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DEFECTS of ENGLISH RAILWAY STATISTICS.

By SIR JULAND DANVERS, K.C.S.I., *the Public Works Secretary at the India Office, and Government Director of the Indian Railway Companies.*

[Read before the Royal Statistical Society, 20th December, 1887.
Dr. T. GRAHAM BALFOUR, F.R.S., a Vice-President, in the Chair.]

IT is, I presume, one of the functions of this Society not only to receive, collect, and disseminate information of a statistical character which is of public utility, but also to endeavour to obtain, whether from the departments of the State or from bodies intrusted with interests of a national character, returns which convey as complete and accurate an account as possible of the matters to which they relate.

My object in bringing this subject forward is to endeavour, through the medium and the influence of the Statistical Society, to induce the railway companies of this country, who are certainly intrusted with interests which affect alike the capitalist, the merchant, the agriculturist, and the general community, to supply a defect in their statistical returns of railway working in order that a more safe and reliable guide for purposes of efficient and economical management than is now given may be provided. The present returns defeat one of the objects of statistics, which is to draw comparisons between facts derived from similar sources and systems, and to establish sound principles of administration.

I may say at once that great credit must be given to the directors and managers for the high condition to which they have brought the railway service in this country. It is wonderful to think what private enterprise has done! Without State aid, and in spite of opposing forces of various kinds, a network of railways has been spread over the country at an enormous expense; and in working them speed, safety, comfort, and convenience have been secured to a degree which has not been reached in any other country. This state of things has no doubt been arrived at by slow

degrees, and competition, or the fear of competition, has aided it. Development has by no means been systematic. Progress has been fitful and spasmodic, according to local requirements and the amount of money available for investment. Most of our early arrangements connected with the regulation, the dimensions, and equipment of railways were governed in a great measure by accidental circumstances. We adopted the 4 feet $8\frac{1}{2}$ inch gauge because it happened to have been applied to road vehicles and to tramways. We adapted the style and character of the old stage coach to the first class passenger vehicles. For some time the third class remained without covering. And yet through the genius of our engineers and the organizing powers of our business men, we have done great things, and we have now arrived at a high pitch of efficiency. But the account of how the railways are worked is imperfect, and the advantage to be derived from a public knowledge of it is wanting. There are certainly indications that of late years economy has been more closely studied than formerly. During the depression of trade which prevailed between 1876 and 1879, railway management received more attention than had probably ever been paid to it before. Just as when the coal famine in 1873 forced consumers to think how they could economise fuel, so when railway dividends were threatened, railway expenditure attracted notice. The results were, reduced working expenses and a check on the diminution of dividends. One form which economy took was, as Sir Bernhard Samuelson describes it, "a more intimate fusion of "the interests of the various railways, either by amalgamation or "by consolidation of their interests;" but, so far as one can judge, no attempt was made to investigate the real sources of waste and expenditure. One of the most interesting problems of the present day is how a railway can be most economically and efficiently worked, and what furnishes the best basis for charges to the public. For its solution the cost of service is an essential factor. Now this factor cannot be ascertained without carefully recorded statistics, showing not merely how many passengers are booked and how many tons of goods are lifted—facts which are available on all railways—but the distances they are transported. In other words, we ought to have the total unit mileages under both coaching and merchandise—the two heads to one or other of which all service must be referred—1 passenger carried 1 mile being the passenger unit, and 1 ton carried 1 mile being the unit of other coaching and of goods traffic. With these data, and with proper rules for the classification of expenses, and for the division between coaching and merchandise of such of those expenses as are common to both, we should be in a position to arrive at the average cost of carrying a passenger and a ton of goods 1 mile, respectively. Such data are

not available for any railway in the United Kingdom. The train mile is not an appropriate unit, for though it may be reduced to an average under both coaching and merchandise for every separate railway, there can be no comparison of working on such a basis, as the constitution of the trains may vary with the circumstances of each line, as well with the skill with which each line is worked. Moreover, as the passenger and the ton are the units of charge to the public, we ought to have the cost of performing the service on like units.

It was my duty for many years to prepare an annual report on Indian railways, showing their progress and the results of working. For some time I was obliged to be content with the usual returns of gross receipts and expenses, the number of train miles run, the number of passengers booked, the number of tons lifted, and the receipts and expenses per train mile. But the results attainable from these data were obviously unsatisfactory. In 1870 Mr., now Sir Alexander Rendel, with whom I had been in constant communication on the subject, brought me the result of discussions which he had with General Richard Strachey in India, in the shape of a statement showing that he had worked out the average receipts and expenses per passenger, and per ton of goods, per mile. An examination of the process of arriving at the figures showed that, although it might be open to criticism, it would serve most useful, economic, and administrative purposes. Averages are of course liable to be inexact, but the question for solution is not one calling for absolute precision. It is more one of approximating sufficiently near for all practical objects to a result in connection with an unexceptionable unit. Ever since that time this information has appeared in the statistical returns of all Indian railways; and I have no hesitation in saying that it furnishes the only sound basis on which economical management can be tested, and that it has been most usefully applied in a great number of cases. The same information is included in colonial and continental railway returns, and is given in a most complete form in American railway statistics; but it is studiously excluded from the accounts of English railways. The attempt to draw comparisons between the working of English and other lines is thus baffled, and the means of obtaining reliable results are withheld.

Some people have been profane enough to indulge in the remark that there is nothing so deceptive as facts and figures. This is certainly true of facts which are not truths, and of figures which profess to give what they do not accomplish. The English railway returns do not, as I have said, go beyond giving the receipts and expenses per train mile; and these afford no real criterion of good or bad working arrangements. Economical management consists

in keeping down the train mileage and keeping up the train loads. The proportion of train miles run to the length of a line is no test of the work done. The train mileage may show a low figure of cost, but if more trains are run than are necessary, the resulting low rate per train mile conveys an altogether erroneous idea of the economy with which the traffic is conducted. Again, a train mile is variable in its meaning: whereas what is required to be of value is a constant unit with a defined meaning. The limited information given by the English companies is thus calculated to mislead.

There is scarcely a single person who has undertaken to investigate the working of railways in various countries, who has not expressed regret that the British returns do not express the work performed in terms of the number of passengers and tons of goods carried one mile. In every annual report issued by the Board of Trade the absence of this information is lamented. "Unfortunately "it is impossible," say Mr. Calcraft and Mr. Giffen in 1884, "to show what is the receipt per ton per mile, which would indicate "decisively whether more business is being done at a cheaper "rate." In previous and subsequent reports the same desideratum is alluded to. The department of the State which is charged with the preparation and publication of statistical facts relating to the various industries of the country, thus acknowledges its inability to perform its duty in regard to one of the most important national institutions, because essential information for the purpose is withheld by those who could supply it. This has given rise to the suspicion that the railway companies are interested in keeping it back, whereas its production would serve their best interests.

In December last year Mr. Jeans read a valuable paper to this Society "On the Cost and the Conditions of Working Railway "Traffic in Different Countries." It contained many interesting and carefully prepared calculations and statements, but he could not arrive at any satisfactory conclusions in regard to the working of lines in this country. In one place he is "confounded by the "extent of the variations that occur on various lines." In another he observes, "these differences are not explained by the not "unnatural variations in the character of the traffic." "The "information given is not such as will enable an inquirer to detect "where the management is defective. The train mileage returns "will not do so, the ton miles would." "In Great Britain," he adds, "the railways, whether by accident or by design, have "hitherto contrived to make it impossible for the public to discover "the average charges for the transport of either the one or the "other for any one railway, or for the country as a whole. The "missing link in the chain of evidence—a link which is not

“ withheld in any leading country except our own—is the number
“ of passengers and the number of tons of goods and mineral
“ traffic transported one mile.”

Mr. Jeans's paper was followed by the publication of his excellent work entitled “*Railway Problems*,” every chapter of which points to the need of the adoption of these units. And so say all other railway economists who have examined the subject. Mr. Price Williams and Mr. Conder, both eminent railway statisticians, in this country; Mr. F. Haggard, who has written much on railway working, and the American statisticians, Dorsey and Poor especially, join the chorus of complaint. Why then is the information not given? Why are figures only furnished which afford no safe guide of economic working? The proportion of working expenses to receipts is of no use for the purpose. The cost of working per mile of railway affords no criterion. The cost per train mile does not, for the lower that cost, the greater may be the extravagance. The cost per vehicle cannot.

So far as I can ascertain them, the chief objections on the part of English railway managers are: (1) that it is difficult, if not impossible, to obtain the information with sufficient accuracy, and (2) that if obtained it would be of no practical use.

