

Supplementary Material

Optimal Planning Method for Large-Scale Historical Exhibits in the Taiwan Railway Museum

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Table S1. The raw data of collected objects for NRMT.

Name	Type	Storage Location	Manufacturer	Year	Cultural Relic History	Size: Length × Width × Height (mm)	Weight (Ton)
Float rail-car	25SA4101	Taipei Inspection Depot Garage	Taipei Railway Factory	1912	It was built in 1912 to congratulate the Emperor of Japan on his enthronement and to prepare for the imperial family to visit Taiwan. It was manufactured by Taipei Railway Works (the predecessor of Taipei Machinery Factory). When Crown Prince Hirohito visited Taiwan in 1913, he traveled from Keelung all the way to the south to patrol the scenic spots in western Taiwan. He took this rail-car. The body and beams of this car are made of Taiwan teak. The interior decoration of the vehicle is mainly made of Taiwan's Alishan high-grade cypress and phoebe. The interior is finely carved, like a small artistic palace. The space in the vehicle is divided into five zones, which are the toilet, guest room (secondary room), main room, bedroom, and service room (slave room) in order.	16,400 × 2706 × 3619	24.6
Float rail-car	20SA4102	Taipei Inspection Depot Garage	Taipei Railway Factory	1904	Built in 1904, it was built by the Taipei Railway Works of the Ministry of Railways of Taiwan (the predecessor of Taipei Machine Works). It is a special	13,988 × 2616 × 3467	17.58

Float rail- car	35SA32820	Taipei In- spection De- pot Garage	National Army Retire- ment Coun- seling Com- mittee of the Executive Yuan	1967	<p>float for the Governor of Taiwan and is known as the "Governor float". The body and beams of this railcar are made of Taiwan teak, and the interior is mainly made of Taiwanese cypress and phoebe. The interior is furnished with sofas, bedrooms, electric lights, fans, and Western toilets, etc., and there is a balcony at the rear of the railcar.</p> <p>The 35SP32820 sightseeing railcar purchased in 1967 was commissioned to design and construct the Taoyuan Wood Factory of the National Army Retirement Guidance Committee of the Executive Yuan. The renovation was completed in 58 and it is scheduled to be used for inspections by the head of state. It is one of the "presidential floats" Good name. The body of this car is designed with a steel body structure, which is specially designed for the use of the head of state. Mr. Jiang's late President Jieshi and Mr. Jiang's late President Jieshi were not allowed to ride. On December 31, 1991, the entire South-Boundary Railway was opened to traffic. Former President Lee Teng-hui patrolled the car for the first time. However, this was only one time and never used it again.</p>	20,000 × 2885 × 3800	31.25
Living room rail- car	35PC32701	Taipei In- spection De- pot	Taipei Ma- chinery Plant Renovation	1971	<p>In the early period (about 1957), the American aid bus was purchased and transformed (formerly No. 35SP32712). The interior is divided into three sections (observation room, dining room and lounge). The most special thing is that there is an outdoor observation deck at the rear of the vehicle. You can go out to enjoy the view. It has been used since 1971, and the</p>	20,000 × 2885 × 3953	31.48

Second class passenger railcar	35SP32426	Kaohsiung Port	Japan Kawasaki Corporation	1966	<p>chariot that served as the head of state in the early days was opened for rent in 1983.</p> <p>In 1966 (Republic of China 55), it was purchased by Japan Kawasaki Co., Ltd., and it was installed with a domestically made turn-back chair, one of the main railcars. In May 2010 (Republic of China), he retired.</p> <p>It was manufactured by the Taipei Railway Works (now Taipei Machine Works) in 1921. In 1961, it was converted into an engineering camping car ES2053, which should be antique in shape. In 1996, Taiwan Railway restored this national treasure-class wooden passenger railcar to its original appearance. This car is a third-class wooden passenger railcar. The lookout model is its characteristic. The interior and exterior of the railcar, the seats, the luggage rack, the floor and the roof are all made of wood, especially the wooden sunshade, although it has been used a long time, it still shows the exquisite craftsmanship of the masters.</p> <p>It was built by Taiwan Railway Taipei Machinery Factory in 1953 and 25TPK2053; in 1991, it was converted into an engineering camper ES2502. Due to its antique shape, in 1996, Taiwan Railway restored this national treasure-class wooden passenger railcar to its original appearance. This car is a second-class wooden passenger car. Although it was manufactured after the war, it still looks like a Japanese 17m-class passenger car. Compared with the 25TPK2053 wooden passenger car, it has a design with no lookout, other things like inside</p>	20,000 × 2865 × 3953	31.2
Wooden passenger railcar	25TPK2053	Miaoli Railway Heritage Exhibition Hall	Taipei Railway Works (now Taipei Machine Works)	1921		16,544 × 2744 × 3750	
Wooden passenger railcar	30SPK2502	Miaoli Railway Heritage Exhibition Hall	Taiwan Railway Taipei Machinery Factory	1953		17,262 × 2900 × 3780	

Narrow gauge passenger carriage	LTPB1813	Miaoli Railway Heritage Exhibition Hall	Japan	1970	<p>and outside the railcar. The equipment, seats, luggage rack, floor, sunshade (using gauze type) and roof are the same as 25TPK2053. They are made of wood and are equipped with seven sets of electric fans, screen windows, shade cloth and other equipment.</p> <p>The trailer of the Eastern Narrow Gauge Guanghua LDR2300 diesel passenger vehicle was imported from Japan in 1970. As the upper part of the body is painted white and the lower part is yellow, the locals call it "yellow vehicle". After the widening of the Huadong gauge in 1982, it was discontinued, gifted to the Penghu County Government and displayed in the Penghu County Cultural Center. In cooperation with the establishment of the Miaoli Railway Heritage Museum of the Taiwan Railway Administration, it was transported to the Taipei Machinery Factory for renovation in December 1999, and the display was completed on May 26, 2000.</p>	11,000 × 2300 × 3200
Alishan Passenger railcar	SPC2	Miaoli Railway Heritage Exhibition Hall	Japanese vehicles	1971	<p>This train is a towed passenger car used in the Alishan Forest Railway Zhongxing diesel passenger train set. It was manufactured by the Japanese Vehicle Company in 1971 and contains 28 plastic leather chairs. In order to meet the requirements of the Alishan Forest Railway passenger trains for advancing operation when going up the mountain, one end of the passenger car is equipped with a captain's room and a window on the end, which can monitor the safety of the train's traveling direction when it is advancing. It was disabled in 1982.</p>	9000 × 2000 × 1500

Narrow gauge wooden sleeper railcar	LTPB1375	Hualien Locomotive Depot	Japan Railway Ministry Hualien Port Repair Factory	1943	<p>The narrow-gauge Ginseng and other passenger railcars were manufactured in 1943 by the Hualien Port Repair Factory (the predecessor of Hualien Machinery Factory) of the Japanese Ministry of Railways. It runs on the eastern trunk line with a gauge of 762 cm. After the expansion of the Huadong Line in June 1982, it succeeded in retreating. Due to its simple shape and wooden carriage, it is of great preservation value. It was designated as a railway cultural relic and was restored by the Kaohsiung Machinery Factory of the Bureau in 2000 and kept in the Hualien Locomotive Depot.</p>	10,364 × 2229 × 3166
Narrow gauge wooden sleeper railcar	LTPS1102	Hualien Locomotive Depot	Japan Railway Ministry Hualien Port Repair Factory	1930	<p>The narrow-gauge ginseng and other passenger and sleeping railcar were manufactured by the Hualien Port Repair Plant (the predecessor of Hualien Machinery Plant) of the Japanese Ministry of Railways in 1930 and traveled on the eastern main line. It features guest bedroom equipment, which can be used for long-distance night travelers to and from Hualien and Taitung. It is the only narrow-gauge passenger sleeper in the world. After the expansion of the Huadong Line in June 1982, it succeeded in retreating. Due to its simple shape and wooden carriage, it is of great preservation value. It was refurbished by Kaohsiung Machinery Factory in 2000 and kept in Hualien Locomotive Depot.</p>	10,583 × 2394 × 3229
Taiwan Sugar Official Patrol engineering car	254	Miaoli Railway Heritage Exhibition Hall	Dainippon Sugar Co., Ltd. Beigang Sugar Works	1941	<p>It was manufactured by Beigang Sugar Co., Ltd. of Dainippon Sugar Co., Ltd. in 1941. It is a two-axle internal combustion passenger car used for sugar business inspections and</p>	4665 × 1660 × 2190

sugar industry track inspections. There is bridge equipment at both ends. This model was initially equipped with a Ford B eight-cylinder gasoline engine. After Taiwan's recovery, the GMC engine was replaced due to the old engine. The maximum speed can reach 40km/h. Due to the shrinkage of the sugar industry in the province, the sugar railway was completely abolished, and the car entered history. The existing No. 254 car is placed in the Miaoli Exhibition Hall of Railway Cultural Relics.

Manufactured in 1917 by Japan's Osaka Automobile Manufacturing Joint Venture. It is the main locomotive of the northern branch lines, which has the advantages of light and quick action and less coal consumption. After being scrapped in December 1974, it was

Steam locomotive	CK101	Changhua fan-shaped garage	Japan Osaka Automobile Manufacturing Joint Venture	1917	placed in the fan-shaped garage of the Chiayi Locomotive Depot. In May 1997, it was transported back to Taipei Machinery Plant for re-drive and repair. It was completed on May 25, 1998. It is currently placed in the fan-shaped garage of the Changhua Locomotive Depot, providing special train operation.	11,404 × 2616 × 3658	48.99
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Manufactured by Japanese vehicles in 1936. Specially drive Jiji branch line. After being scrapped in June 1979, it was

Steam locomotive	CK124	Changhua fan-shaped garage	Japanese vehicles	1936	first stored at the Xinbeitou Station in Danshui Town. After the MRT started, it was moved to the Taiwan Railway Beitou Staff Training Center for display. On September 14, 2000, it was transported back to the Taipei Machinery Plant of the	11,350 × 3936 × 3900	50.85
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first stored at the Xinbeitou Station in Danshui Town. After the MRT started, it was moved to the Taiwan Railway Beitou Staff Training Center for display. On September 14, 2000, it was transported back to the Taipei Machinery Plant of the

