Chapter 4

FREIGHT CAPACITY & THE INDIAN RAILWAY WAGONFLEET

4.1 Capacity Factors in IR Freight Operations

The preceding analysis of IR operational performance revealed the existence of certain inefficiencies in IR freight structure which have led to traffic dominance by bulk-freight on the IR network. Bulk commodities like coal, foodgrains, cement, mineral oils [POL], iron ore and iron & steel now provide as much as 96 percent of originating tonnages and 94 percent of net tonne-km traffic to total freight operations by IR.[1] The analysis has also demonstrated that this change in IR freight composition did not occur instantaneously, but resulted from gradual diversion of low-bulk categories of traffic to alternative modes of carriage, as railways in India were compelled by efficiency considerations to progressively assume the role of a bulk-carrier. The main technical factor that has prevented outright shifts of bulk traffic away from IR is the relative economy and fuel-efficiency with which railways can transport heavy freight commodities over long leads. Although in the wake of the worldwide spiral in fuel and transportation costs following the Oil Shocks of the 1970s, this factor has also become crucial to many other categories of freight, modal shifts of general freight to the roadways have also been induced in several countries - India among them - by the setting of exorbitant tariff rates on low-bulk and break-bulk consignments, or because of the extra value added to roadfreight services by their faster transits, doorstep deliveries, etc. An investigation as to which of these factors can adequately explain the disappearance of general freight from the IR system holds considerable importance towards an assessment of the longterm infrastructural role of Indian railways. The problem will be studied in the present chapter, on the working hypothesis that the shift of high-rated freight to other transportation modes poses difficulties for IR's longterm revenues and capitalisation projects, and that long-lead low-bulk traffic will have to be lured back into the IR freight-system in order to counterpose this threat.

The phenomenal growth evident in bulk-freight operations would also suggest that a change of orientation in IR freight capacity towards the specialised carriage of bulk traffic has occurred on IR, especially over the 1980s. Adaptation of such nature would require the technological modification of track, traction, equipment and rolling stock standards, so that increasing numbers of freight vehicles became available for the carriage of heavier consignments at higher speeds over longer distances. A study of the IR wagonfleet is therefore in order, and should encompass its composition by various wagon-types, the phases of modernisation in special wagon design to adapt IR wagonfleet capacity to specialised haulage of bulk freight, and the constraints originating in such wagon acquisition policies which now impact upon the Indian wagon industry. The overall effect that all these have had on the evolution of IR freight trends shall be evaluated separately by study of wagon utilisation indices and the wagon economics of IR freight operations.

4.1.1 Components of the IR Wagonfleet

The modern railway is believed to have originated in English coalmines where the use of parallel lines of planks secured by crossties to provide a hard surface for haulage of very heavy loads had been known from the 16th century. The first railway wagons were essentially adapted from the coal wagon which ran with fixed axles on flanged rails, and thus adhered to its open-box design.[2] Except for the substitution of wood by steel, this remains the predominant form of wagon design even today. It was only after the technological evolution of swiveling bogie axles which improved the turning characteristics of rolling stock over track curves that the railway wagon could be lengthened to any appreciable degree. Nevertheless a number of other modifications of the open-box design were made periodically to adapt fixed-axle railway wagons for the carriage of special categories of freight. Thus the modern railway wagonfleet generally includes wagons on the open-top and boxcar design, the flatwagon or platform design, the tankwagon design for carriage of liquid freight, and wagons with special load discharge capabilities like the various hopper designs. Progressive lengthening of the wagon body while limiting its body weight has allowed more payload to be carried including freight with odd dimensions, while improvements in axle, brake and coupler design have improved the endurance and reliability characteristics of wagons to allow high speed freight transits.

The major design refinements in wagon technology have all been inducted from time to time into the IR wagonfleet. Thus the IR wagonfleet today forms a composite of several heterogeneous categories of wagons, each designed either for general or special freight, with the major technological thrust having been towards the improvement of bulk haulage capacity and running speeds.

4.1.2a The Standard IR Wagon

The earliest railway wagons used in India were designed on the horse-drawn wagon trucks used for coal and timber haulage in Britain, and hence were fabricated on wooden underframe support, with open or covered high-sided wooden bodies reinforced by metal strappings and knees, and ran on a wheelbase of two fixed wrought-iron axles and spoked wheels . The maximum payload that could be carried by a broad gauge [BG] railway wagon built on this design was just over 12T.[3] Although modifications of the design were made subsequently to accommodate the transportation needs of varied merchandise, the 4-wheeled truck-type wagon with fixed axles or 4-wheeler unit [FWU] is still the most ubiquitous component of the IR wagonfleet.

