The State Railway of Thailand Line Capacity Evaluation using UIC 406 Method (Section Hua Ta Khe Station to Cha Choeng Sao Junction)

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Abstract

This paper evaluates the State Railway of Thailand (SRT) freight line capacity from Hua Ta Khe Station to Cha Choeng Sao Junction using the International Union of Railway's methodology (UIC 406). The approach is to compress the timetable, calculate the capacity consumption and evaluate the possible additional train paths on a macroscopic level.

Two Line Sections (LS) is defined for this Train Path Line Section (TPLS). The analysis shows the 100% capacity consumption for the whole TPLS but 49% and 55% for each LS (using 43% additional time). The new timetable is proposed by dividing the operation into 2 sections. 18 container freight trains and 2 commodity freight trains are added. The line section capacity consumption after the evaluation process is 82% and 91% respectively.

Keywords: The State Railway of Thailand, Railway Capacity, Timetable, Rail Freight, UIC 406.

1. Introduction

Since the 1st edition published in 2004 [1], the International Union of Railways (UIC) methodology for capacity evaluation has been used, discussed, and adopted worldwide. Practical application and comparison with the legacy evaluation on this methodology are made in countries e.g. Austria [2], Denmark [3 – 6], UK [7], Slovakia [8], Germany [9], Lithuania [10], China [11 – 12], to name a few. The lack of station capacity evaluation was raised by many practitioners [3, 7], and led to the enhancement [13] and 2nd edition publication [14] in 2013.

This article aims to boost the freight traffic between the Lat Krabang Inland Container Depot and Laem Chabang Port freight corridor by proposing the practical timetable, in a strategic level, that utilizes the available line capacity while taking the State Railway of Thailand (SRT) operating constraints into account.

Section 2 of the manuscript describes the overview of the studied section, i.e. track layout, signalling, timetable, and operating parameter. Section 3 briefs the related capacity terminology and formula i.e. Occupancy Time, Capacity Consumption, including the SRT capacity calculation using Scott's formula.

Section 4 shows the work results applying the UIC 406 timetable compression procedures i.e. capacity consumption, availability capacity. and the proposed timetable. Discussion, future work, and conclusion are in section 5 and 6.

Fig. 1 SRT Eastern Line Map [15]

2. Area of study: Hua Ta Khe Station to Cha Choeng Sao Junction section

In Thailand, the State Railway of Thailand (SRT) operation between Hua Ta Khe Station to Cha Choeng Sao Junction is considered one of the complicated sections. All freight traffic from Bangkok to the Eastern Economic Corridor (EEC) is passing on this section. This section has a triple track layout and provides service to both passenger and freight traffic. The passenger traffic is the urban and regional train from Bangkok to the Eastern region.

While the freight traffic is mostly the container freight train from Lat Krabang Inland Container Depot (LICD) to Laem Chabang Port.

2.1 Infrastructure, stations, and signalling

The studied section from Hua Ta Khe (HTK) Station to Cha Choeng Sao Junction (CHJ) comprises of 5 stations and 3 stops. Section distance is 30.12 km. This section was upgraded from double track to triple track on 2007 by adding one passenger track into the line. The up main track is assigned for the freight traffic. The mid main track, that was a single bi-directional passenger track, currently is the outbound passenger track. The down main track that newly constructed is assigned for the inbound passenger traffic. The legacy and new infrastructure illustrate in figure 1.

Table 1 Stations and stops in the studied section

Station	Abbreviation	Mid of station (km.)	Type
Lat Krabang Inland Container Depot	LICD	33.86	Special Station
Hua Ta Khe	HTK	30.87	Station
Khlong Luang Phaeng	KLP	39.61	Station
Khlong Udom Chonlachon	KUC	43.30	Stop
Khlong Preng	PRE	46.36	Station
Khlong Khwaeng Klan	KWK	50.90	Stop
Khlong Bang Phra	KBP	53.60	Station
Bang Toei	BTY	56.58	Stop
Cha Choeng Sao Junction	CHJ	60.99	Station

SRT stations and stops location, from Bangkok to CHJ, was strategically designed and determined at every 3, 6, 9 or 12 km. This section contains 4 blocks, HTK – KLP, KLP – PRE, PRE – KBP, KBP – CHJ.

The Signalling system was upgraded from the token block system to the 3-aspects colour light system in 2007. The interlocking is the Computer-Based Interlocking (CBI) type, supports the automatic block system and ETCS Level 1 functionality. All triple tracks support the bi-directional operation, at best, from the Signalling system perspective.

