU ○Work shop on Safety and Services	○Upgrading of Railways Technical Training Center ○Education for all employees on the improvement of safety and customer oriented services ○Training for all manager on market oriented management & Service Quality Reform

Improvement in Metropolitan Area

i. Circular Line Improvement in Yangon area
ii. Improved train operation as an urban commuter system,

Existing Circular Rail: Loco + Passenger Coach

Diesel Multiple-Unit (DMU) - EMU later

The proposal of enforcement measure

(a)Establishment of Service and Sales center in Yangon (proved information ,make reservation and sales)
(b) Improvement of MR Internet homepage by English
(c) Rail Pass for foreign tourist
(d) Special coach for sightseeing, especially for international visitors
(e) Improve station facility (waiting room ,toilet, information shop restaurant)

New Container transportation & freight car service can make door to door service

Containers are one of primary mode of transportation, linking container rail terminals nationwide with road, sea, and air routes. handle everything -- from household necessities to frozen, fresh, and processed foods, from consumer durables to automobiles and waste products. Study of container station is urgent subject

Powerful freight trains are specialized for oil or cement, limestone, chemicals, bulky machinery and other materials, Maximizing the advantages of rail transport, & a significant contribution to business and industry Study of freight station
Facillity such as oil cement forage etc is also essential .

Business improvement Station Development

Strengthening of business planning ability and Establishment of Asset development division

(1) Preparation of a development for Yangon metropolitan Area
(2) Vitalization of local hub-station
(3) Vitalization of Railway asset Yangon metropolitan zone
(4) Development of the wayside in the Yangon suburban area

.In Japan, a number of development schemes were realized by using railway lands and spaces in city areas after the reorganization of Japanese National Railways (JNR).
*** Japanese approach**
1step. To develop surplus spaces in stations on a small scale.
2.step To create new commercial spaces by relocating facilities.
3.step To redesign to improve both its railway functions and its commercial functions.
4. step To redevelop station areas by matching our projects with public works that reinforce city functions.

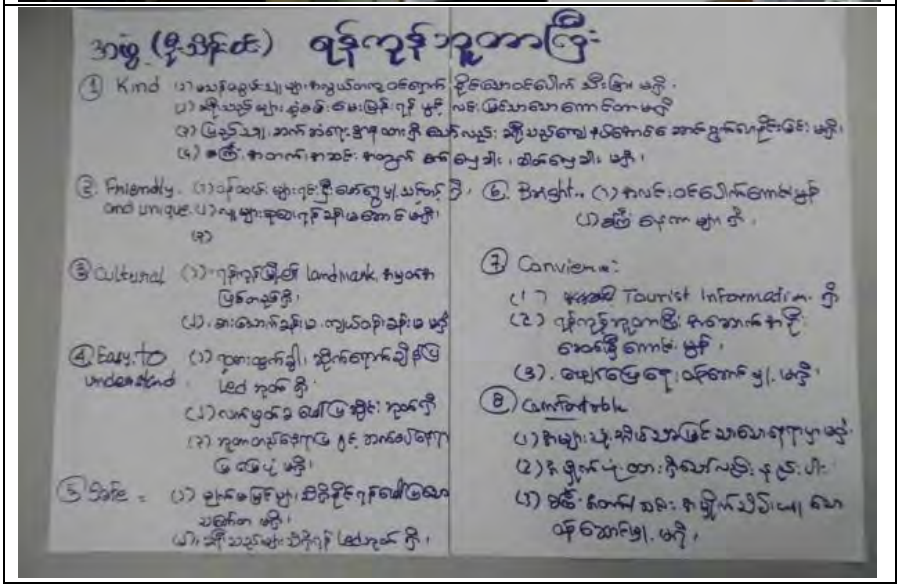
Shinjyuku Station Tokyo

2. Photo

2.1 First round of service training (March 20–April 7)

2.2 Training course for station development, station facilities, and underground and tunnel facilities (May 15–22)

2.2.1 Training for station development and station facilities



2.2.2 Training for underground and tunnel facilities/

Minister for Transport and Communications visited the seminar

2.3 Training for safety and electric power facilities (June 12–17)

2.4 Second round of service training (August 2–10)







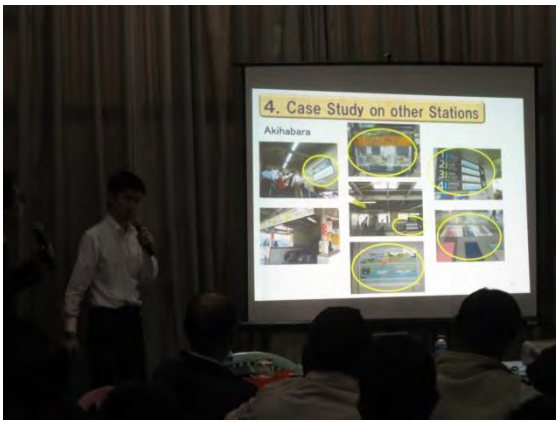

2.5 Third round of service training (October 8–13)








2.6 Fourth round of service training (January 16–21)/MoTC meeting



3.1 Training material: Service training (3/20-4/7)

Challenges for Modernization of Myanma Railways

Three Challenges for Modernization

- Modernization of infrastructure
- Modernization of human resources
- Modernization of organization and system

First workshop 28March-1th April

(1) Railway policy and service

(2) Improvement of Passenger service

Presented by Mr. Mitsuo Higashi, Railways Policy Advisor for Myanmar

Railway should value most is customer satisfaction

The first purpose of this workshop is raising the opinion that Railway should value most is customer satisfaction and should offers solutions to the needs and wants of the customers.

Basic Management Policies should be established as like the eight quality management principles are defined in ISO 9000:2005

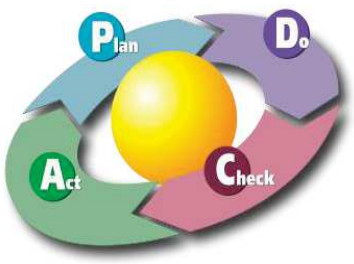
Leaders of an organization establish unity of purpose and direction in which people can become fully involved in achieving the organization's quality object MR should know methods of quality management and techniques

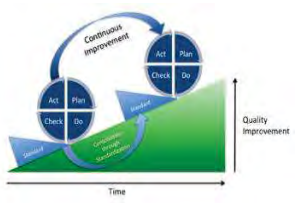
Awareness（KIZUKI） & PDCA (KAIZEN) approach

The second purpose of this workshop is introduction of method of service improvement . We will discuss how to improve the passenger service in Myanmar practically and learn about PDCA approach and several method.

We will introduce examples of service improvement in Japan and consider passenger service in Myanmar practically . For change of Mentality MR should know methods of quality management and techniques

PDCA (KAIZEN) approach





PLAN : establish objectives and processes necessary to deliver results in accordance with communities purposes;
DO: implement processes and achieve objectives;
CHECK: monitor and measure processes against community policy, objectives, compliance obligations ,and report the results;
ACT: take necessary actions to improve performance.

Establishment of Mechanisms for Improving Customer Satisfaction

Modernization program is proceeding from short-term to middle-term now. Establishment of Mechanisms for Improving Customer Satisfaction is very important item for the next phase.

For providing services and products with which customers are satisfied ,We are planning workshop about railway service including all management .
Improvement of the levels of services is can be established by strengthening not only improving functions of equipment and facilities but also Change of Value and Change of Mentality.

Since the organizations depend on their customers, they should understand current and future customer needs, and meet customer requirements and should try to exceed the expectations of customers.

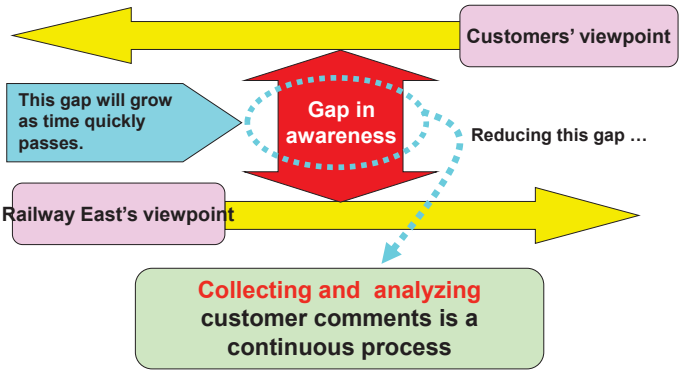
ISO 9000 series are based on
eight quality management principles.

Principle 1 Customer focus
Principle 2 Leadership
Principle 3 Involvement of people

Principle 4 Process approach
Principle 5 System approach to management

Principle 6 Continual improvement
Principle 7 Factual approach to decision making
Principle 8 Mutually beneficial supplier relationships

Why we think customer comments are important?



JREAST
By achieving a level of service that only JR East can provide, we aim to meet the expectations of both local communities and our service users, thereby alleviating grievances and meeting future needs.
To attain this goal, we understand that it is critically important for us to constantly pay attention to customer comments, to learn, for example, exactly what JR customers are interested in or what annoys them, and thus steadily make improvements.

We gather customer comments on a daily basis through a wide-ranging system that includes collection by front line employees, via the Internet and from customer help desks. We are implementing a company-wide initiative to develop a system capable of identifying relevant comments and sharing them with the appropriate departments that can then initiate moves that will lead to improvements in all aspects of our services. We gratefully accept customer comments and act from a customer viewpoint. We believe the origin of customer satisfaction is in each and every customer comment.

Teamwork

In order to guarantee customer satisfaction, we have designated service promoters operating at many front line workplaces.

Furthermore, with a clear awareness that all efforts eventually lead to improved customer satisfaction, we hold regular customer service training sessions and symposiums that involve all Group employees, from top management to front line employees.

We are continually working to create a corporate culture where each employee aims to enhance customer satisfaction, by targeting not only front line employees, but also those in sections that do not have direct contact with customers.

Responding to customer comments

Based on customer comments gathered and social conditions, we take measures to improve customer satisfaction.

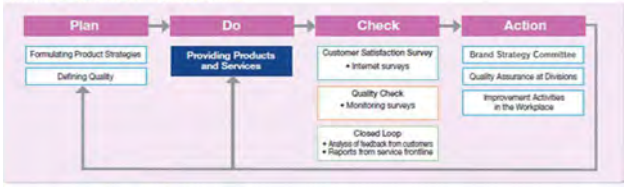
Transport Services Improvements
More Comfortable On-board Air Conditioning
Improvements in Station Toilets
Personal Greetings Campaign

Mechanisms for Improving Customer Satisfaction ANA

The ANA Group's Service Quality Management

The ANA Group is thoroughly committed to the quality of the products and services it offers to customers. We believe that continuing improvement leads to ever-higher customer satisfaction and the creation of value. For that reason, we have established a cycle of accurately assessing the current status of quality linked to specific improvement measures, and regularly ascertain our progress through the Brand Strategy Committee.

Overview of Service Quality Management



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- ⑥13th～15th in June Station development

Railway policy and service (The first work shop)

This course is raising the level of management class

MR have to establishe a cycle of accurately assessing the current status of quality linked to specific improvement measures, and regularly ascertain our progress.

Basic Management Policies should be established and leaders of an organization establish unity of purpose and direction in which people can become fully involved in achieving quality

28 Basic Management Policies

29 PDCA approach and several method

Passenger service The Second work shop

- **We will introduce examples of service improvement in Japan and introduction of method of service improvement in Myanmar practically .**
- **Eligible persons are station master and section of service, etc.**
- **30 Understanding of Mechanisms for Improving Customer Satisfaction**
- **31 Study for PDCA approach and several method**
- **1 Making of Proposals for Improving Customer Satisfaction**

- **Q1 How do you endeavor to improve your employees' customer skills? Any concrete research on this problem, or developments such as employee manuals for handling customers would be of interest to us.**
- **Q2 What are the most common customer comments when rail service is disrupted? How are you organized to respond to these situations?**
- **Q3 How do you collect customer comments and opinions?**
- **Please give us any recent examples where you have improved service based on comments from customers.**
- **Q4 Up to now how have you proceeded in relation to creating a barrier-free system? In the future what do you think will be similar themes that must be pursue**

Improving service of Myanmar Railway
Workshop by JICA

Establishment of Mechanisms for Improving Customer Satisfaction

Raising the opinion that
Railway should value most is customer satisfaction and should offers solutions to the needs and wants of the customers.

Introduction of method of service improvement .

Awareness（KIZUKI） & PDCA (KAIZEN)

Presented by Mr. Mitsuo Higashi, Railways Policy Advisor for Myanmar

Myanmar Railway service improvement practical training

- 13:00 March 30
- Start
- An introduction ; Explanation of curriculum
- Lecture Improve service of Myanmar Railway
- The VTR explanation
- Awareness (KIZUKI) and PDCA (KAIZEN) approach
- Fish born Logic tree and evaluation matrix

- March 31

- 9:00 Lecture
- wareness (KIZUKI) and PDCA (KAIZEN) approach
- eight quality management principles
- Lunch
- 13:30 - 14:30
- Group discussion Element analysis of service improvement Fish born
- Rest
- 15:00-16:00
- Service improvement of Measure Logic tree and evaluation matrix
- Group discussion Why passenger number of railway decrease?