Steel wagons began to come into use after the turn of the century, and gradually substituted the earlier design on the British and Continental railways because of their superior construction and carrying capacity. This technological innovation developed out of the backward linkage between the railways and metallurgical industry. Despite the multitude of companies that built and ran the Indian railways, India had been among the first countries to appreciate the advantages accruing from gauge and wagon standardisation, namely, economies in running, maintenance and inventory holdings of spares. Thus from 1908 onwards, a new BG FWU wagon design employing rolled-steel structural sections and steelplate construction to increase payload capacity to 21.3T was adopted as the *standard* wagon for the Indian BG network. These CR standard wagons were equipped either with flap-doors or dropping ends, and their covered versions with vertical hinge-doors were evolved on the same basic design, in some cases further adapted with dropping flap-sections to facilitate transportation of cattle.[4]

4.1.2b Specialised IR Wagons

Periodic alterations of the basic wagon design became necessary to enable transportation of rising freight volumes of commodities ranging from sand, coal, heavy timber, sugarcane, foodgrains, mineral ores and ballast (rubble for laying railway track-beds), to oils and petroleum fuels. This led naturally to the building of a wide range of non-standard wagon platforms adapted to the specific carriage of coal and other minerals, unwrought timber, edible and volatile oils, as also water tankers, travelling cranes, ballast wagons, etc., which were built for departmental purposes. While the 4-wheeler FWU continued to be the standard wagon design, the elongated 8-wheeler bogie design was gradually introduced to meet special requirements and also to enable the haulage of bigger or bulkier freight loads.

The engineering adaptations made on the basic FWU and bogie-type wheelbase to enable the carriage of various categories of freight merit comment since they represent the technological response of the Indian railways to transportation challenges, at a time when they were still relatively secure from intermodal competition. The modifications were quite interesting. Special cattle wagons were partitioned into pens and provided with ventilators and arrangements for disposal of animal wastes, with troughs being added for feeding and drinking during transit. The special platform wagon for timber haulage was built on the open truck design with a skeletal body which adapted to unwrought timber of various shapes and sizes and prevented their dislodgment during transit. The special hopper-type wagon was designed for the carriage ballast, ores and coal and permitted their unaided gravity-discharge at unloading sites.[5] Particularly ingenious design refinements were made for freighting refrigerated or inflammable goods. Special bogie-type refrigerated vans were built with double-cased timber bodies with an insulating layer of slab cork in between, and were provided with cam-operated and spring-sealed doors for airtight closure. The special cement flooring on these vans covered a timber-boarded undersurface again insulated with cork, and was occupied centrally by an angled-steel ice bunk comprising separate steel racks for holding blocks of ice. A cheaper refrigerated design was also developed specifically for the transportation of chilled dairy cans from milk-surplus areas in

Gujarat to meet the requirements of the city of Bombay. The typical tankwagon design was evolved on the fixed-axle platform mounted with cylindrical top-loading steel tanks for the carriage of various edible and other oils. Refinements to this design were made to allow the safe carriage of petrol, by equipping the tanks with special pressure-release and vapour-return valves and a sealing flap within the manhole that prevented losses of petrol vapour. Petrol wagons were also finished with aluminium-paint or white-paint to minimise internal heating from direct exposure to the sun.[6]

The well-wagon evolved as a specific technical design for the adaptable carriage of extremely large or bulky freight articles such as heavy machinery, and became increasingly important to the infrastructural thrust of India's early FYPs. The prototype was thus designed to carry a unit payload of 132T, distributed over a 'short well'. Although fabrication of the giant wagon was entrusted to the technical skills of a Swiss engineering firm, the prototype design and specifications were prepared in India by the Central Standards Office [CSO] of the Ministry of Railways. The main girder of the well which rested on special rubber-cushioned pivots could absorb jolts and shocks through two main sub-tructures fitted on 6-wheel bogies at either end, and incorporated a hydraulic device which adjusted the main girder to required heights when passing fixed structures such as railway overbridges and tunnels with out-of-gauge loads. Although the giant prototype measured as much as 27.56m over the buffers and 17.25m between pivots, all-welded construction reduced its tare weight to a minimum. An important technical feature in the bogie design allowed the well-wagon to make right-angled turns on a turntable of only 8.23m diameter, thus enabling onsite discharge of critical heavy machinery and equipment for the multipurpose irrigation and hydroelectric projects that were taken up soon after Independence. Projects of national importance such as the Damodar Valley Project, the Bhakra-Nangal Project and the Hirakud Dam Project undertaken during the early FYPs thus greatly benefited from the use of these special wagons to convey their heavy equipment.[7]