However, at present, the SRT operating rule is nevertheless using the absolute block system.

2.2 Track layout

The crossing and overtaking of a freight train can only happen at the HTK, KLP, PRE and CHJ station from the siding track provided. Anyhow, a freight train can travel to and from the mid-track at HTK, PRE and CHJ.

The current station and track layout design do not have the facilities, neither an additional dead-end track nor safety distance between the departure signal and the fouling point, to accommodate the parallel train movement. [6]

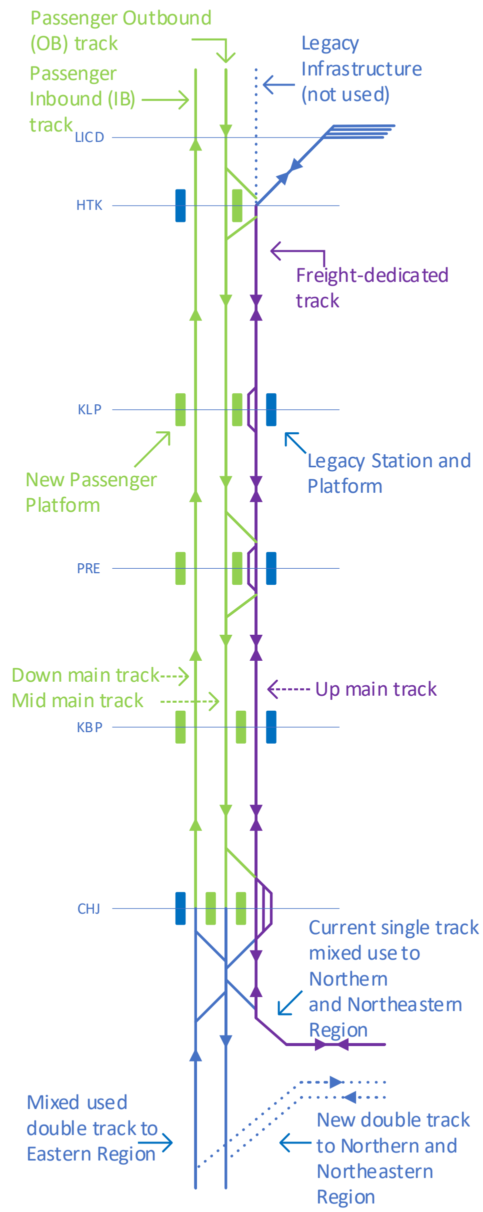

Fig. 2 Track layout

2.3 Timetable and freight operation

There are 24 passenger trains and 45 freight trains using this section [16]. Most of the traffic is a pair-train, except for the #899 train. Brief of line service shown in table 2.

Table 2 Train service in the section

Train number	Train type	Train amount
505 – 510, 831 – 860	Scheduled Freight	36
564/565, 569/570, 777/778, 897/898, 899	Per-request Freight	9
275 – 284, 367/368, 371/372, 383/384, 388/389, 390/391.	Weekday Passenger	20
285/286, 997/998	Weekend Passenger	4

Focusing to the scheduled freight train, train number #831 – #860 are the pair-train from LICD to Leam Chabang port (in the Eastern region), while train number #505 – #510 are the pair-train from Hin Lap station (in the Northeastern region) to PRE.

The pair-train number #831 – #860 are the container freight trains depart HTK every 80 – 100 minutes (with an Average Headway 88 minutes) and back to HTK every 6 hours 8 minutes (Average Turnaround/Circuit Time). The outbound (OB) and inbound (IB) travelling time are almost identical, 31 and 32 minutes. Fleet operates in 24 hours basis. The last train (#859) departs HTK on 20:50 and back to HTK (#860) on 03:30.

Train-pair number #505 – #510 are the commodity freight trains, transport cement to PRE. The IB average travelling time (19 mins) is higher than the OB average travelling time (16 mins) because of the transported goods weight. The nominal travelling time of each traffic presents in figure 2.