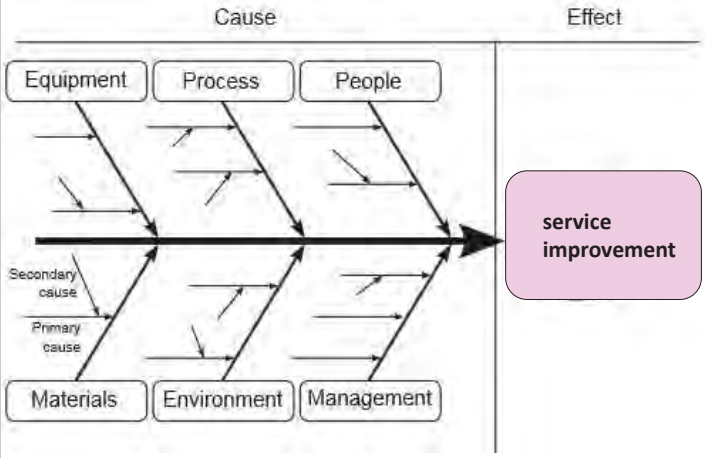
- April 1

- 9:00 Lecture
- A trigger for “awareness”
- Successful improvement measures
- Lunch
- 13:30 - 14:30
- Group discussion My target of service improvement PDCA.
- Rest
- 15:00-16:00
- Presentation and comment
- A summary of Lecture & Questionnaire

- **Q1 How do you think about Customer service of MR?**

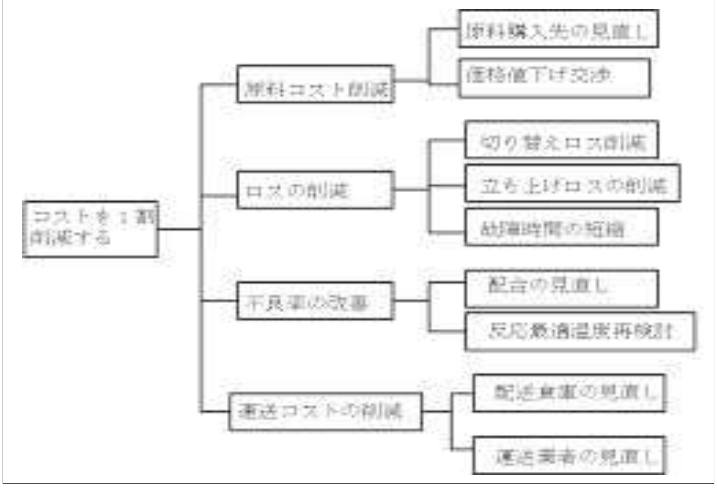
Q2 Please make definition of customer satisfaction.

- Q3 How do you think about Element of Railway service improvement?



Q4 Why passenger number of railway decrease?

- **Q5 What can we do as measures ?**



Evaluation items	Option A	Option B	Option C	Evaluation

- My target of service improvement.
- Q6 How do you improve service of Myanmar Railway ?
- Q7Who is responsible for customer satisfaction ?
- Q8 What can you do for improvement of customer satisfaction on your job?

PLAN : establish objectives and processes necessary to deliver results in accordance with communities purposes;

DO: implement processes and achieve objectives;

CHECK: monitor and measure processes against community policy, objectives, compliance obligations ,and report the results;

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Challenges for Modernization of Myanma Railways

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- Modernization of human resources
- Modernization of organization and system

Improvement of the levels of services is can be established by strengthening not only improving functions of equipment and facilities but also Change of Value and Change of Mentality.

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By achieving a level of service that only JR East can provide, we aim to meet the expectations of both local communities and our service users, thereby alleviating grievances and meeting future needs.
To attain this goal, we understand that it is critically important for us to constantly pay attention to customer comments, to learn, for example, exactly what JR customers are interested in or what annoys them, and thus steadily make improvements.

We gather customer comments on a daily basis through a wide-ranging system that includes collection by front line employees, via the Internet and from customer help desks. We are implementing a company-wide initiative to develop a system capable of identifying relevant comments and sharing them with the appropriate departments that can then initiate moves that will lead to improvements in all aspects of our services. We gratefully accept customer comments and act from a customer viewpoint. We believe the origin of customer satisfaction is in each and every customer comment.

Establishment of Mechanisms for Improving Customer Satisfaction

Modernization program is proceeding from short-term to middle-term now. Establishment of Mechanisms for Improving Customer Satisfaction is very important item for the next phase.

For providing services and products with which customers are satisfied ,We are planning workshop about railway service including all management .
Improvement of the levels of services is can be established by strengthening not only improving functions of equipment and facilities but also Change of Value and Change of Mentality.

Since the organizations depend on their customers, they should understand current and future customer needs, and meet customer requirements and should try to exceed the expectations of customers.

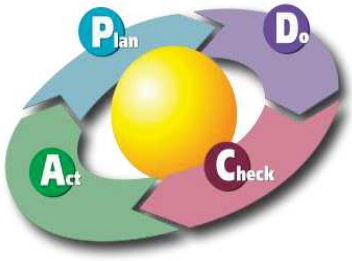
ISO 9000 series are based on
eight quality management principles.

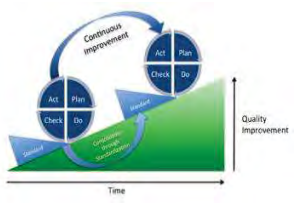
Principle 1 Customer focus
Principle 2 Leadership
Principle 3 Involvement of people

Principle 4 Process approach
Principle 5 System approach to management

Principle 6 Continual improvement
Principle 7 Factual approach to decision making
Principle 8 Mutually beneficial supplier relationships

PDCA (KAIZEN) approach





PLAN : establish objectives and processes necessary to deliver results in accordance with communities purposes;
DO: implement processes and achieve objectives;
CHECK: monitor and measure processes against community policy, objectives, compliance obligations ,and report the results;
ACT: take necessary actions to improve performance.

Teamwork

In order to guarantee customer satisfaction, we have designated service promoters operating at many front line workplaces.
Furthermore, with a clear awareness that all efforts eventually lead to improved customer satisfaction, we hold regular customer service training sessions and symposiums that involve all Group employees, from top management to front line employees.
We are continually working to create a corporate culture where each employee aims to enhance customer satisfaction, by targeting not only front line employees, but also those in sections that do not have direct contact with customers.

Responding to customer comments

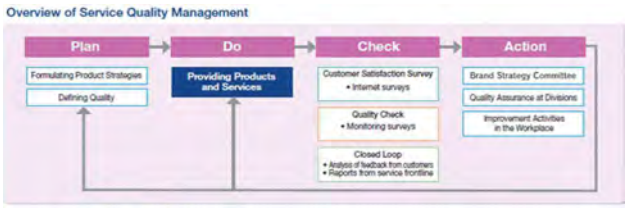
Based on customer comments gathered and social conditions, we take measures to improve customer satisfaction.

Transport Services Improvements
More Comfortable On-board Air Conditioning
Improvements in Station Toilets
Personal Greetings Campaign

Mechanisms for Improving Customer Satisfaction ANA

The ANA Group's Service Quality Management

The ANA Group is thoroughly committed to the quality of the products and services it offers to customers. We believe that continuing improvement leads to ever-higher customer satisfaction and the creation of value. For that reason, we have established a cycle of accurately assessing the current status of quality linked to specific improvement measures, and regularly ascertain our progress through the Brand Strategy Committee.



- **Q1 How do you endeavor to improve your employees' customer skills? Any concrete research on this problem, or developments such as employee manuals for handling customers would be of interest to us.**
- **Q2 What are the most common customer comments when rail service is disrupted? How are you organized to respond to these situations?**
- **Q3 How do you collect customer comments and opinions?**
- **Please give us any recent examples where you have improved service based on comments from customers.**
- **Q4 Up to now how have you proceeded in relation to creating a barrier-free system? In the future what do you think will be similar themes that must be pursue**

Customer satisfaction

Every job, without exception, affects customers.

Needless to say, the improvement of service quality such as ensuring safe and punctual transportation would directly contribute to customer satisfaction.

Improvements such as "Cost down," "Productivity improvement," or "Response to environmental issues (ecology)" lead to customer satisfaction ultimately as well as customers' peace of mind and trust from communities.

What is your own role to do?

In order to pursue customer satisfaction thoroughly, We should have "awareness of the issues"

What is the issue?

The issue is a gap between "current status" and "ideal status "

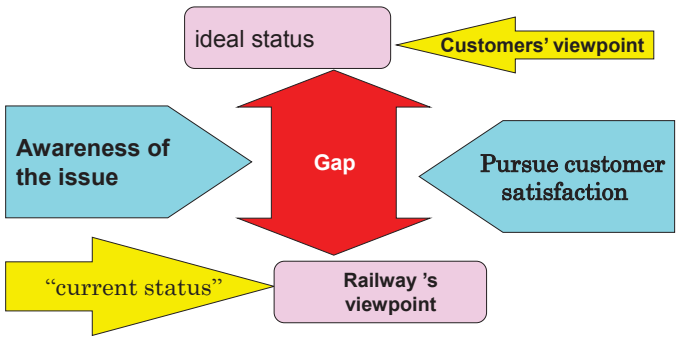
You need to understand "What's the issue" in order to conduct improvement activities.

An issue can be defined as a gap between "current status" and "ideal status."

Current status mean the situation at present or the one projected in the near future.

Ideal status mean such a situation that is supposed to be, qualified, expected, desired, or ideally exemplified.

Awareness of the issue



There are lot of triggers in in the daily work that brings awareness.

Collecting and analyzing customer comments

3

A trigger for "awareness"

There are lot of triggers in in the daily work that brings awareness.

What you felt "something is wrong" "that's what should have been"
Troubles on your work
Customers' voices
My crisis experience
Issues discussed at various activities or meetings in the workplace

Improvement through PDCA cycle

PDCA is an initializing term, combining
Plan, Do, Check, and Action.
It expresses a fundamental cycle for business improvement.

Plan To identify an issue and formulate effective improvement measures for the root cause of the issue.

Do To implement the formulated improvement measures.

Check To confirm how much improvement has been brought in the issue as a result of the implementation.

Action To take appropriate actions depending on the success or failure in the improvement.

The essence of the PDCA cycle is "continued improvement.",

It is not completed with one time rotation of "P→D→C→A." On the contrary, it is imperative to repeatedly rotate the cycle as P→D→C→A→P→D→...."

It starts with a thorough analysis on the current situation first, and decides a solution(s) to be implemented from various ideas generated, and then implement it surely. And the cycle rotates by formulating the next action after fairly assessing the result.

The PDCA cycle was advocated by Dr. W. Edwards Deming who was the authority in quality control and others.In the 1980s, when the Japanese manufacturers including Toyota had emerged in the global market, the PDCA cycle as well came to attract attention as a measure that supported the surge of Japanese manufacturers.

Example of quantitative index

Service improvement

・Number of praises ・Number of complaints ・Number of users

・Customer's waiting time

Safety improvement

・My crisis experience

Productivity improvement

・Working time ・Working headcounts ・Work cost

・Work productivity（processing time per unit）

・Labor productivity（processing volume per headcount）

・Facility efficiency

Sales increase/Cost down

・Sales amount ・Number of tickets sold ・Cost incurred

Improvement in ecology

・Garbage volume ・Recycle paper usage rate

We need to reveal a root cause (core cause) that has caused an issue from the viewpoint of "Why the current status has come up?"

We should explore every possibility that could cause the issue, and then narrow down to a root cause by verifying through factual data.

A root cause is not necessarily a single one. Rather, it could be said that multiple causes interact each other and invite an issue as a result in the majority of cases. On the other hand, it is difficult as well as inefficient to take countermeasures for each of possible cause.

Among the various causes, a root cause that highly attributes to an issue should be narrowed down as a "core cause."

Taking appropriate improvement measures to the core cause allows efficient and effective improvement.

The important thing in pursuing a core cause is that to identify it based on fact as we did in grasping the current status.

Logic tree (Tree diagram)

The logic tree (tree diagram) decomposes the relationships among events into a tree like shape such as "trunk→branch→twig" by following the logic. As the decomposition proceeds further, the event in question becomes more concrete. Largely logic trees may be classified into three categories

①Whole／part system tree（What tree）

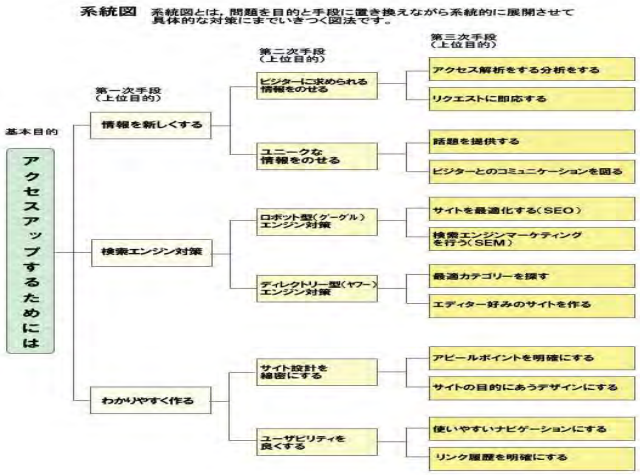
A tree that exhibits what constituencies create an event as a whole by decomposing: the decomposition is processed with repeated queries of "By what it is constituted? "

②Outcome／cause system tree（Why tree）

A tree that exhibits a causal relationship by decomposing: the decomposition is processed with repeated queries of "Why the outcome has come up? "

③Goal／measure system tree（How tree）

A tree that exhibits a relationship between a goal and measures to achieve the goal by decomposing: the decomposition is processed with repeated queries of "How the goal can be achieved? "



For example, we can make a deeper analysis in seeking causes for the decrease of users for a service by utilizing a Why tree.

Why ? Users for the service are decreasing

Why ? There is dissatisfaction in the service contents.

Why ? There is dissatisfaction in the way of delivering the service.

There are no services that customers want to use.

The fee for the service is expensive.

The service lacks consistency in the quality.

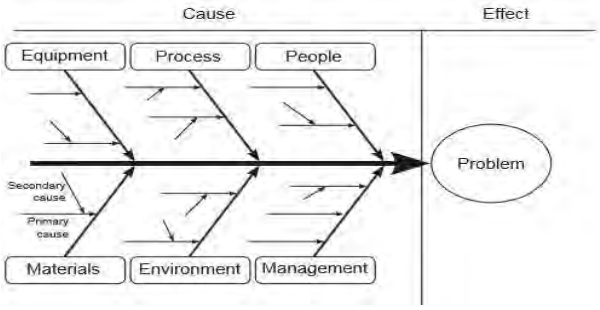
The business hour for the service counter is limited.

The services counter's response is bad.

The service counter is hard to be found.

Characteristic-factor chart

A characteristic-factor chart systematically summarizes the relationship between a characteristic（outcome）and factors that affect the characteristic. Since the systematized chart takes a form looking like a fish bone shape, it is called as another name of "fish bone."



The creation processes for a characteristic-factor chart are as follows:

《Process1》 Determination of characteristic

Determine the characteristic to be addressed and write it down in the right side with a big frame surrounding it. Using description that can provide a specific image of the issue state would be recommended such as "Taking time for entering and leaving the yard."

《Process2》 Drawing a factor backbone

Draw a backbone (horizontal arrow) heading to the characteristic.

