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Proposed Track Classification for Egyptian Railway Lines

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***Abstract*: The present research paper aims to reclassify the Egyptian Railway Network taking into consideration the safety and economy factors as Egyptian Railway suffers from track maintenance shortage. Lines are classified into several groups depending on dynamic load parameters to facilitate economic studies and comparisons between the worldwide railways.**

Then, discussions of four Railway line classifications are studied as follows:

Theoretical classification of line Sections according to ENR, Actual classification of line sections according to ENR, UIC line classification and proposed classification of line sections for ENR by following the mentioned techniques.

Three objectives are studied to reclassify the Egyptian Railway tracks: determine the traffic loads for all line sections of ENR based on official train schedule for year 2019, the track classification should be continuously defined each year taking the load, train type and the running speed as the main three effective parameters. The present methodology deduce some conclusion and recommendations to ensure both track safety and economical operational.

Keywords* : *Egyptian Railway Network, Theoretical traffic load, Classification.

I. INTRODUCTION

Track maintenance (as compared to vehicle maintenance) is a rather complex activity due to the geographical spread of the asset. Unlike vehicles which can be brought to sheds or other common points for inspection while track inspection repair or data collection requires physical movement of man and material, adding to the cost and time involved in the task [1].

Track maintenance decisively affects both train safety and passenger comfort. Track maintenance expenses represent a significant percentage of total railway network expenses. Egyptian Railway suffers from track maintenance shortage, the following items summarize it:

1. ENR does not possess a software maintenance program at this moment.
2. Regions, districts, zones and sections do not depend on technical base.
3. Track maintenance for single track is treated as that for the double track [2].

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Therefore, it is recommended to reclassify the Egyptian Railway Network taking into consideration the safety and economy factors.

To facilitate economic studies and comparisons between the different railways, lines are classified into several groups depending on the following load parameters: [3]

- The static axle load level, to which the dynamic increment is added, in principle determines the required strength of the track.
- Tonnage borne (sum of the axle loads).
- Running speed.
- The dynamic load component which depends on speed and horizontal and vertical track geometry also plays an essential part here[4]

Consequently, traffic loads are one of the key factors that have a direct bearing on track maintenance.

Various kinds of rail vehicles are running on a railway track such as; passenger cars (coaches), freight cars (wagons), mainline locomotives, and shunting engines. The algebraic sum of the rolling stock loads can't give an accurate picture of the running load, because it does not take into account the way in which the load is applied, the running speed, and so on. Therefore, a complex parameter giving an accurate estimate of the passing traffic load is necessary. Union International de Chemins de Fer, UIC, proposed a method to calculate the theoretical traffic load for this purpose [4].

The most effective factor on the safety of trains is the irregularities in the railway track, which can affect the comfort of passengers. A novel framework has been proposed in order to identify patterns and rules for prediction of track irregularities by using characteristic deterioration of track. The proposed model has been validated using measured data of track irregularity [5].

Machine learning algorithms has been adopted for prognosis and diagnosis of rail defects to help the railway industry in carry out timely responses to failures. The machine learning approaches has been used in different maintenance tasks of railway track. A taxonomy has been provided in order to classify the literature based on the types of methods and data types. A shortcomings of proposed techniques has been presented and discussed [6].

II. STUDY OBJECTIVES

The present paper deals with the following objectives to realize maintenance management system for Egyptian Railway tracks:

1. Determine the traffic loads for all line sections of ENR based on official train schedule for year 2019 [5].

2. The track classification should be continuously defined each year taking the load, train type and the running speed as the main three effective parameters.

III. RAILWAY LINE CLASSIFICATIONS

A. Theoretical ENR Classification

The Egyptian Railway Network is classified into three classes shown in table (I).