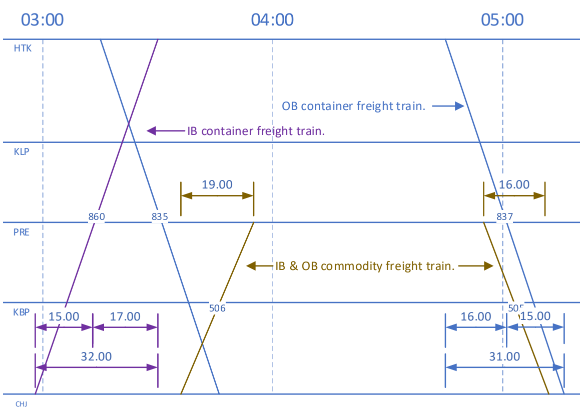

Fig. 3 A typical time-speed diagram (train graph) of freight trains before compression.

Note that all freight trains in this study are the container type. Train #505 - #510 is defined as the commodity type as to distinguish it from train #831 - #860.

3. Capacity Equation

UIC 406 uses the concept from UIC 405, Links between Railway Infrastructure Capacity and the Quality of Operations, published in 1996 [17]. Thus, the principle of calculation is on the infrastructure occupancy.

3.1 UIC 406 capacity consumption

The capacity consumption calculation in UIC 406 bases on the track utilization principle. The percentage of *Capacity Consumption* (%) formula is as equation 1.

$$\frac{Occupancy\ Time + Additional\ Time}{Defined\ Time\ Period} \times 100 \qquad (1)$$

Occupancy Time is the total time required for one train to pass through a single block. [13] This macroscopic study is using the travelling time derive from the timetable representing the *Occupancy Time* of each block. The percentage of *Occupancy Time* (%) formula is as equation 2.

$$\frac{Occupancy\ Time}{Defined\ Time\ Period} \times 100 \qquad (2)$$

Additional Time is the time to make the timetable stable and robust. It includes the Supplement and Buffer time to absorb a primary and suppress secondary delay, respectively, and withstand the delay occurring. [18] The more sensitive train service (i.e. high-speed line) or complicated service (i.e. mixed-traffic operation), the more additional time requires. [14] Equation 3 presents the *Additional Time Rate* (%) formula.

$$\left[\frac{100}{Occupancy\ Time\ Rate} - 1\right] \times 100 \qquad (3)$$

Defined Time Period is the interested time duration. This study uses the one day (1440 minutes), to be comparable to the SRT capacity calculation formula.

3.2 SRT capacity calculation formula

SRT is using Scott's formula to calculate the capacity, as illustrated in equation 4. Unit is a trip per day.

$$\frac{1440\ mins}{T+t} \times 70\% \qquad (4)$$

Where T is the travelling time of a train in the longest block (Representative Block) of the line section and t is the operating time required in handling the arrival and departure train.

Originally t value is 3 minutes for the legacy token block system. Now the one-minute t value is using for the computer-based interlocking sections.

70% is the *Occupancy Time* rate that SRT is using. Thus, the SRT's *Additional Time* is 30% of the Defined Time Period or 43% of the *Occupancy Time*.

Table 3 SRT capacity calculation using Scott's Formula

Section	Representative Block	Representative Block Distance (km.)	Formula	Capacity (trips/day)
HTK – PRE	HTK – KLP	15.49	$\frac{1440\times70\%}{17.0+1}$	56
PRE – CHJ	PRE – KBP	14.63	$\frac{1440\times70\%}{15.0+1}$	63
HTK – CHJ	HTK – CHJ	30.12	$\frac{1440\times70\%}{32.0+1}$	30

Experimental re-evaluation of the SRT calculation is made and shows in table 3. Using the nominal inbound travelling time for T. Note the HTK – CHJ section capacity is 30 trips per day, the same number with the current daily scheduled container freight train number.

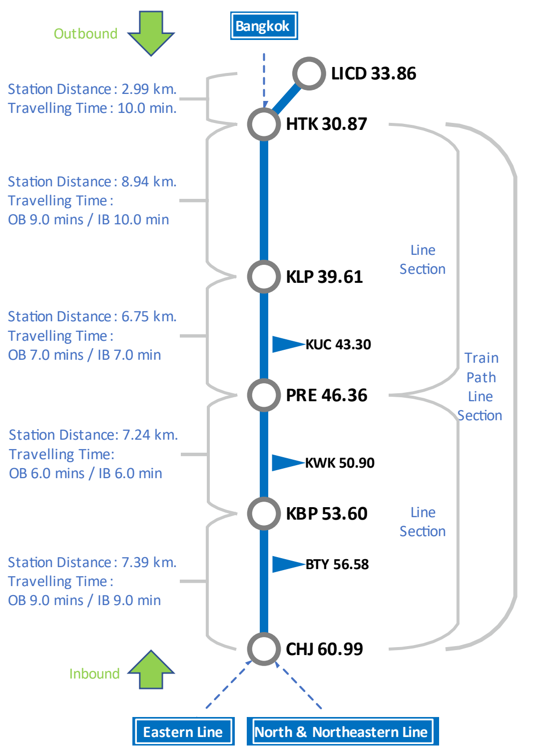

Fig. 4 Schematic diagram of station distance and travelling time of freight trains *#831 - #860*.