Steam locomotive	DT668	Changhua fan-shaped garage	Japan Kawasaki Shipbuilding (Hyogo) Corporation	1940	<p>Taiwan Railway Administration for re-drive and repair. It was completed on April 30, 2001. It is currently placed in the fan-shaped garage of the Zhang Locomotive Depot, providing special train operation.</p> <p>Manufactured by Japan Kawasaki Shipbuilding (Hyogo) Corporation in 1940. One of the largest steam locomotives of the Taiwan Railway Administration, with a speed of 85 km/h, it is a dual-purpose locomotive with superior performance. The restoration was completed on October 28, 2011, and the cultural assets dynamic display of the Taiwan Railway Administration was added.</p> <p>Manufactured by Kawasaki Shipbuilding (Hyogo) Corporation, Japan in 1943. One of the fastest steam locomotives of the Taiwan Railway Administration and the main locomotive for passenger transportation. In June 1982, due to the completion of the widening of the eastern route, it was suspended. It was transported back to the Taiwan Railway Administration from Changhua Taiwan Folk Village on February 2, 2010. The Taipei Machinery Factory was restored in mid-2012 and joined the Taiwan Railway Administration's cultural assets dynamic display.</p>	19,730 × 2890 × 3980	124.46
Steam locomotive	CT273	Changhua fan-shaped garage	Japan Kawasaki Shipbuilding (Hyogo) Corporation	1943	<p>Manufactured in 1919 by Japan's Osaka Automobile Manufacturing Joint Venture. It is a steam locomotive for feeder and passenger and cargo. In 1947, it participated in the opening ceremony of the Neiwān Line from Hsinchu to</p>	20,280 × 2936 × 3945	115.25
Steam locomotive	CT152	Miaoli Railway Heritage Exhibition Hall	Japan Osaka Automobile Manufacturing Joint Venture	1919		16,775 × 2616 × 3885	78.57

Steam locomotive	DT561	Miaoli Railway Heritage Exhibition Hall	American Locomotive Company	1919	Zhudong. After the electrification of the railway in July 1979, it was suspended. Manufactured by American Locomotive Company in the United States in December 1919 (arrived in Taiwan in May 1920). The main locomotive for freight. The only American-made steam locomotive in Taiwan.	10,306 × 2591 × 3747	91.14
Narrow gauge steam locomotive	LDK59	Hualien Locomotive Depot	Hitachi Mfg. Co., Ltd.	1930	Manufactured in 1930 by Hitachi Manufacturing in Japan. In June 1982, the Huadong Line was decommissioned after the gauge widening was completed. It was given to the Taitung County Government and displayed in Taitung Liyushan Park. After refurbishing the running part of the car in Hsinchu in February 2001, it was sent back to Hualien Locomotive Depot. The restoration was completed in 2010 and is currently stored in the Hualien Locomotive Depot for dynamic display.	7422 × 2261 × 3042	21.6
Narrow gauge steam locomotive	LDK58	Taipei Main Station	Japan Vehicle Association	1923	Manufactured by the Japan Automobile Association in 1923. Uses the central buffer chain coupling and adopts the car side water tank device. In June 1982, the Huadong Line was closed after the completion of the widening. It was shipped to Magong, Penghu on September 7, 1985, presented to the Penghu County Government and displayed at the County Cultural Center. On October 21, 1999, it was transported from Penghu to Taipei Machinery Plant for refurbishment. On June 8, 2000, the restoration was successfully completed.	7217 × 2286 × 3100	21.6
Narrow gauge steam locomotive	LDT103	Hualien Railway Museum	Japan Vehicle Association	1942	Manufactured in 1942 by the Japan Automobile Association in Japan. It is the only coal-water	14,346 × 2235 × 3200	40.48

Steam locomotive Alishan	28	Miaoli Railway Heritage Exhibition Hall	American LIMA Company	1913	<p>locomotive among steam locomotives on the Huadong Line.</p> <p>It was displayed in Meilun Mountain Park in Hualien after the suspension of the Eastern Route's diesel power in 1969. It was refurbished by Hualien Machinery Factory in May 2000 and is currently placed in the Hualien Railway Heritage Museum.</p> <p>Manufactured in 1913 by the American company LIMA. It is a special steam locomotive for mountain railways. In order to meet the multiple bends and poor track conditions of mountain railways, the design is changed to an upright cylinder. The drive shaft is driven through the crankshaft, and the power is transmitted from the bevel gear to the driving wheel on the bogie. Since the design of this type of locomotive is still rare in the history of the world's railways, there are currently very few of the same type of locomotive remaining around the world. Decommissioned successively in 1973.</p> <p>In 1935, two 15-ton three-acting axle light rail water tank steam locomotives purchased by Dainippon Sugar Co., Ltd. from Japan Rolling Stock Co., Ltd. were decommissioned due to the full diesel power of the sugar industry railway. It is now placed in Miaoli Railway Heritage Exhibition Hall.</p> <p>In 1953, it was purchased by the Forest Service Bureau from Japan's New Mitsubishi Heavy Industries. This type of locomotive was originally designed with three moving axles. Later due to poor cornering performance, a pair of guide wheels were added to the front and</p>	9870 × 2000 × 3020
Taiwan Sugar Steam Locomotive	331	Miaoli Railway Heritage Exhibition Hall	Japan Vehicle Association	1935	<p>In 1935, two 15-ton three-acting axle light rail water tank steam locomotives purchased by Dainippon Sugar Co., Ltd. from Japan Rolling Stock Co., Ltd. were decommissioned due to the full diesel power of the sugar industry railway. It is now placed in Miaoli Railway Heritage Exhibition Hall.</p> <p>In 1953, it was purchased by the Forest Service Bureau from Japan's New Mitsubishi Heavy Industries. This type of locomotive was originally designed with three moving axles. Later due to poor cornering performance, a pair of guide wheels were added to the front and</p>	5800 × 1910 × 3370
Alishan diesel locomotive	11403-1	Miaoli Railway Heritage Exhibition Hall	Japan New Mitsubishi Heavy Industries	1953	<p>In 1953, it was purchased by the Forest Service Bureau from Japan's New Mitsubishi Heavy Industries. This type of locomotive was originally designed with three moving axles. Later due to poor cornering performance, a pair of guide wheels were added to the front and</p>	9250 × 1955 × 3100

Alishan diesel locomotive	11403-5	Miaoli Railway Heritage Exhibition Hall	Japan New Mitsubishi Heavy Industries	1955	<p>rear of the locomotive as a response. However, the overall performance is still poor, so it is mostly used in the flat area between Chiayi and Zhuqi. It was discontinued in 1982.</p> <p>In 1955, the Forest Service purchased it from Japan's New Mitsubishi Heavy Industries, using Bo-Bo axle configuration. Although the cornering performance of this locomotive was improved, the engine output was insufficient to fully replace the shay-type steam locomotive, so it was deactivated in 1982.</p>	9500 × 2050 × 3020
Narrow gauge diesel-hydraulic locomotive	DH210	Hualien Machinery Factory	Japan Vehicle Company	1969	<p>In 1969, it was manufactured by the Japanese Rolling Stock Company, and it drove freight trains on the narrow-gauge railway of the Eastern Line. The center is the driver's cab, and the front and rear devices are equipped with power engines, which operate synchronously to increase horsepower. It is the main model of eastern freight.</p> <p>In June 1982, the East Line Railway was widened. The wheelbase of the axles was widened (reserved for new cars) and allocated to various locomotive depots for shunting. After 1986, they were scrapped. Currently stored in Hualien Machinery Factory.</p>	11,800 × 2450 × 3600
Narrow gauge diesel electric locomotive	LDH101	Miaoli Railway Heritage Exhibition Hall	Hualien Repair Shop	1970	<p>In September 1970, the Hualien Repair Factory (the predecessor of Hualien Engine Factory) used spare cummins diesel engines, reversing machines and bogies to design and assemble the LDH101 diesel-hydraulic locomotive. This is the first diesel-hydraulic locomotive in the history of China's railways. The locomotive is a dual-purpose machine for the main line/shunting of light railways.</p>	15,000 × 2300 × 3300

It was only retired after the east line was widened and completed in June 1982. It was transported to the Cultural Center of Magong, Penghu for display in September 1985. It was moved and placed in 2000. Miaoli Exhibition Hall of Railway Cultural Relics. Although this model did not enter mass production due to various reasons, Hualien Machinery Factory, with limited technology and resources at the time, built the first self-made diesel-hydraulic locomotive in the history of railways, which can be regarded as a milestone in the history of Taiwan railway vehicle technology.

The western main line of the Taiwan Railways began to power diesel. The diesel electric locomotives initially introduced were purchased from Hitachi, Japan in 1960. After that, the purchase of two vehicles originally under warranty was added, for a total of 12 vehicles.

The engine of this model adopts a diesel engine with an exhaust turbocharger through technical cooperation between Germany and Japan. The engine was modified by Taiwan Railway maintenance technicians for power equipment. In 1971, the engine was tested and converted into a Qimu 645E engine. Six vehicles were refitted one after another. This type of car was scrapped in 1996, and currently only the R6 car is displayed in the Miaoli Museum.

In 1966, it was manufactured by the American GM Company. There are 21 vehicles in total, mainly for shunting. The biggest difference between this model and other diesel-electric

Diesel locomotive	R6	Miaoli Railway Heritage Exhibition Hall	Japan Hitachi Mfg. Co., Ltd.	1960	It was only retired after the east line was widened and completed in June 1982. It was transported to the Cultural Center of Magong, Penghu for display in September 1985. It was moved and placed in 2000. Miaoli Exhibition Hall of Railway Cultural Relics. Although this model did not enter mass production due to various reasons, Hualien Machinery Factory, with limited technology and resources at the time, built the first self-made diesel-hydraulic locomotive in the history of railways, which can be regarded as a milestone in the history of Taiwan railway vehicle technology. The western main line of the Taiwan Railways began to power diesel. The diesel electric locomotives initially introduced were purchased from Hitachi, Japan in 1960. After that, the purchase of two vehicles originally under warranty was added, for a total of 12 vehicles. The engine of this model adopts a diesel engine with an exhaust turbocharger through technical cooperation between Germany and Japan. The engine was modified by Taiwan Railway maintenance technicians for power equipment. In 1971, the engine was tested and converted into a Qimu 645E engine. Six vehicles were refitted one after another. This type of car was scrapped in 1996, and currently only the R6 car is displayed in the Miaoli Museum.	15,370 × 2875 × 3750	84.5
Diesel locomotive	S305	Miaoli Railway Heritage Exhibition Hall	American GM Company	1966	In 1966, it was manufactured by the American GM Company. There are 21 vehicles in total, mainly for shunting. The biggest difference between this model and other diesel-electric	11,230 × 2667 × 3600	54