Table I: Theoretical ENR classification [7], [8]

Tracks of class	Speed (S) Km/h	daily load (W)1000 tons
I	S >120	W > 40
II	90 < S <120	15 < W < 40
III	S < 90	W < 15

B. Actual ENR Classification

The actual ENR classification does not depend on design speed, track type and traffic volume. It is totally different from the theoretical classification as shown in the table (I). ENR does not apply the last mention classification shown in table (II).

It divides the Egyptian Railway Network into three classes totally different from above-mentioned table.

The following tables show the actual classification which does not depend on design speed, track type and traffic volume.

Table II-a: Actual classification: Class I [7], [8]

Line	Distance		Length			Total Line	Total Tracks	Welded Tracks	Speed km/hr
	from	To	single	double	fourth				
Cairo - Alexandria	0	15			15				90
	15	203		188					140
	203	208			5	208	456	404	105
Cairo - Aswan	0	376		376					120
	376	671		295					120
	671	768		97					110
	768	875		107					110
	875	895		20		895	1790	1750	90
Benha - Port Said	0	114	78	114					110
	114	192				192	306	220	90
Ismalia – Rafah ***	0	100	100			100	100	60	90
Tanta - Mansoura	0	54		54		54	108	93	90
Helwan – Elmarg *	0	42		42		42	84	-	70
ShoubraKema – Giza *	0	23		23		23	46	-	70
Abis - Ras El teen **	0	15		15		15	30	-	70
Total			178	1331	20	1529	2920	2527	

* These lines are considered as metro lines under the supervision of Greater Cairo Underground Metro Authority.
** This line is considered as suburban line.
*** This line was cancelled.

Table II-b: Actual classification: Class II [7], [8]

Line	Distance		Length		Total Line	Total Tracks	Welded Tracks	Speed km/hr
	from	To	single	double				
Nefisha - Suez	0	88		88	88	176	-	70
Tafarou - Souknaa	0	52	52		52	52	-	70
Mansoura - Damitta	0	63	63		63	63	52	90
Zagazig - Tanta	0	30	30				-	60
	30	57	27		57	57	-	70
Embaba - Etay Elbaroud	0	16	16				-	70
	16	120	104		120	120	120	100
SidiGaber - AbouKir	0	17		17	17	34	-	70
Qaluib – Menouf - Tanta	0	59	59				-	90
	59	93	34		93	93	70	70
Ain Shams - Suez	0	128	121	7	128	135	-	90
El wasta – Elfayom – Abu Kash	0	37	37		37	37	-	90
Marg - Shben Kanater	0	21	21		21	21	-	70
Mansoura - Mataria	0	70	70		70	70	-	60
Mamoura - Rasheed	14	66	52		52	52	-	70
Total			686	112	798	910	242	

Table II-c: Actual classification: Class III [7], [8]

Line	Distance		Length		Total Line	Total Tracks	Welded Tracks	Speed km/hr
	from	To	single	double				
Qaluib - Zagazig	0	63	63		63	63	56	90
Zagazig - Mansoura	0	69	69	-	69	69	65	90
Desouk - Metoubes	0	27	27		27	27	-	40
Abou Kiber - Salheya	0	18	18				-	60
	18	34	34		34	34	-	70
Benha – Zefta - Meet Gamr	0	32	32		32	32	-	70
Fakous - Samanaa	0	10	10		10	10	-	70
Nazlet Elshawesh – Manshyt Abd Elsamad***	0	12	12		12	12	-	15
Beni Swief – Elshon***	0	25	25		25	25	-	40
Menouf - Zayat	0	49	49		49	49	-	60
Benha - Menouf	0	25	25		25	25	-	60
Santaa - Mahalet Rouh	0	19	19		19	19	-	65
Iron Ore	0	15	15		15	15	-	40
Industrial line	0	7	7		7	7	-	40
Mahalet Rouh - Damanhour	0	74	74		74	74	25	90
Qabary - Mstrouh	0	296	281	15	296	311	-	90
Sherbeen - Qaleen	0	81	81		81	81	-	70
Kafr Battekh - Damitta Port	0	20	20		20	20	-	70
Kafr Saad - Faraskour	0	3	3		3	3	-	25
El Bosely – Metoubes – El Qasaby	0	14	14				-	40
	14	29	15		29	29	-	55
Mgarat - Geesh	0	8	8		8	8	-	40
Abssia - Toraa	0	20	20		20	20	-	40
Samala - Saloum	0	261	261		261	261	-	40
Etehad – Mena Alexandria	0	108	108		108	108	-	40
Qena – Abo Tartor	0	451	451		451	451	270	60
Qena – Safaga Line***	0	235	235		235	235	230	60
El Kharga - Paris	0	42	42		42	42	-	60
El Wahat El Bharia Line	0	346	346		346	346	346	60
Shark Port Saeid***	0	30	30		30	30	-	60
Total			2376	15	2391	2406	992	