4.2 Freight Capacity Development on the Indian Railways

Although as a major area for application for railway capital, rolling stock investments are a crucial determinant of freighting capacity on railway systems, the extent to which such investments are undertaken by nationalised railway systems is largely a matter of public policy. When transportation policies are designed to stimulate economic growth, the primary investment decision comprises two parts. While the first determines the extent to which state investment should be committed to transportation infrastructure vis-a-vis the producing sectors of the economy, the second defines the allocation of infrastructural investment made between alternative transportation modes. Developmental allocations of funds towards transportation in the Indian FYPs have displayed this segmented character, even while IR have remained their principal point of focus. Nevertheless a secondary and final component in the investment decision jointly comprises internal decisions within the transport authority - IR, in this case - regarding the allocation of development funds that have been made available between the different spheres of railway investment. Thus the allocation of railway capital towards the augmentation of wagonfleets and IR freighting capacity traverses a tortuous hierarchy of decisions through different planning levels.

4.2.1 Growth of IR Wagonfleet

The actual freighting capacity of a railway system is composed of two elements. While the number of wagons online indicates the raw physical capacity of the system, a refinement is posted by the differing levels of technology embodied in the special wagons that are on the online wagonfleet. To avoid confusion on this count, it is usual for railway systems to quote their wagonfleets in terms of standard-wagon equivalents, which in the case of IR is the 4-wheeler CR standard wagon with unit-payloading capacity of just under 22T. Again, while the online wagonfleet with its heterogeneous wagon variants defines the aggregate tonnage-freight capacity available on the system in the general sense, the extent of wagon specialisation towards the loading of specific categories of freight posts a compartmental limit to tonnages that can be transported of any individual commodity. However - no matter in which sense freighting capacity is viewed - shortfalls in rolling stock inventories can cause serious transportation bottlenecks with an impact detrimental to the overall growth of the economy. Maintenance of adequate freighting capacity in the transportation sector thus becomes imperative for economic development and can be evaluated, in the case of IR, in terms of the growth of the IR wagonfleet.

Table 4.1: The Indian Railway Wagonfleet
1950-51 to 1994-95

Year	Total Online Wagonfleet	Composition by Wagon Categories % Covered Wagons	% OHS Wagons	% OLS Wagons	% BOX/BOB Wagons	% Departmental Wagons
1950-51	205597	58.9	25.5	3.4	7.2	5.0
1955-56	240756	58.1	24.7	4.2	8.7	4.3
1960-61	307907	57.3	25.5	2.5	10.6	4.1
1965-66	370019	53.1	27.2	2.1	13.3	4.3
1968-69	381685	53.3	26.1	1.8	14.6	4.2
1969-70	*n.a*	*n.a*	*n.a*	*n.a*	*n.a*	*n.a*
1970-71	383990	*n.a*	*n.a*	*n.a*	*n.a*	*n.a*
1971-72	382725	53.3	25.5	1.8	15.1	4.3
1972-73	384283	53.1	25.7	1.7	15.6	4.1
1973-74	388366	52.8	25.8	1.7	15.6	4.1
1974-75	390968	53.7	28.3	3.1	11.4	3.5
1975-76	395250	54.0	28.0	3.0	11.5	3.5
1976-77	397773	54.1	28.1	3.0	11.4	3.4
1977-78	399971	53.8	28.4	3.1	11.3	3.4
1978-79	401885	*n.a*	*n.a*	*n.a*	*n.a*	*n.a*
1979-80	405185	*n.a*	*n.a*	*n.a*	*n.a*	*n.a*
1980-81	400946	53.3	28.3	3.2	11.8	3.4
1981-82	392062	52.7	28.3	3.2	12.5	3.3
1982-83	374756	52.2	28.1	3.2	13.2	3.3
1983-84	374757	52.2	28.1	3.2	13.2	3.3
1984-85	365392	52.1	27.8	3.4	13.4	3.3
1985-86	359617	51.9	28.0	3.4	13.4	3.3
1986-87	354041	51.7	28.2	3.4	13.4	3.3
1987-88	346844	51.2	28.5	3.4	13.5	3.4
1988-89	345821	50.6	28.9	3.5	13.7	3.3
1989-90	349560	49.8	29.3	3.5	14.1	3.3
1990-91	346102	49.1	29.6	3.6	14.4	3.3
1991-92	346394	47.7	30.7	3.6	14.6	3.4
1992-93	337562	46.7	31.2	3.6	14.9	3.6
1993-94	312405	44.4	32.4	3.8	15.7	3.7
1994-95	291360	41.9	33.9	3.9	16.5	3.8