In answer to both these objections I would refer to those countries, especially America and India, where the information is without much difficulty supplied, and where it is found to be of the greatest service in ascertaining where economy and good management is needed, and in determining rates and fares which shall be alike profitable to the railways and advantageous to the customer.

I admit that in this country the labour and trouble in giving the passenger and ton miles would be greater than in India; but the machinery for preparing statistics is so perfect, that this difficulty should be easily overcome, and the result would fully compensate for any extra expense.

In America the difficulty is as great as here, and yet the figures are not only given for each line as a whole, but for each of its parts. The late lamented Mr. Grierson, in his able treatise on railway administration, entitled “*Railway Rates, English and Foreign*,” objected to any attempt being made to show the cost of carrying a passenger or a ton 1 mile, because it could not be obtained with sufficient accuracy to justify its application in determining rates. One of his arguments was that the cost of conveyance bears no relation to the value of goods. This may be so, but it does not interfere with my point, viz., that the knowledge of the *average* cost of carrying a passenger, and a ton of goods 1 mile, must be of the greatest use in determining the rates to be charged for such units.

It is recognised as a rule of management that goods of a valuable description may properly be charged higher rates than goods of an inferior value. The actual cost of conveyance may or may not be more, but risks are incurred, and extra care is bestowed upon them which justify the higher rate; on the other hand, charges for staple commodities may be lower than the average cost of transport and yet be remunerative. It is contended that the aim of railway companies should be to charge what the traffic will bear; and this was explained by Mr. Grierson as "only another way of saying" that rates should be so fixed as to enable a manufacturer or a trader and the railway company to obtain a reasonable profit, "and that rates should ultimately be determined by the law of supply and demand."

What does this mean? Can a rate which shall give a reasonable profit to trader and railway company be ascertained by the law of supply and demand? I do not think it would be found practicable. If the supply be more than the demand is the charge to be increased, and if less is it to be reduced? A railway charge may to a certain extent be likened to a tax: it must be paid whether convenient or not. We see the effect of a tax upon an article of general consumption. The tax is high: the supply of the article remains the same, but the demand is diminished in consequence of the tax. Lower the tax, the price is less. The consumer immediately takes advantage of the reduced price; and demand and supply increase simultaneously. So it is with railway charges: rates and fares are reduced, and the number of passengers and the quantity of goods increase at once. But both had to bear the higher rates which existed before, and the customer and the railway suffered accordingly.

If it had not been for competition in this country, and for the interference of Parliament in fixing maximum rates, it is impossible to say what the charges would have been. Even now, being determined not with reference to the cost of transport, but according to what the traffic will bear, an undue charge is in the absence of competition often persisted in, and both railway and customer suffer, the one by a restricted traffic and less profits, the other by raising the price of his goods in the market. But if in most cases competition is the governing factor in the matter, it is important, if not necessary, to know what the cost of service is, or as it may be termed the cost of production. Otherwise a ruinous competition may be carried on, and goods may be carried at a loss. The transport of goods, and the conveyance of passengers from one place to another, may be regarded in the light of a purchasable commodity. The price of the service rendered is expressed by the charge; and whether the vehicle be a wagon drawn by

horses on the high road, a ship on the ocean, a ferry across a river, or a carriage on a first class railway, the exchange value, *i.e.*, the money given for the work done, must in a great measure depend upon the cost of production. Sir Rowland Hill, when once describing his reflections on the question of reforming Post Office charges, said, "Before making up my mind as to what "simplification of arrangement and reduction of charge were "practicable, I set myself to analyse carefully each item of cost in "the service performed by the Post Office as regarded letters "committed to its charge. In the course of the investigation I "found that the chief items of cost were what I might call the "terminal services, *i.e.*, those of collection and delivery;" and he came to the conclusion that many more letters could be conveyed at the same cost as was then incurred, and that if only numbers were sufficiently increased, a lower rate of postage would cover expenses and produce a profit. The principle is the same in respect to railway traffic. By ascertaining the unit cost as near as practicable, means are provided for quoting a rate with some pretension to knowledge as to what margin is left for profit.

The following tables show the cost of carrying a ton and a passenger 1 mile, and the receipts from each, on several Indian railways; and illustrate clearly that low rates are not incompatible with high profits. Shareholders, on whose account high rates are so often excused and advocated, would suffer if the rates which produce the results here given were raised. It will also be seen how deceptive the train mileage returns may be. Taking the goods traffic, the railway for instance (the Rajputana-Malwa) which appears to work at the lowest rate according to the expenditure per train mile, is the fourth on the list when the expenses are analysed by the ton mile expenditure; and the East Indian Railway, which conveys 1 ton per mile at the lowest cost, is third according to the train mileage return.

First Half of 1886.

Railways.	GOODS TRAFFIC.											
	Number of Train-Miles.	Average Number of Tons in a Train.	Per Train-Mile.				Number of Ton-Miles.	Per Ton-Mile.				
			Total Earnings.	Working Expenses.	Comparison of Expenses on the Different Railways (the lowest taken as 100).	Net Earnings.		Total Earnings.	Working Expenses.	Comparison of Expenses on the Different Railways (the lowest taken as 100).	Net Earnings.	
BROAD GAUGE.												
East Indian.....	3,111,280	186·01	5·72	2·09	131	3·63	578,714,181	5·90	2·16	100	3·74	
North-Western	2,059,237	120·50	4·41	2·26	141	2·15	248,291,001	7·03	3·61	167	3·42	
Eastern Bengal	233,188	118·50	4·71	3·86	241	0·85	27,514,166	7·63	6·26	290	1·37	
Madras	644,754	85·30	3·45	2·22	139	1·23	54,997,385	7·76	5·00	231	2·76	
Great Indian Peninsula	3,393,926	120·28	5·48	2·22	139	3·26	408,211,624	8·75	3·55	164	5·20	
Bombay and Baroda ...	768,285	178·87	7·50	2·84	178	4·66	137,422,362	8·05	3·05	141	5·00	
Oude and Rohilkund ...	543,478	156·51	3·86	2·14	134	1·72	85,060,695	4·73	2·62	121	2·11	
METRE GAUGE.												
Rajputana-Malwa	2,048,590	77·70	3·29	1·60	100	1·69	182,981,197	7·07	3·43	159	3·64	
Burma	210,051	84·41	3·97	2·41	251	1·56	17,730,882	9·04	5·48	254	3·56	
South Indian	524,448	54·20	2·14	1·69	106	0·45	28,426,955	7·59	5·98	277	1·61	

TABLE B.

	BROAD GAUGE.			
	East Indian.			Great
	1877.	1882.	1886.	1877.
Mean mileage worked(miles)	1,503	1,506½	1,712·67	1,268½
Average number of passengers in a train ...	237	259·35	247·50	222
" tons of goods in a train(tons)	135·5	165·91	188·87	85
Average number of passengers per vehicle	14	15·36	15·58	15
" tons of goods per wagon(tons)	4·52	5·65	5·66	3·51
Number of passengers carried 1 mile.....	627,117,403	778,988,659	914,214,793	344,400,000
" tons of goods carried 1 mile	841,308,637	1,003,429,077	1,061,229,793	562,158,600
Average sum received for carrying a passenger one mile.....	Pies 3·29	Pies 2·88	Pies 2·71	Pies 3·26
Average cost of carrying a passenger 1 mile	" 1·09	" 0·83	" 0·82	" 1·66
" profit on carrying a passenger 1 mile	" 2·20	" 2·05	" 1·89	" 1·60
Average sum received for carrying 1 ton of goods 1 mile	" 7·13	" 6·26	" 5·85	" 8·75
Average cost of carrying 1 ton of goods 1 mile	" 1·90	" 2·42	" 2·15	" 4·32
Average profit on carrying 1 ton of goods 1 mile	" 5·23	" 3·84	" 3·70	" 4·43

Note—It should be explained that the figures given for the year 1877 were arrived at by and that the statements for the other years are made under the new formula explained in

First Half of 1886.