*** These lines were cancelled.

The classification is fixed yearly regardless the traffic, load and speed change. Calculations are made by hand. A software program does not exist. The classes are defined for 6236 km of tracks of the network and cover 48 routes, corresponding to complete corridors. No distinction is made, if sections within these corridors belong to a higher or lower class (speed differences or load differences). No distinction is made between both tracks of the same corridor for double track lines.

C. UIC Line Classification

The UIC classification is based on 6 groups, according to the value of their theoretical traffic (T_f). The following formula is internationally accepted and is defined on the basis of the theoretical traffic load conforming UIC 714 leaflet[3]

$$T_f = S_v \cdot (T_v + K_t \cdot T_{tv}) + S_m \cdot (K_m \cdot T_m + K_t \cdot T_{tm})$$

Where, (T_f): theoretical traffic per ton per day

The following three parameters are the most effective ones.

First parameter: (the load)

T_v: The mean daily passenger tonnage in gross tons hauled.

T_m: The mean daily freight tonnage in gross tons hauled.

T_{tv}: The mean daily tonnage of tractive units used in passenger traffic, in tons.

T_{tm}: The mean daily tonnage of tractive units in freight traffic, in tons.

Second parameter: (train type)

K_m: A coefficient allowing both for the influence of the load and wear effect of freight bogies, which normally corresponds to the following value:

- 1.15 for tracks handling heavy loads.
- 1.30 for traffic based primarily on 20 t axle loads (>50 % of traffic) or for a significant portion of traffic with 22.5 t axle load (> 25 % of traffic)
- 1.45 for traffic based primarily on 22.5 t axle load (> 50 % of traffic) or for traffic largely consisting of 20 t or heavier axle loads (> 75 % of traffic)

K_t: a coefficient equal to 1.40 that takes into account the traction motor axle wear factor.

Third parameter: (running speed)

S_v and S_m: coefficients which take into account train running speeds as shown in table (III).

S_v relates to the speed of the fastest passenger train on the section.

S_m relates to the speed of ordinary freight trains.

Table III: Speed Coefficients S_v and S_m According to the Running Speed

S_v	1	1.05	1.15	1.25	1.35	1.4	1.45	1.5
S_m	1	1.05	1.15	1.25	-	-	-	-
Speed(Km/hr)	S<60	60<S<80	80<S<100	100<S<130	130<S<160	160<S<200	200<S<250	250<S

Table IV: UIC Classification Group According to Theoretical Traffic (T_f)

Group	1	2	3	4	5	6
T_f (1000t/d)	$130 < T_f$	$80 < T_f \le 130$	$40 < T_f \le 80$	$20 < T_f \le 40$	$5 < T_f \le 20$	$T_f \le 5$

D. Proposed Classification of Line Sections to be Applied on ENR

In order to dispose of a work tool that is internationally accepted and that allows to compare data and statistics of ENR with the same data and statistics of other railway companies, a proposed classification can be adapted for the existing system similar to the UIC 714 leaflet.