Source: *IRYB*, various years, Directorate of Statistics & Economics, Railway Board, Ministry of Railways, Government of India, New Delhi *(for wagon descriptions, see sec.4.3.2)*

Table 4.1 summarises the growth of the IR wagonfleet in terms of standard FWUs over the era of planning. It had been noted earlier that the drawn-down condition of railway inventories after WWII and the partial transfer of railway assets to Pakistan Railways during the process of partition kept IR occupied over the transitional years with rebuilding wagon numbers to restore its lost freighting capacity. The institution of planning shifted the focus towards the upgradation of freighting capacity to match transportation needs in a growing economy. As such, both plan allocations and IR investment policy decisions during the early FYPs were directed to the removal of infrastructural deficiency. Sharp growth in the online wagonfleet is noticeable therefore over the period from the 1FYP uptil the end of the 3FYP, during which freight capacity increases were planned ahead of the materialisation of equivalent traffic demands. Hence online wagonfleet numbers increased by over 80 percent compared to 1950-51 levels, with average net annual acquisitions of 7032, 13430 and 12422 wagons, respectively, over the three plan periods. It had been noted however that the 3FYP period witnessed a traffic shortfall arising mainly from lack of adequate freight support from the PSUs, as a result of which the IR freight system found itself saddled with excess capacity. Net increases of the online wagonfleet during the 4FYP were therefore much more restrained at 1336 wagons annually. Over the 'plateau' period of the 1970s, the online wagonfleet thus hovered at just under the 400 lakh FWU mark, with marginal net annual acquisitions of 2321 wagons over the 5FYP period. The IR wagonfleet peaked at just over 400 lakh FWUs when the 6FYP commenced in 1980-81. Since the 6FYP, the infrastructural thrust of planning has been more towards fleet modernisation than towards expansion in wagon numbers. The upshot has been a reversal of earlier growth trends and an absolute decline in the number of wagons online. Over the 6FYP period, the average net annual decrement in the online fleet was (-)7111 wagons, with capacity shedding then declining somewhat to (-)2011 wagons over the 7FYP. Within the 8FYP period, the net annual decrement in the wagonfleet averaged as many as (-)18345 wagons over three plan-years between 1992-95. Thus in terms of wagon numbers, the IR online wagonfleet in 1994-95 stood 42 percent higher than the 1950-51 level, but had declined by about 28 percent from its all-time peak in 1980-81.

Since online fleet decrements at least partially reflect non-replacement of wornout railway wagons, a point of vital consideration while evaluating growth in IR freight capacity concerns the replacement acquisitions of wagons. Annual wagon purchase by IR serves dual purposes, namely *maintenance* of wagon inventories at prior levels as a first step, and further *augmentation* of wagon inventories as a second step through net acquisition of wagons. Thus the figures for average net annual wagon acquisitions presented above offer only a partial picture of wagon purchases made by IR. Railway policy in India till the 3FYP had been oriented towards the extraction of maximum service from existing equipment and rolling stock inventories and did not therefore witness high rates of replacement for overaged and obsolete rolling stock. Consequently, even as wagon numbers increased, efficiency declined. The principle adopted while projecting IR rolling stock requirements for the 3FYP in fact postulated retention of all locomotives and railway wagons upto the age of 45 years, posing a striking contrast to US railroad policies of the time which permitted only 4 percent inclusion in online traction-fleets of locomotives with an age of 20 years or more.[8]