COACHING TRAFFIC.											Railways.
Number of Train-Miles.	Average Number of Passengers in a Train.	Per Train-Mile.				Number of Passenger-Miles.	Per Passenger-Mile.				
		Total Earnings.	Working Expenses.	Comparison of Expenses on the Different Railways (the lowest taken as 100).	Net Earnings.		Total Earnings.	Working Expenses.	Comparison of Expenses on the Different Railways (the lowest taken as 100).	Net Earnings.	
		Rs.	Rs.		Rs.		Pies.	Pies.		Pies.	
1,823,161	356·59	4·13	1·19	127	2·94	467,824,984	2·70	0·80	101	1·90	
1,098,089	259·09	3·86	1·54	164	2·32	284,499,678	2·50	1·00	127	1·50	
287,735	226·83	3·56	2·08	221	1·48	65,266,175	2·68	1·43	181	1·25	
457,601	279·75	3·50	1·62	172	1·88	128,012,715	2·06	0·96	122	1·10	
1,382,685	168·21	2·87	1·31	139	1·56	232,583,281	2·71	1·11	141	1·60	
481,168	273·02	4·17	1·28	136	2·89	131,369,300	2·63	0·81	103	1·82	
569,514	166·68	2·43	1·06	113	1·37	94,924,370	2·61	1·09	138	1·52	
985,349	208·75	2·64	0·94	100	1·70	205,690,541	2·15	0·79	100	1·36	
258,046	152·38	2·63	1·50	160	1·13	39,330,272	3·10	1·75	222	1·35	
425,616	265·31	3·00	1·65	175	1·35	112,937,234	2·07	1·03	130	1·04	
BROAD GAUGE.											
East Indian											
North-Western											
Eastern Bengal											
Madras											
Great Indian Peninsula											
Bombay and Baroda											
Oude and Rohilkund											
METRE GAUGE.											
Rajputana-Malwa											
Burma											
South Indian											

TABLE B.

BROAD GAUGE.					METRE GAUGE.		
Indian Peninsula.		Bombay and Baroda.			Rajputana-Malwa.		
1882.	1886.	1877.	1882.	1886.	1877.	1882.	1886.
1,446 $\frac{3}{4}$	1,501 $\frac{1}{4}$	443 $\frac{1}{2}$	458 $\frac{1}{2}$	461	396	1,115 $\frac{1}{2}$	1475
145·54	163·40	279	249·59	258·47	202	188·95	208·16
97·96	118·62	123·5	147·48	177·24	62	60·93	87·07
12·13	12·57	30	16·39	19·72	12·32	13·99	16·56
4·08	4·57	2·91	4·14	4·21	2·59	2·86	3·45
370,659,387	459,383,213	143,251,300	209,686,200	252,680,806	82,772,400	301,826,920	415,455,232
545,028,710	687,763,372	85,760,420	135,414,841	231,253,935	26,922,142	130,807,716	332,726,651
Pies 3·07	Pies 2·72	Pies 3·21	Pies 2·72	Pies 2·64	Pies 2·08	Pies 2·16	Pies 2·15
„ 1·41	„ 1·39	„ 1·53	„ 1·41	„ 0·95	„ 1·98	„ 1·19	„ 0·88
„ 1·66	„ 1·33	„ 1·68	„ 1·31	„ 1·69	„ 0·10	„ 0·97	„ 1·27
„ 9·70	„ 8·65	„ 10·73	„ 9·43	„ 7·79	„ 12·22	„ 10·29	„ 6·94
„ 4·64	„ 3·86	„ 3·45	„ 4·73	„ 3·27	„ 6·46	„ 5·32	„ 3·77
„ 5·06	„ 4·79	„ 7·28	„ 4·70	„ 4·52	„ 5·76	„ 4·97	„ 3·17

Sir A. M. Rendel according to an equal division of expenses between goods and passengers, the paper.

If more economy is now exercised on Indian railways, it is in a great measure due to the returns of traffic, together with an analysis rendered week by week and half-year by half-year by every railway administration in that country. Economical results may, I admit, be also partially accounted for by the increase of traffic, by competition, and by a suitable division of railway systems, but it is chiefly due to an increase of the train loads, and a proportionate reduction in the train mileage; in other words, to a better management of the traffic. The returns just referred to revealed a waste of power and of vehicle space which was not before realised. The forms of these statements are appended. In this country the high authority (Mr. Grierson) I have already referred to acknowledges that "wagons containing only a small quantity of goods are often sent long distances at little profit if not at a loss. Goods trains are run at an excessive speed, and therefore do not and cannot carry such remunerative loads as in other countries, notwithstanding some of the undoubtedly low rates charged there. So-called concessions not really essential are made to trading and other interests, when it would be better that the companies should earn on the traffic a reasonable income to go into the pockets of the shareholders, or be expended as suggested by Sir Bernhard Samuelson, in improved accommodation." All this is attributed to undue competition; but, whatever the cause, stronger testimony could scarcely be borne to the present unscientific plan of working pursued in this country: a system which necessarily entails severe loss upon the shareholder, and adds to the charge upon the customer.

I may be told that the proposal to obtain the cost of service, and to make it the basis of measures of economy and of charges, has been already considered and discarded, and that a committee of the House of Commons in 1872 pronounced it to be impracticable; I am not, I think, wanting in respect to a committee of the House of Commons if I question its infallibility. Committees have frequently changed their opinion on railway administration, and the legislature itself has from time to time altered its decisions. Besides, within the last fifteen years much has been done in improving railway statistics; and it is not likely, with the actual proof before them of the information being now obtained and published in other countries, that a committee of the House of Commons would declare it to be impracticable. Difficulties have been made by the excessive zeal of those objectors who to cast ridicule on the movement endeavour to point out the inutility of attempting to obtain perfect accuracy. "Will those," we are asked, "who talk about cost of service, reveal the formula by

“ which they can accurately calculate the cost of carriage of a particular article carried in the same truck with a dozen others, all coming from different places and destined for different stations over three or four different lines, the cost of no two of which has been the same, and the working expenses of which are totally dissimilar?” Such refinement of investigation even if possible would be very troublesome, and is unnecessary for practical purposes. We go further, and admit that approximation only is possible. But we contend that the approximation capable of being arrived at is invaluable. The formula that has for some years been in use for Indian railways was not adopted without much consideration and discussion, and the method has been varied as experience was gained. A chief difficulty in a satisfactory analysis is the apportionment of the expenses between the goods and passenger services; but the difficulty is common to any system which seeks to discriminate between the two, and no system is worth attention that does not. It was originally assumed by Sir A. Rendel for his calculations that a passenger and goods train cost the same per train mile run. In working the system out in India, however, the expenses of the different departments, maintenance, locomotive, &c., were apportioned on different bases considered more correct, and the detailed analyses were for many years prepared accordingly. In the year 1880 a committee of experts was appointed in India to consider the matter, and the conclusion they came to was that division should be made in the ratio of the gross¹ ton miles for coaching and goods respectively, the expenses of maintenance, of the locomotive department, of carriages and wagons, of traffic, of general superintendence and miscellaneous charges being treated alike. By dividing the whole working expenses between the different descriptions of traffic in proportion to the gross ton mileage performed for each, an approximately correct statement of the cost of working each description of traffic is arrived at. It is then a simple matter to calculate the unit cost.

It will probably be said that these various modes of attempting to attain the nearest approximation to absolute correctness prove the difficulty of obtaining the desired unit cost in this country. But surely it will not be contended that they are difficulties which cannot be overcome, and which it is worth some trouble to overcome. In Sir Bernhard Samuelson's valuable report to the President of the Association of the Chambers of Commerce of the United Kingdom, on the railway goods tariffs of Germany, Belgium, and Holland, compared with those of this country, he pronounces

¹ That is the freight and the dead weight, including engines, tenders, and brake vans.

this opinion, after a most careful investigation of the systems pursued in those countries: "The traffic in commodities in the countries of the north of Europe, which compete with us for the trade of the world, is carried on under rates founded on intelligible principles, and not, as is frequently the case in this country, on the hap-hazard estimate by traffic managers of what the traffic will bear." This points to a question of vital interest to this country, and in these days of intense and universal competition between the different countries of the world and our own, should not be neglected by our railway administrators. I do not contend that rates should be based *only* on the cost of service, but that cost of service, whether ascertained or not, must be one of the most important elements in the charge which may properly be made, and therefore that it is important to ascertain what it is, and then to use it as a guide, just as I have before observed the cost of production must influence prices in every transaction of commerce. The knowledge of what the cost is should, as regards railways, prevent undue competition, should assist in the judicious application of rates to different classes of goods and passengers, and enable useful comparisons to be made between different railways for the mutual benefit of each.

It may now be useful to compare, by way of illustration, the working results of different lines. While doing so I am not unmindful of the fact that conditions of traffic and of working vary considerably in different countries, and on different railways; that, for example, the leads in some are much longer than in others; that the price of labour, of fuel, and of materials is greater in some than in others; that the alignment is more or less favourable, that the articles conveyed also are different, some requiring more care and involving more risk than others; but in the main, comparisons of average working may be justly made on the passenger and ton mile basis, and an opinion may be fairly formed of the economy of working and success of management by means of this information.

The railways to which the tables appended relate, are characteristic examples of fully developed systems in India on the 5 feet 6 inches, and the metre, gauges.