The proposed classification should take into consideration the theoretical traffic on ENR network which has smaller range than that of UIC one to ensure uniformly distribution. The lines shall be classified into 3 groups, according to (T_f * Length) as shown in table (V)

Table V: Proposed Classification Group According to Theoretical Traffic (T_f)

Group	1	2	3
T_f * Length (1000t.km/d)	4.1< T_f * Length * 10^6	4.1< T_f * Length * $10^6 \le 0.70$	T_f * Length* $10^6 \le 0.70$

E. Calculations of Theoretical Traffic (T_f) based on ENR Official train Schedule on Year 2019

ENR divides its networks into 12 regions, 24 districts and 72 zones according to the geographical organization for maintenance and renewal purposes while it divides the network into 48 line sections for traffic and operating purpose. Table (VI) summarizes ENR network according to line sections and the corresponding running speed, track type, line length, daily passenger traffic (N_p), number of cars per passenger train (n_{cp}), average passenger car weight (w_{cp}), average passenger locomotive weight (w_{lp}) daily freight traffic (N_f), number of cars per freight train (n_{cf}), average freight car weight (w_{cf}) and average freight locomotive weight (w_{lf}).

Table VI: Theoretical traffic (T_f) for ENR (Based on Official Train Schedule on 2019)

Line Section	Speed	Type	Length	S_v	N	n	w	T_v	K_t	T_{tv}	S_m	K_m	N	n	w	T_m	T_{tm}	T_f	Tf * Length	Tf * Length /million
Cairo - Alexandria	140	Double	208	1.35	65	12	50	39000	1.4	6500	1.25	1.3	27	25	60	40500	2700	135473	28178384	28.178384
Cairo - Asiut	120	Double	376	1.25	39	14	50	27300	1.4	3900	1.15	1.15	12	25	60	18000	1200	66687	25074312	25.074312
Asiut - Luxor	120	Double	295	1.25	36	14	50	25200	1.4	3600	1.15	1.3	12	25	60	18000	1200	66642	19659390	19.65939
Luxor - Edfo	110	Double	97	1.25	21	14	50	14700	1.4	2100	1.15	1.3	12	25	60	18000	1200	50892	4936524	4.936524
Edfo - Aswan	110	Double	107	1.25	26	14	50	18200	1.4	2600	1.15	1.3	10	25	60	15000	1000	51335	5492845	5.492845
Aswan - El Sad El Ali	90	Double	20	1.15	13	14	50	9100	1.4	1300	1.05	1	0	25	60	0	0	12558	251160	0.25116