《Process3》 Drawing factor big bones

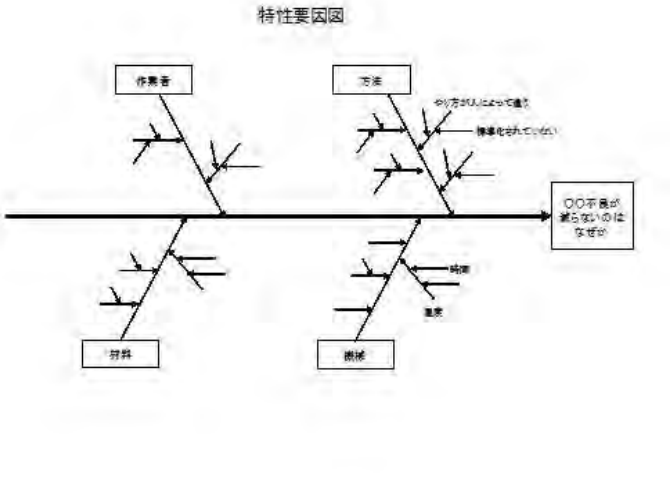
Write down factors that are deemed to affect the characteristic as big bones. Specifically, draw a big bone from diagonally backward left heading to the backbone and then write the factor at the end of the big bone with a frame surrounding it.

《Process4》 Drawing factor middle/small/grand small bones

For each big bone, draw middle/small/grand small bones by repeating break down queries "Why" "Why" and "Why" to break down the factor. Draw a middle bone parallel to the backbone, a small bone parallel to the big bone, and a grand small bone parallel to the backbone, and write a factor at the end of each bone.

《Process5》 Confirmation of the factor

Check the depicted chart if there is any omission or if any relation between the characteristic and the factors is uncertain. Complete the chart with necessary revisions and additions.



Upon assessing improvement measures, “Option Matrix” should be a help.

List each improvement measure vertically and set each evaluation item horizontally. Then, assess each improvement measure by scoring, which allows exhibiting the priority by showing total scores.

Evaluation method Once the determination of evaluation items, we will clarify how they are going to be assessed. For example, there is a method that applies three-grade evaluation for each item: an improvement measure that has a higher total score by the evaluation will be implemented as priority.

Evaluation items/method

Evaluation items

Effect

This is an item to evaluate “How much improvement effect we can expect?”

Needless to say, an improvement measure that has a larger improvement effect should be prioritized.

Speed

This is an item to evaluate “At what point of time, we can see improvement effect?”

An improvement measure that has an earlier improvement effect should be prioritized.

Feasibility

This is an item to evaluate “Will it really be able to realize the improvement?”

This will assess the risk associated with the realization such as “Is it feasible, given requiring high technology?” “This essentially requires cooperation with outside entities. Will we be able to ensure such cooperation?”

Economy

This is an item to evaluate “How much money it will take to implement?”

However improvement effect is expected, it is difficult to be implemented for improvement measures that require substantial cost exceeding the tolerance.

Successful improvement measures

As for successful improvement measures, we should think of the ways to keep the good condition and implement “locking” as a countermeasure.

Locking and Standardization
“Locking” refers to a continuing measure that is implemented so that the effective improvement can take root. By implementing “locking,” the result of improvement can be remained across the workplace.

The basic of locking lies in “standardization” that establishes standards for a certain work and has the entire workplace thoroughly adhere to the standards. With standardization, we will be able to avoid such situations as “I don’t know what to do in case of emergency although I can deal with in usual times.” “Mr.B alone cannot implement it while Mr.A can.” It is critical for us to establish a system where “anybody can achieve the same level at any time.”

Locking （a continuing measure to keep a good condition）

Standardization Anybody can achieve the same level at anytime

Establishing standards

Utilizing standards

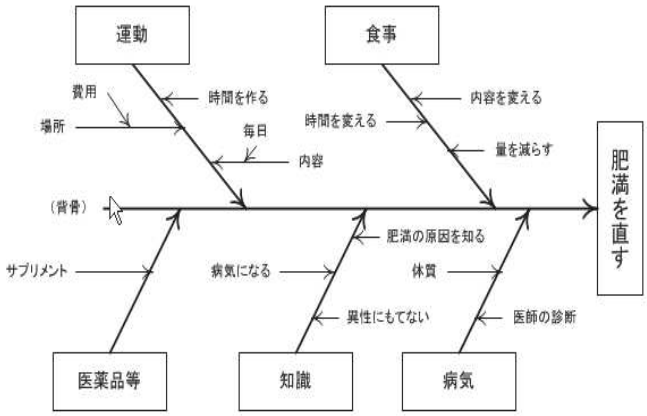
The first step of standardization is to establish standards on the way to conduct a certain work.

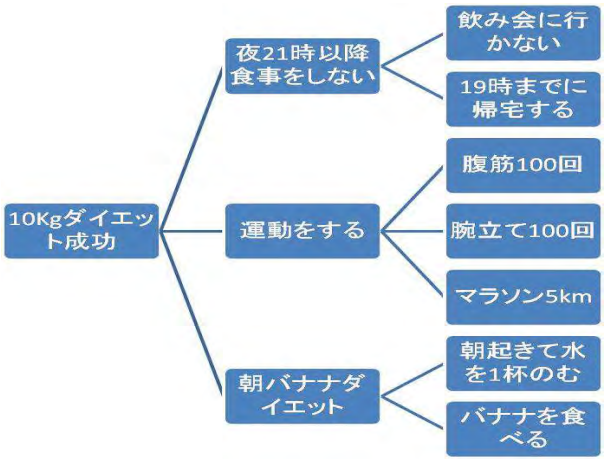
①Documentation of know-how on improvement

Document know-how acquired through planning/implementation of successful improvement measures in such a manner that clarifies “What should be implemented with what kind of processes in order to succeed.”

②Issue a manual to be available for anybody

In order to turn the documented know-how into standards, we need to summarize working processes and the like, and edit into a manual so that they can be available for anybody.





3.2 Training material: Training course for station development, station facilities, and underground and tunnel facilities (5/15-22)

Station Facilities

Japan International Consultants for Transportation Co., Ltd.
Nobuyuki MATSUO

18/5/2016

Contents

Yangon Station

Mandalay Station

Station design concept

From "functionalist station design" to "station design for personality, culture, and amenities"

① Station full of personality that is a landmark of the city
② Station full of features and with a high scent of culture
③ Station designed for its users and that offers many amenities

Mawlamyaing Station

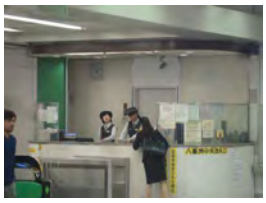
Pathein Station

Keywords of station design concept

①Kind

- Easy transfers thanks for operation in each direction
- Ramps, escalators, moving walkways, elevators
- Trial use of low-gradient stairs
- Expansion of ticket gate width (for wheelchair access)
- Open counters

Left gate is wide for wheelchair access



Open Counter

②Friendly and unique

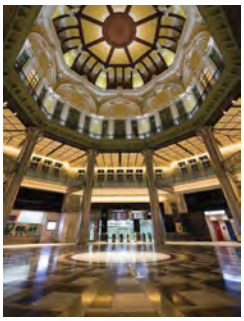
- Unique design that makes the station a landmark
- Design as a communication center
- Preservation and use of station buildings
- Development of unmanned station

Begayet Station(Alter in the station)

③Cultural

- Creation of network of cultural facilities
- Provision of fine restaurants and lounges
- Holding of a variety of events

Tokyo Station Hotel



Gate of Tokyo Station

④Easy to understand

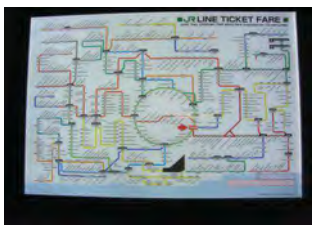
- Improvement of guidance and signage
- Improvement of departure boards
- Maintenance and inspection of advertising space
- Concise signage (use of pictograms)
- Signage providing guidance to facilities in the city

Departure Boards

Guide map to the city

Ticket gate information

Station Map



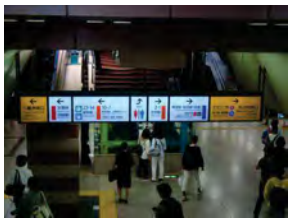
Fare Map

Delayed Train Information

⑤Safe

- Improvement of platform height
- Maintenance and inspection of reporting equipment and disaster-prevention equipment for abnormal conditions
- Increase in number of stations equipped with guidance tiles and warning block
- Installation of tactile guide plates and guide signs

Tactile guide



Guide Sign

⑥Bright

- Adequate lighting and improved brightness
- Use of tiles for platform floor
- Installation of sunroofs over platform sheds and stairs
- Total design of station facilities and fixtures
- Expansion of beautified area touristic train stations, etc.
- Creation of service centers at platform operations offices
- Beautification of platform side walls

Tokyo Station Yaesu side(Grandroof)

Shimbashi Station

⑦Convenient

- Integration with urban facilities
- Promotion of station building and other commercial facilities
- Installation of general service counters
- Improvement of functions for daily living
- Intelligent station design
- Installation of Tourist Office

Service Center

Tourist Office

⑧Comfortable

- Beautification of restrooms
- Speedy maintenance
- Daily beautification and cleaning
- Improvement of broadcast facilities for user friendliness

Restroom

Beautification

Station planning

Prior to the station implementation planning, careful investigation of the following points are necessary.

- Grasp of the actual situation of the station business
- Study of integration and verticalization
- Review and adjustment of future plans
- Environmental survey

LUMINE (Shopping Center at Shinjyuku Sta.)

Hotel METS (Komagome Sta.)

Related law and rule in Japan

Railway Act

- Railway Operation Act.
- Railway Business Act.

(These are various regulations based on above 2 laws.)

Other Act

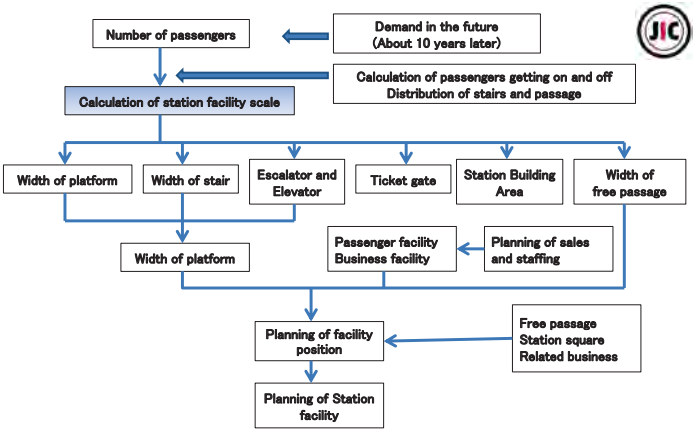
- City Planning Act.
- Building Standards Act.
- Fire Service Act.
- Transportation Accessibility Improvement Act.

Preparation items for main station building planning

Within site	1) Railway line placement and usage methods 2) Future plans 3) Existing of improvement plan and overview	
Station plaza	1) Verification of current situation ● Layout and surface area ● Ways in which plaza is used ● Passerby, car traffic, hourly traffic ● Number of taxi parking spaces, number of cars entering area Number of operating bus lines, service frequency	2) Planning ● Plaza plan decision time ● Plaza business decision time ● Planned plaza area ● Building line and 1/6 line ● Plaza construction shape and uses
Scale calculation	1) Urban population trend 2) Evolution and concept of station's sphere of influence 3) Changes in number of boarding passengers ● By time, direction, commuter, non-commuter Number of boarding and alighting passengers ● Changes in ratio of commuter/non-commuter passengers Seasonal waves	4) Changes in number of trains 5) Estimate of number of boarding and alighting passengers 6) Documents detailing calculation of area/size of each room
Floor planning	1) Passenger flow lines from the Plaza 2) Concept of main station building 3) Placement of station operations offices 4) Placement of shops and other service facilities	5) Arrangement of restrooms for passengers 6) Coordination with living services business development plan 7) Facilities for the mobility-handicapped 8) Consideration of future planning

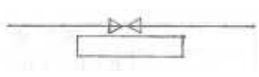
Preparation items for main station building planning

Laws and regulations, and structural planning	1) Verification of relevant laws, regulations, and ordinances 2) Verification of ground condition 3) Organization of choices by type of structure	4) Verification of adequacy of story heights and ceiling heights 5) Suitability of pillar spacing 6) Consideration of building extension
Design planning	1) Determination of grade 2) Determination of design 3) Preliminary determination of finishing materials	4) Coordination of display devices and advertising
Facility planning	1) Determination of disaster-prevention equipment systems 2) Determination of air-conditioning range and equipment system	3) Water supply and drainage facility planning 4) Electrical and communication equipment
Other	1) Construction planning ● Temporary facilities/switching procedures ● Selection of construction methods and heavy equipment to be used	2) Consideration of maintenance ● Planning of maintenance and inspection ● Consideration of cleaning work

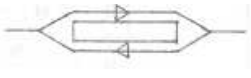


Flaw of station facility planning

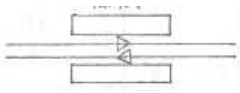
Type of Platform



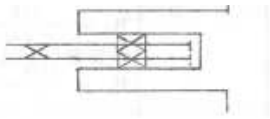
Single platform



Island platform

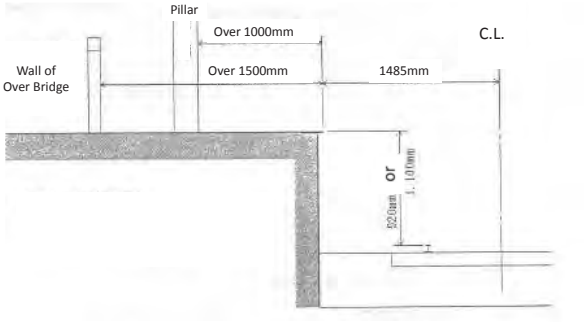


Opposite platform

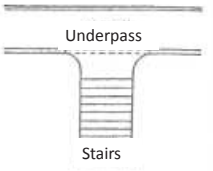


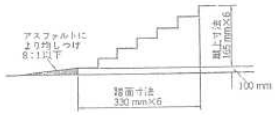
Stub platform

Cross section of Platform (In case of Japan)



Stairs (In case of Japan)



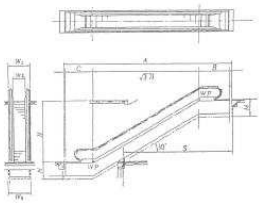


Rule in Japan

- Gradient is 2:1
- Height of step is under 18cm.
  (Standard is 16.5cm)
- Surface of step is over 26cm.
  (Standard is 33cm)
- If the height of stairs is over 3m, landing must be equipped.
- Width is 1m per 2,500 passengers/h.