Taking the most important of these lines, viz., the East Indian, it will be found on examination that last year 914,214,793 passengers of all classes were carried 1 mile at a cost of 292,834*l.*; that 1,061,229,793 tons of goods and minerals were carried 1 mile at a cost of 891,267*l.*; and that this traffic was conveyed in 56,013 passenger trains, running 3,693,753 miles, and in 27,141 goods trains, running 5,618,799 miles. Thus each passenger was conveyed at the cost of about 0.82 pie, or, at the present rate of

exchange of 1s. 6d. the rupee, a little more than three-tenths of a farthing per mile, at a profit of about seven-tenths of a farthing, being 230 per cent. on the cost; and each ton was carried at the cost of 2.15 pies or about eight-tenths of a farthing, at a profit of one and four-tenths of a farthing, being 175 per cent. on the cost.²

When, by means of these returns, it was found that there was waste in the train miles run and in the train loads, measures were taken to prevent the extravagance. The number of wagons in a train was increased, and the load in each wagon was made greater. The consequence has been that the average loads by train and by vehicle have been larger. Economy has been secured, and the public have benefited: for the railway authorities found that it was expedient and desirable to reduce rates. This has provoked more traffic, and brought larger profits. The usual rate for a third class passenger is now 2 pies, or about three-quarters of a farthing per mile, and it appears by the last report that reductions to $1\frac{3}{4}$ pies, and $1\frac{1}{2}$ pies on some lines, has resulted in a considerable increase in the number of passengers, with a satisfactory improvement in receipts. The first and second classes scarcely yield a profit: so that the average cost arrived at is higher than that at which the bulk of the passenger traffic is worked, the proportion of the lowest class carried being about 97 per cent. of the whole. The same remark applies equally to goods. The lowest rates for staples such as grain, seeds, and salt, are from $\frac{1}{2}$ d. to $\frac{1}{3}$ d., per ton per mile. I believe that for economy of working and for lowness of charges the Indian railways will compare favourably with railways in any other part of the world.

I would now only remark in conclusion that the problems involved in railway management are not only very interesting, but are intimately connected with the welfare and prosperity of a country. Economy is of the first importance both for the shareholders and the public; extravagant management and high rates go together, and both are opposed to the interests of all concerned. Any one item of information that leads to a clear issue is valuable, and should be welcomed. It may seem a small matter, and some may think that its importance has been exaggerated; but if it could be the means of reducing expenditure and of placing rates and fares upon a better footing, the benefit would soon be felt, and the legitimate claims of the public would be met. The question is apart from that of equal mileage rates or differential rates. These are matters of principle in connection with management, and the knowledge of the cost of service would no doubt assist in facilitating such arrangements. Nor would it interfere with that

² These calculations have been made at the exchange of 1s. 6d. the rupee.

1886.

Pro- gres- sive Num- ber.	Headings.	Broad Gauge.			
		East Indian. ^b	North- Western. ^c	Eastern Bengal.	Madras.
1	Miles open on 31st Dec., 1886 Miles	1,723·17	1,850·78	233·69	860·38
1A	Mean mileage worked during } the year }	1,712·67	1,863·78	233·69	860·38
2	Total capital outlayRs.	37,08,95,711	29,40,97,667	5,02,19,726	11,59,31,134
3	„ per mile open ^a „	2,10,903	1,58,280	2,04,971	1,31,086
4	Coaching receipts „	1,47,40,607	83,40,511	19,34,753	33,27,011
5	Goods receipts „	3,23,39,405	1,62,80,663	28,78,183	44,57,841
6	Gross earnings „	4,79,87,847	2,53,04,949	52,03,359	79,66,098
7	Working expenses „	1,66,55,524	1,33,39,242	32,24,406	47,36,854
8	Ditto per cent. of gross receipts.....	34·71	52·71	61·97	59·46
9	Net earningsRs.	3,13,32,323	1,19,65,607	19,78,953	32,29,244
10	Ditto per cent. on capital outlay.....	8·45	4·7	3·94	2·79
11	Ditto ditto on paid-up capital	—	—	—	2·78
12	Passenger train-miles No.	3,693,753	2,242,185	594,270	973,753
13	Goods train-miles..... „	5,618,799	3,807,938	528,803	1,299,320
14	Total „ „	9,312,552	6,050,123	1,123,073	2,273,073
15	Coaching receipts per passen- } ger train-mile } Rs.	3·99	3·72	3·26	3·42
16	Goods receipts per goods train- } mile } „	5·76	4·28	5·44	3·43
17	Gross earnings per train-mile „	5·15	4·18	4·63	3·50
18	Working expenses per train-mile „	1·79	2·21	2·87	2·08
19	Net earnings per train-mile „	3·36	1·97	1·76	1·42
20	Average number of passengers in } a passenger train }	247·50	248·26	204·60	285·39
21	Average number of tons in a goods } train }	188·87	127·19	116·66	85·84
	Average number of vehicles (ex- cluding brake-vans)—				
22	In each passenger train	15·88	15·30	14·53	15·08
23	„ goods train	33·34	27·01	32·66	20·47
24	In each { Passenger carriages	15·79	10·75	9·97	7·17
	mixed mile { Goods vehicles	3·62	7·68	5·32	12·35
25	Number of passengers carried 1 mile	914,214,793	556,646,049	121,585,796	277,898,184
26	„ tons of goods carried } 1 mile..... }	1,061,229,793	484,332,584	61,689,166	111,539,083
	Average cost of hauling for 1 mile—				
27	One passenger unit Pies.	0·82	1·18	1·42	0·97
28	„ ton of goods „	2·15	3·57	5·94	5·13
	Average sum received for carrying for 1 mile—				
29	One passenger unit Pies.	2·71	2·53	2·71	1·96
30	„ ton of goods „	5·85	6·45	8·96	7·67

^a Excluding steamer service and suspense accounts.

^b Includes the branch lines worked by the East Indian Railway Company.

^c Includes the Amritsar-Pathankot Railway, except in items 2, 3, 9, and 10.

^d Includes rent of leased line (Rs. 56,052).

* Includes the Bhopal-Itarsi, Dhond-Manmád and Berar State Railways, except in items 2, 3, 9, 10, and 11.

1886.

Broad Gauge.			Metre Gauge.			
Great Indian Peninsula. ^a	Bombay, Baroda, and Central India. ^a	Oudh and Rohilkhand.	Rajputana-Malwa. ¹	Southern Mahratta.	Burma.	South Indian. ^j
1,504'75	461'00	686'54	1,664'42	476'50	327'00	662'00
1,501'23	461'00	681'48	1,475'01	341'37	327'00	662'00
26,94,17,522	9,35,35,807	8,27,96,821	12,80,59,507	3,66,01,346	2,85,59,214	4,67,57,701
2,02,995	1,97,147	1,16,367	74,342	71,729	85,310	67,945
78,85,564	38,86,050	26,85,513	52,44,152	5,39,366	13,93,744	25,64,140
3,09,98,367	93,81,161	34,09,992	1,20,33,740	10,66,965	12,10,786	23,35,149
3,92,57,906	1,35,05,635	65,05,408	1,74,57,146	16,34,918	26,57,955	49,35,618
1,82,50,182 ^f	55,52,879	36,44,653	87,76,027	11,41,593	17,14,684	34,44,262
46'49	41'12	56'02	50'27	69'83	64'51	69'78
2,10,07,724	79,52,756	28,60,755	86,81,119	4,93,325	8,43,271	14,91,356
7'80	8'58	3'46	6'80	1'35	3'30	3'16
7'90	8'64 ^h	3'25	—	0'91	—	3'14
2,811,418	977,611	1,007,622	1,995,864	204,542	516,579	850,364
57,99,745	1,304,715	1,058,870	3,821,213	495,091	316,335	1,088,873
8,611,163	2,282,326	2,066,492	5,817,077	699,633	832,914	1,939,237
2'80	3'98	2'66	2'63	2'64	2'70	3'02
5'34	7'19	3'22	3'15	2'16	3'83	2'14
4'56	5'92	3'14	3'00	2'3	3'19	2'55
2'21	2'43	1'76	1'51	1'6	2'06	1'78
2'44	3'49	1'38	1'49	0'71	1'13	0'77
163'40	258'47	182'63	208'16	176'82	152'53	266'85
118'62	177'24	133'18	87'07	49'19	84'62	54'69
13'00	13'10	14'53	12'57	14'91	17'69	13'23
26'00	42'09	25'26	25'27	21'62	29'12	12'51
7'00	8'00	} 17'33 {	12'24	7'69	12'20	11'71
8'00	16'98		8'38	7'43	21'33	12'42
459,383,213	252,680,806	184,024,196	415,455,232	36,167,416	78,795,506	226,919,207
687,963,372	231,253,989	141,019,833	332,726,651	24,355,434	26,766,716	59,552,470
1'39	0'95	1'13	0'88	1'73	1'87	1'06
3'86	3'27	2'99	3'77	6'21	5'83	6'16
2'72	2'64	2'62	2'15	2'63	3'11	2'07
8'65	7'79	4'64	6'94	8'41	8'69	5'53

^f Includes rent of leased lines (Rs. 3,54,907), but excludes Rs. 12,415, being charges incurred direct by the State on the Dhond-Manmád Railway.