Diesel locomotive	S405	Miaoli Railway Heritage Exhibition Hall	American GM Company	1970	<p>vehicles is that the traction motor is installed on the frame and the wheels are driven by the drive shaft. At present, only the S318 car is still in use, and another two cars are displayed statically.</p> <p>In 1970, it was manufactured by GM Company of the United States. It was mainly used for the hump shunting of Qidu Marshalling Yards. At present, only No. S405 is reserved in the Railway Heritage Miaoli Exhibition Hall.</p>	12,080 × 2970 × 3700	54
Diesel locomotive	S316	Sun Moon Lake	American GM Company	1966	<p>In 1966, it was manufactured by the American GM Company. There are 21 vehicles in total, mainly for shunting. The biggest difference between this model and other diesel-electric vehicles is that the traction motor is installed on the frame and the wheels are driven by the drive shaft. At present, only the S318 car is still in use, and another two cars are displayed statically.</p>	11,230 × 2667 × 3600	54
Diesel locomotive	S318	Changhua Locomotive Depot	American GM Company	1966	<p>In 1966, a total of 21 vehicles were manufactured by American GM Company, mainly for shunting. The biggest difference between this model and other diesel-electric vehicles is that the traction motor is installed on the frame and the wheels are driven by the drive shaft. At present, only the S318 car is still in use, and another two cars are displayed statically.</p>	11,230 × 2667 × 3600	54
Diesel locomotive	S201	Kaohsiung Locomotive Depot	American GM Company	1960	<p>In 1960, it was purchased from General Motors Corporation of the United States. It was the first time that Taiwan Railway purchased 12 locomotives for use as a transfer station.</p>	12,160 × 2787 × 3665	65
Diesel locomotive	R21	Changhua Locomotive Depot	American GM Company	1959	<p>In 1959, they used World Bank loans to purchase from the American company General</p>	14,226 × 2787 × 3665	78

Diesel locomotive	R50	Changhua Locomotive Depot	American GM Company	1959	<p>Motors. There are a total of 52 vehicles of this model. The powertrain is a single unit that can be disassembled and replaced independently. This design is also a common design criterion for future models. The R70 model is equipped with electric power control for the first time. This type of car originally used an engine. As the American company no longer produces parts, Taiwan Railways Taipei Machinery Plant researched and replaced it with a 645E engine in order to keep the vehicle running.</p> <p>In 1959, they used World Bank loans to purchase from the American company General Motors. There are a total of 52 vehicles of this model. The powertrain is a single unit that can be disassembled and replaced independently. This design is also a common design criterion for future models. The R70 model is equipped with electric power control for the first time. This type of car originally used an engine. As the American company no longer produces parts, Taiwan Railways Taipei Machinery Plant researched and replaced it with a 645E engine in order to keep the vehicle running.</p>	14,226 × 2787 × 3665	78
Diesel locomotive	R71	Changhua Locomotive Depot	American GM Company	1959	<p>In 1959, he used a loan from the World Bank to purchase from the American company General Motors. There are a total of 52 vehicles of this model. The powertrain is a single unit that can be disassembled and replaced independently. This design is also a common design criterion for future models. The R70 model is equipped with electric power control for the</p>	14,226 × 2787 × 3665	78

Diesel locomotive	R68	Taipei machine factory	American GM Company	1959	<p>first time. This type of car originally used an engine. As the American company no longer produces parts, Taiwan Railways Taipei Machinery Plant researched and replaced it with a 645E engine in order to keep the vehicle running.</p> <p>In 1959, he used a loan from the World Bank to purchase from the American company General Motors. There are a total of 52 vehicles of this model. The powertrain is a single unit that can be disassembled and replaced independently. This design is also a common design criterion for future models. The R70 model is equipped with electric power control for the first time. This type of car originally used an engine. As the American company no longer produces parts, Taiwan Railways Taipei Machinery Plant researched and replaced it with a 645E engine in order to keep the vehicle running.</p>	14,226 × 2787 × 3665	78
Electric locomotive	E101	Changhua Locomotive Depot	British GEC Company	1976	<p>Railway electrification was introduced. It was manufactured by British GEC Company in 1976. There are a total of 20 vehicles. The main traction equipment adopts four traction motors. This type of car has no passenger air-conditioning power supply facilities, mainly traction freight trains, and non-air-conditioned passenger cars. Da Quling was scrapped one after another in 2005, and only the E101 car was retained.</p>	15,120 × 2995 × 4003	72
Diesel passenger railcar	25DR2053	Changhua Locomotive Depot	Hualien Machinery Factory	1975	<p>In 1985, the Hualien Machinery Factory of the Taiwan Railway Bureau widened the original east line and suspended the LDR2300 Guanghua, modified it to 1067 mm gauge. The body painting was changed to a blue base with a white line, and the</p>	15,600 × 2420 × 3290	18.4

car registration was changed, but the car body remained. It retains the size of the old Eastern Front, and the color of the modified body is like the color of Tinkerbell, so it is nicknamed "Tinkerbell." After the last train departed on November 4, 1996, it officially stopped and entered history. In June 1998, in conjunction with the resurrection of the steam locomotive CK101, four trailers including DR2053, DR2055, DR2056, and DR2057 were refurbished into tourist nostalgic railcars. The car is now stored in the Changhua Locomotive Depot.

In 1985, the Hualien Machinery Factory of the Taiwan Railway Bureau widened the original east line and suspended the LDR2300 Guanghua, modified it to 1067 mm gauge. The body painting was changed to a blue base with a white line, and the car registration was changed, but the car body remained. It retains the size of the old Eastern Front, and the color of the modified body is like the color of Tinkerbell, so it is nicknamed "Tinkerbell." After the last train departed on November 4, 1996, it officially stopped and entered history. In June 1998, in conjunction with the resurrection of the steam locomotive CK101, four trailers including DR2053, DR2055, DR2056, and DR2057 were refurbished into tourist nostalgic buses. The car is now stored in the Changhua Locomotive Depot.

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Diesel passenger railcar	25DR2055	Changhua Locomotive Depot	Hualien Machinery Factory	1975	15,600 × 2420 × 3290	18.4
Diesel passenger railcar	25DR2056	Changhua Locomotive Depot	Hualien Machinery Factory	1975	15,600 × 2420 × 3290	18.4

painting was changed to a blue base with a white line, and the car registration was changed, but the car body remained. It retains the size of the old Eastern Front, and the color of the modified body is like the color of Tinkerbelle, so it is nicknamed "Tinkerbelle." After the last train departed on November 4, 1996, it officially stopped and entered history. In June 1998, in conjunction with the resurrection of the steam locomotive CK101, four trailers including DR2053, DR2055, DR2056, and DR2057 were refurbished into tourist nostalgic buses. The car is now stored in the Changhua Locomotive Depot.

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In 1985, the Hualien Machinery Factory of the Taiwan Railway Bureau widened the original east line and suspended the

Diesel passenger railcar	25DR2057	Changhua Locomotive Depot	Hualien Machinery Factory	1975	of Tinkerbelle, so it is nicknamed "Tinkerbelle." After the last train departed on November 4, 1996, it officially stopped and entered history. In June 1998, in conjunction with the resurrection of the steam locomotive CK101, four trailers including DR2053, DR2055, DR2056, and DR2057 were refurbished into tourist nostalgic buses. The car is now stored in the Changhua Locomotive Depot.	15,600 × 2420 × 3290	18.4
Diesel passenger railcar	25DR2060	Taitung Railway Art Village	Hualien Machinery Factory	1975	Bureau widened the original east line and suspended the	15,600 × 2420 × 3290	18.4

Diesel passenger railcar	25DR2067	Taitung Railway Art Village	Hualien Machinery Factory	1975	<p>LDR2300 Guanghua, modified it to 1067 mm gauge. The body painting was changed to a blue base with a white line, and the car registration was changed, but the car body remained. It retains the size of the old Eastern Front, and the color of the modified body is like the color of Tinkerbell, so it is nicknamed "Tinkerbell." After the last train departed on November 4, 1996, it officially stopped and entered history. Currently stored in Taitung Railway Culture and Art Village.</p> <p>In 1985, the Hualien Machinery Factory of the Taiwan Railway Bureau widened the original east line and suspended the LDR2300 Guanghua, modified it to 1067 mm gauge. The body painting was changed to a blue base with a white line, and the car registration was changed, but the car body remained. It retains the size of the old Eastern Front, and the color of the modified body is like the color of Tinkerbell, so it is nicknamed "Tinkerbell." After the last train departed on November 5, 1996, it officially stopped and entered history. Currently stored in Taitung Railway Culture and Art Village.</p>	15,600 × 2420 × 3290	18.4
Diesel passenger railcar	25DR2069	Taitung Railway Art Village	Hualien Machinery Factory	1975	<p>LDR2300 Guanghua, modified it to 1067 mm gauge. The body painting was changed to a blue base with a white line, and the car registration was changed, but the car body remained. It retains the size of the old Eastern Front, and the color of the modified body is like the color of Tinkerbell, so it is nicknamed "Tinkerbell." After the last train departed on November 5, 1996, it officially stopped and entered history. Currently stored in Taitung Railway Culture and Art Village.</p> <p>In 1985, the Hualien Machinery Factory of the Taiwan Railway Bureau widened the original east line and suspended the LDR2300 Guanghua, modified it to 1067 mm gauge. The body painting was changed to a blue base with a white line, and the car registration was changed, but the car body remained. It retains the size of the old Eastern Front, and the color of the modified body is like the color of Tinkerbell, so it is nicknamed</p>	15,600 × 2420 × 3290	18.4

Diesel passenger railcar	35DR2102	Taipei Machinery Factory (Dongxing Street Site)	Japan Ministry of Railways	1931	<p>"Tinkerbell." After the last train departed on November 6, 1996, it officially stopped and entered history. Currently stored in Taitung Railway Culture and Art Village.</p> <p>The predecessor of the DR2100 diesel railcar was the Kiha100 gasoline vehicle purchased by the Japanese Ministry of Railways in 1931. Subsequent updates were made to diesel engines, which were changed to DR2100 diesel passenger cars in 1957. It is currently kept at the old site of Dongxing Street, Taipei Machinery Factory of Taiwan Railway Bureau.</p>	19,916 × 2660 × 3600	29.22
Diesel passenger railcar	35DR2404	Taipei Machinery Factory (Dongxing Street Site)	Kawasaki, Japan	1969	<p>The predecessor of DR2400 is the Kiha400 gasoline vehicle manufactured by Kawasaki, Japan. Subsequent updates were made to diesel engines, which were changed to DR2400 diesel passenger cars in 1969. It is currently kept at the old site of Dongxing Street, Taipei Machinery Factory of Taiwan Railway Bureau.</p>	19,916 × 2660 × 3600	29.22
Diesel passenger railcar	35DR2752	Taitung Locomotive Section	Japan Tokyu Vehicles	1966	<p>In 1966, it was built by Tokyu Vehicles of Japan, with a total of 31 vehicles (a total of 25 powered vehicles numbered DR2700, and a total of six unpowered trailers DR2750). The stainless steel car body was used on the Western Main Line under the name Guanghua, setting the record for the fastest train on the Western Main Line (up to 110 km per h). Its stainless steel car body was in sharp contrast with the black steam train at the time. After the completion of the electrification of the Western Railway in 1979, the diesel express trains were changed to run on the northern loop line and the section north of Taichung on the Western</p>	20,274 × 2885 × 3975	27.5