4. Capacity Evaluation

Five steps are proposed by the UIC 406 for calculating the capacity consumption section by section.

4.1 Defining infrastructure and timetable boundaries

Only the freight-dedicated up main track between HTK and CHJ is selected to be a Train Path Line Section (TPLS) for the study. Studied timetable interval is total one day period, to be comparable to SRT calculation.

Passenger track is not the scope of this study. It has a different timetable and stopping pattern. Anyway, there is a brief analysis of the passenger track utilization in section 5.

Figure 4 presents the stopping pattern and dwelling time of the passenger train at each station and stop.

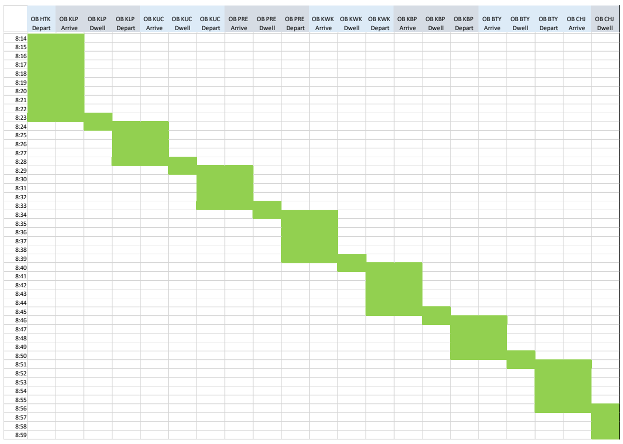

Fig. 5 Blocking time diagram of train #283, before compression.

4.2 Defining sections for investigation

From the physical infrastructure, station location, actual timetable of a scheduled freight train and to be comparable with the issued SRT calculation result, the determination of Line Section (LS) in TPLS are HTK – PRE and PRE – CHJ.

4.3 Calculating occupancy time and capacity consumption (compression)

Only the 36 scheduled freight trains are calculated. 9 per-request freight trains are excluded. The pair-train #831 - #860 is a long train path using both 2 LSs, while the pair-train #505 - #510 is a short train path using only PRE – CHJ LS.

Compression made in 2 aspects. 1st aspect compressed the whole TPLS, respecting the current timetable. The result shows in figure 5 (left-side). 2nd aspect compressed each LS as UIC 406 definition and to compare with SRT's formula result. The result shows in figure 5 (right-side). The capacity consumption of these 2 LSs, using 43% and 66% additional time, shows in table 4.