While it might be argued that a policy basis was provided to the non-replacement of IR rolling stock assets by the overall constraints on investment resources and the rapid expansion of traffic, the appearance of traffic slack changed the situation dramatically after the mid-1960s. As a result, while wagon acquisitions decreased on the whole, a larger proportion of the acquisitions made each year were directed to the replacement of wagons which were long past their prime. After the focus of IR policy shifted progressively towards the modernisation of railway inventories, greater commitments of investment towards the acquisition of nonstandard equipment including periodic imports of stock and technology ruled that less money was available for financing wagon replacement. Hence negative figures for net wagon acquisitions ever since the 6FYP reflect both shortfalls in plan allocations as well as the incidental impact of the policies on railway technology. What IR have been undergoing since the start of this period might thus be termed as technological renewal at high capital cost.

The foregoing analysis has made an exposé of the real freight-capacity anomaly that has been confronting IR. The period of planning, which produced the three operational phases outlined in the previous chapter, was composed of three analogous phases in the railway infrastructural policy pertaining to the development freight capacity. In the first of these phases stretching between the 1FYP and 3FYP, a policy of rapid wagonfleet increments kept freight capacity well ahead of traffic demand and allowed rapid expansion in operations. The second phase lasting through the 1970s and spanning the 4FYP and 5FYP put a brake on capacity expansion and brought about an operational plateau. Redirection of the infrastructural thrust towards fleet modernisation commenced with the 6FYP and brought about renewed expansion in subsequent IR freight operations, but has been accompanied as shown in the preceding chapter, by freight specialisation favouring select flows of commodity-traffic, leading to surrender of other commodity freight to alternative transportation. Analysis of the growth of IR wagonfleet identifies certain issues which require further attention. It becomes necessary therefore to evaluate the degree to which technological upgradation of IR freight capacity has compensated the reduction in absolute wagon numbers. Other technological features of railway development such as gauge conversion and the improvement of track and traction also need to be evaluated in terms of their possible impact on the expansion of IR freighting capacity in terms of traffic, *i.e.* in net tonne-km terms. These issues shall now be approached.

4.2.2 Growth of IR Freighting Capacity

The importance of wagon capacity to this analysis can be gauged from the fact that while the IR wagonfleet had grown numerically by around 70 percent over the period between 1FYP and 7FYP (*see table*), the freighting capacity of the system had risen 173 percent or 7.3MT over its 1950-51 level. Expansion of this order sustained the growth of aggregate IR freighting capacity even through the period of declining wagon numbers witnessed after the mid-1970s. By 1994-95, the average carrying capacity of an IR wagon had risen by 176 percent compared to 1950-51, although the proportion of increase in the wagonfleet excluding its departmental wagons was only 73 percent. Table 4.2 summarises the growth of IR freighting capacity in both aggregate and average wagon-unit terms. While the even match maintained between the growth of wagonfleet and aggregate freighting capacity till the end of the 1950s indicated the absence of wagon upgradation to any noticeable degree, the situation changed markedly over the 3FYP when the growth rates of freighting capacity began to outpace the growth of the online wagonfleet, indicating considerable induction of upgraded railway wagons. Total freighting capacity of the online IR wagonfleet then stabilised over a temporary plateau during the 1970s and early-1980s, before another rise commenced towards the end of the 7FYP. The number of online wagons have gradually fallen, on the other hand, after peak levels were reached in the mid-1970s.