^a Includes the Pátri branch, except in items 10 and 11.

^h Deducting Rs. 39,765 for interest on overdrawn capital from the net earnings, the percentage on the paid-up capital will be 8'60 per cent.

¹ Includes the figures of the Cawnpore-Achnera for the last three months of 1886.

^j Includes the Pondicherry Railway, except in items 2, 3, 10, and 11.

elasticity of management and the proper discrimination as to charges which is so desirable for accommodating the circumstances of traffic.

I hope I have shown good reason for pressing that the imperfections in the statistical returns obtained from the railway companies in this country should be remedied. I trust that any objection on the part of the companies to supply what is required will be removed, and that, at any rate, the Council of this Society will feel it right to exercise its influence with Her Majesty's Government to require that in any future railway Bill powers should be given to the Board of Trade to call upon the railway companies of this country to render such statistical returns as may be considered desirable in the public interests.

General Results of Working Indian Railways.

	1884.	1885.	1886.
Mean mileage open for traffic	11,114.37	12,091.27	12,548.83
Number of passengers carried	73,815,119	80,864,779	88,436,318
„ tons of goods moved	16,663,007	18,925,385	19,576,365
Passenger unit miles	3,355,746,323	3,640,337,596	3,894,076,609
Ton mileage of goods	2,761,518,023	3,319,574,447	3,388,606,208
Train-miles	39,606,785	45,422,502	45,475,834
Gross receipts Rs.	15,97,63,256	17,88,05,185	18,58,41,170
Working expenses „	8,06,26,463	8,77,01,962	8,84,22,951
Net receipts „	7,91,36,793	9,11,03,223	9,24,18,219

APPENDIX.

*Form of Audited Return of Traffic and Mileage for the Week ending
, 1887.*

RECEIPTS.

Description of Traffic.	Week ending		1887.	
	1886.	1887.	Increase.	Decrease.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.
COACHING TRAFFIC.				
1st class passengers				
2nd "				
Intermediate class passengers				
3rd class passengers				
Passengers' luggage				
Military baggage				
Ordinary carriages, horses, dogs, &c.				
Military " "				
Parcels				
Special trains				
Mails —				
Haulage and hire of post office vehicles				
Special trains				
Parcels				
Miscellaneous				
Total				
Less outstandings irrecoverable....				
Total coaching receipts				
GOODS TRAFFIC.				
Merchandise, general				
Military stores				
Railway materials for construction				
Coal—				
For the public				
For the railway (construction only)				
For locomotive department (revenue only)				
For other departments (revenue only) ..				
Revenue stores—				
For all departments, excepting coal and locomotive fuel.....				
Wood and patent fuel for locomotive department				
Live stock—				
Ordinary				
Military				
Rents and demurrage, wharfage, storage, &c.				
Interest on outstanding bills				
Miscellaneous				
Total				
Less outstandings irrecoverable....				
Total goods receipts.....				

*Form of Audited Return of Traffic and Mileage—Contd.*RECEIPTS—*Contd.*

Description of Traffic.	Week ending		1887.	
	1886.	1887.	Increase.	Decrease.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.
SUNDRY TRAFFIC.				
Electric telegraph (for private messages)				
Hire of locomotives and mileage, demur- rage, and hire of vehicles—				
Coaching				
Goods				
Rent of stations, &c., jointly occupied....				
Clearing accounts with other lines				
Soane Bridge tolls				
Tonse Bridge and Jumna Bridge tolls, Allahabad.....				
Jumna Bridge tolls, Delhi				
More Bridge tolls.....				
Rent				
Profits of workshops for work done for other railways, &c.				
Sale of unclaimed and damaged goods				
Unpaid or unclaimed salaries.....				
Excess cash				
Ferry receipts for crossing passengers when Hooghly Bridge is closed.....				
Miscellaneous minor receipts.....				
Fees on transfers of annuities, &c.				
Receipts from N.-W.S. Railway for use of the line between Ghāziabad and Delhi				
Deposits of periodical ticket holders for- feited.....				
Receipts from branch lines for use of rolling stock				
Sale of revenue stores				
Steamboat earnings.....				
Proportion of charges on goods over Shalimar branch				
Total				
Less outstanding irrecoverable...				
Total sundry receipts				
Total for the week				
Amount for previous seven weeks of half-year				
Total for eight weeks				
Average receipts per week for eight weeks				
Receipts per mile open, weeks ending and				
Average receipts per mile open per week for eight weeks				
Receipts per train mile, weeks ending and				
Average receipts per train mile for eight weeks				

*Form of Audited Return of Traffic and Mileage—Contd.***MILEAGE—Contd.***Number of Passengers, and Weight of Luggage, Parcels, Merchandise, Coal, and Railway Materials Conveyed.*

Description.	Week ending		1887.	
	1886.	1887.	Increase.	Decrease.
1st class passengers				
2nd „				
Intermediate class passengers				
3rd class passengers				
Total number of passengers				
Luggage	Tons. cwt.	Tons. cwt.	Tons. cwt.	Tons. cwt.
Parcels				
Merchandise, general				
Military stores				
Railway materials for construction				
Coal—				
For the public				
„ the railway (construction only) ...				
„ locomotive depart. (revenue only)				
„ other departments („)				
Revenue stores—				
For all departments, excepting coal }				
and locomotive fuel..... }				
Wood and patent fuel for loco. depart.				
Total				

Passenger Mileage and Ton Mileage of Luggage, Parcels, and Goods Conveyed.

1st class passengers				
2nd „				
Intermediate class passengers				
3rd class passengers				
Total				
Luggage				
Parcels				
Merchandise, general				
Military stores				
Railway materials for construction				
Coal—				
For the public				
„ the railway (construction only) ...				
„ locomotive depart. (revenue only)				
„ other departments („)				
Revenue stores—				
For all departments, excepting coal }				
and locomotive fuel..... }				
Wood and patent fuel for loco. depart.				
Total				

Form of Analysis of Traffic for Week ending

, 1887.

Coaching Traffic.		Goods Traffic.	
Receipts from passenger traffic £		Receipts from goods traffic..... £	
Passenger train-miles run No.		Goods train-miles run..... No.	
Average passenger train-mile receipts } s.		Average goods train-mile receipts..... } s.	
Number of passengers carried 1 mile } No.		Tons of goods carried 1 mile, including live stock, &c. } No.	
Average sum received for carrying a passenger (taking all classes together) 1 mile } d.		Average sum received for carrying 1 ton (taking all classes together) 1 mile } d.	
Average number of passengers in a train at any one time } No.		Average number of tons in a goods train at any one time.. } No.	
Average number of passenger trains per diem each way, supposing each train to traverse the whole line open } "		Average number of goods trains per diem each way supposing each train to run over the whole line open } "	
Average number of passengers passing over each mile of line daily (both ways)..... } "		Average number of tons of goods passing over each mile of line daily (both ways)..... } "	

Note.—The passenger mileage is taken at the result given by dividing the earnings of each class by the rate per mile, and adding thereto the receipts from parcels, luggage, &c., converted into passenger miles by dividing them by the average rate obtained from passengers.

Passenger Unit Mileage and Ton Mileage of Luggage, Parcels, and Goods Conveyed.

Passenger.		Description.	Goods.		
Description.	Unit Mileage.		Up.	Down.	Total.
1st class		Merchandise, general			
2nd „		Railway materials for construction }			
3rd „		Revenue stores..... }			
Coolie class		„ coal			
Total		Total			
Nos. Tons.					
Luggage					
Parcels		Live stock, &c.		Total	

Chief Auditor's Office,

DISCUSSION *on* SIR JULAND DANVERS'S PAPER.