	HTK - PRE		PRE - CHJ					HTK - PRE		PRE - CHJ		
831	0:00	0:16	0:16	0:31			831	0:00	0:16	0:00	0:15	
	1:03	0:46	0:46	0:31	858			0:33	0:16	0:30	0:15	858
833	1:03	1:19	1:19	1:34			833	0:33	0:49	0:30	0:45	
	2:06	1:49	1:49	1:34	860			1:06	0:49	1:00	0:45	860
835	2:06	2:22	2:22	2:37			835	1:06	1:22	1:00	1:15	
			2:56	2:37	506					1:34	1:15	506
505			2:56	3:13			505			1:34	1:51	
837	2:57	3:13	3:13	3:28			837	1:22	1:38	1:51	2:06	
	4:00	3:43	3:43	3:28	832			1:55	1:38	2:21	2:06	832
839	4:00	4:16	4:16	4:31			839	1:55	2:11	2:21	2:36	
	5:03	4:46	4:46	4:31	834			2:28	2:11	2:51	2:36	834
841	5:03	5:19	5:19	5:34			841	2:28	2:44	2:51	3:06	
	6:06	5:49	5:49	5:34	836			3:01	2:44	3:21	3:06	836
843	6:06	6:22	6:22	6:37			843	3:01	3:17	3:21	3:36	
	7:09	6:52	6:52	6:37	838			3:34	3:17	3:51	3:36	838
845	7:09	7:25	7:25	7:40			845	3:34	3:50	3:51	4:06	
			8:02	7:40	508					4:28	4:06	508
	8:34	8:17	8:17	8:02	840			4:07	3:50	4:43	4:28	840
847	8:34	8:50	8:50	9:05			847	4:07	4:23	4:43	4:58	
507			9:05	9:21			507			4:58	5:14	
	9:54	9:37	9:37	9:21	842			4:40	4:23	5:30	5:14	842
849	9:54	10:10	10:10	10:25			849	4:40	4:56	5:30	5:45	
	10:57	10:40	10:40	10:25	844			5:13	4:56	6:00	5:45	844
851	10:57	11:13	11:13	11:28			851	5:13	5:29	6:00	6:15	
	12:00	11:43	11:43	11:28	846			5:46	5:29	6:30	6:15	846
853	12:00	12:16	12:16	12:31			853	5:46	6:02	6:30	6:45	
	13:03	12:46	12:46	12:31	848			6:19	6:02	7:00	6:45	848
855	13:03	13:19	13:19	13:34			855	6:19	6:35	7:00	7:15	
	14:06	13:49	13:49	13:34	850			6:52	6:35	7:30	7:15	850
857	14:06	14:22	14:22	14:37			857	6:52	7:08	7:30	7:45	
			14:55	14:37	510					8:03	7:45	510
	15:27	15:10	15:10	14:55	852			7:25	7:08	8:18	8:03	852
509			15:10	15:26			509			8:18	8:34	
859	15:27	15:43	15:43	15:58			859	7:25	7:41	8:34	8:49	
	16:30	16:13	16:13	15:58	854			7:58	7:41	9:04	8:49	854
	16:45	16:28	16:28	16:13	856			8:15	7:58	9:19	9:04	856

Fig. 6 The compressed timetable of whole TPLS and by LS.

Table 4 Freight track capacity consumption

Line Section	Trains in LS	Occ Time (mins)	Occ Time Rate (%)	Add Time 43% (mins)	Cap Cnsmp @43% (%)	Add Time 66% (mins)	Cap Cnsmp @66% (%)
HTK – PRE	30	495	34	212	49	330	57
PRE – CHJ	36	559	39	240	55	373	65
HTK – CHJ	36	1005	70	431	100	670	116

** Abbreviation: Occ is Occupancy. Add is Additional. Cap is Capacity. Cnsmp is Consumption.*

4.4 Evaluation of capacity consumption values

Given the current timetable that no stopping or crossing on the line, the whole TPLS has a 70% occupancy rate. With the additional time 43%, it reaches its capacity consumption limitation 100%.

When analyze by LS, the occupancy rate of HTK – PRE and PRE – CHJ LS is 34% and 39% respectively. With additional time 43%, the capacity consumption is 49% and 55% respectively. With additional time 66%, the capacity consumption is 57% and 65% respectively.

4.5 Evaluating available capacity

By UIC 406 definition, there is no available capacity in this TPLS using the current timetable. This is also true calculating with Scott's formula (refer to table 3).

But when analyzed by LS, using additional time 43%, there is an available capacity left. Refer to the occupancy time 559 mins of PRE – CHJ section, the available time that can add the additional train into the timetable is 449 mins as equation 5.

$$(1440\ mins \times 70\%) - 559\ mins = 449\ mins \quad (5)$$

Given the solid available time, this study proposes the simple method to increase the capacity by dividing section into two, let the container freight train to cross at PRE station, instead of driving through it.

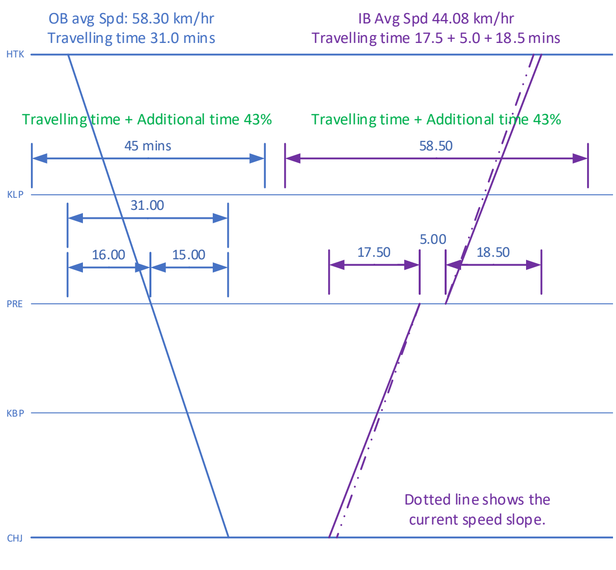

Fig. 7 The representative container freight train model.