Diesel passenger railcar	35DR2009	Hualien Machinery Factory	Hualien Machinery Factory	1985	<p>Main Line. After that, the Taiwan Railway Bureau introduced the Ziqiang diesel combined vehicle to run on the eastern main line, and it was converted to medium and short distance diesel. Duikuai, Dhai-kuai, and Chaipu trains are active in the northern section of the Zongguan line, the middle section of the Zongguan line, the Pingtung line, the Nanhui line, and the Taitung line. At present, there are still eight vehicles in dynamic storage, running as cultural trains; the other eight vehicles in static storage. In 1985, the Hualien Machinery Factory of the Taiwan Railway Bureau widened the original east line and suspended the LDR2300 Guanghua, modified it to 1067 mm gauge. The body painting was changed to a blue base with a white line, and the car registration was changed, but the car body remained. It retains the size of the old Eastern Front, and the color of the modified body is like the color of Tinkerbell, so it is nicknamed "Tinkerbell." After the last train departed on November 4, 1996, it officially stopped and entered history. Currently stored in Hualien Machinery Factory.</p> <p>In 1985, the Hualien Machinery Factory of the Taiwan Railway Bureau widened the original eastern route and suspended the LDR2300 Guanghua, modified it to a 1067 mm gauge, changed the body painting to a blue background and a white line, and the car registration was changed to DR2000, etc. The car body still retains the size of the old Eastern Front, and the color of the modified car body is like the color of</p>	15,600 × 2420 × 3290	22.5
Diesel passenger railcar	35DR2010	Hualien Machinery Factory	Hualien Machinery Factory	1985	<p>Main Line. After that, the Taiwan Railway Bureau introduced the Ziqiang diesel combined vehicle to run on the eastern main line, and it was converted to medium and short distance diesel. Duikuai, Dhai-kuai, and Chaipu trains are active in the northern section of the Zongguan line, the middle section of the Zongguan line, the Pingtung line, the Nanhui line, and the Taitung line. At present, there are still eight vehicles in dynamic storage, running as cultural trains; the other eight vehicles in static storage. In 1985, the Hualien Machinery Factory of the Taiwan Railway Bureau widened the original east line and suspended the LDR2300 Guanghua, modified it to 1067 mm gauge. The body painting was changed to a blue base with a white line, and the car registration was changed, but the car body remained. It retains the size of the old Eastern Front, and the color of the modified body is like the color of Tinkerbell, so it is nicknamed "Tinkerbell." After the last train departed on November 4, 1996, it officially stopped and entered history. Currently stored in Hualien Machinery Factory.</p> <p>In 1985, the Hualien Machinery Factory of the Taiwan Railway Bureau widened the original eastern route and suspended the LDR2300 Guanghua, modified it to a 1067 mm gauge, changed the body painting to a blue background and a white line, and the car registration was changed to DR2000, etc. The car body still retains the size of the old Eastern Front, and the color of the modified car body is like the color of</p>	15,600 × 2420 × 3290	22.5

Diesel passenger railcar	35DR2652	Taipei machine factory	Japan Tokyu Vehicles	1955	<p>Ding Dong, so it is nicknamed "Little Ding Dong". After the last train departed on November 4, 1996, it officially stopped and entered history. In June 1987, in conjunction with the resurrection of the steam locomotive CK101, four trailers including DR2053, DR2055, DR2056, and DR2057 were refurbished into tourist nostalgic passenger cars (the four cars are now stored in the Hualien Locomotive Depot of the Taiwan Railway Administration). In addition, three vehicles including DR2060, DR2067 and DR2069 are stored in Taitung Railway Cultural Art Village, and two vehicles including DR2009 and DR2010 are stored in Hualien Machinery Factory.</p> <p>In 1955, it was manufactured by Tokyu Vehicles, a total of eight vehicles, one of which was assembled and imported by Tokyu Vehicles, and the remaining seven were assembled by Taipei Machine Works. The operation started in February 1956. It takes about 2 h and 25 min from Taipei to Taichung, and about 5 h and 30 min from Taipei to Kaohsiung, greatly shortening the travel time. In 1957, DR2600 and DR2650 were introduced to Tokyu Vehicles. The basic design was the same as the DR2500, with a total of 14 vehicles. At present, there is still one vehicle such as DR2652, which is kept in the Taipei Machine Factory of the Taiwan Railway Bureau.</p> <p>A steel-body diesel passenger car for light railways produced by Taiwan Railway Bureau Taipei Machinery Plant/Hualien Machinery Plant in 1958. It has 50 seats and is the main force</p>	19,916 × 2784 × 3600
Narrow gauge diesel passenger railcar	LDR2201	Taipei Main Station	Taipei machine factory/Hualien Machinery Factory	1958	<p>A steel-body diesel passenger car for light railways produced by Taiwan Railway Bureau Taipei Machinery Plant/Hualien Machinery Plant in 1958. It has 50 seats and is the main force</p>	19,916 × 2600 × 3600

Narrow gauge diesel passenger railcar	LDR2204	Hualien Locomotive Depot	Taipei machine factory/Hualien Machinery Factory	1958	<p>for passenger transportation on the Huadong Line of Taiwan Railways. It is used for the gauge widening project of the Eastern Main Line of Taiwan Railways. All decommissioned after completion. It is currently located in the East Square of Taipei Main Station, Taipei City.</p> <p>A steel-body diesel passenger car for light railways produced by Taiwan Railway Bureau Taipei Machinery Plant/Hualien Machinery Plant in 1958. It has 50 seats and is the main force for passenger transportation on the Huadong Line of Taiwan Railways. It is used for the gauge widening project of the Eastern Main Line of Taiwan Railways. All decommissioned after completion. It is currently placed in Hualien Locomotive Depot.</p> <p>The original car number was LTP1801. In 1958, the Taipei Machinery Factory produced aluminum shell panels, and the Hualien Machinery Factory assembled the body and power pack parts to become a diesel powered car. In July 1971, it changed its status to LDR2307, which was the fastest running car on the Eastern Line at that time. After the expansion of the Huadong Railway was completed in June 1982, it was a success. Due to its simplicity and preservation value, it was refurbished by Hualien Machinery Factory in 2000 and is currently parked in Hualien Locomotive Depot.</p> <p>During the electrification of the railway in 1978, the Ziqiang electric multiplexed car made in the UK was first introduced, with a total of 65 vehicles in 13</p>	19,916 × 2600 × 3600	33.69
Narrow gauge diesel passenger railcar	LDR2307	Hualien Locomotive Depot	Taipei machine factory/Hualien Machinery Factory	1968	<p>for passenger transportation on the Huadong Line of Taiwan Railways. It is used for the gauge widening project of the Eastern Main Line of Taiwan Railways. All decommissioned after completion. It is currently placed in Hualien Locomotive Depot.</p> <p>The original car number was LTP1801. In 1958, the Taipei Machinery Factory produced aluminum shell panels, and the Hualien Machinery Factory assembled the body and power pack parts to become a diesel powered car. In July 1971, it changed its status to LDR2307, which was the fastest running car on the Eastern Line at that time. After the expansion of the Huadong Railway was completed in June 1982, it was a success. Due to its simplicity and preservation value, it was refurbished by Hualien Machinery Factory in 2000 and is currently parked in Hualien Locomotive Depot.</p> <p>During the electrification of the railway in 1978, the Ziqiang electric multiplexed car made in the UK was first introduced, with a total of 65 vehicles in 13</p>	19,916 × 2600 × 3600	33.69
Ziqiang Electric Combined railcar	ET115	Taipei machine factory	British GEC Company	1978	<p>for passenger transportation on the Huadong Line of Taiwan Railways. It is used for the gauge widening project of the Eastern Main Line of Taiwan Railways. All decommissioned after completion. It is currently located in the East Square of Taipei Main Station, Taipei City.</p> <p>A steel-body diesel passenger car for light railways produced by Taiwan Railway Bureau Taipei Machinery Plant/Hualien Machinery Plant in 1958. It has 50 seats and is the main force for passenger transportation on the Huadong Line of Taiwan Railways. It is used for the gauge widening project of the Eastern Main Line of Taiwan Railways. All decommissioned after completion. It is currently placed in Hualien Locomotive Depot.</p> <p>The original car number was LTP1801. In 1958, the Taipei Machinery Factory produced aluminum shell panels, and the Hualien Machinery Factory assembled the body and power pack parts to become a diesel powered car. In July 1971, it changed its status to LDR2307, which was the fastest running car on the Eastern Line at that time. After the expansion of the Huadong Railway was completed in June 1982, it was a success. Due to its simplicity and preservation value, it was refurbished by Hualien Machinery Factory in 2000 and is currently parked in Hualien Locomotive Depot.</p> <p>During the electrification of the railway in 1978, the Ziqiang electric multiplexed car made in the UK was first introduced, with a total of 65 vehicles in 13</p>	20,090 × 2802 × 4170	33.69

formations (five independent small formations were used, and the formation type was EP-EM-ET-ET-ED configuration). Each group of this type of trolley can be driven at the front and rear ends, so when arriving at the terminal, there is no need to turn back and shunt, which is very convenient. The electric and electronic control system adopted was a major innovation at the time, especially with the conditions for speed control, allowing drivers to feel convenient and easy to drive. The Ziqiang through train can reach Taipei=Taiwan within 2 h, and Taipei=Kaohsiung can be reached within 4 h. In the Hsinchu Touqian River accident on March 8, 1982, a group of electric multiple railcars fell into the stream due to the ED trailer. They were severely damaged and could not be repaired. They were scrapped in 1983. Later, they were driven by the power supply due to application requirements. EP112 was changed to driving trailer EPD112. At present, because it has reached the operating life, it is gradually discontinued and scrapped, leaving 15 cars in the register.

In 1969, 12 vehicles were manufactured by Tokyu Corporation of Japan, and the Tangrong Iron Factory in Taiwan updated 6 railvans, totaling 18 railvans, exclusively for carrying luggage and cargo. It is currently stored at the Kaohsiung Machinery Plant of Taiwan Railway Administration.