Escalator

Install Standard in Japan



New Station and
big scale improvement station

- More than 5,000 passengers per day.
- More than 5m difference level between platform and passage

Existing Station

- Based on new station
- Consideration of passenger, landform and station structure, etc.

Escalator (1step)

MOV06274.MPG

Escalator (3steps)

MOV06280.MPG

Moving Walkway

A moving walkway is a slow moving conveyor mechanism that transports people across a horizontal or inclined plane over a short to medium distance. Moving walkways can be used by standing or walking on them. They are often installed in pairs, one for each direction.

Elevator

MOV06239.MPG

Elevator

MOV06238.MPG

Platform Door

Platform door at train or subway stations screen the platform from the train. They are a relatively new addition to many metro systems around the world, some having been retrofitted to established systems. They are widely used in newer Asian and European metro systems.

Platform Door

MOV06255.MPG

Leading Block

Leading block is a system of textured ground surface indicator found on footpaths, and train station platforms to assist pedestrians who are blind or visually impaired.

Warning Block

Warning Block is a system of textured ground surface indicator found in front of stairs, escalator elevator, etc. to assist pedestrians who are blind or visually impaired.

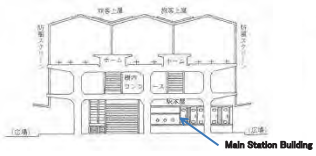
Ticket gate

The ticket gate is the part of a train or subway station where machines or station personnel check passengers' tickets as they enter or leave.

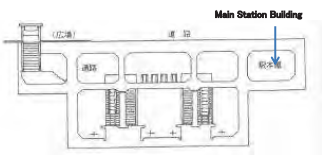
Type of Main Station Building

Grand Station

Over – track Station



Under – viaduct Station



Underground Station

Station plaza

Attention must be paid to the following points when planning a station plaza.

① Use "Station Plaza Research Committee Calculation Formula (enacted in 1953)" for the calculation of the area of the station plaza.

② Calculation of the number of boarding and alighting passengers is to be done as a projection of that number in 20 years.

③ If a road designed mainly for road traffic is to pass by the station plaza, perform the planning without including that road in the station plaza area.

Example of Calculation Formula of station plaza area in Japan

	Electric train station (commuter stations, etc.)	Steam train station (small and medium-sized city stations, etc.)	Article
Condition	X≦73,000	X≦30,000	A: Station plaza area (㎡) X: number of boarding and alighting passengers (persons/day)
Standard	A=0.119X	A=9.846√X+0.238X	
Upper limit	A=0.128X	A=11.218√X+0.271X	
Lower limit	A=0.08X	A=8.989√X+0.217X	
Condition	X>73,000	X>30,000	
Standard	A=0.0259X+25.088√X	A=51.657√X	
Upper limit	A=0.0277X+26.846√X	A=58.880√X	
Lower limit	A=0.0189X+18.316√X	A=47.162√X	

Way of thinking of the station plaza area

- Bus (Bus Stop, Parking lot)
- Taxi (Taxi Stop, Parking lot)
- Car (Getting on and off, Parking lot)
- Sidewalk
- Road
- Others(Additional facilities)

Parking lot for taxi

Bus stop

Free passage

The areas behind station buildings, which serve as gateways for cities, has always been an urban development issue.

In the case of many stations, the residents living close to the back side of the station have to walk across a distant railway crossing, buy a platform ticket, and go to the front entrance of the station.

Further, from the viewpoint of urban development, the existence of facilities allowing free passage between the front and back of a station makes it possible to integrate the entire area between the front and back of a station, significantly promoting urban development.

Type of Free passage

Free passage at Chiba Station (Flyover)

Free passage at Tokyo Station (Underground)

Width Calculation of free passage

The calculation of the width of free passage is done based on the number of railway passengers (number of boarding and alighting passengers using the station during 1 hour of rush period) and the number of general public walking through the station.

However, width calculation is generally done by the city, and whether the width is appropriate for the number of boarding and alighting passengers is to be determined with simplified method.

Free passage at Tachikawa Station

Simplified method 1 m width for each 3,000 persons/h

Tokyo Station at night

Thank you for your attention.

Definitions of Tunnel-related Terms

Mountain tunneling method: The tunneling method that maintains the internal space using support measures after the excavation by drill and blast, mechanical or manpower excavation. This assumes that the ground near the face can keep standing after excavation until the installation of supports.

Urban mountain tunneling method: The Mountain tunneling method that excavates 'soil ground' in 'urban areas'.

Urban area: An area where buildings and houses exist near the tunnel and there are some restrictions against the settlement of ground or subsidence of groundwater in the cities and the surroundings. This includes areas that will be urbanized and have possibility of future tunnel excavation in the vicinity.

Ground: The general term for the earth and rock materials surrounding the tunnel. It includes discontinuities, voids and improved materials.

Soil ground: The ground that consists of Quaternary or Pliocene of Neogene deposit, or heavily weathered residual soil etc. It is unconsolidated or in low degree of consolidation.

Ground condition: The topographical, geological and hydrological condition of the ground surrounding the tunnel.

Ground classification: The general estimation and classification of the ground based on quantitative factors and experimental indices. The term 'ground division' is also used.

Class of ground: The grading system for the ground characteristics based on the 'ground classification'. This is generally used as the criterion for the evaluation and classification of the ground.

Location condition: The general term that includes natural, social and living environment conditions of the construction site. The term 'site condition' is also used.

Original design: The design based on the plan and investigation in the stage prior to the start of construction. The term 'preliminary design' is also used.

Modified design: The reviewed and revised 'original design' based on the observation and measurement during the construction stage.

Overburden: The ground above the tunnel. The term of 'depth of overburden' means the thickness of the overburden.

Watertight tunnel: A tunnel that generally blocks groundwater and prevents water inflow after completion. The hydraulic pressure is considered in the design of the lining.

Excavation method: The construction method that is determined by the partition of the section of excavation. Full face method, bench-cut method, drift advancing method and

center diaphragm method. The partition of the section of excavation is called 'division of heading'.

Tunnel driving method: A classification of tunnel construction methods based on the method of excavation depending on the strength of the ground. This includes drill and blast excavation, mechanical excavation and manual excavation.

Face: The forefront and peripheral part of the ground under excavation and supports.

Support: The means, procedures and resultant structures to restrain the deformation and to stabilize the ground surrounding the tunnel. The main support members used in the ordinary mountain tunneling method are shotcrete, rock bolts and steel supports.

Lining: The means, procedures and resultant structures to construct the necessary shape and function of the tunnel, and to preserve the long-term stability of the tunnel.

Invert: The inverse arch concrete placed in the floor that preserves the long-term stability of tunnel bonding with lining. It is also expected to stabilize the surrounding ground at the stage when structures are bonding with supports.

Countermeasure: The auxiliary or special method to stabilize the face, guarantee the safety of the tunnel, and preserve the surrounding environment.

Observation and measurement: The means to verify the stability and safety of the tunnel structure and to evaluate the validity of the design and construction. It mainly consists of grasping the behavior of the surrounding ground, the effect of the support members and the impact on structures in the vicinity during excavation of the tunnel.

Control criterion: The index to evaluate the result of 'observation and measurement', determined in order to decide the validity of the design and construction of the tunnel.

LECTURE ON RAILWAY TECHNOLOGY :UNDERGROUND STRUCTURE, TUNNEL


- Harutoshi Hayasaka
- General Manager, Engineering Headquarters
- Japan International Consultants for Transportation Co.,Ltd

BRIEF ABOUT THE SPEAKER'S MAJOR JOBS

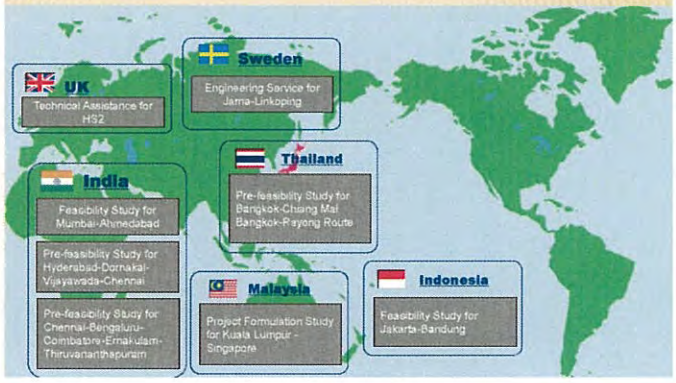
Major Jobs :

- HSR Construction/Acting Leader: Joint Feasibility Study for Mumbai-Ahmedabad, High Speed Railway Corridor in India.
- Team Leader : The Study of Countermeasures against Snow Damage and Demonstration of Railway Technology in Sweden
- Chief Railway Expert – cum – Team Leader: Pre-Feasibility Study for HSR Line-6 in India (Chennai – Bengaluru – Coimbatore – Ernakulam – Thiruvananthapuram with branch line to Mysore)
- Chief Project Manager : Planning on MAGLEV Construction Project in Japan.
- Technical Adviser : The Eurotunnel Project Financing by the Banking Syndicate in UK and France.

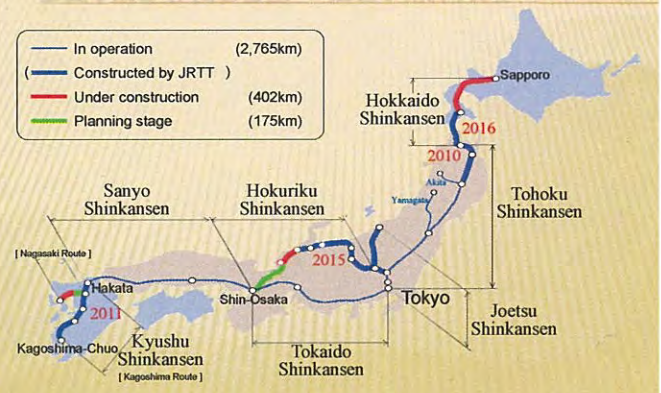
◆ JIC's Mission - Project Stage

■ **We Are Able to Manage Every Project Stage and Field**

HSR Projects JIC in hand



SHINKANSEN NETWORK



Source : JRTT

THE LONGEST RAILWAY TUNNEL IN THE WORLD

(As of May 2016)

No.	Tunnel	Length	Location	Open
1	Gotthard Base	57.07 km	Switzerland	Construction completed
2	Basis Brenner	55.00 km	Austria, Italy	Under Contemplation
3	Seikan	53.85 km	Hokkaido, Aomori	1988
4	Basis Montd' Ambin	52.11 km	France, Italy	Under Construction
5	Channel (Euro)	50.45 km	France, UK	1994
6	Lotschberg Basis	34.58 km	Switzerland	2007
7	Koralm	32.80 km	Austria	Under Contemplation
8	Guadarrama	28.38 km	Spain	2007
9	Taihang	27.85 km	China	2008
10	Hakkouda	26.46 km	Aomori	2010
11	Iwate Ichinohe	25.81 km	Iwate	2002
12	Pajares Base	24.67 km	Spain	Under Contemplation
13	Lainzer-Wienerwald	23.94 km	Austria	Under Contemplation
14	Iiyama	22.23km	Nagano,Niigata	2015
15	Ohshimizu	22.22km	GummaNiigata	1982

SHINKANSEN TUNNELS


Kyushu Shinkansen Tunnel


Tunnel and Slab Track


Seikan Undersea Tunnel


Iwate-Ichinohe Tunnel

CONTENTS

1.CLASSIFICATION OF TUNNEL

- Mountain Tunnels: Applied from mountainous areas to urban areas
- Shield Tunnels: Applied to urban areas using a shield tunnel boring machine
- Cut and Cover Tunnels: Applied to urban areas and low overburden areas
- Submerged Tunnels: Tunnel structures are first build on land, then are moved and settled in their final location in the bottom of the sea

1. CLASSIFICATION OF TUNNEL

Comparison of tunneling methods

	Mountain tunneling method	Shield method	Cut and cover method
Overview	Making full use of the natural support function of the surrounding ground. The ground is stabilized during excavation with shotcrete, rock bolts, steel supports etc. Prerequisite condition that a 'ground arch' is formed and that the face remains standing when excavated. Otherwise, counter-measures are necessary.	The shield is thrust in the ground to make the tunnel. The outer layer of the shield and the segment support the walls of the tunnel. Closed-type shield stabilizes the face using earth or slurry to counter earth or hydraulic pressure. Open-type shield is only usable when the face remains standing. Otherwise, countermeasures are necessary.	The ground is excavated from the surface to build the tunnel at the desired depth. Then the excavated earth is brought back to restore the surface. Full face method is generally employed.
Applicable geology	Generally from hard rock to Tertiary soft rock. It may also be applied to the diluvium layer depending on the condition. Can also be used in unconsolidated ground with unconfined strength of 0.1 N/mm^2 and modulus of deformation over 10 N/mm^2, including softer ground. Rigidity of steel supports, excavation method and countermeasures can be changed according to geological variation.	It is applied to extra soft ground such as the alluvium layer, the diluvium layer, and the Neogene layer, to ground that has unconfined strength(q_u) of thousands kN/m^2. It is usually used for unconsolidated ground. Recently there have been an increasing number of cases of ground with unconfined strength of some ten N/mm^2.	Basically there is no ground condition where this method cannot be used. Appropriate earth-retaining system and/or auxiliary method is selected according to the ground condition.
Countermeasures for groundwater	When there is water inflow that affects the self-support of the face or the stability of the ground during excavation, water sealing method such as by deep well, well point, or drainage tunnel is necessary.	Usually, closed type shield does not require countermeasures, but the open type does.	Countermeasures such as deeper penetration of earth retaining wall, groundwater reducing method, soil improvement etc. are usually necessary to overcome boiling or heaving.