Table 4.2: Wagon Capacities on the Indian Railways 1950-51 to 1994-95

Year	BG Wagonfleet *['000]*	Average Wagon Capacity *[T]*	MG Wagonfleet *['000]*	Average Wagon Capacity *[T]*	Total IR Wagonfleet *['000]*	Total IR Freighting Capacity *[MT]*
1950-51	149	22.6	43	17.1	195	4.14
1955-56	161	22.6	64	18.0	230	4.87
1960-61	207	23.1	83	18.0	295	6.30
1965-66	257	26.4	91	18.0	354	8.52
1970-71	271	27.8	91	19.1	368	9.35
1971-72	270	28.1	90	19.1	366	9.37
1972-73	273	28.2	89	19.1	368	9.49
1973-74	279	28.6	88	19.1	372	9.74
1974-75	285	29.1	87	20.7	377	10.17
1975-76	291	29.3	86	20.9	382	13.37
1976-77	294	29.7	85	20.9	384	10.61
1977-78	296	29.9	85	21.1	386	10.74
1978-79	*n.a*	*n.a*	*n.a*	*n.a*	*n.a*	*n.a*
1979-80	*n.a*	*n.a*	*n.a*	*n.a*	*n.a*	*n.a*
1980-81	299	30.6	83	23.0	387	11.14
1981-82	294	31.1	80	21.5	379	10.95
1982-83	290	31.7	77	21.7	371	10.92
1983-84	284	32.5	74	22.0	362	10.95
1984-85	279	33.1	70	22.4	353	10.98
1985-86	276	33.9	68	22.3	348	10.96
1986-87	275	34.3	64	22.4	342	10.88
1987-88	272	34.5	60	22.4	335	10.77
1988-89	274	35.2	57	22.6	334	10.99
1989-90	278	36.3	57	22.7	338	11.44
1990-91	276	36.9	55	22.9	335	11.50
1991-92	278	37.9	54	23.3	335	11.84
1992-93	272	38.7	51	24.0	326	11.79
1993-94	259	39.7	40	25.0	301	11.32
1994-95	246	40.2	33	25.8	280	10.76

Source: *IRYB*, various years, Directorate of Statistics & Economics, Railway Board, Ministry of Railways, Government of India, New Delhi

Note: *Listed wagonfleet numbers exclude Departmental wagons*

While considering such capacity trends, it needs to be remembered however that the gauge composition of the wagonfleet precedes all other technical factors as a determinant of freighting capacity, since broad gauge [BG] wagons have higher payloading capacity compared to metre gauge [MG] wagons. While more will be said about gauge and other factors shortly, the growth of average BG and MG wagon capacities evident above can first be analysed in relation to the growth of the aggregate IR wagonfleet.

Till the shift in policy stress towards the modernisation of railway equipment and inventories, freight operations on IR's MG feeder networks had been important to the mainline operations on BG. A sharp increase was consequently witnessed in MG wagon numbers till the commencement of the 4FYP in 1969-70. In net-terms, *i.e.* wagon acquisition minus obsolescence, 0.43 lakh MG wagons were added to the IR wagonfleet over the period of first three FYPs and interplan years between 1950-51 and 1968-69, representing an indexed increase of 114 percent in the MG wagonfleet. Compared to the net addition of 1.19 lakh BG wagons during the same period where the indexed increase was only 80 percent, this would imply that the proportional rates of wagon acquisition over the relevant period were substantially higher for MG wagons. Thus in capacity terms, the ratio of BG-to-MG freighting capacity had declined by 1968-69 to around 3.9:1 from a starting level of 4.6:1 in 1950-51, again reflecting greater *pro rata* addition of MG wagons to the total wagonfleet. Against this however, the net BG wagonfleet increment represented the augmentation of IR freighting capacity by 3.65MT, against 1.06MT added by MG wagon acquisition. Considering the hinterland character of MG freight services in India, these figures would show that the expansion in mainline freighting capacity on IR during the initial planning period was not entirely unrelated to the anticipated expansion in feeder-freight flows, although a substantial proportion could be attributed to freight which needed to be moved exclusively along IR's mainline corridors.

The planning focus during subsequent augmentations of freighting capacity on the MG feeder networks shifted towards upgrading the carrying capacity of the MG wagon, to which little attention had been paid in the initial period. Since the average capacity of the MG wagon continued to rise subsequently without substantive increase in MG wagon numbers, this appears to have been accomplished during the replacement of obsolescent wagons implying that a shift of emphasis from feeder freight to mainline freight was beginning to occur. Although a full exploration of the planning shift would extend beyond the purposes of this brief review, the reasons underlying it would relate to anticipated change in nature of IR freight flows during the 4FYP.[9] With the memory of traffic failures during the 3FYP then still being fresh, transportation priorities for the 4FYP were reorganised around the need for industrial recovery, calling for specific augmentation of the capacity of IR to handle bulk-freight in large technological units. In retrospect, this spelt the death-knell for feeder-freight operations on the MG network and reversed the flows of IR freight traffic by progressively reducing its focus to a few select commodities, in the process also opening the huge general-freight market to open entry by the Indian roadways. These and related issues concerning the evolution of IR commodity-freight patterns will be approached again later in the present study.