In 1969, 12 vehicles were manufactured by Tokyu Corporation of Japan, and the Tangrong Iron Factory in Taiwan updated

Luggage railvan	40BK32406	Kaohsiung Machinery Factory	Japan Tokyu Corporation	1969	6 railvans, totaling 18 railvans, exclusively for carrying luggage and cargo. It is currently stored at the Kaohsiung Machinery Plant of Taiwan Railway Administration.	20,000 × 2865 × 3953	29.8
Luggage railvan	40BK32409	Kaohsiung Machinery Factory	Japan Tokyu Corporation	1969	In 1969, 12 vehicles were manufactured by Tokyu Corporation of Japan, and the Tangrong Iron Factory in Taiwan updated	20,000 × 2865 × 3953	29.8

Luggage railvan	35BK32353	Kaohsiung Machinery Factory	Taipei machine factory	1967	6 railvans, totaling 18 railvans, exclusively for carrying luggage and cargo. It is currently stored at the Kaohsiung Machinery Plant of Taiwan Railway Administration. In 1967, it was transformed by the 35EGK32300 power locomotive manufactured by the Taiwan Railway Bureau Taipei Machine Works. It is specially used for carrying luggage and cargo. Currently, only 35BK32353 remains and it is stored in the Taiwan Railway Bureau Kaohsiung Machine Factory.	17,000 × 2865 × 3953	26.7
Luggage railvan	35BK32952	Kaohsiung Port	Japan	1970	Manufactured in Japan in 1989, it was originally a 45PBK32900 type. It was updated to a 35BK92900 luggage trolley in Republic of China. Currently preserved in Kaohsiung Dagou Railway Cultural Park. It was originally a passenger railcar No. 35SPK32389. When the West Line was electrified in 1978, it was transformed into an inspection car for electric power section tram line surveys. The length of the car is only 17 m. It is equipped with a TR32 bogie. This is the only car of this type.	20,000 × 2865 × 3953	27.5
Checking Engineering car	30EOB32389	Kaohsiung Machinery Factory		1978	The original 30SP32375 was transformed into a camper car for public works construction in 1995. The car is only 17 m long and is equipped with a TR32 bogie. This model is the only car left. The aluminum body was assembled in 1978 by Taiwan Aluminum Corporation at Taipei Machine Works. The original car was a caravan No. 17C17001. In 1990, it was transformed into an engineering camper for public works. The only car of this type remains.	20,000 × 2865 × 3953	33.96
Engineering car	30ES32375	Public Works Maintenance Corps		1995		17,000 × 2865 × 3953	27
Engineering car	10ES17001	Public Works Maintenance Corps	Taiwan Aluminum Corporation/Taipei machine factory	1978		7850 × 2762 × 3721	8.6

Engineering car	10EW11	Sun Moon Lake	Kaohsiung Machinery Factory	1931	The original train was a 10W11 water tanker (made in 1931), which was rebuilt in 1979 for a special power supply engineering vehicle. This model is the only one remaining.	6286 × 2100 × 2863	7.89
Engineering car	15EF19	Kaohsiung Port	Japan	1911	The prototype was a 15F10 flat car introduced by Japan in 1911. It was transformed into a special electric engineering car at Kaohsiung Machinery Factory in 1980. This car is old, and the only car of this type is left.	8266 × 2242 × 2134	8.05
Large cargo Engineering car	30D11	Kaohsiung Machinery Factory	Taipei machine factory	1928	In 1928, it was built by the Taipei Machinery Factory for the first time for transporting heavy and large cargo. The bogie was TR75 and wheel-type wheels.	12,068 × 2505 × 2023	17.28
Large cargo Engineering car	30D13	Kaohsiung Machinery Factory	Taipei machine factory	1935	The truck was manufactured by Taipei Machinery Works in 1935 for transporting heavy and heavy goods. The bogie was originally TR75, wheel-type wheels, but was changed to TR82-type, integrated wheels in 1982.	12,068 × 2505 × 2023	17.28
Large cargo Engineering car	50D11	Kaohsiung Machinery Factory	Taiwan Machinery Company	1931	Manufactured by Taiwan Machinery Company in 1931, specially designed for carrying large cargo. The original 2-2 axle compound bogie was used. It was replaced with 30D111.30D112 four-axle type when it was fully repaired in 1988. It was the longest freight car of Taiwan Railway. Only iron remains.	21,290 × 2300 × 1580	39.6
Oil tank railvan	20L757	Hsinchu Locomotive Depot	Taipei machine factory	1961	It was manufactured by Taipei Machinery Works in 1961. In 1966 there was a traffic accident at Tanwen Station, in which it was overturned and hurt. After the frame was updated, it continued to be used for oil transportation. It is currently statically stored in Hsinchu Locomotive Depot for diesel storage.	9142 × 2250 × 3754	13.9

Oil tank railvan	30L853	Kaohsiung Machinery Factory	Taipei machine factory	1966	Established in 1966, exclusively for carrying oil.	13,400 × 2420 × 3896	18
Alternative platform railvan	35GF6061	Sun Moon Lake	Japan Hitachi/Taipei machine factory	1958	Manufactured in 1958, it is one of the three-type substitute flat cars of Taiwan Railways. A total of 27 railvans of this type were transformed from the original 35G6000 gondola from 1981 to 1987, and they have been scrapped since 1995. Only this type of car remains.	14,430 × 2890 × 1100	18.64
Platform railvan	35F20133	Sun Moon Lake	Tang Rong Company	1975	In 1975, Tang Rong Company manufactured 180 vehicles, which were the main vehicle types for transporting military vehicles and containers.	14,430 × 2890 × 1100	18.64
Platform railvan	35F20106	Kaohsiung Port	Tang Rong Company	1975	In 1975, Tang Rong Company manufactured a total of 181 vehicles, which were the main vehicle types for transporting military vehicles and containers in that era.	14,430 × 2890 × 1100	18.64
Platform railvan	50F108	Department of Defense Army Academy	Japan Iino Heavy Industries	1962	Manufactured in 1962, it was the main vehicle type for transporting military vehicles and containers at that time.	15,500 × 2890 × 1200	26.26
Platform railvan	35F20146	Department of Defense Army Academy	Tang Rong Company	1975	In 1975, Tang Rong Company manufactured a total of 181 vehicles, which were the main vehicle types for transporting military vehicles and containers in that era.	14,430 × 2890 × 1100	18.64
Platform railvan	35F20003	Department of Defense Army Academy	Tang Rong Company	1975	In 1975, Tang Rong Company manufactured a total of 181 vehicles, which were the main vehicle types for transporting military vehicles and containers in that era.	14,430 × 2890 × 1100	18.64
Caravan railvan	35C21305	Department of Defense Army Academy	Tang Rong Company	1971	Manufactured in 1971, it was the main vehicle type for transporting military vehicles and containers in that era.	14,080 × 2874 × 3607	18.48
Caravan railvan	25C10008	Kaohsiung Machinery Factory		1939	In 1939, the first batch of newly built wooden roofs, floor panels, and steel body rivet caravans were made by Taiwan Railways. There was a serious shortage of passenger cars in 1960 and 1970. This model was	13,950 × 2750 × 3840	18.1

Caravan railvan	25C10077	Kaohsiung Machinery Factory	1939	<p>equipped with simple seats, windows and lighting equipment and used as a substitute passenger car. It was replaced in 1978. Equipped with bogies (TR76 changed to TR204), using RCT bearings and integrated wheels; it is a representative vehicle type in the era of domestic economic take-off.</p> <p>In 1939, the first batch of newly built wooden roofs, floor panels, and steel body rivet caravans were made by Taiwan Railways. There was a serious shortage of passenger cars in 1960 and 1970. This model was equipped with simple seats, windows and lighting equipment and used as a substitute passenger car. It was replaced in 1978. Equipped with bogies (TR76 changed to TR204), using RCT bearings and integrated wheels; it is a representative vehicle type in the era of domestic economic take-off.</p>	13,950 × 2750 × 3840	18.1
Caravan railvan	25C10056	Sun Moon Lake	1939	<p>equipped with simple seats, windows and lighting equipment and used as a substitute passenger car. It was replaced in 1978. Equipped with bogies (TR76 changed to TR204), using RCT bearings and integrated wheels; it is a representative vehicle type in the era of domestic economic take-off.</p> <p>In 1939, the first batch of newly built wooden roofs, floor panels, and steel body rivet caravans were made by Taiwan Railways. There was a serious shortage of passenger cars in 1960 and 1970. This model was equipped with simple seats, windows and lighting equipment and used as a substitute passenger car. It was replaced in 1978. Equipped with bogies (TR76 changed to TR204), using RCT bearings and integrated wheels; it is a representative vehicle type in the era of domestic economic take-off.</p>	13,950 × 2750 × 3840	18.1
Caravan railvan	10C1216	Sun Moon Lake	1920	<p>The wooden two-axle caravan in 1920 had no ram-cylinder equipment, only two brake shoes on one axle, and ram-machine equipment. The corner</p>	7850 × 2762 × 3721	9.9

Refrigerated truck (railvan)	10R104	Sun Moon Lake		1928	posts were angle irons, so this is the only car left. The wooden two-axle refrigerated truck in 1928 has no squeeze cylinder equipment, one axle has only two brake shoes, and has squeeze machine equipment, the corner posts are made of wood, and the compartment is equipped with heat insulation equipment. This is the only car left. In 1970, 50 vehicles were manufactured by the Japan Automobile Association. There are six ventilation holes on the roof and multiple vents on both sides of the upper part of the car. Since 1996, it has been scrapped one after another, and one car is currently retained.	8000 × 2785 × 3740	
Ventilation railvan	15V2016	Sun Moon Lake	Japan Automobile Association	1970	Manufactured by Kaohsiung Machinery Factory in 1967, it was designed to meet the needs of transporting chickens, ducks and other small domestic animals. The wooden body and axles are basically 12-ton long axles, and the speedometer is KC180; this is the only car left. In 1967, 100 vehicles were manufactured in Japan. They belonged to two-axle double-spring cranes, and were the first-generation cabooses. It was manufactured by Tang Rong Company in 1982, with a total of 26 vehicles, supplied for train cabooses. A total of 145 vehicles were manufactured in Japan in 1969, which were the main vehicle types for the transportation of general goods in that era. Molasses carts, manufactured by the Hualien Port Repair Factory (the predecessor of Hualien Machinery Factory) of the Japanese Ministry of Railways in 1945, travel on the Eastern	7780 × 2480 × 3880	10.91
Livestock cart (railvan)	10K524	Sun Moon Lake	Kaohsiung Machinery Factory	1967		7850 × 2637 × 3722	9.35
Caboose railvan	3CK1573	Sun Moon Lake	Japan	1967		7850 × 2600 × 3902	10.5
Caboose railvan	3CK2109	Kaohsiung Port	Tang Rong Company	1982		8580 × 2640 × 3650	12.4
Gondola railvan	35G20060	Kaohsiung Port	Japan	1969		14,316 × 2809 × 2753	17.48
Narrow gauge molasses carts	LFT7602	Hualien Railway Museum	Japan Railway Ministry Hualien Port Repair Factory	1945		5830 × 2150 × 2850	

Main Line. Its characteristic is to transport molasses in sugar factories. As the only remaining narrow-gauge molasses car, in June 1982, after the expansion of the Huadong line was completed, it was successful. Due to its simple shape, it has preservation value. It was designated as a railway cultural relic and was refurbished by the Hualien Machinery Factory of the Bureau's Office of Maintenance in 2000. It is now located in the Hualien Railway Heritage Museum.