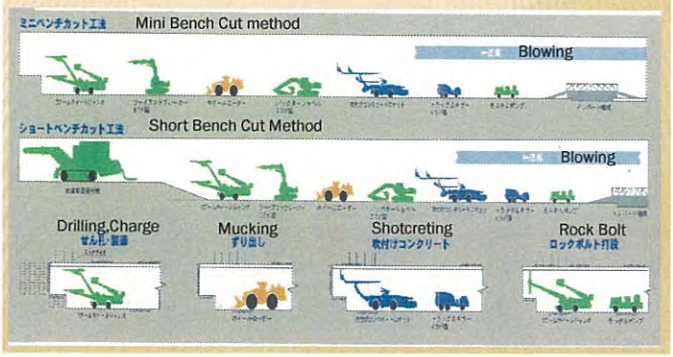
Source: JSCE

1.CLASSIFICATION OF TUNNEL

- Mountain Tunnels
- NATM is the standard method for the mountain tunneling in Japan.
- NATM stands for New Austrian Tunneling Method

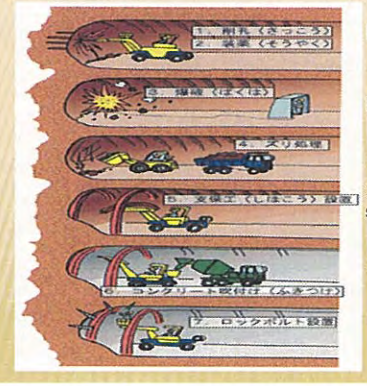
1.CLASSIFICATION OF TUNNEL

Construction Procedure Drawing for Mountain Tunnel



1.CLASSIFICATION OF TUNNEL

Mountain Tunnels



Drilling

Blasting

Mucking

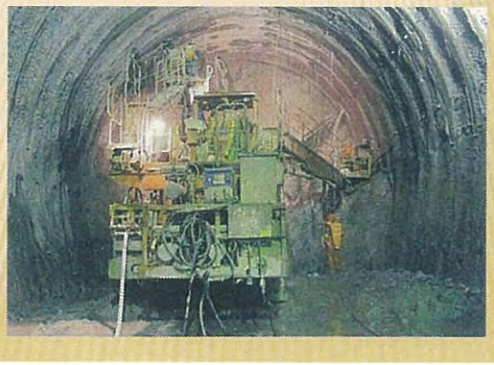
1st Shotcrete,Steel support

2nd Shotcrete

Rock bolts

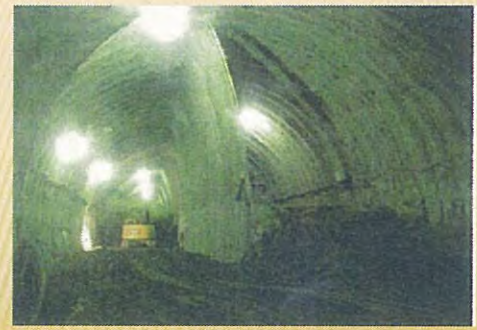
1.CLASSIFICATION OF TUNNEL

Mountain Tunnels



1.CLASSIFICATION OF TUNNEL

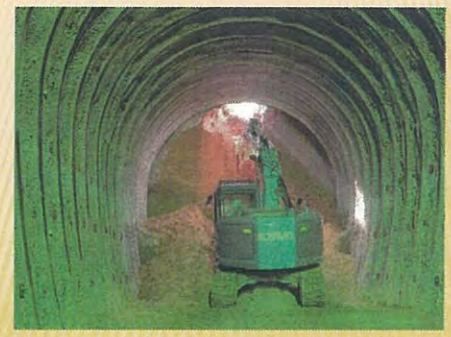
Mountain Tunnels



View of Large-section Station Tunnel by Urban NATM

1.CLASSIFICATION OF TUNNEL

Mountain Tunnels



Source: JTA

1.CLASSIFICATION OF TUNNEL

Mountai Tunnels

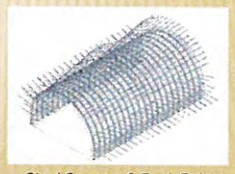
Source: JTA

EAMPLES OF URBAN NATM

Urban NATM of Keiyo Line

CRD Method for Settlement Measure

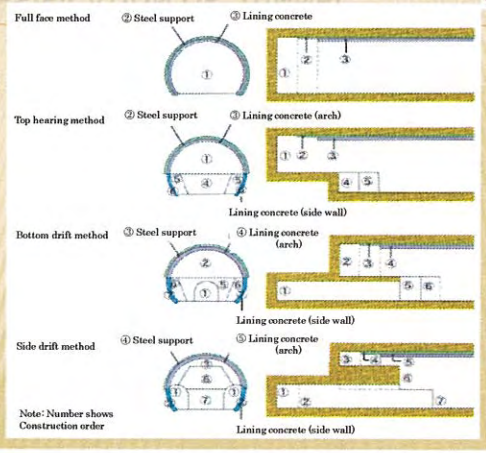
Large Sectional Area Urban NATM



Steel Support & Rock Bolts

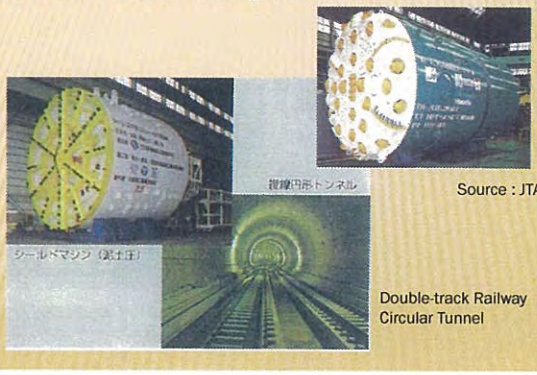
1.CLASSIFICATION OF TUNNEL

Mountain Tunnels



1.CLASSIFICATION OF TUNNEL

Shield Tunnel & Tunnel Boring machines



Source : JTA

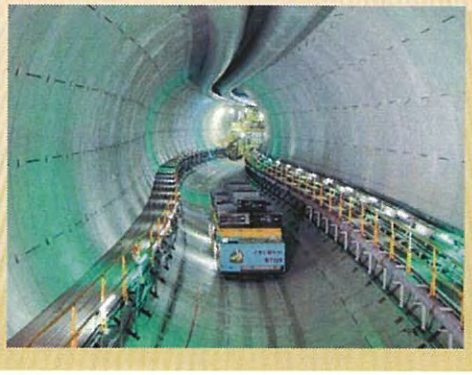
Double-track Railway Circular Tunnel

1.CLASSIFICATION OF TUNNEL

Shield Tunnels

1.CLASSIFICATION OF TUNNEL

Shield Tunnels



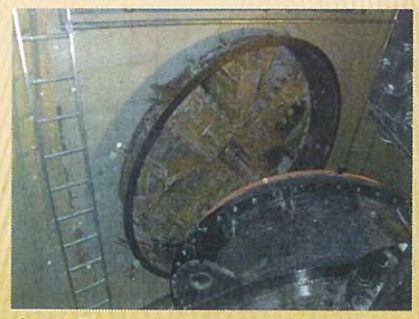
1.CLASSIFICATION OF TUNNEL

× Shield Tunnels

Source : JTA

1.CLASSIFICATION OF TUNNEL

× Shield Tunnels



Source: JTA

1.CLASSIFICATION OF TUNNEL

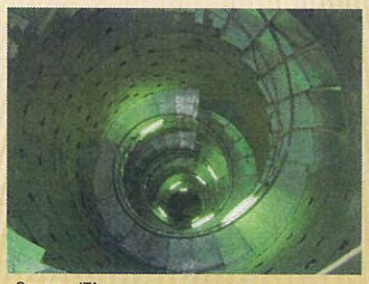
- Shield Tunnels

Source : JTA

Shield Tunnel under Construction with Ceiling Crane & Escape Passage

1.CLASSIFICATION OF TUNNEL

- Vertical Shaft as Common Ditch for Water Pipe & Power Supply Cable by Shield Method



Source : JTA

1.CLASSIFICATION OF TUNNEL

- Starting Shaft of Shield Machine

Source : JTA

Rainwater Drainage Culvert's Internal Diameter : 500cm

1.CLASSIFICATION OF TUNNEL

- Shield Tunnel

Source : JTA

The Metropolitan Expressway in Tokyo

1.CLASSICIFICATION OF TUNNEL

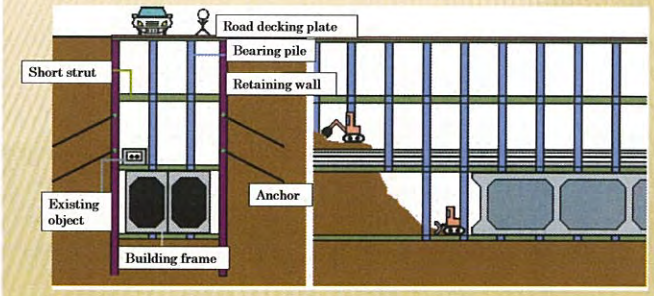
Shield Tunnel

Source : JTA

U-turn Process of the Shield Machine

1.CLASSIFICATION OF TUNNEL

Cut and Cover Tunnels



1.CLASSIFICATION OF TUNNEL

Cut-and-cover Tunnel through a Densely Congested Area

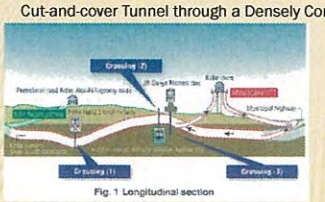


Fig. 1 Longitudinal section

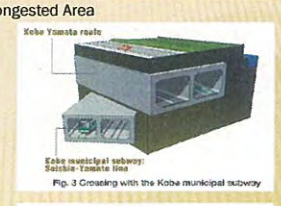


Fig. 3 Crossing with the Kobe municipal subway

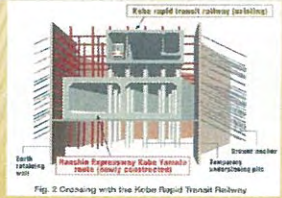


Fig. 2 Crossing with the Kobe Rapid Transit Railway

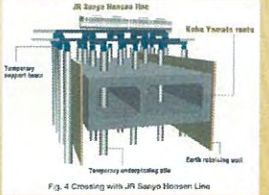


Fig. 4 Crossing with JR Sanyo Honsen Line

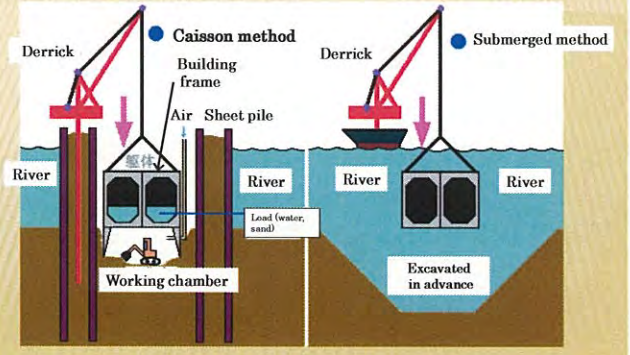
Source : JTA

1.CLASSIFICATION OF TUNNEL

Cut and Cover Tunnels

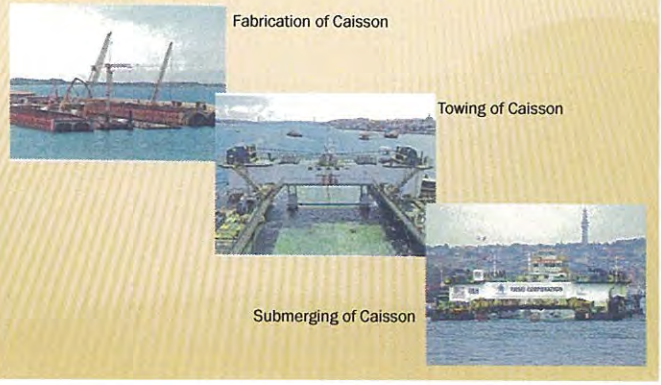
1.CLASSIFICATION OF TUNNELS

Caisson & Submerged Methods



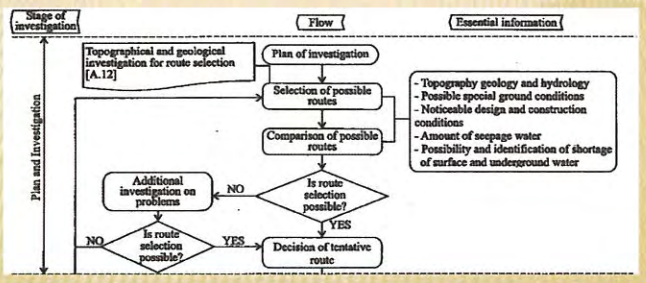
1.CLASSIFICATION OF TUNNEL

Submerged Tunnel



2. PLANNING & INVESTIGATION

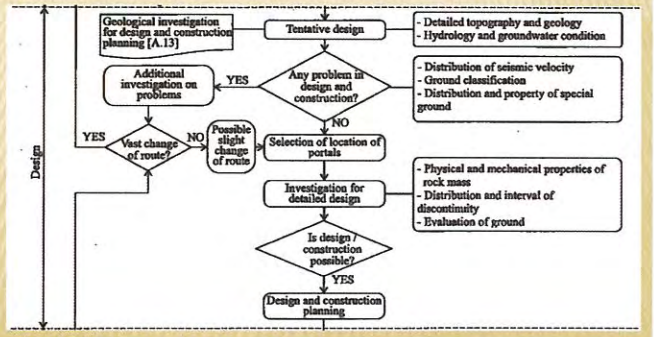
Flowchart of Investigation of Ground Conditions Plan & Investigation Stages



Source: JSCE

2. PLANNING & INVESTIGATION

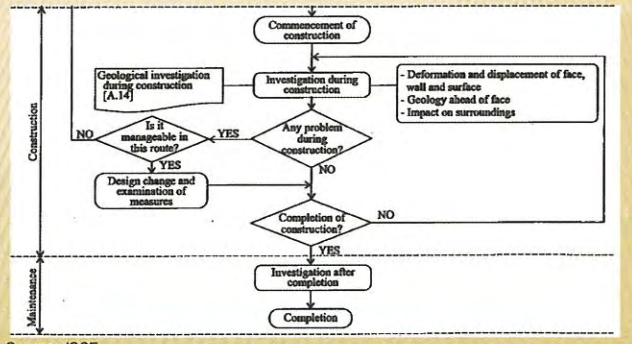
Flowchart of Investigation of Ground Conditions Design Stage