Benha - Ismailia	110	Double	114	1.25	31	12	50	18600	1.4	3100	1.15	1.45	30	25	60	45000	3000	108543	12373902	12.373902
Ismailia - Port Said	90	Single	78	1.15	24	12	50	14400	1.4	2400	1.05	1.45	22	25	60	33000	2200	73901	5764278	5.764278
Tanta - Mansoura	90	Double	54	1.15	28	10	50	14000	1.4	2800	1.05	1.3	9	25	60	13500	900	40359	2179386	2.179386
Nefisha - Suez	70	Double	88	1.05	13	10	50	6500	1.4	1300	1	1.45	20	25	60	30000	2000	55036	4843168	4.843168
Tafaroa - Soukhna	70	Single	52	1.05	0	8	50	0	1.4	0	1.05	1.45	16	25	60	24000	1600	38892	2022384	2.022384
Mansoura - Damietta	90	Single	63	1.15	30	12	50	18000	1.4	3000	1.05	1.3	25	25	60	37500	2500	80393	5064727.5	5.0647275
Zagazig - Zefta	60	Single	30	1	24	10	50	12000	1.4	2400	1	1.3	8	25	60	12000	800	32080	962400	0.9624
Zefta - Tanta	70	Single	27	1.05	29	10	50	14500	1.4	2900	1	1.15	8	25	60	12000	800	34408	929016	0.929016
Embaba - Elmanashy	70	Single	16	1.05	36	12	50	21600	1.4	3600	1	1.3	31	25	60	46500	3100	92762	1484192	1.484192
Elmanashy - Etay Elbaroud	100	Single	114	1.15	38	12	50	22800	1.4	3800	1.05	1.3	32	25	60	48000	3200	102562	11692068	11.692068
SidiGaber - AboudKir	70	Double	17	1.05	74	10	50	37000	1.4	7400	1	1.15	3	25	60	4500	300	55323	940491	0.940491
Qaliub - Menouf	90	Single	59	1.15	44	10	50	22000	1.4	4400	1.05	1.15	4	25	60	6000	400	40217	2372803	2.372803
Menouf - Tanta	70	Single	34	1.05	35	10	50	17500	1.4	3500	1	1.15	4	25	60	6000	400	30980	1053320	1.05332
Ain Shams - Suez	90	Single	128	1.15	22	10	50	11000	1.4	2200	1.05	1.3	8	25	60	12000	800	33748	4319744	4.319744
El wasta - Elfayom - Abu Kash	90	Single	37	1.15	22	10	50	11000	1.4	2200	1.05	1.3	8	25	60	12000	800	33748	1248676	1.248676
Marg - Shben Kanater	70	Single	21	1.05	46	10	50	23000	1.4	4600	1	1.15	12	25	60	18000	1200	53292	1119132	1.119132
Mansoura - Mataria	60	Single	70	1	18	10	50	9000	1.4	1800	1	1	0	25	60	0	0	11520	806400	0.8064
Mansoura - Rasheed	70	Single	52	1.05	26	10	50	13000	1.4	2600	1	1.3	9	25	60	13500	900	36282	1886664	1.886664
Qaliub - Zagazig	90	Single	63	1.15	33	10	50	16500	1.4	3300	1.05	1.3	28	25	60	42000	2800	85734	5401242	5.401242
Zagazig - Mansoura	90	Single	69	1.15	35	10	50	17500	1.4	3500	1.05	1.3	15	25	60	22500	1500	58678	4048747.5	4.0487475