The flat vehicle was manufactured by Taiwan Machinery Company in 1970, and the bogie was manufactured by Japan's Sumitomo Steel Co., Ltd. At that time, because Hualien produced wood, large logs had to rely on rail transportation. It was a model designed for the purpose of carrying logs in response to business needs. Later, it was also used to carry military vehicles or large items. After the east line was widened in June 1982, it was successfully retired. In December 1999, it was renovated by the Hualien Machinery Factory of the Taiwan Railway Administration. It is now located in the Hualien Railway Museum.

Manufactured by Japanese vehicles in the 2nd year of the Republic of China, the main function of this type of vehicle is to transport timber or long-shaped goods. In order to facilitate the train's turning, a rotatable bracket is set above the vehicle platform, which can automatically deflect when the train is turning to prevent the growing wood from preventing the

Narrow gauge flat railvan	LCFC9706	Hualien Railway Museum	Taiwan Machinery Company	1970	11,300 × 2600 × 1800
Alishan Cargo Flat railvan	15F6006	Miaoli Railway Heritage Exhibition Hall	Japanese vehicles	1913	9000 × 2300 × 1800

Narrow gauge steel body railvan	LCC5801	Hualien Railway Museum	Japan Railway Ministry Hualien Port Repair Factory 1923	<p>train from running. It was disabled in 1973. It is now placed in the Miaoli Exhibition Hall of Railway Cultural Relics.</p> <p>The steel-body caravan was manufactured by the Hualien Port Repair Factory (the predecessor of Hualien Machinery Factory) of the Japanese Ministry of Railways in 1923. It drove on the eastern trunk line. After the expansion of the Huadong Line in June 1982, it was a success. Due to its simple shape, it has preservation value. It was designated as a railway cultural relic and was refurbished by the Hualien Machinery Factory of the Bureau's Office of Maintenance in 2000. The Hualien Railway Heritage Museum is now located.</p>	7010 × 2749 × 2134
Narrow gauge steel-body gondola (railvan)	LOC7170	Hualien Railway Museum	1969	<p>The steel-body gondola drove on the Eastern Main Line in 1969. After the expansion of the Huadong Line in June 1982, it was successful. Due to its simple shape, it has preservation value. Designated as a railway cultural relic, it was refurbished by the Hualien Machinery Factory of the Bureau's Office of Maintenance in 2001. It is not located in the Hualien Railway Heritage Museum.</p>	5110 × 2250 × 1660
Narrow gauge wooden caravan (railvan)	LCC5006	Hualien Railway Museum	Railway Bureau Hualien Machinery Factory 1963	<p>The wooden caravan was manufactured by the Hualien Machinery Factory of the Railway Bureau in 1963 and traveled on the eastern trunk line to transport Hualien, Taitung agricultural and fish products. After the expansion of the Huadong Line in June 1982, the Huadong Line retreated. Due to its simple shape and wooden carriage, it is of great preservation value. In 2000, it was refurbished by the Kaohsiung Machinery Factory of the Railway</p>	4880 × 1920 × 2720

Narrow gauge wooden gondola (railvan)	LOC7363	Hualien Railway Museum	Japan Railway Ministry Hualien Port Repair Factory	1929	Administration and placed in the Hualien Railway Heritage Museum. The wooden gondola was manufactured in 1929 by the Hualien Port Repair Factory (the predecessor of Hualien Machinery Factory) of the Japanese Ministry of Railways. Due to its simple shape, it has preservation value. It was designated as a railway cultural relic and was refurbished by the Hualien Machinery Factory of the Bureau's Office of Maintenance in 2000. It is now located in the Hualien Railway Heritage Museum.	5868 × 2286 × 1368	
Narrow gauge wooden caravan (railvan)	LCC5521	Hualien Railway Museum	Railway Bureau Hualien Machinery Factory	1929	The wooden caravan was manufactured by the Hualien Machinery Factory of the Taiwan Railway Bureau in 1929. It drove on the Eastern Main Line. After the expansion of the Huadong Line in June 1982, it was successful. Due to its simple shape, it has preservation value. It was designated as a railway cultural relic and was refurbished by the Hualien Machinery Factory of the Bureau's Office of Maintenance in 2000. It is now located in the Hualien Railway Heritage Museum.	5870 × 2380 × 2690	
Ballast preparation engineering car	Ballast vehicle	Miaoli Railway Heritage Exhibition Hall	Austria PLASER Company	1992	The PBR201 ballast preparation vehicle has a length of 9.96 m, a width of 2.78 m, a height of 3.2 m, a weight of 14 tons, and a traveling speed of 55 km per h. Its main function is to be responsible for the preparation of ballast along the railway. The service life is 8 years. In 2000, it was scrapped at the end of the age and was displayed statically.	99,600 × 2780 × 3200	14
Ballast preparation engineering car	Ramming vehicle	Miaoli Railway Heritage Exhibition Hall	Austria PLASER Company	1992	The PBC800 ballast ramming vehicle has a length of 6.4 m, a width of 2.7 m, a height of 3.07 m, a weight of 14 tons, and a traveling speed of 55 km per h.	64,000 × 2700 × 3070	14

Its main function is to be responsible for the ramming of ballast along the railway. The service life is 8 years. In 2000, it was scrapped at the end of the age and was displayed statically.

Table S2. The ranked score of evaluated variables of each train in the objects database.

No	Name	Type	Year	Length (m)	Width (m)	Height (m)	λ_{sort}	λ_{Rarity}	λ_{Story}
1	Float railcar	25SA4101	1912	16.4	2.706	3.619	8	10	10
2	Float railcar	20SA4102	1904	13.988	2.616	3.467	8	10	10
3	Float railcar	35SA32820	1967	20	2.885	3.8	8	10	10
4	Living room railcar	35PC32701	1971	20	2.885	3.953	8	10	8
5	Second class passenger railcar	35SP32426	1966	20	2.865	3.953	8	9	8
6	Wooden passenger railcar	25TPK2053	1921	16.544	2.744	3.75	8	9	8
7	Wooden passenger railcar	30SPK2502	1953	17.262	2.9	3.78	8	9	8
8	Narrow gauge passenger carriage	LTPB1813	1970	11	2.3	3.2	8	9	8
9	Alishan passenger railcar	SPC2	1971	9	2	1.5	8	9	8
10	Narrow gauge wooden sleeper railcar	LTPB1375	1943	10.364	2.229	3.166	8	10	8
11	Narrow gauge wooden sleeper railcar	LTPS1102	1930	10.583	2.394	3.229	8	10	8
12	Taiwan Sugar Official Patrol engineering car	254	1941	4.665	1.66	2.19	4	10	10
13	Steam locomotive	CK101	1917	11.404	2.616	3.658	10	10	10
14	Steam locomotive	CK124	1936	11.35	3.936	3.9	10	10	8
15	Steam locomotive	DT668	1940	19.73	2.89	3.98	10	10	10
16	Steam locomotive	CT273	1943	20.28	2.936	3.945	10	10	10
17	Steam locomotive	CT152	1919	16.775	2.616	3.885	10	10	8
18	Steam locomotive	DT561	1919	10.306	2.591	3.747	10	10	8
19	Narrow gauge steam locomotive	LDK59	1930	7.422	2.261	3.042	10	10	8
20	Narrow gauge steam locomotive	LDK58	1923	7.217	2.286	3.1	10	10	8
21	Narrow gauge steam locomotive	LDT103	1942	14.346	2.235	3.2	10	10	10
22	Steam locomotive Alishan	28	1913	9.87	2	3.02	10	9	10
23	Taiwan Sugar Steam Locomotive	331	1935	5.8	1.91	3.37	10	9	10
24	Alishan diesel locomotive	11403 – 1	1953	9.25	1.955	3.1	10	8	8
25	Alishan diesel locomotive	11403 – 5	1955	9.5	2.05	3.02	10	8	8
26	Narrow gauge diesel-hydraulic locomotive	DH210	1969	11.8	2.45	3.6	10	8	8

27	Narrow gauge diesel electric locomotive	LDH101	1970	15	2.3	3.3	10	10	6
28	Diesel locomotive	R6	1960	15.37	2.875	3.75	10	7	6
29	Diesel locomotive	S305	1966	11.23	2.667	3.6	10	6	6
30	Diesel locomotive	S405	1970	12.08	2.97	3.7	10	6	6
31	Diesel locomotive	S316	1966	11.23	2.667	3.6	10	6	6
32	Diesel locomotive	S318	1966	11.23	2.667	3.6	10	6	6
33	Diesel locomotive	S201	1960	12.16	2.787	3.665	10	6	6
34	Diesel locomotive	R21	1959	14.226	2.787	3.665	10	5	8
35	Diesel locomotive	R50	1959	14.226	2.787	3.665	10	5	8
36	Diesel locomotive	R71	1959	14.226	2.787	3.665	10	5	8
37	Diesel locomotive	R68	1959	14.226	2.787	3.665	10	5	8
38	Electric locomotive	E101	1976	15.12	2.995	4.003	10	4	4
39	Diesel passenger railcar	25DR2053	1975	15.6	2.42	3.29	8	8	6
40	Diesel passenger railcar	25DR2055	1975	15.6	2.42	3.29	8	8	6
41	Diesel passenger railcar	25DR2056	1975	15.6	2.42	3.29	8	8	6
42	Diesel passenger railcar	25DR2057	1975	15.6	2.42	3.29	8	8	6
43	Diesel passenger railcar	25DR2060	1975	15.6	2.42	3.29	8	8	6
44	Diesel passenger railcar	25DR2067	1975	15.6	2.42	3.29	8	8	6
45	Diesel passenger railcar	25DR2069	1975	15.6	2.42	3.29	8	8	6
46	Diesel passenger railcar	35DR2102	1931	19.916	2.66	3.6	8	8	6
47	Diesel passenger railcar	35DR2404	1969	19.916	2.66	3.6	8	8	6
48	Diesel passenger railcar	35DR2752	1966	20.274	2.885	3.975	8	8	6
49	Diesel passenger railcar	35DR2009	1985	15.6	2.42	3.29	8	8	6
50	Diesel passenger railcar	35DR2010	1985	15.6	2.42	3.29	8	8	6
51	Diesel passenger railcar	35DR2652	1955	19.916	2.784	3.6	8	8	6
52	Narrow gauge diesel passenger railcar	LDR2201	1958	19.916	2.6	3.6	8	8	6
53	Narrow gauge diesel passenger railcar	LDR2204	1958	19.916	2.6	3.6	8	8	6
54	Narrow gauge diesel passenger railcar	LDR2307	1968	19.916	2.6	3.6	8	8	8
55	Ziqiang Electric Combined railcar	ET115	1978	20.09	2.802	4.17	8	6	10
56	Luggage railvan	40BK32406	1969	20	2.865	3.953	6	6	6
57	Luggage railvan	40BK32409	1969	20	2.865	3.953	6	6	6
58	Luggage railvan	35BK32353	1967	17	2.865	3.953	6	10	8
59	Luggage railvan	35BK32952	1970	20	2.865	3.953	6	8	10
60	Checking Engineering car	30EOB32389	1978	20	2.865	3.953	4	10	8
61	Engineering car	30ES32375	1995	17	2.865	3.953	4	10	8
62	Engineering car	10ES17001	1978	7.85	2.762	3.721	4	10	8
63	Engineering car	10EW11	1931	6.286	2.1	2.863	4	10	8
64	Engineering car	15EF19	1911	8.266	2.242	2.134	4	10	8
65	Large cargo Engineering car	30D11	1928	12.068	2.505	2.023	4	8	6
66	Large cargo Engineering car	30D13	1935	12.068	2.505	2.023	4	8	8
67	Large cargo Engineering car	50D11	1931	21.29	2.3	1.58	4	6	8
68	Oil tank railvan	20L757	1961	9.142	2.25	3.754	6	8	10
69	Oil tank railvan	30L853	1966	13.4	2.42	3.896	6	8	6
70	Alternative platform railvan	35GF6061	1958	14.43	2.89	1.1	6	10	8
71	Platform railvan	35F20133	1975	14.43	2.89	1.1	6	4	6