Source: JSCE

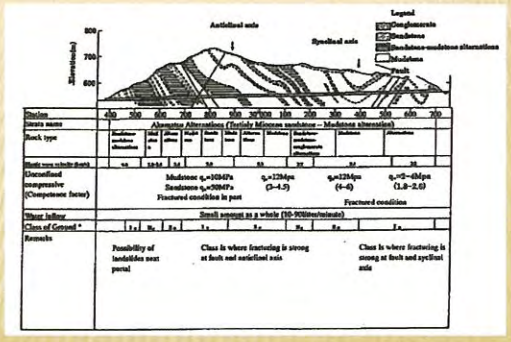
2. PLANNING & INVESTIGATION

Flowchart of Investigation of Ground Conditions Construction & Maintenance Stages



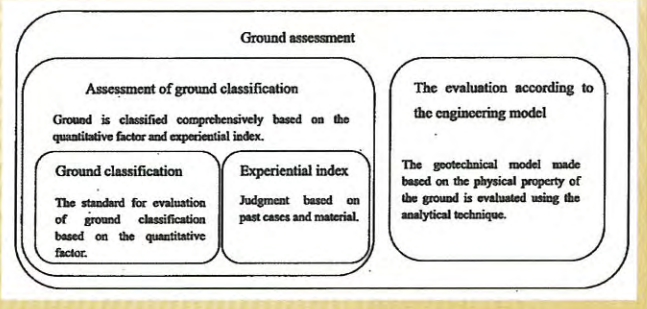
Source: JSCE

2. PLANNING & INVESTIGATION



Source: JSCE Example of the Longitudinal Geological Profile

2. PLANNING & INVESTIGATION



Source: JSCE Approaches for Ground Assessment

2.PLANNING & INVESTIGATION

Tabol-2.10 List of Typical Indoor Tests

			Hard	Soft	Cracking	Ultrasonic velocity	
Mechanical test	Uniaxial compression test	Uniaxial compressive strength Static modulus of elasticity Static Poisson's ratio	○	●	●	●	Basic index to judge mechanical properties of rocks
	Triaxial compression test	Rock strength test c, Φ Rock property of deformation		●	●	●	Basic index to judge mechanical properties of rocks
	Tensile strength test	Tensile strength		○	○		Mainly use test of pressure crack
	Ultrasonic propagation velocity test	Dynamic modulus	●	●	●		By bedrock surrogated degree vs ground elastic wave speed
Physical test	Specific gravity test	Specific gravity	●	●	●	●	
	Moisture content test	Natural water content Degree of saturation		○	●	●	
	Density test	Wet density/Dry density	●	●	●	●	
	Gradation test	Gradation composition Uniformity coefficient			●	●	Existence of quicksand
	Liquid limit, plastic limit test	Liquid limit/plastic limit index			●	○	
	Slaking test	Slaking property		○	●		Swelling
	X-ray diffraction test	Kinds of clay mineral		○	○		Existence of swelling clay mineral
	Cation exchange capacity test (CEC)	Assumption of smectite content			○		

Note:
● is needed to do in many cases
○ can be omitted.

Source: JGS

2.PLANNING & INVESTIGATION

Bedrock Classification

Kind of Rock	Layer Name / Rock Name
A	① Paleozoic strata, Mesozoic strata (slate, sand stone, conglomerate, chert, schalstein, lime stone, etc.) ② Plutonic rock (granite, diorite, etc.) ③ Hypabyssal rock (porphyrite, granite porphyry, diabase, etc.) ④ Volcanic rock (dolerite, basalt, etc.) ⑤ Metamorphic rock (schist, gneiss, phyllite, hornfels, etc.)
B	① Extremely-fissile metamorphic rock (schist, gneiss) ② Extremely-fissile or fine-bedding Paleozoic strata, Mesozoic strata (phyllite, slate, schale, etc.)
C	① Mesozolic strata (schale) ② Volcanic rock (rhyolite, liparite, andesite, etc.) ③ A part of Paleogene strata (siliceous sand stone, siliceous schale, etc.)
D	Paleogene strata~Neogene strata (schale, sand stone, conglomerate, tuff, tuff breccia, etc.)
E	Neogene strata (mud stone, silt rock, sand stone, tuff, etc.)
F	Diluvial layer, a part of Neogene strata (low-consolidation, unconsolidated layer, sand, hard pan, etc.)
G	Topsoil, colluvium, etc.

Source: JGS

3. DESIGN

Selection of Initial Design Method

① Application of the standard design
② Application of the similar conditioned design
③ Application of the analytical method

Design Condition / Ground Condition	General Case	Special Case(Extremely large/small area, twin-bored tunnel, closely-situated tunnel with another structure)
General Case	Application of standard design	Application of similar conditioned design or analytical methods
Special Case (swelling ground, very small overburden)	Application of similar conditioned design or analytical methods	

Source: JGS

3. DESIGN

Main Points of Observation on Similarity Consideration

Item		Point of the Observation
Tunnel use		Same tunnel use
Ground Condition	Ground Classification	Same ground classification
	Landform/overburden	Similarity of landform/overburden (unstable, unsymmetrical pressure landform, special ground property)
	Ground Property	Similar kind of rock/geological era, groundwater condition
Sectional Shape/Scale		Similar sectional shape/scale
Environs Influence		Similar regulatory value (surface subsidence, and the like)
Neighboring Construction after Completion		Similar specifications (kind, location, scale and the like)

Source: JGS

3. DESIGN

Analytical Method of the Design

Method	Design Object	Main Purpose of Analysis
Theoretical analysis	Support members	• Preliminary review of numerical analysis • Stability evaluation of the support members
FEM	Auxiliary method Support members Lining	• Ground behavior during construction • Stability evaluation of the support members • Effect of the auxiliary method • Influence prediction to the surrounding environment • Lining behavior in the swelling ground • Influence review to the neighboring construction
Framed structural analysis	Lining	• Evaluation of the lining's structural stability

Source: JGS

3. DESIGN

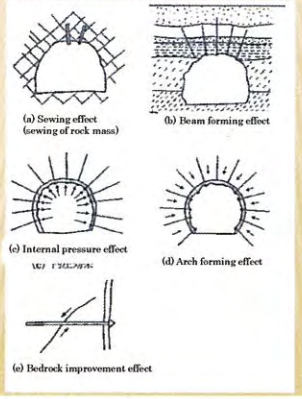
Concepts of the Shotcrete's Function

Function	Category of function, effect	Summary of function and expected effect
	I axial compaction resistance of concrete	Resisting comparatively uniform external forces mainly against the internal space creating the arch, and resisting the axial forces which cause deformation, using the axial compaction resistance and rigidity of concrete.
	II shear resistance of concrete	Resisting shear force and shear displacement which causes localized ejection, using the shear resistance and rigidity of concrete. Adhesion between the bedrock and shotcrete is necessary. If adhesion is lost, concrete goes into flex resistance mode.
	III flex resistance of concrete	Resisting flexing moment which causes localized ejection, using the flex resistance and rigidity of concrete.
	IV shear resistance, adhesion resistance of concrete - bedrock interface	Support of loads taken by I to III above, and distribution of that support function over the bedrock, using the shear resistance (adhesion resistance) at the shotcrete - bedrock interface.

Source: JSCE

3. DESIDN

Concepts of Function Effects of Rock Bolts



Source: JGS

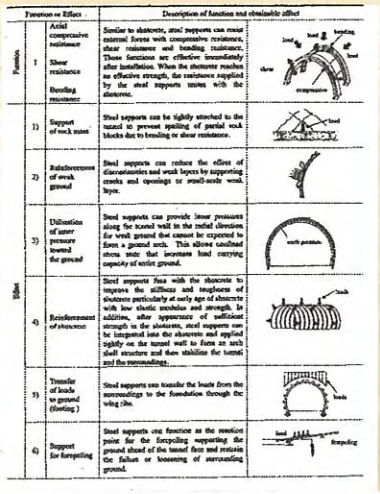
3. DESIGN

Classification by Anchoring Mechanism	Method and Kind	Anchoring Method	Characteristics and Fields of Application
Full Anchoring Method	Filling type: Mortar anchor, Capsule type	• To anchor the whole rock bolt to the ground by resin, mortar, etc. • Anchoring agent is filled before or after the rock bolt inserting.	• Applicable to all ground. • For borehole crashing, the driving/drilling types can be often used.
	Grouting: Insert type, Driving type, Drilling type		
Friction anchoring Method	Slit spring Steel pipe expansion type	• Rock bolt itself is anchored with the ground by the frictional force without the anchoring agent.	• Promptness of anchoring is expectable. • No decrease of anchoring effects due to the seepage etc. needless of fixing agent.
Combined Method			• Useful for the swelling ground, introduction of prestress

Source: JGS

3. DESIGN

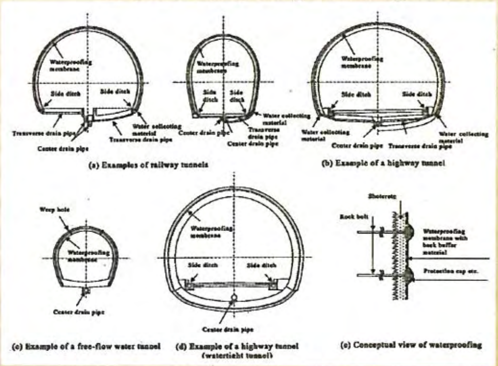
Concept of Function and Effect of Steel Support



Source: JSCE

3. DESIGN

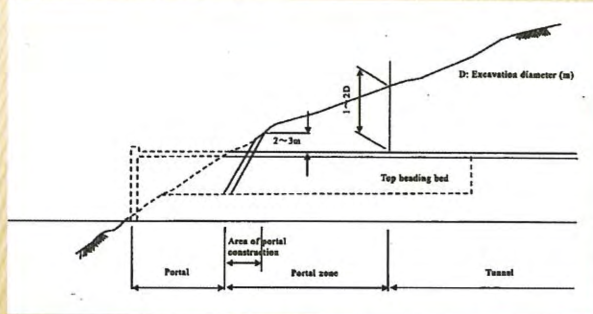
Examples of Waterproofing and Drainage



Source: JSCE

3. DESIGN

Area of a Standard Portal Zone

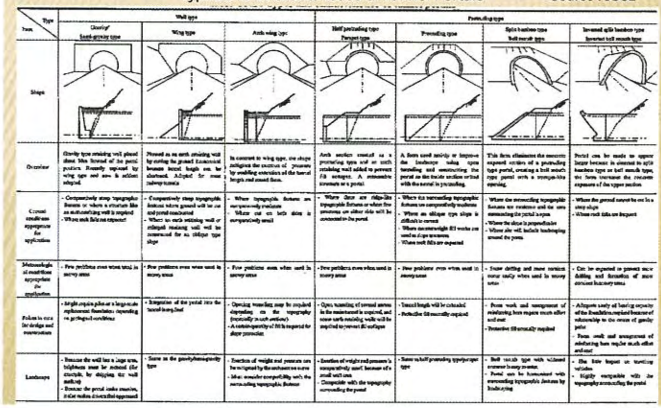


Source: JSCE

3. DESIGN

Types and Characteristics of Tunnel Portals

Source : JSCE



Item \ Type	Wall type: Gravity/Semi-gravity type	Wall type: Wing type	Wall type: Arch wing type	Protruding type: Half protruding type / Parapet type	Protruding type	Protruding type: Split bamboo type / Bell mouth type	Protruding type: Inverted split bamboo type / Inverted bell mouth type
Shape							
Overview	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Ground conditions appropriate for application	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Meteorological conditions appropriate for application	- Few problems even when used in snowy areas	- Few problems even when used in snowy areas	- Few problems even when used in snowy areas	- Few problems even when used in snowy areas	[illegible]	[illegible]	[illegible]
Points to note for design and construction	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Landscape	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