MR. G. BADEN-POWELL, M.P., was specially pleased to be able to say a few words on the paper, to which they had all listened with such interest, because it was one of special value to Members of Parliament personally, seeing that one of the great tasks for next session would be the discussion of the Railway Rates Bill. He congratulated the Society on having placed before Parliament such an excellent example of practical analysis of railway returns as was found in the appendix to the paper. If, as the author had stated, the railways of the United Kingdom in speed, safety, comfort, and convenience, were far above the railways of any other country, they must, he thought, be far advanced on the road to perfection. But he noticed one great omission; nothing was said as to the cheapness of carriage either for passengers or goods, which from a consumer's point of view he took to be one of the most important elements in the railway question. But then although they were told that the railways in England were so excellent in their management in many points, they were also told that there were no data available from any railway in the kingdom which could supply the real facts that would enable Parliament to legislate in defence either of vested interests, or of the consumer. He was perhaps rather vain to find so high an authority as Sir Juland Danvers backing up some remarks that he (Mr. Baden-Powell) and others had made last December concerning Mr. Jeans's paper,—to the effect that in England there was really no available statistical knowledge of railways to go upon. Nevertheless, the unfortunate House of Commons next session had to legislate on railways, and in the absence of sufficient information. He therefore hoped that Sir Juland Danvers's paper would rouse the public, whether interested as consumers or shareholders in railways, to provide Parliament with that amount of information which was absolutely essential to proper legislation. It would be seen from the records and the tables, that Indian railways under the skilled charge of Sir Juland Danvers and his colleagues, as many of them knew who had invested in them, had developed an amount of economy which was eminently satisfactory. While thanking the author for his valuable paper, he would add that he thought government would be exercising a very wise discretion if they at once entrusted that gentleman with the task of providing Parliament with information on British railways such as he had given in his paper with regard to Indian railways.

MR. CHARLES R. HAIG wished to make a remark on one branch of statistical railway returns which during the present agitation for free trade came somewhat nearly home to those who were engaged in commerce. Those who had observed the controversies that had been raised on the subject of the competition with the foreigner, would know that through rates were given to foreign goods imported into this country, concealing of course the rate which was actually charged for the carriage over the English lines; and

if what was proposed by the author would lead to the publication by the railways of statistics which would enable them to judge what was charged for the foreign goods, it would no doubt lead to a better state of things with regard to those matters. He might best illustrate what he meant by stating what had come within his own knowledge as a wine and spirit merchant. In sending thirty cases of bottled wine from Calais to London the goods were shipped from Calais, carried by the steamer, unshipped, handled at Dover, put on the train, sent up to London, and delivered within town limits for 6*d.* a case. If those thirty cases were sent from London to Dover the cost would be at least 8*d.* That was only an example of a multitude of through rates, concealing a preferential protection of foreign goods. A case had recently come under his notice in which a gentleman, wishing to send wheat to London from Liverpool, actually shipped it to New York, and had it shipped back by steamer on the through rate, going over exactly the same line to London as it would have travelled had it only been sent from Liverpool. It was most desirable, he submitted, at this crisis when questions of fair trade were being discussed, to see that corporations such as railways, to whom special privileges, parliamentary charters, and monopolies had been granted, should not at the expense of the English producer protect the foreign producer. Undoubtedly, if the proposals of the author were properly carried out they would lead to a better knowledge of railway rates, and more particularly of those through rates in which the protection of foreign interest was concealed.

Mr. PRICE-WILLIAMS, M.Inst.C.E., said letters had been read from the chairman of the London and North Western Railway Company expressive of their regret at not being able to be present this evening; he shared that regret, and had hoped that the general managers of some of their great railway systems might have been present to give them the benefit of their views in regard to the admirable paper which had just been read; he doubted whether any valid argument could be adduced against the soundness of the views so ably advocated by the author of the paper; but if there were, he trusted they would be brought forward now and thoroughly discussed before the meeting closed. As a railway man himself, he could only say he entirely endorsed the views of Sir Juland Danvers; views which in fact for many years past he had been endeavouring to enforce in season and out of season, as much in the interest he considered of the railway companies as of the public, by trying to induce the leading railway authorities to furnish the data in their half-yearly reports advocated by the author of the paper. The ton per mile and passenger mile unit had, as the author stated, already been adopted on the Indian, American, New Zealand, and other railways, and he considered that until this unit was given for the railways in the United Kingdom, it would be impossible to determine with anything approaching to accuracy the cost of working the different classes of traffic; he had adopted a different and more detailed method than that applied in the case of the Indian railways, viz., the respective ratios of the ton per mile and the passenger mile unit; but failing a better it

afforded, in his opinion, a reliable means of very closely determining separately what the actual cost of transferring a ton of goods per mile and a passenger per mile was. He had recently made an analysis of the working expenses of the principal railways in this country, notably in the case of the London and North Western and Great Northern Railways. Through the kindness of Mr. Findlay, the general manager of the first named company, in allowing him access to the earlier half-yearly reports and other valuable data, he had been enabled to prepare a tabular statement of the receipts and expenses per passenger, the receipts and expenses per ton per mile of the goods traffic and of the mineral traffic separately, from 1860 down to the present time; and with the kind assistance of Mr. Oakley, the general manager of the Great Northern Railway, he had prepared a similar analysis of the receipts and working expenses of that railway, and inasmuch as these were based chiefly upon the companies, half-yearly reports, he thought there would be no objection to his presenting them to the Society. His mode of apportioning the expenses between the different classes of traffic was, as he had already observed, much more detailed, and certainly had not the same advantage of simplicity as that adopted by Sir J. Danvers in the case of the Indian railways. The railway companies in this country had admittedly all the data at hand to enable the working expenses of the different classes of traffic to be accurately apportioned, not merely for the whole line, but on the different sections. Whatever slight error there might be in his own system of apportioning the working expenses, the results he had arrived at in the case of the London and North Western Railway during the long period between 1860 and 1885 were, as Mr. Findlay had admitted, reliable for the purposes of comparing one year with another, the errors in the system of apportionment being common in all cases. During his recent visit to New Zealand, through the kindness of the government railway authorities there, he had been afforded the opportunity of examining the greater part of the railways in both islands, and had also been furnished with copies of the admirable system of railway accounts which had been introduced by the general manager, Mr. Maxwell, M.Inst.C.E. The mileage of the New Zealand railways was almost exactly the same as that of the London and North Western, and he might add that in addition to adoption of the ton per mile and passenger mile unit, the traffic receipts and cost of working was given separately on different sections of the railways in both islands. The importance of this, where the gradients on some sections were much heavier than on others, would at once be realised, when he mentioned the fact that the tractive power of an engine up a comparatively easy gradient of 1 in 264 was only just half what it was on the level, or in other words the same engine with the same expenditure of power was capable of hauling twice the load on the level that it could do on that gradient. The ruling gradients on these heavy sections of the New Zealand railways was 1 in 50, where it should be remembered an engine can only haul about one-seventh of the load it could draw on the level. The cost of working these heavy

grades he was glad to find was separately given, and as might be expected there was a great difference in the cost of working, and mainly due to the large consumption of fuel. The cost of fuel only on the Great Northern Railway constitutes more than one-fourth of the total locomotive expenses.¹ In addition to this there is of course the extra wear and tear of the machines and permanent way on these steep gradients. All these facts should be taken into account by railway companies in determining the traffic rates on different portions of their systems. There was another important matter he had carefully considered in allocating the cost of working the different classes of railway traffic, and that was the return empty mileage, which amounted in the case of the minerals to as much as 90 per cent., and to 10 per cent. in the case of goods traffic. He might further mention that notwithstanding this large amount of unprofitable mileage, the total mineral traffic working expenses per ton per mile on the London and North Western Railway for the year 1884 amounted on an average to only 0·1687*d.*, and the gross receipts to 0·4224*d.* per ton per mile; while the mineral traffic expenses on the Great Northern Railway for the same period were 0·1386*d.*, or just about one-seventh of a penny per ton per mile, and the gross receipts to 0·2791*d.*, or somewhere between a farthing and a third of a penny per ton per mile, showing a net profit of 320,359*l.*, or over 50 per cent. on a total of 4,875,795 tons of coal carried by that company in the year. Nothing in his opinion more clearly showed the utter fallacy of the train-mile principle, to which the author of the paper had drawn attention, than the fact of all this empty train mileage, if the mineral traffic was used at present as on all English railways for the purpose not only of arriving at the average receipts and working expenses of the mineral traffic, but of the goods traffic also, with which it had nothing earthly to do. The absurdity of comparing train-mile receipts and expenses on different railways where the coal traffic varied was equally manifest. The valuable statistics given in the paper clearly showed the practicability of allocating the expenses by a very simple, and he believed reliable method; he had had the opportunity of roughly comparing the results arrived at in the case of the East Indian railways with his own obtained by a more detailed method, and he found they agreed very closely. He considered that the element of speed ought to be taken into account in allocating the running expenses of the passenger and goods traffic in the increased ratio of the speed as he had done. The item of wages constituted considerably more than one-third of the entire locomotive expenses,² but taken altogether the method adopted by the author was sufficiently near for all practical purposes, and he trusted it would soon be adopted by the railway companies in this country, enabling them to determine separately and within very narrow limits of error the actual cost of carriage of the three great branches of railway traffic, viz., passengers, goods, and minerals. The difficult