72	Platform railvan	35F20106	1975	14.43	2.89	1.1	6	4	6
73	Platform railvan	50F108	1962	15.5	2.89	1.2	6	8	6
74	Platform railvan	35F20146	1975	14.43	2.89	1.1	6	4	6
75	Platform railvan	35F20003	1975	14.43	2.89	1.1	6	4	6
76	Caravan railvan	35C21305	1971	14.08	2.874	3.607	6	6	6
77	Caravan railvan	25C10008	1939	13.95	2.75	3.84	6	8	8
78	Caravan railvan	25C10077	1939	13.95	2.75	3.84	6	8	8
79	Caravan railvan	25C10056	1939	13.95	2.75	3.84	6	8	8
80	Caravan railvan	10C1216	1920	7.85	2.762	3.721	6	10	8
81	Refrigerated truck (railvan)	10R104	1928	8	2.785	3.74	6	10	8
82	Ventilation railvan	15V2016	1970	7.78	2.48	3.88	6	4	8
83	Livestock cart(railvan)	10K524	1967	7.85	2.637	3.722	6	10	8
84	Caboose railvan	3CK1573	1967	7.85	2.6	3.902	6	4	6
85	Caboose railvan	3CK2109	1982	8.58	2.64	3.65	6	6	6
86	Gondola railvan	35G20060	1969	14.316	2.809	2.753	6	4	6
87	Narrow gauge molasses carts	LFT7602	1945	5.83	2.15	2.85	6	10	8
88	Narrow gauge flat railvan	LCFC9706	1970	11.3	2.6	1.8	6	8	6
89	Alishan Cargo Flat railvan	15F6006	1913	9	2.3	1.8	6	10	8
90	Narrow gauge steel body railvan	LCC5801	1923	7.01	2.749	2.134	6	8	6
91	Narrow gauge steel-body gondola (railvan)	LOC7170	1969	5.11	2.25	1.66	6	8	8
92	Narrow gauge wooden caravan(railvan)	LCC5006	1963	4.88	1.92	2.72	6	10	6
93	Narrow gauge wooden gondola(railvan)	LOC7363	1929	5.868	2.286	1.368	6	10	6
94	Narrow gauge wooden caravan(railvan)	LCC5521	1929	5.87	2.38	2.69	6	10	6
95	ballast preparation engineering car	PBR201	1992	99.6	2.78	3.2	4	4	6
96	ballast preparation engineering car	PBC800	1992	64	2.7	3.07	4	4	6

Table S3. The attributions of buildings in Taipei Railway Workshop.

No	Name	Length	Width	Area	Story	Total Area	Height	Year
1	Main office	70	12	840	2	1680	7.26	1959
2	Small auditorium	42	12	504	2	1008	8.36	1967
3	Union office	38	10	380	2	760	8.36	1959
4	Rear wing of the main office	15	8	120	2	240	7.26	1959
5	Training center	16	16	256	2	512	7.26	1959
6	Electric 2 west factory	120	24	2880	1	2880	12.23	1962
7	Diesel factory	84	38.4	3226	1	3226	14.54	1962
8	Diesel-electric bogie yard	33	24	792	1	792	12.42	1978
9	Chipping field	16.4	11	174	1	173	4.00	--
10	Combustion engine factory	22.2	20	444	1	444	9.26	1962
11	Diesel paint field	45	6	263	1	263	5.88	1978
12	Assembly factory	168	24	4032	1	4032	14.86	1991
13	Machine factory	168	15	2520	1	2520	13.70	1991
14	Dianyi factory	67	15	992	1	992	11.86	1991

15	Machine factory	108	15	1598	1	1598	11.86	1991
16	Underground lathe	42	10	420	1	420	5.77	1945
17	Power laboratory	18	10	180	1	180	6.45	1991
18	Assembly and power shop	25	15	375	1	375	6.22	1991
19	warehouse	15	12	180	1	180	7.76	1951
20	Prime engineering room	48	15	720	1	720	11.90	1991
21	Forge factory	60	49	2940	1	2940	9.00	1933
22	Shop for trains in and out	66	24	1584	1	1584	11.28	1959
23	Car workshop 1	57	24	1368	1	1368	16.80	1991
24	Car workshop 2	48	24	1152	1	1152	12.69	1991
25	Sheet metal shop 1	123	24	2952	1	2952	12.69	1991
26	Sheet metal shop 2	123	33	4059	1	4059	18.19	1959
27	Railcar parts shop	129	66	8514	1	8514	18.19	1959
28	Material field 1	24	16	384	2	768	7.87	1971
29	Material field 2	95	18	1710	2	3420	9.15	1933
30	Material field 3	48	15	720	3	2160	10.00	1959
31	Material field 4	15	15	225	2	450	7.00	1971
32	Supply plant office	70	12	840	2	1680	7.00	--
33	Welfare agency	24	10	240	2	480	9.16	1959
34	Auditorium	66.48	42	1596	1	1596	12.06	1959
35	Guard room	15	10	150	1	150	3.60	1959
36	Material warehouse	9	8	72	2	144	3.60	--
37	Garage	13	13	169	1	169	3.60	--
38	Bathhouse	73	6	240	1	240	3.91	1959
38	Wings of bathhouse	58	12	696	1	696	3.91	1959
39	Machine garage	34	20	680	1	680	9.15	--
40	General factory	32	14	448	1	448	7.50	1959
41	General workshop wing	15	10.8	165	1	165	3.93	1959
42	Assemble beam repair yard	48	20	960	1	960	8.10	1970
43	Electric field 2 (East)	48	38	1824	1	1824	18.45	1970
44	Air conditioner repair shop	36	25	900	1	900	11.75	1933
45	Bearing center	36	6	216	1	216	5.33	1961
46	Material field 7	20	10	200	1	200	4.50	1961
47	Cylinder center	20	15	300	1	300	6.91	1961
48	Wooden mold shop	21	15	315	3	945	10.34	1933
49	paint workshop	100	24	2400	1	2400	11.7	1978
50	Material field 8	20	20	400	1	400	5.68	1961
51	Material field 9	20	20	400	1	400	4.63	1961
52	Material field 10	25	15	375	1	375	7.12	1978
	Total floor area					67,730		

Source: Adapted from TRA. Note: (1) the width of a building wall that surpassed 17 m is in Body Text; (2) the height of a story that surpasses 10 m is in Body Text; (3) the building, whose width and the height are both complied with the aforementioned containments, is a candidate as exhibition gallery; (4) the candidate buildings are marked in a green row; (5) the building for a model example of exhibition gallery is marked in an orange row; (6) the symbol "--" means no data.

Algorithm S1. The calculating process of scores of layout instances for ELP.

1. Generating parent layout instance

Select four trains from the objects database at random, one by one, as the Parent I. Select another four trains from the objects database at random again as Parent II.

(i) Parent I:

$$\textcircled{1} \text{ Story_score } (\lambda_{\text{Story}}) = (10, 6, 6, 8)/4 = 7.5$$

$\textcircled{2}$ Year_score (λ_{Year})

$$Y1 = [(2020-1912)/(2020-1904)] \times 10 = 9.31$$

$$Y2 = [(2020-1975)/(2020-1904)] \times 10 = 3.88$$

$$Y3 = [(2020-1975)/(2020-1904)] \times 10 = 3.88$$

$$Y4 = [(2020-1921)/(2020-1904)] \times 10 = 8.53$$

$$\text{Year_score } (\lambda_{\text{Year}}) = (9.31 + 3.88 + 3.88 + 8.53)/4 = 6.4$$

$$\textcircled{3} \text{ Sort_score } (\lambda_{\text{Sort}}) = (8, 8, 8, 8)/4 = 8$$

$$\textcircled{4} \text{ Rarity_score } (\lambda_{\text{Rarity}}) = (10, 8, 8, 9)/4 = 8.75$$

$\textcircled{5}$ Space-gap _ score ($\lambda_{\text{Space-gap}}$)

$$L1 = 10 - |(20 - 16.4)| = 6.4, W1 = 10 - |(3 - 2.7)| = 9.7$$

$$L2 = 10 - |(20 - 15.6)| = 5.6, W2 = 10 - |(3 - 2.42)| = 9.42$$

$$L3 = 10 - |(20 - 15.6)| = 5.6, W3 = 10 - |(3 - 2.42)| = 9.42$$

$$L4 = 10 - |(20 - 16.54)| = 6.54, W4 = 10 - |(3 - 2.74)| = 9.74$$

$$\text{Space-gap_score } (\lambda_{\text{Space-gap}}) = (6.4 + 9.7 + 5.6 + 9.42 + 5.6 + 9.42 + 6.54 + 9.74)/8 = 7.8$$

$\textcircled{6}$ Ratio _ score (λ_{Ratio})

$$\text{Area1} = 16.4 \times 2.7 = 44.28$$

$$\text{Area2} = 15.6 \times 2.42 = 37.75$$

$$\text{Area3} = 15.6 \times 2.42 = 37.75$$

$$\text{Area4} = 16.54 \times 2.74 = 45.32$$

$$\text{Floor area of exhibition gallery: } 84 \times 38.4 = 3225.6$$

$$\text{Ratio_score } (\lambda_{\text{Ratio}}) = [(44.28 + 37.75 + 37.75 + 25.3)/3225.6] \times 100\% = 5.12$$

$$\text{Total score of Parent I } (\lambda_{\text{I}}^{(*)}) = (7.5 + 6.4 + 8 + 8.75 + 7.8 + 5.12)/6 = 7.26$$

(ii) Parent II:

$$\textcircled{1} \text{ Story_score } (\lambda_{\text{Story}}) = (10, 10, 6, 8)/4 = 8.5$$