On the BG network however, augmentation of the wagonfleet continued, accompanied by substantial technological upgradation of wagon capacity. As a result, while growth trends in the BG wagonfleet generally remained positive through the 1970s with net addition of 0.31 lakh wagons over the fleet level that existed at the commencement of the 4FYP, the MG wagonfleet witnessed a sharp decline in wagon numbers, with a net decrement of around (-) 9000 wagons over the same period. In terms of equivalent tonnages, BG wagon acquisition added net freighting capacity of 2.25MT to IR against the loss of 0.04MT on the MG network. The ratio of BG-to-MG freighting capacity consequently climbed to 5:1. While reductions were witnessed in both BG and MG wagonfleets during the 1980s, the decline on the BG network related primarily to IR's inability to finance wagon replacement at an adequate level, since the average carrying capacity of BG wagons continued to improve. The decline in the MG wagonfleet was however especially sharp as a consequence of the policy decision to unify the IR gauge and gradually phase out MG railway operations, thereby doing away altogether with the need for wagon replacement. The net cutback in fleet levels over the decade amounted to around (-) 0.21 lakh BG wagons and (-) 0.26 lakh MG wagons. Inspite of this, technological upgradation in the BG wagonfleet allowed the addition of 0.82MT to total BG freighting capacity while MG capacity fell by 0.52MT, allowing aggregate IR freight capacity to increase in net terms by around 0.30MT. As another consequence of the selective phasing out of MG operations, the ratio of BG-to-MG freighting capacity rose to 7.7:1 by the end of the decade, indicating the degree to which the IR traffic focus had switched over from MG to BG sections.

A curious ambivalence can thus be noticed over the planning period regarding the infrastructural character of railway freight operations and the maintenance of adequate wagon capacity for the same. This has been captured in the gauge-wise analysis of freighting capacity on the mainline and feeder networks of IR. In the planning philosophy that guided the early FYPs, the need for augmenting the capacity of the feeder network to handle the downstream traffic anticipated from augmented mainline flows of freight appears to have been acutely felt. In the spatial sense, IR freight services spread outwards to reach the transportation needs of the hinterlands, marking a change from older colonial railway patterns and the conscious use of IR as a development instrument. Freight polarisation in the opposite direction, which became a feature of transportation planning thereafter, was precipitated by traffic setbacks and industrial recession. IR specialisation and the substitution of general freight flows by special freight appears to have been initially undertaken as a temporary device in order to stimulate an industrial recovery by providing IR with guaranteed traffic flows from the PSUs. For a period of time through the 1970s, IR still struggled over maintaining equivalent capacity on both feeder and trunk networks. However as freight specialisation became institutionalised over time because of the durable nature of the railway technology that had been inducted, the importance of expanding downstream railway operations in the hinterlands gradually declined, eventually justifying the write-off of feeder capacity. Instead, the downstream freight flows of the economy gravitated to the roadways where they became subject to increasingly greater transportation costs.

While this seems to have been the broad picture, the onus would not rest entirely with the railways. During a period of capital abundance relative to the size of their existing freight operations, IR strove valiantly to expand into feeder regions and meet the infrastructural needs of the regional economy, maintaining railway technology at appropriate levels. As seen from the financial analysis in previous chapter, the malaise set in after capital support to IR had declined to levels where they had to sustain their services from their operating profits. Hence despite maintaining a surplus position through the subsequent period, IR have progressively been compelled to reduce the horizontal spread of their freight services to maintain capital and wagonfleet adequacy for technology-intensive bulk-freight operations. The results of this have told heavily on the infrastructural character of railway freight operations in India.

4.3 IR Wagonfleet Composition

The preceding analysis has offered a fleeting glimpse of the technical problems created by the simultaneous presence of different gauges on the IR network, which render BG and MG equipment inventories incompatible with each other besides creating economic separation between trunk and feeder operations. As noted previously, early railways in India had been constructed over a BG trunk network on one of the widest railway gauges of 1.6764m [5' 6"]. While this was an administrative decision made under Dalhousie, it was informed by the gauge controversies that had occurred during early railway development in Britain and by the engineering merits displayed by Brunel's 2.2m [7'] gauge on the Great Western, against the narrower 1.435m [4'8½"] gauge adopted as standard gauge on British railways.[10] The purpose behind this choice of gauge was to reduce eventual running costs on Indian trunk operations, although construction on this wider gauge necessitated higher capital outlays per track-kilometre. It is interesting also to note that construction on the 1.6764m gauge appears to have been widely preferred whenever British capital was involved in railway construction overseas, since the same gauge is found presently on railways in Spain, Portugal and Latin America whose construction was undertaken by British companies. Although the later Indian preference for the MG [1m or 3' 3⅜"] gauge arose when the branch and feeder network was under construction because of the financial stringency that occurred after the first phase of railway construction was over and the interest guarantee system had been withdrawn, it was also justified as a means for lowering railway construction costs by using a lighter railway gauge in sectors where traffic density was expected to be limited. Light railways were also specifically constructed to two narrow gauges of 0.7620m [2'6" or QNG] and 0.6096m [2' or NG] to keep engineering costs low in mountain areas and other feeder regions where traffic was expected to be exceptionally light.[11]