4. CONSTRUCTION

- Tunnel Driving Method
- Mechanical Excavation

Boom Type Cutting Machine

4. CONSTRUCTION

- Drill and Blast

Jumbo Drilling Machine

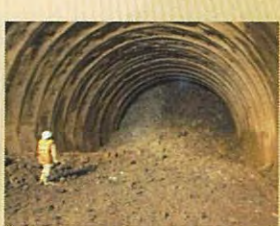
4. CONSTRUCTION

- Drill and Blast

4. CONSTRUCTION

- Drill and Blast

Charging



Blasting

4. CONSTRUCTION

- Excavation by Mechanical Method

4. CONSTRUCTION

× Mucking

Side dump type wheel roader

Mucking

4. CONSTRUCTION

× Mucking

Mucking in the tunnel

Temporary storage of excavated muck in the tunnel

Source : JTA

4. CONSTRUCTION

Mucking by Belt Conveyor

Photo 1 Belt conveyor outside the tunnel

Photo 2 Continuous belt conveyor in the tunnel

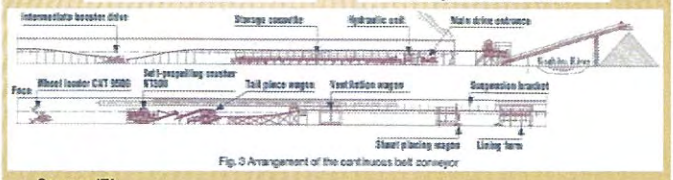


Fig. 3 Arrangement of the continuous belt conveyor

Source: JTA

4. CONSTRUCTION

× Shotcrete

Shotcreting Machine

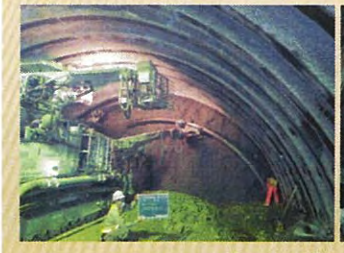
Shotcreting

4. CONSTRUCTION

× Shotcrete

4. CONSTRUCTION

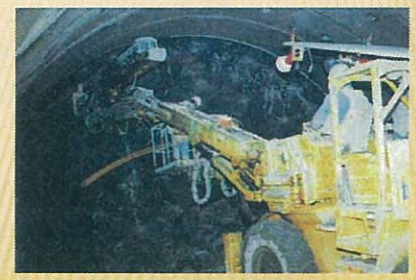
× Steel Supports



Erecting Steel Supports

4. CONSTRUCTION

× Steel Support



Erecting Steel Support

4. CONSTRUCTION

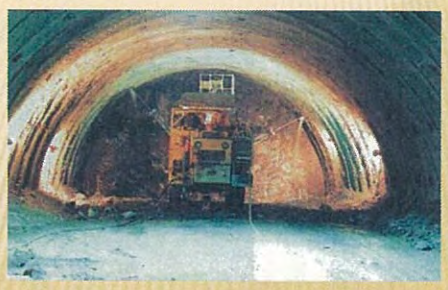
× Rock Bolts

4. CONSTRUCTION

× Rock Bolts

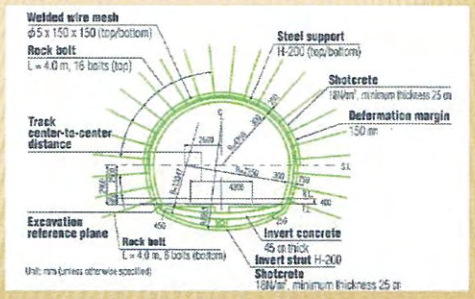
4. CONSTRUCTION

× Rock Bolts



4. CONSTRUCTION

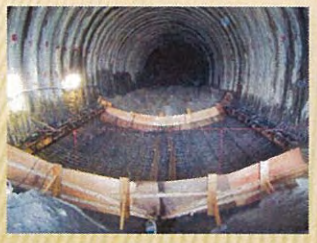
× Rock Bolts : Support pattern



Source : JTA Support Pattern of Tawarazaka Tunnel in Kyushu Shinkansen

4. CONSTRUCTION

× Invert

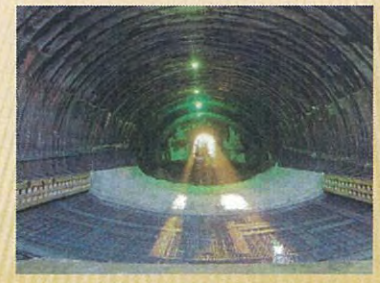


Invert under construction

Invert copmleted

4. CONSTRUCTION

× Reinforced Invert Concrete

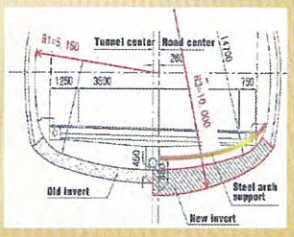


Source: JTA Road Tunnel in unconsolidated Rock Mass

4. CONSTRUCTION

× Reconstruction works of invert as measures against heaving of the bottom due to swelling mud stone

Repairing work of the invert



Invert geometry

Source : JTA

4. CONSTRUCTION

× Waterproofing

4. CONSTRUCTION

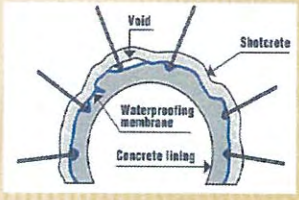
× Lining

Form for Tunnel Lining

Completion of Tunnel Lining

4. CONSTRUCTION

- Lining



Source: JTA

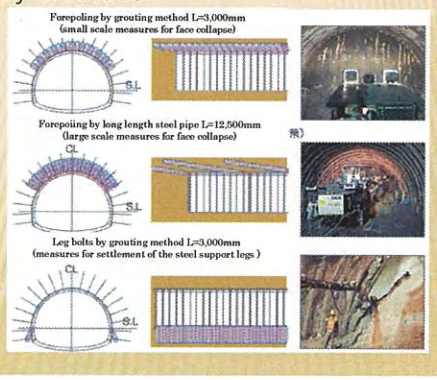
4. CONSTRUCTION

- Backfill Grouting & Rock Bolting

Machine Train Sets for Back Fill Grouting & Rock Bolting

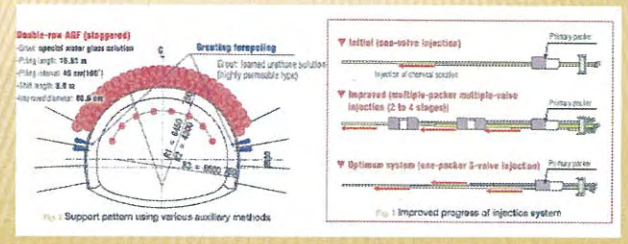
4. CONSTRUCTION

- Auxiliary Methods



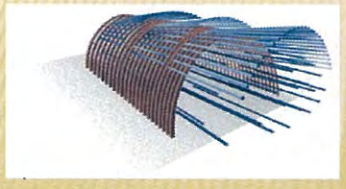
4. CONSTRUCTION

- **Auxiliary Method:** Stabilization methods for the crown by AGF (All Ground Fasten)



4. CONSTRUCTION

- Auxiliary Method
  - Stabilization methods for the crown
  - AGF (All Ground Fasten)



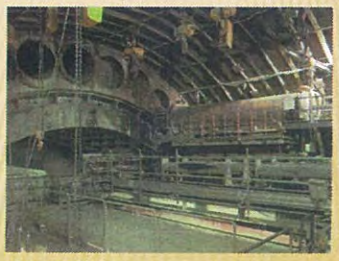
4. CONSTRUCTION

- Auxiliary Methods
- Stabilization methods for working face
- LL-Fp method (Long distance and Large caliber forepiling method)
- L=30m, Φ=140mm

Source: JTA

4. CONSTRUCTION

- Auxiliary Methods
- Pipe-roof Protection : L= 6.5m, Φ= 1,200mm



Source: JTA

4. CONSTRUCTION

- **Auxiliary Methods**
- Stabilization methods for working face
- Working face shotcrete

4. CONSTRUCTION

- Auxiliary Methods
- Stabilization methods for working face
- Long working face bolt

4. CONSTRUCTION

- Auxiliary Methods
- Artificial Soil Freezing method

Source : JTA

Rainwater Harvesting Culvert Tunnel

4. CONSTRUCTION

- Auxiliary Method
- Ultra-long Pilot Boring

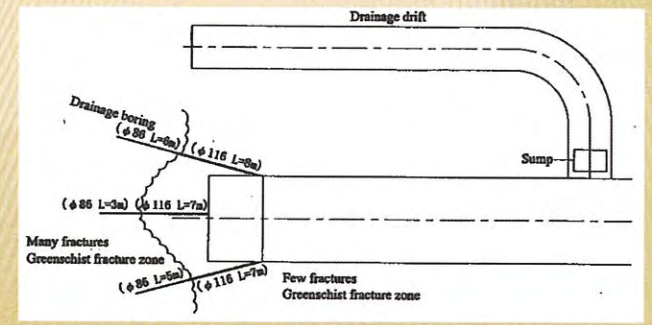
Source : JTA

1,000m-class ultra-long pilot boring

4. CONSTRUCTION

- Auxiliary method

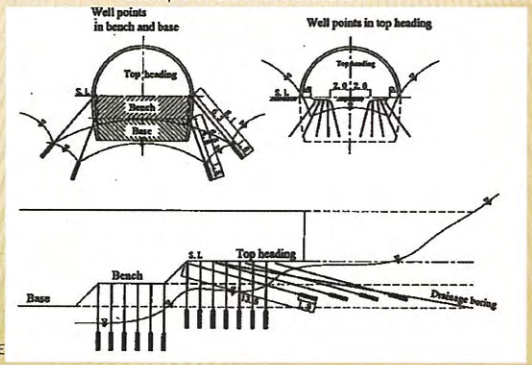
Example of Combined Use of Drainage Drift & Drainage Boring



4. CONSTRUCTION

- Auxiliary method

Example of the Well Point Sunk

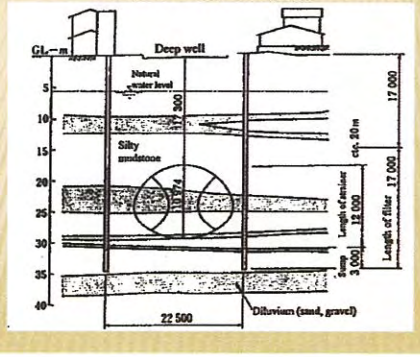


Source: JSCE

4. CONSTRUCTION

- Auxiliary method

Example of a Deep Well System



Source: JSCE

4. CONSTRUCTION

- Facilities

Tunnel Mouth, Portal-in

4. CONSTRUCTION

- Facilities

Surface Installations

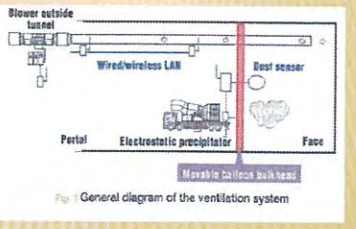
4. CONSTRUCTION

× Facilities : Ventilation

Ventilation Facility

4. CONSTRUCTION

Facilities: Ventilation



General diagram of the ventilation system

Source :JTA

4. CONSTRUCTION

Classification of Surveys

Classification	Time of Survey	Purpose of Survey	Contents	Results
Survey of control points outside tunnel	After design completion and prior to construction	Set up control points for the survey of tunnel excavation	GPS Survey Trilatertion Triangulation, Traversing, Leveling,	Set up control points and direction stakes for centerline
Survey in detail	After setting outside control points and before construction	Make topography plans for a portal and hypothetical tunnel plan	Topographic survey with electro-optical distance meter Tachymetry, Leveling, Traversing survey	Topography plans on scales of 1/100 to 1/500
Tunnel Survey	During construction	Setting centerline and levels in the tunnel Check excavation, support and forms	Traversing, Leveling, Gyro-survey, Laser Survey	Set up control points in tunnel and marking
Survey from working drift	After completion of working drift	Centerline and levels transferred from the working drift	Same as above or special survey method	Setup control point in tunnel

Source: JSCE

4. CONSTRUCTION

× Surveys

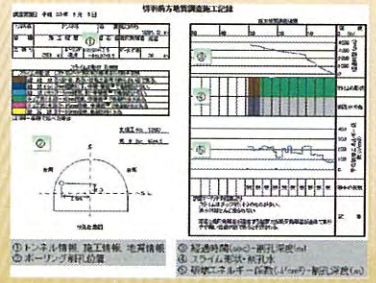
4. CONSTRUCTION

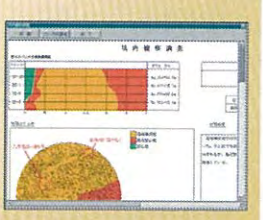
× Surveys

Tunnel Survey

5. OBSERVATION & MEASUREMENT

× Examples of Observation of Working Face





6.Lecturer's Experiences

COMPOSITION AND FUNCTION OF TUNNEL

- **Pilot tunnel**: Investigation and confirmation of comprehensive ground condition
- **Service tunnel**: Investigation and confirmation of Main tunnel's ground condition
- **Main tunnel**: Transport of passenger & freights
- **Inclined shaft**: Entrance / exit and pumping / drainage route for pilot and service tunnels

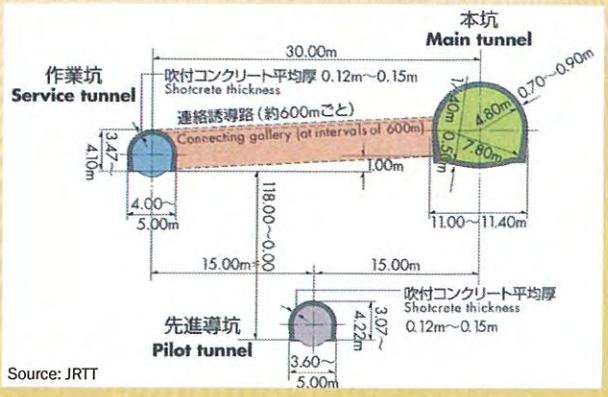
(Function for investigating and confirming ground condition)

- **Vertical shaft**: Entrance / exit and ventilation route for service tunnel
- **Connecting shaft**: Entrance / exit from service tunnel for partitioned main tunnel sections
- **Ventilation shaft**: Ventilating shaft for pilot and service tunnels Drainage (To flow down seepage in service tunnel to pilot tunnel)

Source: JRTT

6. Lecturer's Experiences

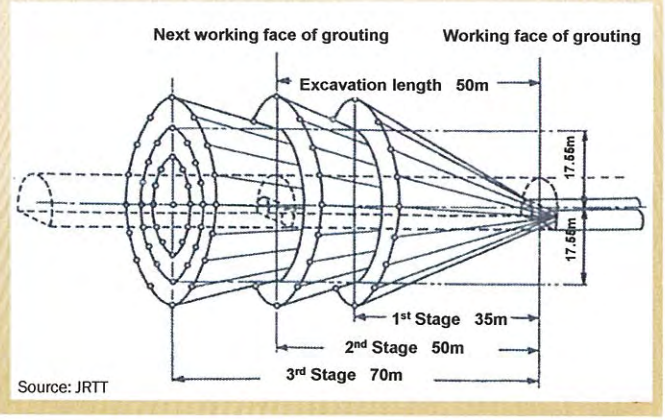
CROSS SECTION OF SEIKAN TUNNEL (2)



Source: JRTT

6.Lecturer's Experiences

SCHEMA OF GROUTING

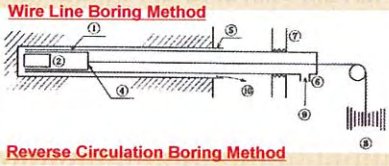


Source: JRTT

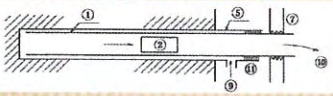
6.Lecturer's Experiences

SCHEMA OF BORING METHOD

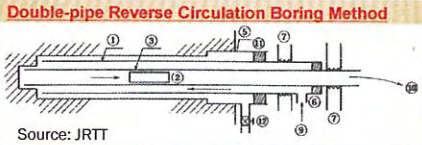
Wire Line Boring Method



Reverse Circulation Boring Method



Double-pipe Reverse Circulation Boring Method



Source: JRTT

① Rod
② Core
③ Rod (inner pipe)
④ Core barrel
⑤ Casing pipe at the month
⑥ Water swivel
⑦ Driller chuck
⑧ Hoist
⑨ Water pumping
⑩ Slime and dewatering
⑪ Preventer
⑫ Valve