Approach to add the additional train is to model each of the representative trains on the line. For this TPLS, there are only 2 train types, container freight train from HTK to CHJ (the long train path) and the commodity freight train from CHJ to PRE (the short train path). The representative container freight train model is as figure 6. The dotted line presents the current average speed slope, 54.67 km./hr. for HTK – PRE LS, 58.52 km./hr. for PRE – CHJ LS.

The representative of an outbound container freight train is using the current train as a model, 31 mins travelling time and no stop at PRE. Average speed is 58.30 km./hr. The inbound representative container freight train will stop at PRE for 5 mins. The average speed of each section is determined to reduce to 50 km./hr. (approximately) compensating the breaking and acceleration at PRE. The travelling time of each LS is as table 5.

The representative of a commodity freight train is using the current train as a model. The travelling time is as table 6.

Table 5 Travelling time of the representative container freight train

Direction	Travelling time HTK – PRE LS (mins)	Dwelling time at PRE (mins)	Travelling time PRE – CHJ LS (mins)	TPLS travelling time (mins)	TPLS avg speed formula	TPLS avg speed (km./hr.)
OB	16.0	0.0	15.0	31.0	$\frac{30.12}{31.0/60}$	58.30
IB	18.5	5.0	17.5	41.0	$\frac{30.12}{41.0/60}$	44.08

Table 6 Travelling time of the representative commodity freight train

Direction	Travelling time HTK – PRE LS (mins)	Dwelling time at PRE (mins)	Travelling time PRE – CHJ LS (mins)	TPLS travelling time (mins)	TPLS avg speed formula	Avg speed (km./hr.)
OB	-	-	16.0	16.0	$\frac{14.63}{16.0/60}$	54.86
IB	-	-	19.0	19.0	$\frac{14.63}{19.0/60}$	46.20

Next process is to add train by its ratio on the line. For this TPLS case, there are 30 long trains and 6 short trains, by principle the insertion to be one short train after every five long trains. Anyway, by the crossing nature of the inbound and outbound long train path, the short train path is scheduled every 3 pair-trains.

Result of adding the representative train to its LS capacity limit and the uncompressed proposed timetable is as figure 7. It has more 18 long and 2 short train paths comparing to the current timetable. The capacity consumption of HTK – PRE and PRE – CHJ LS after an evaluation is 82% and 91% respectively. Hence, the unused capacity of HTK – PRE and PRE – CHJ LS after an evaluation is 18% and 9% as shown in table 7