Desouk - Metoubes	40	Single	27	1	10	10	50	5000	1.4	1000	1	1.3	8	25	60	12000	800	23120	624240	0.62424
Abou Kiber - Fakous	60	Single	18	1	24	10	50	12000	1.4	2400	1	1	0	25	60	0	0	15360	276480	0.27648
Fakous - Salheya	70	Single	16	1.05	22	10	50	11000	1.4	2200	1	1	0	25	60	0	0	14784	236544	0.236544
Benha - Zefta - Meet Gamr	70	Single	32	1.05	22	10	50	11000	1.4	2200	1	1	0	25	60	0	0	14784	473088	0.473088
Fakous - Samaana	70	Single	10	1.05	14	10	50	7000	1.4	1400	1	1	0	25	60	0	0	9408	94080	0.09408
Menouf - Zayat	60	Single	49	1	22	8	50	8800	1.4	2200	1	1	0	25	60	0	0	11880	582120	0.58212
Benha - Menouf	60	Single	25	1	26	8	50	10400	1.4	2600	1	1	0	25	60	0	0	14040	351000	0.351
Santaa - Mahalet Rouh	65	Single	19	1.05	22	8	50	8800	1.4	2200	1	1	2	25	60	3000	200	15754	299326	0.299326
Mahalet Rouh - Damanhour	90	Single	74	1.15	53	10	50	26500	1.4	5300	1.05	1.15	11	25	60	16500	1100	60549	4480607.5	4.4806075
Qabary - Matrouh	90	Single	296	1.15	25	10	50	12500	1.4	2500	1.05	1.3	11	25	60	16500	1100	42540	12591692	12.591692
Sherbeen - Qaleen	70	Single	81	1.05	36	10	50	18000	1.4	3600	1	1.15	4	25	60	6000	400	31652	2563812	2.563812
Kafr Batekh - Damietta Port	70	Single	20	1.05	29	8	50	11600	1.4	2900	1	1.3	13	25	60	19500	1300	43613	872260	0.87226
Kafr Saad - Faraskour	25	Single	3	1	21	6	50	6300	1.4	2100	1	1.15	2	25	60	3000	200	12970	38910	0.03891
El Bosely - Metoubes	40	Single	14	1	18	8	50	7200	1.4	1800	1	1	0	25	60	0	0	9720	136080	0.13608
Metoubes - El Qasaby	55	Single	15	1	10	8	50	4000	1.4	1000	1	1	0	25	60	0	0	5400	81000	0.081
Mgarar - Gersh	40	Single	8	1	3	6	50	900	1.4	300	1	1	0	25	60	0	0	1320	10560	0.01056
Abnia - Torra	40	Single	20	1	3	6	50	900	1.4	300	1	1.45	8	25	60	12000	800	19840	396800	0.3968
Samala - Salouni	40	Single	261	1	2	8	50	800	1.4	200	1	1.45	2	25	60	3000	200	5710	1490310	1.49031
Dehad - Mena Alexandria	40	Single	108	1	0	8	50	0	1.4	0	1	1.45	24	25	60	36000	2400	55560	6000480	6.00048
Qena - Abo Tartor	60	Single	451	1	2	8	50	800	1.4	200	1	1	0	25	60	0	0	1080	487080	0.48708
El Kharga - Paris	60	Single	42	1	3	8	50	1200	1.4	300	1	1	0	25	60	0	0	1620	68040	0.06804
El Wahat El Baharia Line	60	Single	346	1	0	8	50	0	1.4	0	1	1.45	10	25	60	15000	1000	23150	8009900	8.0099