$\textcircled{2}$ Year_score (λ_{Year})

$$Y1 = [(2020-1967)/(2020-1904)] \times 10 = 4.57$$

$$Y2 = [(2020-1904)/(2020-1904)] \times 10 = 10$$

$$Y3 = [(2020-1985)/(2020-1904)] \times 10 = 3.02$$

$$Y4 = [(2020-1970)/(2020-1904)] \times 10 = 4.31$$

$$\text{Year_score } (\lambda_{\text{Year}}) = (4.57 + 10 + 3.02 + 4.31)/4 = 5.48$$

$$\textcircled{3} \text{ Sort_score } (\lambda_{\text{Sort}}) = (8, 8, 8, 8)/4 = 8$$

$$\textcircled{4} \text{ Rarity_score } (\lambda_{\text{Rarity}}) = (10, 10, 8, 9)/4 = 9.25$$

⑥ Space-gap _score ($\lambda_{\text{Space-gap}}$)

$$L1 = 10 - |(20 - 20)| = 10, W1 = 10 - |(3 - 2.9)| = 9.9$$

$$L2 = 10 - |(20 - 14)| = 4, W2 = 10 - |(3 - 2.62)| = 9.62$$

$$L3 = 10 - |(20 - 15.6)| = 5.6, W3 = 10 - |(3 - 2.42)| = 9.42$$

$$L4 = 10 - |(20 - 11)| = 1, W4 = 10 - |(3 - 2.3)| = 9.3$$

$$\text{Space-gap _score } (\lambda_{\text{Space-gap}}) = (10 + 9.9 + 4 + 9.62 + 5.6 + 9.42 + 1 + 9.3)/8 = 7.36$$

⑥ Ratio_score (λ_{Ratio})

$$\text{Area1} = 20 \times 2.9 = 58$$

$$\text{Area2} = 14 \times 2.62 = 36.68$$

$$\text{Area3} = 15.6 \times 2.42 = 37.75$$

$$\text{Area4} = 11 \times 2.3 = 25.3$$

$$\text{Floor area of exhibition gallery: } 84 \times 38.4 = 3225.6$$

$$\text{Ratio _score } (\lambda_{\text{Ratio}}) = [(58 + 36.68 + 37.75 + 25.3)/3225.6] \times 100\% = 4.89$$

$$\text{Total score of Parent II } (\lambda_{\text{II}}^{(*)}) = (8.5 + 5.48 + 8 + 9.25 + 7.36 + 4.89)/6 = 7.24$$

(iii) Result

The total score of Parent I is 7.26, and the Parent II is 7.24. The Parent I is slightly better than Parent II, but these scores are similar.

2. *Producing offspring layout instance*

Exchange the first and second position trains (genes) in the chromosomes of Parent I and Parent II (Figure 8), and Offspring I and Parent II are produced.

(i) Offspring I:

① Story_score (λ_{Story}) = (10, 10, 6, 8)/4 = 8.5

② Year_score (λ_{Year})

$$Y1 = [(2020 - 1967)/(2020 - 1904)] \times 10 = 4.57$$

$$Y2 = [(2020 - 1904)/(2020 - 1904)] \times 10 = 10$$

$$Y3 = [(2020 - 1975)/(2020 - 1904)] \times 10 = 3.88$$

$$Y4 = [(2020 - 1921)/(2020 - 1904)] \times 10 = 8.53$$

$$\text{Year_score } (\lambda_{\text{Year}}) = (4.57 + 10 + 3.88 + 8.53)/4 = 6.75$$

③ Sort_score (λ_{Sort}) = (8, 8, 8, 8)/4 = 8

④ Rarity_score (λ_{Rarity}) = (10, 10, 8, 9)/4 = 9.25

⑥ Space-gap _score ($\lambda_{\text{Space-gap}}$)

$$L1 = 10 - |(20 - 20)| = 10, W1 = 10 - |(3 - 2.9)| = 9.9$$

$$L2 = 10 - |(20 - 14)| = 4, W2 = 10 - |(3 - 2.62)| = 9.62$$

$$L3 = 10 - |(20 - 15.6)| = 5.6, W3 = 10 - |(3 - 2.42)| = 9.42$$

$$L4 = 10 - |(20 - 16.54)| = 6.54, W4 = 10 - |(3 - 2.74)| = 9.74$$

$$\text{Space-gap _score } (\lambda_{\text{Space-gap}}) = (10 + 9.9 + 4 + 9.62 + 5.6 + 9.42 + 6.54 + 9.74)/8 = 8.1$$

⑥ Ratio_score (λ_{Ratio}):

$$\text{Area1} = 20 \times 2.9 = 58$$

$$\text{Area2} = 14 \times 2.62 = 36.68$$

$$\text{Area3} = 15.6 \times 2.42 = 37.75$$

$$\text{Area4} = 16.54 \times 2.74 = 45.32$$

$$\text{Floor area of exhibition gallery: } 84 \times 38.4 = 3225.6$$

$$\text{Ratio_score } (\lambda_{\text{Ratio}}) = [(58 + 36.68 + 37.75 + 25.3)/3225.6] \times 100\% = 5.51$$

$$\text{Total score of Parent I } (\lambda_{\text{I}}^{(*)}) = (8.5 + 6.75 + 8 + 9.25 + 8.1 + 5.51)/6 = 7.69$$

(ii) Offspring II:

① Story_score (λ_{Story}) = (10, 6, 6, 8)/4 = 7.5

② Year_score (λ_{Year})

$$Y1 = [(2020-1912)/(2020-1904)] \times 10 = 9.7$$

$$Y2 = [(2020-1975)/(2020-1904)] \times 10 = 3.88$$

$$Y3 = [(2020-1985)/(2020-1904)] \times 10 = 3.02$$

$$Y4 = [(2020-1970)/(2020-1904)] \times 10 = 4.31$$

$$\text{Year_score } (\lambda_{\text{Year}}) = (9.31 + 3.88 + 3.02 + 4.31)/4 = 5.13$$

③ Sort_score (λ_{Sort}) = (8, 8, 8, 8)/4 = 8

④ Rarity_score (λ_{Rarity}) = (10, 8, 8, 9)/4 = 8.75

⑤ Space-gap_score ($\lambda_{\text{Space-gap}}$)

$$L1 = 10 - |(20 - 16.4)| = 6.4, W1 = 10 - |(3 - 2.7)| = 9.3$$

$$L2 = 10 - |(20 - 15.6)| = 5.6, W2 = 10 - |(3 - 2.42)| = 9.42$$

$$L3 = 10 - |(20 - 15.6)| = 5.6, W3 = 10 - |(3 - 2.42)| = 9.42$$

$$L4 = 10 - |(20 - 11)| = 1, W4 = 10 - |(3 - 2.3)| = 9.3$$

$$\text{Space-gap_score } (\lambda_{\text{Space-gap}}) = (6.4 + 9.7 + 5.6 + 9.42 + 5.6 + 9.42 + 1 + 9.3)/8 = 7.06$$

⑥ Ratio_score (λ_{Ratio})

$$\text{Area1} = 16.4 \times 2.7 = 44.28$$

$$\text{Area2} = 15.6 \times 2.42 = 37.75$$

$$\text{Area3} = 15.6 \times 2.42 = 37.75$$

$$\text{Area4} = 11 \times 2.3 = 25.3$$

$$\text{Floor area of exhibition gallery: } 84 \times 38.4 = 3225.6$$

$$\text{Ratio_score } (\lambda_{\text{Ratio}}) = [(44.28 + 37.75 + 37.75 + 25.3)/3225.6] \times 100\% = 4.5$$

$$\text{Total score of Case II'} (\lambda_{\text{II}}^{(*)}) = (7.5 + 5.13 + 8 + 8.75 + 7.06 + 4.5)/6 = 6.82$$

(iii) Result:

The total score of Offspring I is higher than Offspring II. The score of Offspring I is 7.69, which is better than the original score of Parent I (7.26). At the same time, the score of Offspring II after crossover is 6.82, which is worse than the original score of Parent II (7.24). In other words, Offspring I is a good option for mutation.

3. Mutating layout instance

If the third position train (gene) is replaced with another train (DR688, 1940), and count type scores to distinguish and compare the parent and generations.

(i) Story_score (λ_{Story}) = (10, 10, 10, 8)/4 = 9.5

(ii) Year_score (λ_{Year})

$$Y1 = [(2020 - 1967)/(2020 - 1904)] \times 10 = 4.57$$

$$Y2 = [(2020 - 1904)/(2020 - 1904)] \times 10 = 10$$

$$Y3 = [(2020 - 1940)/(2020 - 1904)] \times 10 = 6.9$$

$$Y4 = [(2020 - 1921)/(2020 - 1904)] \times 10 = 8.53$$

$$\text{Year_score } (\lambda_{\text{Year}}) = (4.57 + 10 + 6.9 + 8.53)/4 = 7.5$$

(iii) Sort_score (λ_{Sort}) = (8, 8, 10, 8)/4 = 8.5

(iv) Rarity_score (λ_{Rarity}) = (10, 10, 10, 9)/4 = 9.75

(v) Space-gap _score ($\lambda_{\text{Space-gap}}$)

$$L1 = 10 - |(20 - 20)| = 10, W1 = 10 - |(3 - 2.9)| = 9.9$$

$$L2 = 10 - |(20 - 14)| = 6, W2 = 10 - |(3 - 2.62)| = 9.62$$

$$L3 = 10 - |(20 - 19.73)| = 9.73, W3 = 10 - |(3 - 2.89)| = 9.89$$

$$L4 = 10 - |(20 - 16.54)| = 6.54, W4 = 10 - |(3 - 2.74)| = 9.74$$

$$\text{Space-gap_score } (\lambda_{\text{Space-gap}}) = (10 + 9.9 + 6 + 9.62 + 9.73 + 9.89 + 6.54 + 9.74)/8 = 8.68$$

(vi) Ratio_score (λ_{Ratio}):

$$\text{Area1} = 20 \times 2.9 = 58$$

$$\text{Area2} = 14 \times 2.62 = 36.68$$

$$\text{Area3} = 19.73 \times 2.89 = 57.02$$

$$\text{Area4} = 16.54 \times 2.74 = 45.32$$

$$\text{Floor area of exhibition gallery: } 84 \times 38.4 = 3225.6$$

$$\text{Ratio_score } (\lambda_{\text{Ratio}}) = [(58 + 36.68 + 57.02 + 45.32)/3225.6] \times 100\% = 6.11$$

Total score of Offspring I' ($\lambda_{I'}$) = (9.5 + 7.5 + 8.5 + 9.75 + 8.68 + 6.11)/6 = 8.34

(vii) Result:

After the mutation of the better Offspring I, the total score of Offspring I' (8.34) is higher than Offspring I, and gets optimization result. The Offspring I' is much better than the original score of Parent I (7.26). Then, the list of the next generation after mutation is rewritten in Table 9.