	HTK - PRE		PRE - CHJ		
831	0:12:30	0:28:30	0:28:30	0:43:30	
	0:49:30	0:31:00	0:26:00	0:08:30	I04
833	1:03:00	1:19:00	1:19:00	1:34:00	
	1:40:00	1:21:30	1:16:30	0:59:00	I05
			2:03:30	1:44:30	506
835	2:19:30	2:35:30	2:35:30	2:50:30	
	2:56:30	2:38:00	2:33:00	2:15:30	I06
837	3:10:00	3:26:00	3:26:00	3:41:00	
	3:47:00	3:28:30	3:23:30	3:06:00	I07
839	4:00:30	4:16:30	4:16:30	4:31:30	
	4:37:30	4:19:00	4:14:00	3:56:30	I08
505			4:42:30	4:58:30	
841	5:15:00	5:31:00	5:31:00	5:46:00	
	5:52:00	5:33:30	5:28:30	5:11:00	I09
843	6:05:30	6:21:30	6:21:30	6:36:30	
	6:42:30	6:24:00	6:19:00	6:01:30	832
845	6:56:00	7:12:00	7:12:00	7:27:00	
	7:33:00	7:14:30	7:09:30	6:52:00	834
			7:56:30	7:37:30	508
847	8:12:30	8:28:30	8:28:30	8:43:30	
	8:49:30	8:31:00	8:26:00	8:08:30	836
849	9:03:00	9:19:00	9:19:00	9:34:00	
	9:40:00	9:21:30	9:16:30	8:59:00	838
851	9:53:30	10:09:30	10:09:30	10:24:30	
	10:30:30	10:12:00	10:07:00	9:49:30	840
507			10:35:30	10:51:30	
853	11:08:00	11:24:00	11:24:00	11:39:00	
	11:45:00	11:26:30	11:21:30	11:04:00	842
855	11:58:30	12:14:30	12:14:30	12:29:30	
	12:35:30	12:17:00	12:12:00	11:54:30	844
857	12:49:00	13:05:00	13:05:00	13:20:00	
	13:26:00	13:07:30	13:02:30	12:45:00	846
			13:49:30	13:30:30	510
859	14:05:30	14:21:30	14:21:30	14:36:30	
	14:42:30	14:24:00	14:19:00	14:01:30	848
O01	14:56:00	15:12:00	15:12:00	15:27:00	
	15:33:00	15:14:30	15:09:30	14:52:00	850
O02	15:46:30	16:02:30	16:02:30	16:17:30	
	16:23:30	16:05:00	16:00:00	15:42:30	852
509			16:28:30	16:44:30	
O03	17:01:00	17:17:00	17:17:00	17:32:00	
	17:38:00	17:19:30	17:14:30	16:57:00	854
O04	17:51:30	18:07:30	18:07:30	18:22:30	
	18:28:30	18:10:00	18:05:00	17:47:30	856
O05	18:42:00	18:58:00	18:58:00	19:13:00	
	19:19:00	19:00:30	18:55:30	18:38:00	858
			19:42:30	19:23:30	CF1
O06	19:58:30	20:14:30	20:14:30	20:29:30	
	20:35:30	20:17:00	20:12:00	19:54:30	860
O07	20:49:00	21:05:00	21:05:00	21:20:00	
	21:26:00	21:07:30	21:02:30	20:45:00	I01
O08	21:39:30	21:55:30	21:55:30	22:10:30	
	22:16:30	21:58:00	21:53:00	21:35:30	I02
CF2			22:21:30	22:37:30	
O09	22:54:00	23:10:00	23:10:00	23:25:00	
	23:31:00	23:12:30	23:07:30	22:50:00	I03

** Legend: O01 – O09 are the added OB container freight train. I01 – I09 are the added IB container freight train. CF1 and CF2 are the added commodity freight train.*

Fig. 8 The proposed timetable (uncompressed).

Table 7 Freight track capacity consumption (after evaluation).

Line Section	Trains in LS	Occ Time (mins)	Occ Time Rate (%)	Add Time 43% (mins)	Cap Cnsmp @43% (%)	Unused Cap (%)
HTK – PRE	48	828	58	355	82	18
PRE – CHJ	54	920	64	394	91	9

** Abbreviation: Occ is Occupancy. Add is Additional. Cap is Capacity. Cnsmp is Consumption.*

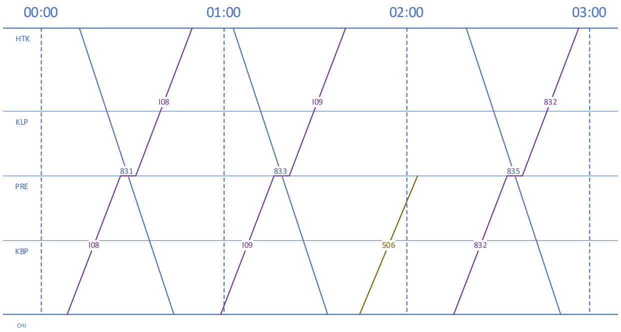

Fig. 9 Train graph of the proposed timetable (part).

Considering the travelling time, the proposed timetable makes an IB trip longer 28% (41 mins) (equation 6) comparing to the current IB travelling time (32 mins). The OB travelling time does not change, 31 mins.

$$9 \text{ mins} \div 32 \text{ mins} = 0.28 \quad (6)$$

Even the inbound travelling time increase by 28% but it is less than a 50% change. Given the number of container freight pair-trains increase from 15 to 24, the overall capacity of TPLS increases, thus this increase in the travelling time is acceptable [14].

5. Discussion

The proposed timetable is on the changing of SRT operation from whole TPLS between HTK – CHJ to 2 line sections. The train will cross at PRE station. This proposal bases on the following rational concepts.

(i) The distance of 2 LSs is almost equal, 15.49 and 14.63 km. Crossing at mid of TPLS (PRE) is optimum.

(ii) SRT already has the crossing facilities e.g. enough length of siding track at PRE.