F. Classification According to Actual ENR, Theoretical ENR, UIC Line and Proposed Line.

The four classifications can be summarized as shown in table VII, and the difference between Actual ENR classification and Theoretical ENR classification has been shown in figure 1. Also, the difference between UIC line classification and proposed line classification has been shown in figure 2.

Table VII: Comparison between the Classifications According to: Actual ENR, Theoretical ENR, UIC Line and Proposed Line classification

Line Section	Speed	Type	Length	Tf	Tf* Length *million	Actual ENR class	Theoritical ENR class	UIC Line class	Proposed Line class
Cairo - Alexandria	140	Double	208	135473	28.17828	1	1	1	1*
Cairo - Assuit	120	Double	376	66687	25.074312	1	1	3	1
Assuit - Luxor	120	Double	295	66642	19.65939	1	1	3	1
Luxor - Edfo	110	Double	97	50892	4.936524	1	2	3	1
Edfo - Aswan	110	Double	107	51335	5.492845	1	2	3	1
Aswan - El Sad El Ali	90	Double	20	12558	0.25116	1	3	5	3
Benha - Ismalia	110	Double	114	108543	12.373845	1	2	2	1*
Ismalia - Port Said	90	Single	78	73901	5.764239	1	2	3	1*
Tanta - Mansoura	90	Double	54	40359	2.179359	1	2	3	2*
Nefisha - Suez	70	Double	88	55036	4.843168	2	3	3	1*
Tafarou - Soukaaa	70	Single	52	38892	2.022384	2	3	4	2*
Mansoura - Damitta	90	Single	63	80393	5.0647275	2	2	2	1*
Zagazig - Zefta	60	Single	30	32080	0.9624	2	3	4	2*
Zefta - Tanta	70	Single	27	34408	0.929016	2	3	4	2*
Embaba - Elmanashy	70	Single	16	92762	1.484192	2	3	2	2
Elmanashy - Etay Elbaroud	100	Single	114	102562	11.692068	2	2	2	1
SidiGaber - AbouKir	70	Double	17	55323	0.940491	2	3	3	2*
Qaliub – Menouf	90	Single	59	40217	2.372803	2	2	3	2*
Menouf - Tanta	70	Single	34	30980	1.05332	2	3	4	2*
Ain Shams - Suez	90	Single	128	33748	4.319744	2	2	4	1
El wasta – Elfayom – Abu Kash	90	Single	37	33748	1.248676	2	2	4	2
Marg - Shben Kanater	70	Single	21	53292	1.119132	2	3	3	2
Mamoura - Mataria	60	Single	70	11520	0.8064	2	3	5	2*
Mamoura - Rasheed	70	Single	52	36282	1.886664	2	3	4	2*
Qaliub - Zagazig	90	Single	63	85734	5.401242	3	2	2	1*
Zagazig - Mansoura	90	Single	69	58678	4.0487475	3	2	3	2*
Desouk - Metoubes	40	Single	27	23120	0.62424	3	3	4	3*
Abou Kiber - Fakous	60	Single	18	15360	0.27648	3	3	5	3*
Fakous - Salheya	70	Single	16	14784	0.236544	3	3	5	3*
Benha – Zefta - Meet Gamr	70	Single	32	14784	0.473088	3	3	5	3*
Fakous - Samanaa	70	Single	10	9408	0.09408	3	3	5	3*
Menouf - Zayat	60	Single	49	11880	0.58212	3	3	5	3*
Benha - Menouf	60	Single	25	14040	0.351	3	3	5	3*
Santaa - Mahalet Rouh	65	Single	19	15754	0.299326	3	3	5	3*
Mahalet Rouh - Damanhour	90	Single	74	60549	4.4806075	3	2	3	1*
Qabary - Matrouh	90	Single	296	42540	12.591692	3	2	3	1*
Shebeen - Qaleen	70	Single	81	31652	2.563812	3	3	4	2*
Kafr Battekh - Damitta Port	70	Single	20	43613	0.87226	3	3	3	2*
Kafr Saad - Farask our	25	Single	3	12970	0.03891	3	3	5	3*
El Bosely – Metoubes	40	Single	14	9720	0.13608	3	3	5	3*
Metoubes – El Qasaby	55	Single	15	5400	0.081	3	3	5	3*
Mgarar - Geeih	40	Single	8	1320	0.01056	3	3	6	3
Abasia - Toraa	40	Single	20	19840	0.3968	3	3	5	3
Samala - Saloum	40	Single	261	5710	1.49031	3	3	5	2*
Etehad – Mena Alexandria	40	Single	108	55560	6.00048	3	3	3	1*
Qena – Abo Tartor	60	Single	451	1080	0.48708	3	3	6	3
El Kharga - Paris	60	Single	42	1620	0.06804	3	3	6	3
El Wahat El Baharia Line	60	Single	346	23150	8.0099	3	3	4	1*

*Lines belong to Lower Egyptian Railway Network and Ports.

From the above-mentioned table VII, one concludes that there are no correlations between the four classifications that is due to unscientific base on which the classifications are adapted. On the other hand, the proposed classification takes into consideration the main three effective parameters: the load, train type and the running speed as well as the practical and special operational conditions for ENR.