6.Lecturer's Experiences

ADVANCED BORING BASE

— Yoshioka Side B-35 in the Pilot Tunnel —

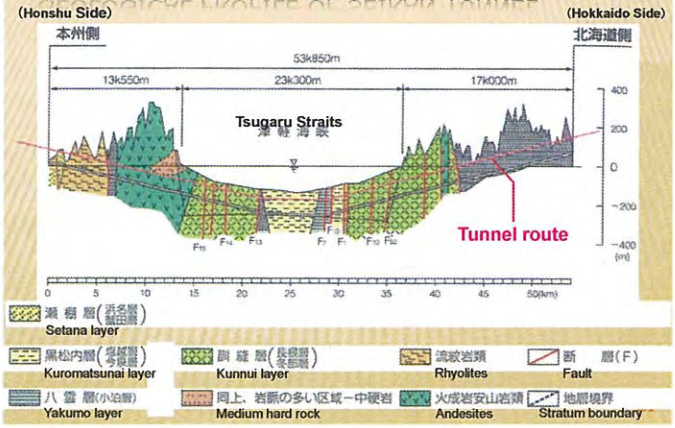
Source: JRTT

6.Lecturer's Experiences

LOCATION OF SEIKAN TUNNEL

6.Lecturer's Experiences

GEOLOGICAL PROFILE OF SEIKAN TUNNEL



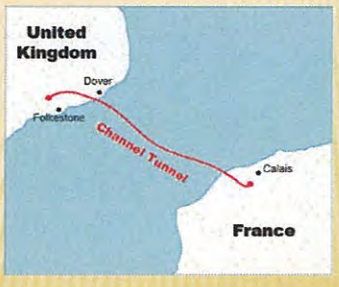
TBM USED FOR CHANNEL TUNNEL

CHANNEL TUNNEL & EURO STAR

6. Lecturer's Experiences

LOCATION OF CHANNEL TUNNEL

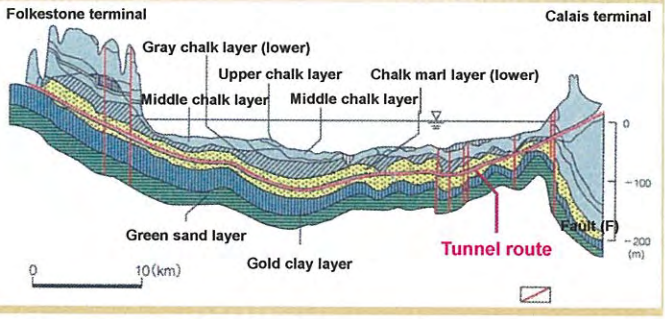
Channel Tunnel connects UK and France



6. Lecturer's Experiences

GEOLOGICAL PROFILE OF CHANNEL TUNNEL

Britain **France**



6. Lecturer's Experiences

OVERVIEW OF THE DOVER STRAIT IN UK SIDE

Coastal cliff of the UK side consists of chalk layer.

Source: Zenchiren

6.Lecturer's Experiences

COMPARISON OF SEIKAN TUNNEL AND CHANNEL TUNNEL

Item		Seikan Tunnel	Channel Tunnel
Length (Sea bottom)		53.85 (23.3)km	50.5 (37.9)km
Max. sea depth		140m	60m
Max. depth from surface		240m	108m
Steepest gradient		12‰	10.05‰
Min. curve radius		6,500m	4,000m
Geology		Neocene igneous rocks, Sedimentary rocks	Mesozoic era Cretaceous layer
Tunnel shape		Horse shoe shape	Circular tunnels
Construction methods		Combination of conventional method and road header	Full face excavation by TBM
Lining		Cast-in-place concrete	Segment (RC or Ductile)
Grouting		Cement, water glass injection	Cement grout injection
Advanced boring		Horizontal boring (1,000~2,000m, Max. 2,150m)	Approx. 100m length boring from working face
Breakthrough deviation	Vertical	14.6cm (Pilot tunnel)	10cm (Service tunnel)
	Horizontal	64.4cm (Pilot tunnel)	50cm (Service tunnel)
Work period		24 years (1964~1988)	11 years (1984~1995)

Source : Author

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EPISODE 缘奇求鱼

JRCC directly carried out the advanced boring in the Pilot Tunnel at the Tappi side of the Seikan Tunnel.
In Jan.31.1976, the boring work accidentally broke through the sea bottom of the Tsugaru Straights.

Naturally, sea water flew in the Pilot Tunnel through the borehole. The water was accompanied by rock cores, sea weeds as well as two swimming fishes named fat greenling, to be more exact, a scientific name was Hexagrammos otaki Jordan et Starks.

Generally speaking, this kind of fish is eaten as Sashimi, Teriyaki and french-fry in Japan. Fortunately, one of them was stuffed and displayed at the office in the Kajima Corporation, one of major general contractors in Japan.

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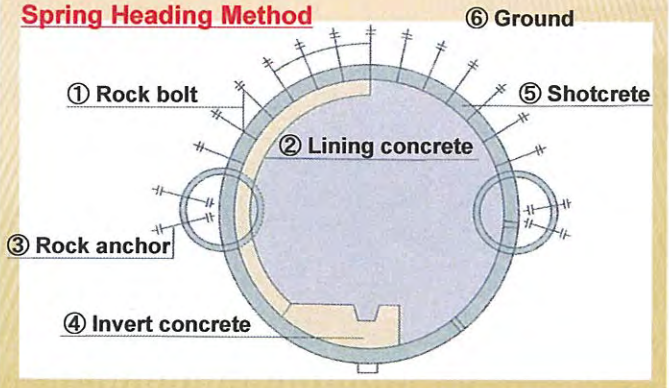
EXCAVATION METHOD (1)

Spring Heading Method



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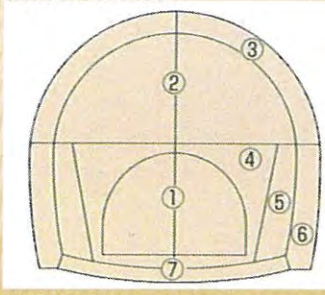
EXCAVATION METHOD (2)

Bottom Heading Method

The most common method applied to excavate 19% of Seikan Tunnel.



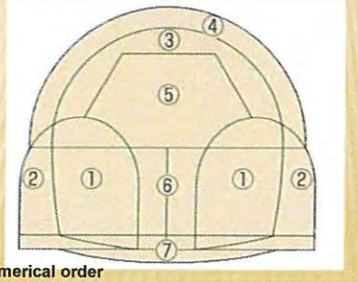
Excavating in numerical order

110

EXCAVATION METHOD (3)

Side-drift Heading Method

Injects concrete fluid into the ground from two side-drifts to cover, followed by surface excavation and fill.



Excavating in numerical order

111

EXCAVATION METHOD (4)

Side-drift Heading Upper Half Cut Method

112

6.Lecturer's Experiences

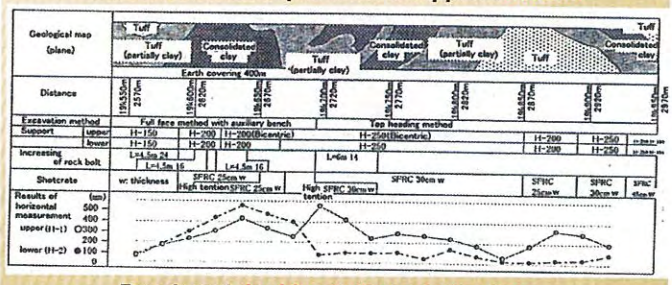
LOCATION OF ASAHI TUNNEL

Source : Author

6.Lecturer's Experiences

GEOLOGICAL MAP AND HORIZONTAL DISPLACEMENT

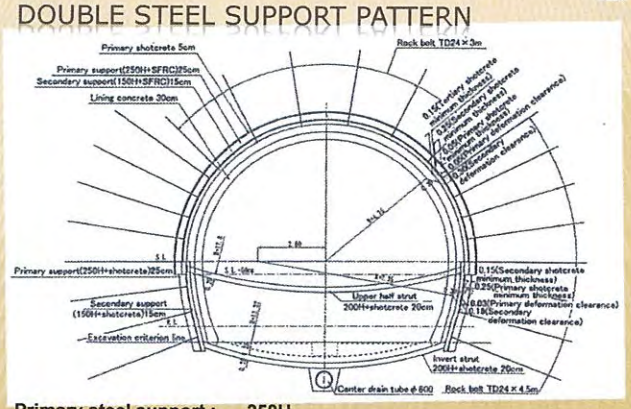
Max. horizontal displacement : Approx. 550mm



Developed double steel support pattern instead of replacing of timbering

6.Lecturer's Experiences

DOUBLE STEEL SUPPORT PATTERN



Primary steel support : 250H
Secondary steel support : 150H

6.Lecturer's Experiences

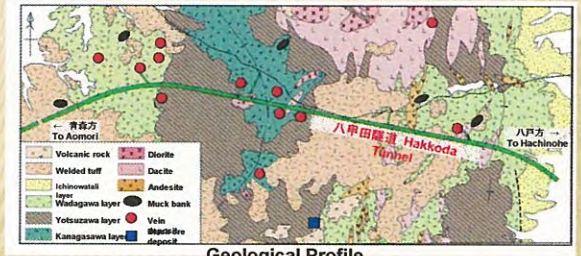
LOCATION OF HAKKODA TUNNEL

Hakkoda Tunnel is 26.455km long Shinkansen Tunnel broke through on Feb. 2005

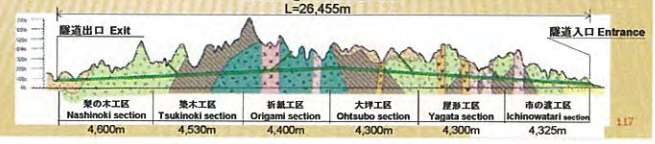
6.Lecturer's Experiences

GEOLOGICAL PROFILE OF HAKKODA TUNNEL

Geological Plan



Geological Profile



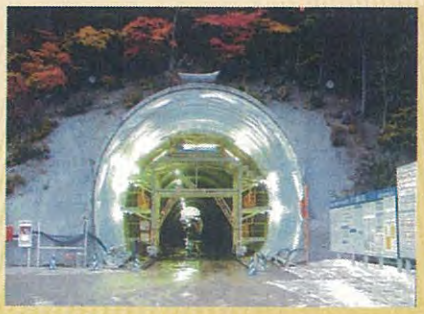
6Lecturer's Experiences

HAKKODA TUNNEL L= 26.46KM

Source : JRTT

6.Lecturer's Experiences

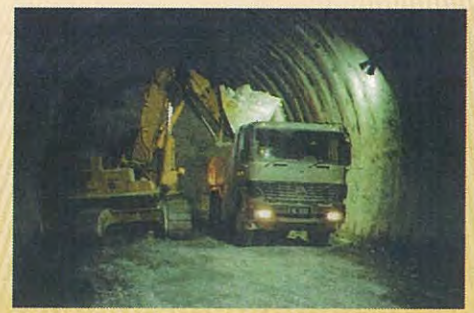
HAKKODA TUNNEL L= 26.46KM



Source : JRTT

6.Lecturer's Experiences

HAKKODA TUNNEL L= 26.46KM



Source : JRTT

6.Lecturer's Experiences

HAKKODA TUNNEL L= 26.46KM

Source: JRTT

A NEW CONSTRUCTION SYSTEM "SENS"

Rapid Excavation using SENS ,the extruded concrete lining system with shield

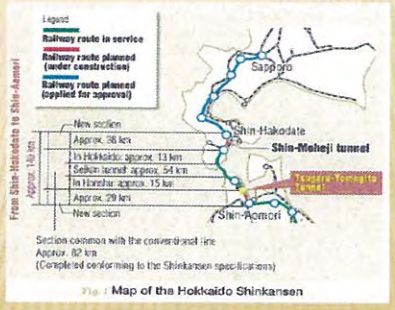


Fig. 1 Map of the Hokkaido Shinkansen

Source : JTA

A NEW CONSTRUCTION SYSTEM "SENS"

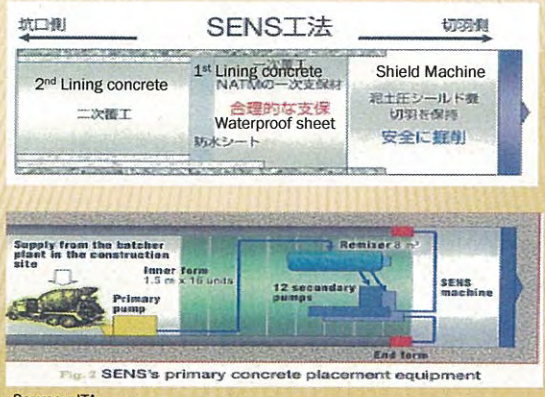
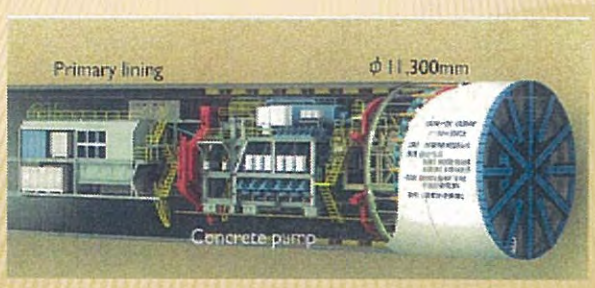


Fig. 2 SENS's primary concrete placement equipment

Source : JTA

SENS MACHINE



Source :JTA

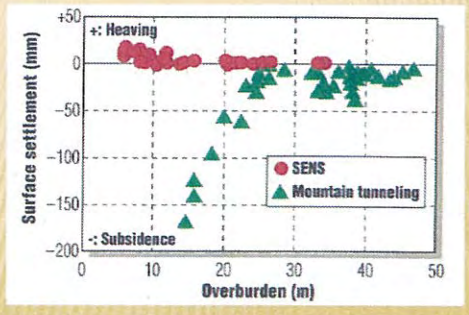
A NEW CONSTRUCTION SYSTEM "SENS"

The name SENS stands for :

S : Shield Machine
E : Extruded Concrete Lining (ECL)
N : New Austrian Tunneling Method (NATM)
S : System

Source : JTA

A NEW CONSTRUCTION SYSTEM "SENS"



Source : JTA Comparison of Surface Settlement between SENS and NATM

A NEW CONSTRUCTION SYSTEM "SENS"

The name is a shield tunneling technique to perform excavation while maintaining the face, and to achieve early invert closure with cast-in-place concrete primary lining (ECL).

In the SENS practice, secondary lining which carries no load is placed according to the concept of the NATM.

Since no prefabricated segments are used, the SENS is more economical than shield tunneling.

Thank you for your kind attention.