(iii) SRT has 4 blocks from HTK – CHJ (see section 2.1), that is safe for the single-track operation to cross at PRE. The train will not enter the ahead LS unless the next block is clear to proceed.

The proposed timetable still bases on the current SRT Operating Rule, absolute block.

There are many possibilities to increase the freight traffic capacity in this TPLS, ranging from the infrastructure upgrade, signalling upgrade, to Operation Rule update. More utilization of the outbound passenger track (mid main track) is one of the possibilities. Given the current passenger timetable (Figure 10 left side), the available capacity is 92% and 91% for the OB and IB track (Table 8), respectively. Both passenger tracks are under-utilization.

	HTK - KLP		HTK - KLP					HTK - KLP		HTK - KLP		
			6:25	6:16	384					0:09	0:00	384
275	7:03	7:10					275	0:00	0:07			
			6:59	6:50	372					0:18	0:09	372
			7:35	7:27	388					0:26	0:18	388
997	7:33	7:41					997	0:07	0:15			
283/285	8:14	8:23					283/285	0:15	0:24			
281	8:57	9:05					281	0:24	0:32			
			9:09	9:01	278					0:34	0:26	278
			11:06	10:56	280					0:44	0:34	280
367	11:09	11:17					367	0:32	0:40			
389	13:04	13:10					389	0:40	0:46			
			13:14	13:05	368					0:53	0:44	368
279	13:48	13:54					279	0:46	0:52			
			14:34	14:27	390					1:00	0:53	390
			16:08	16:00	282					1:08	1:00	282
277	16:18	16:23					277	0:52	0:57			
			17:05	16:55	284/286					1:18	1:08	284/286
391	17:53	18:00					391	0:57	1:04			
			18:06	17:59	998					1:25	1:18	998
			18:41	18:33	276					1:33	1:25	276
371	18:42	18:50					371	1:04	1:12			
383	19:24	19:32					383	1:12	1:20			

** Train-pair #283/284 and #285/286 is the same train path. Different in weekday and weekend operation.*

*** Train-pair #997/998 is a special tourism train, operates only weekend.*

**** Left side is the current timetable. The right side is a compressed one.*

Fig. 10 The passenger timetable.

Table 8 Passenger track capacity consumption (HTK – KLP)

Direction	Trains in LS	Occ Time (mins)	Occ Time Rate (%)	Add Time 43% (mins)	Cap Cnsmp @43% (%)	Available Cap (%)
OB	11	80	6	34	8	92
IB	11	93	6	40	9	91

** Abbreviation: Occ is Occupancy. Add is Additional. Cap is Capacity. Cnsmp is Consumption.*

*** HTK – KLP block is the representative of the whole TPLS because of its longest distance.*

5.1 Future Work

Future work is to analyze the next TPLS, between Cha Cheng Sao Junction (CHJ) and Laem Chabang (LCB). It has traffic from both the Northern and Northeastern region. The future work might use the microscopic tool e.g. Railsys to run the stochastic simulation and validate the robustness of the proposed timetable.

The proposed timetable does not include the SRT delay analysis into account but using the legacy 70% track occupancy rate as to be comparable with the issued SRT capacity result. Anyway, the future work might include the analysis of actual SRT delay in this freight corridor.

A junction is normally the major congested location [14]. The 2nd edition of UIC 406 includes the guideline of the station capacity evaluation. So, the capacity evaluation of the major junction like Cha Cheng Sao (CHJ) or Sri Racha (SRC) could be the future work.

The study of the underutilization passenger track of this TPLS for the mixed traffic and study the effect of the ETCS signalling to the capacity might be one of the future works.

6. Conclusions

The UIC 406 approach to compress the timetable, calculate the capacity consumption, and evaluate the possible additional train paths is made on the HTK to CHJ TPLS. The analysis shows the 100% capacity consumption for the whole TPLS but 49% and 55% for each LS (using 43% additional time). The new timetable is proposed by dividing the operation into 2 sections. 18 container freight trains and 2 commodity freight trains were added. The line section capacity consumption after the evaluation process is 82% and 91% respectively.

The UIC 406 methodology is straightforward in calculating track utilization from the compressed timetable. It can use the simple spreadsheet tool in quick macroscopic estimation.

The evaluation in this paper can be used for other SRT rail network, both freight and passenger service. It has equality in the concept of track utilization of Scott's Formula but has a widespread standardization and is adopted worldwide.

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