¹ Great Northern Railway locomotive expenses, 1884: coal, 134,001*l.*; total locomotive expenses, 510,246*l.*

² Great Northern running expenses, 1884: wages, 181,808*l.*; total expenses, 510,246*l.*

and complicated question of determining the terminal charges alluded to in the paper had engaged a great deal of his attention, and he considered there was much force in Sir Rowland Hill's remark on the subject to which the author of the paper had referred. The result of his own investigations showed that the cost of railway transport resolved itself into a question of the two terminals and a line charge. By a method of his own he had been able to ascertain the average load of each class of traffic on a railway; with this given, the question of determining the amount of the two terminals becomes a comparatively easy matter, regard being paid to the distance, gradients, and class of stations between which the traffic passed. In investigating some years ago the cost of telegraphic traffic he had found that it similarly resolved itself into a question of the cost of the two terminals and the line charge; and the result of his investigation proved that an average cost of the line charge for an average load was just one-third of the whole message, and that for each terminal amounted to about the same; and he believed that on every system of railway where there was a fair average traffic mileage lead, the same ratio between the terminals and line charge would be found to obtain. The present method of charging railway rates was, as Sir Bernhard Samuelson had said, quite haphazard, and he had never met any one yet who had been able to furnish him with data which would enable a particular rate to be determined by any reliable principle. In the majority of cases the rates were confessedly determined by certain precedents, and by what the different companies concerned could get out of it. He had great pleasure in handing in the analysis he had referred to of the London and North Western Railway receipts and expenses from 1860 to 1884, which he had prepared chiefly from the company's half-yearly reports.

Sir ALEXANDER M. RENDEL, K.C.I.E., said he was associated with Sir Juland Danvers in early days in the production of the statistics mentioned in the paper. He did not know of any railways in the world that were so economically worked, or paid a better rate of interest on their capital at such low charges as the Indian railways, and he was satisfied that it was largely due to the use of those statistics; the result of which was that they had increased their train loads so immensely, that they could carry at a very low cost, and therefore at very low rates. On the East Indian Railway at the present time the charge per ton per mile at the present rate of exchange was barely a halfpenny, while the average cost of carrying a ton a mile was less than a sixth of a penny. He supposed the average charge in England was not less than a penny, and the average cost not less than a halfpenny. That was due to the fact that on the East Indian railway the average load of a goods train was about 200 tons, whereas here it was not more than 60 tons. If the train loads on the East Indian Railway were about the same as in England, he did not suppose it would pay one-third of what it did. Instead of paying 8 or 9 per cent. it would not pay more than $2\frac{1}{2}$, because they would be compelled to increase the charges, which would shut out a great mass of traffic that was now carried. It was rational to suppose that if the same

class of statistics were in use the same results would be obtained. Ever since the American railways had published that form of statistics their average charges had been going down, the train loads had been going up, and their working cost going down. That was why the American railways could carry goods at four-tenths of a penny, whereas in England they were obliged to charge a penny.

Mr. E. H. CARBUTT (President of the Institution of Mechanical Engineers) said that it had been his good fortune to be connected with Sir Juland Danvers, and he had moved in the House of Commons for a Committee to be appointed to inquire into the question of Indian railways with a view to prevail upon the Government to expend very much more money in increasing them. Undoubtedly the cost of English railways was much greater than the cost of those in India, which had not to incur the large preliminary expense of a parliamentary fight. It had been stated, and he believed correctly, that the cost of a parliamentary fight in England had amounted to more per mile than the construction of railways in Germany. That being the case, it was hardly remarkable that rates should be higher in England than elsewhere. Besides nobody would here tolerate the slow rate of speed with which goods were carried in India. A Manchester merchant would expect his goods to be in the London market the following morning, and if they were not delivered within one hour of the prescribed time he would probably make a claim against the company. The East Indian railway had train loads running 600, 800, and 1,400 miles at one stretch, whereas in England 200 miles was rarely exceeded. The same of course applied to passenger traffic, on account of the great number of stations. He trusted that better data would soon be forthcoming, but at present they must not be disappointed that rates were higher here than in other countries. They could not expect the facilities of having 40 trains a day between Manchester and London, and 60 a day between Leeds and Bradford, and at the same time have the cheap rate that was obtained in other countries where comparatively few trains were run. Being a Midland man himself, he was glad that the Midland Railway had taken the lead in showing that reduced charges were a benefit not only to the company but to the district through which its line passed. A reduction in passenger rates undoubtedly induced people to travel about and encouraged them in looking after trade, and caused manufacturers to enter into severer competition in order to maintain the position they ought to hold in the country.

Major-General E. C. S. WILLIAMS, R.E., C.I.E., thought that they must be specially careful in the application of the average cost of carrying a passenger or a ton of goods a mile. An average could only be applied to an average case. Until, however, they arrived at an average working cost, it was impossible to know at all how they were charging. He took it that the main point of the paper they had just heard was the imperfection of the train-mile unit. With such *pseudo* unit the first question to be asked is, "what is a train-mile?" Sir Juland Danvers had answered that question. He had shown that the number of tons in a goods train

varied on the broad gauge railways of India from 85 to 186 tons; that is to say, a train-mile varied from 85 to 186 tons of freight, besides the dead weight of wagons, brake vans, engine and tender, carried a mile. On the metre gauge it varied from 54 to 85 tons of freight. He did not think therefore that anyone who was prepared to fight for that unit could stand up and say that it conveyed anything definite to the mind. If a proper unit were once adopted on English railways, there would be no difficulty in settling the details requisite to work out the average cost. In arriving at it the question of speed was an important detail, for speed meant more coal and better maintenance; but on the other hand the expenditure on the running staff was less. The fixed or standing expenses was another matter that called for attention. A common plan once arrived at, however, for the division between coaching and merchandise traffic of the expenses of the various departments, the working cost could be easily found. There was an enormous amount of dead weight hauled which proper statistics brought out in strong relief. In every passenger train for every 12 tons carried only 1 ton consisted of passengers, the other 11 tons being dead weight, and on many of the English railways he believed it was more than that. For every 3 tons of goods carried only 1 ton was freight. He had no doubt that much good would result from the adoption of the ton-mile unit; but to be of real use as a check on the working it was of course necessary to split up each large railway system into sections, as is done in the United States, and to make due allowance for the effect of competition in this country, the final result of which is increased facilities and conveniences to the public almost regardless of cost to the shareholder. One speaker had referred to the desirability of discriminating between mineral and merchandise traffic; that he thought was very important. It used to be done on the Indian railways previous to 1880, even with their comparatively insignificant mineral traffic, and with the advantage of showing that, notwithstanding the lower rates charged to the public compared with those charged for merchandise generally, the profit was large; and the margin for even lower rates considerable. They also used to discriminate between the different classes of passengers, and they found that the first class passenger was an exceedingly expensive person; in fact the agent of one of the Indian railways used to declare that it would pay the company to present the first class passenger with his fare and let him depart. This could not however apply to England, where there was a very considerable first class traffic. Another speaker had referred to the effects on working expenses of the heavier first cost of the English railways compared with the Indian railways. On this point it was only necessary to say that, whether the land for a railway cost more or less, or was given free, the actual cost of working the traffic could not be affected by it. Working cost was dependent on capital cost in this way only, viz., that other things being equal the higher the construction standard of a railway the cheaper it should be to haul traffic over its rails. But the question is not whether Indian railways are worked for less than English railways, but what is the amount of *work* done in

carrying the traffic on English railways—a point on which there is at the present moment the most profound ignorance—and what it really costs to do that work, expressed in intelligible language. The first step to this result is the adoption of the units advocated by Sir Juland Danvers.