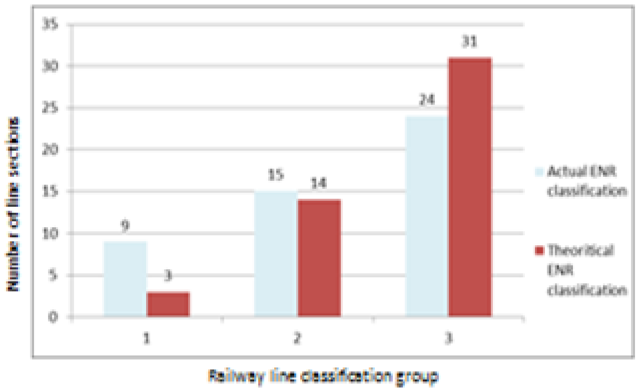


Figure 1: Difference between actual and theoretical ENR classification

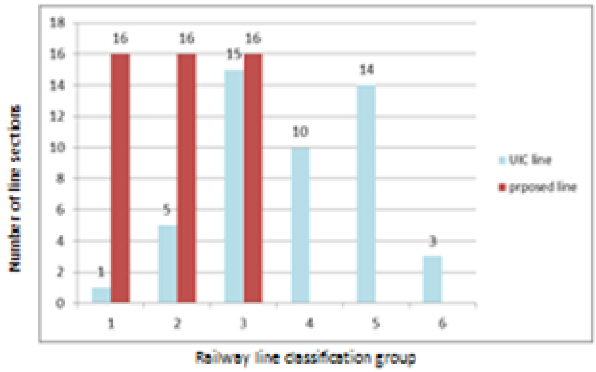


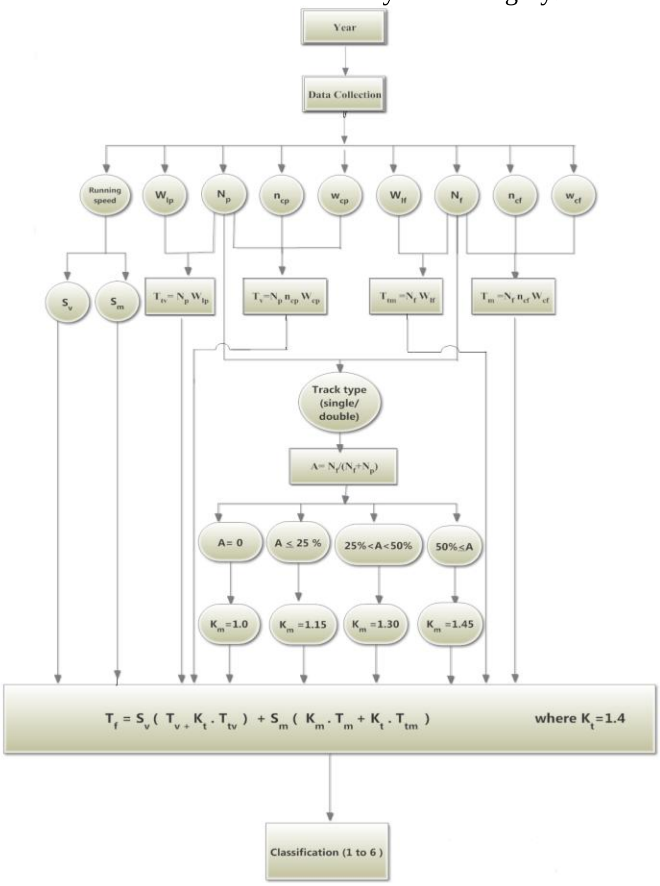
Figure 2: Difference between UIC and proposed line classification

From the above two figures, one concludes that there are no correlations between the four classifications that is due to unscientific base on which the classifications are adapted. On the other hand, the proposed classification takes into consideration the main three effective parameters: the load, train type and the running speed as well as the practical and special operational conditions for ENR.

Note:

1. The proposed classification is considered to be uniformly distributed to ensure the lines shall be classified into 6 groups, according to (T_f).
2. This classification should be varied from year to year according to the load, train type and the running speed as the main three effective parameters.

Figure 3 shows the flow chart of the proposed track classification for ENR which classify track category.



IV. CONCLUSIONS AND RECOMMENDATIONS

1. According to the comparison of the four classifications (theoretical ENR, actual ENR, UIC line and proposed of track sections to be applied on ENR for year 2019), The statistical analysis shows that the classifications of the above-mentioned categories are totally different as shown in the two following examples:
   * Aswan - El Sad El Ali line section has classified as first, third, fifth and third respectively
   * Qaluib – Zagazig line section has classified as third, second, second and first respectively
2. The present methodology reveals the following recommendations to ensure both track safety and economic operation.

a) It is recommended to relate the required traffic volume and time with the available budget.

b) The line operational capacity according to the proposed classification

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