Mr. H. OAKLEY (General Manager, Great Northern Railway) said he had been very interested in the paper which had been submitted to the Society, but if the author or any one else expected to attain any very marked result in English railways by working out the principle of a ton-mile unit or passenger-mile unit, he thought they would be very much mistaken, because, as General Williams had very properly said, no average could be applied to the trade of this country. First of all, no commercial man or passenger would for a moment stand the speeds and the delays that were inseparable from any attempt to carry goods or passengers in the most economical manner. Every district had its peculiarities. Owing to the conformation of certain parts of the country an engine could only carry 10 or 15 waggons, whereas in flat districts such as Lincolnshire a train might consist of as many as 45 waggons. If they took the ton-mile on each individual section of the line, and saw what was earned, some reasonable approximation might be arrived at, but practically for every district there would be a varying ton-mile. The train-mile had been sneered at, and some gentlemen had said that railway managers knew nothing of the reasons that influenced them in fixing rates. The gentleman who dealt in wine had complained that he could get his wine carried from Dover to London cheaper than from London to Dover; but he entirely forgot that a port was a place of concentration, and that every train coming from Dover to London would probably be full, and that there would be large loads in each truck. On the other hand wine sent from London to Dover would go in small quantities, and each particular article would have to be separately invoiced and dealt with, and separately delivered, so that every element of cost except the mere carriage between London and Dover would be increased. It had also apparently been forgotten that the wine could be sent from Calais to London by boat, and it therefore became a question whether the railway company should either carry the goods for what it could get or not carry them at all. The same applied throughout the country. Being a sea-girt country, every port had its claims to the trade. The difficulty that a railway manager had to contend with was not so much in fixing an equitable rate, as in reconciling as best he might the conflicting claims of the district he had to serve. He was not at all surprised at the low rate at which minerals were carried on the continent and in India. In England, in consequence of the pressure of traffic, minerals had to be carried nearly as fast as passengers, 18 miles an hour was about the rate at which all such trains were taken day and night, being watched every 2 or 3 miles of the journey by wide awake signalmen, pushed into the manufacturer's sidings, and the empty waggons hauled back to their destination. Practically every mineral train meant double mileage. The same applied to a great deal of the

metropolitan and suburban traffic. They might take an average of a ton-mile or a passenger-mile for metropolitan traffic, but for mineral trains and all goods trains they would have to subdivide it into mixed trains, because the goods and minerals in some districts had to go together, there not being enough of either separately to make a train. The speed at which the trains were run had also to be fitted into the account. Goods were taken at the packers at 5 or 6 o'clock in the evening, and were delivered at the manufacturer's doors, a distance of 200 miles, by 9 o'clock the following morning. Was there any work of the sort done anywhere else in the world? The rates included cartage, collection from the packer, loading and haulage by railway, and delivery in town. The railway companies in England were not merely haulers of traffic, but were practically intermediaries in trade. It certainly was hard at times to hear the educated *qua* railway public sneer at railways, and one would almost think it was the general opinion that every man but a railway manager was fitted to manage a railway. The problem to be dealt with was not the mere question of calculating the average receipt of a ton-mile or a passenger-mile, but what work had to be done for the money, and what responsibilities and risks had to be incurred, and comparing the cost of working here and abroad. If worked out, the element of wages alone he believed would more than justify the difference in cost between working a railway in England and in India. He had known the author by reputation for many years, and he had attended for the purpose of hearing how a man of his experience and talent would put the case for the ton-mile. It had been tried on the Great Northern Railway, but the diversities of traffic, the pressure of competition, and the need of speed, had blown the average theory to the winds. To give some idea of the ramifications of the question of rates, he might mention that on the Great Northern Railway alone there were 13 million separate rates between towns on their own system and other towns all over the country. He was quite sure that if Sir Juland Danvers or anybody else could put before them a practical way by which they could see after reasonable consideration a more facile way than was now possessed of arriving at rates, they would vote him a statue as being one of their greatest benefactors.

Mr. EDMUND KIMBER confessed that although he had carefully studied the tables, he could not exactly understand what a "train-mile" so called was. The author had stated that last year 914 millions of passengers were carried one mile by the East Indian Railway at a cost of 292,834*l*. He presumed that the author divided that by the 914 million passengers and arrived at the three-tenths of a farthing per mile. They were afterwards told, however that that was only an approximation to the unit. That being so, he confessed there must be exactly the difficulty which Mr. Oakley had asserted, namely, that in dealing with English railways there was in fact no possibility of arriving at anything like a subjection to the ruling of the unit. Although he admired the ability with which the paper was written, he still thought that the unit would be thrust to the winds in India as much as it had

been in England. Mr. Price-Williams had said that if railway companies would give all the data, it only needed an official like the author to be put into the Board of Trade for the purpose of working out the unit from those data. In that case perhaps some data could be given with regard to the future prospects of work from past experience. Looking back for the last twenty years to the applications to Parliament for private bills for railways, it would be found that they were continually on the decrease, and for the simple reason that England had nearly all the railways made to meet its wants. There was not, he thought, a single line that could now be made in any part of the country which in two years would pay 1 per cent.; and it would take years and years before it could pay 5 per cent. Englishmen must seek for their enterprises and investments in other countries. The great merit of the paper, with the calculations, was that it would enable them to know what to avoid, both here and in India; and would give them experience in the construction and working of railways in a quicker way than could before be obtained.

Mr. H. TENNANT, Manager, North Eastern Railway, said he greatly admired the paper from the standpoint of the author, but it was important to remember how exceedingly difficult it was to compare two things which were not alike. He thought the railway systems in India and in Great Britain were about as unlike as any two things could well be. He was much struck by the observations of Sir Alexander Rendel, when he spoke of the advantages derived in India from the knowledge gained by statistics of the kind dealt with by Sir Juland Danvers. He understood Sir A. Rendel to say that they were enabled in India owing to such information to increase the train loads, and to diminish the train mileage. If that were so, then they seemed in India to be able to manage exactly as they liked. In England there were many determining circumstances besides statistical results. A grocer, for example, instead of keeping a large stock, wrote or telegraphed to Glasgow or other places, and expected to receive his supply, say of sugar, by the next market day; and it must be conveyed and delivered whether any other truck was going in the same direction or not, it could not be kept waiting for a full train. Any comparison of the working of one railway with another would be most misleading. On his line, for instance, carrying 30,000,000 tons of goods and mineral traffic in a year, the cost per ton per mile might be very high owing to so many millions of tons being carried for a very short distance, whilst on the Great Northern the rate of working per ton per mile would be much less owing to the greater quantity carried a much greater distance. The results of the proposed statistics would not therefore afford any proof that the one railway was as well or better managed than the other. If the advice that had been given with regard to non-paying traffic were followed, many branch lines might have to be closed—a result which would in this country not be tolerated. With reference to the remark of a previous speaker, it was idle to suggest that English railway companies had any love for the foreigner. They did their best to aid Englishmen in every department of their trade and commerce.

The whole question of foreign traffic assumed a different complexion when understood from what it did in newspaper paragraphs. It was a matter solely of competition—in other words how goods could best be dealt with so that the railway of one company or another should get a share of traffic which, but for special arrangements, they might lose. With regard to the illustrative statistics of Mr. Price-Williams, he had expected that some practical conclusions would have been advanced, but that did not appear to have been done.

MR. PRICE-WILLIAMS in reply to Mr. Tennant's remark that he had failed to give them the result of his analysis of the London and North Western Company's working expenses, said that he had not done so simply because he did not like to weary the meeting with a lot of dry figures, but as briefly stated the result of his investigations showed that since third class carriages had been attached to all trains, and the second class carriages had been abolished by the Midland Company, the first and second class traffic of the London and of most other railways had been carried at a loss; that the goods traffic as a whole paid exceedingly well; and further, that the coal traffic, handicapped as it was with its 90 per cent. of return empty mileage, was on the London and North Western, as on the Midland and Great Northern Railways, yielding a large profit of more than 50 per cent.; full details however would be found in the analysis he had handed in. He ventured to think that both Mr. Oakley and Mr. Tennant in their remarks had failed to meet the main points urged in the author's paper, viz., that it was a radical defect in the present system of railway accounts in this country that no means were afforded of ascertaining the cost of transport of the various classes of traffic.

SIR JULAND DANVERS, in reply, said that notwithstanding the difficulties pointed out by Mr. Oakley, he had failed to be convinced that it would be impossible to arrive at an average which would be of practical use to the railways of this country. Such an average would of course be considered intelligently and in connection with the circumstances of each case, and not taken as arbitrarily fixing a unit upon which the rates should depend. He would ask Mr. Oakley and Mr. Tennant, instead of dwelling on the difference between English and Indian railways, which everybody admitted, to draw a comparison between the statistics furnished by English and American railway companies, the latter of which gave particulars not only of a main line, but of parts of a line. He thought therefore that the example of America, where much the same difficulties existed, might be usefully followed in England. The managers connected with Indian and American railways had acknowledged the value of the information in question, and admitted that they had been influenced by it in their decision as to the rates. He fully recognised the extreme skill and ability that had long been shown in the management of the traffic on English railways; but his complaint was that no opportunity was given of comparing the cost with railways in other countries or with each other, or of ascertaining whether the same accommodation could not be obtained at less expenditure.