The decision on multigauge construction was fraught with future consequences on the composition and utilisation of railway inventories in India, since it necessitated a large volume of transhipment when freight originating on the trunk network was destined for feeder lines, and long detainments when feeder freight was being assembled for trunk operations. This made traffic transit laborious and time-consuming, while entailing additional handling costs that are avoided on through-transits.[12] Also the vast inventories of track, equipment and rolling stock maintained on low-intensity MG networks could not be deployed against shortfalls on the BG system. Gradual conversion of MG to BG at huge capital costs - the byword for which has been the UNIGAUGE scheme launched with much fanfare by IR during the 8FYP, is necessitated by the imperative of doing away with these transhipment costs and delays, but also imposes additional inventory costs of its own as new replacement needs arise for the MG equipment inventories that are rendered redundant. Differentiation between BG and MG has also posed perpetual problems for IR freight planners, since the composition of IR wagon stocks is determined by the rates of apportionment of financial resources over the MG and BG networks.

Substantial improvement in the average carrying capacity of IR wagons was observed to have accompanied the growth of BG and MG wagonfleets. Thus besides multiplying wagon numbers in order to handle the growing freight flows of the planning period, the IR wagonfleet has also diversified into several new wagon-types. Till the mid-century, nearly all commodity-freight had been carried on general-purpose railway wagons, comprising the CR *covered* boxwagon, the *open low-sided* [OLS] K gondola wagon and the KC *open high-sided* [OHS] gondola wagons. The KC open wagon design that was standard for the BG network had evolved as a 4-wheeler wagon with fixed axles, 10.31T *tare* weight (deadweight or unloaded weight), with maximum payloading capacity of 22.19T. The MG network instead employed a smaller 5.69T tare boxwagon with 18.69T payloading capacity running on the smaller MG wheelbase.[13] As a comparative yardstick, it might be noted that the US Class I Railroads already operated much heavier wagon designs of 27T tare with 77T payloading weight, and 34T tare with 109T payloading weight for special freightage of coal.[14] Subsequent upgradations in IR wagon designs, while considerably improving loading-to-tare ratios, have also been directed towards the carriage of special freight.

4.3.1 Freight Innovation and Wagon Design

It has been observed in writings on economic history that the multiple streams of specialised production that imparted an industrial character to modern civilisation only became possible after the prior development of an efficient transportation system. Thus the improvements in standards of living over the 20th-century which have arisen from the 'external' specialisation of entire communities derive historically from the great 19th century advances in transportation.[15] As methods of manufacture increased in industrial complexity, the facility of freightage became correspondingly more crucial to the transformation of finished products from one industry into intermediate material inputs for others. The imperative of minimising transportation costs at a time when product prices were also falling as a result of the economies of largescale production generated a rising need for specialisation within the transportation sector. Specialised innovations on the railways thus arose from the need to provide efficient freight carriage to various industrial sectors at lowest cost. Similar needs have guided the technical adaptations witnessed on the IR freight system.

An important means for augmenting railway freight capacity in a specifically technical sense is superior wagon design. As a part of the technical emphasis in the FYPs on raising wagon payloads, IR have favoured the bogie design which permits longer wagon-body construction using swivelling wheelbases instead of fixed axles. Simultaneous mechanical upgradation of handling facilities for special categories of traffic has also been made. The more important classes of bulk-freight have since been increasingly carried on these high-capacity wagons, even though the standard 4-wheeler boxwagon still remains the workhorse of the IR wagonfleet. The principal wagon-types in current use by IR include the standard OHS KC 4-wheeler wagon and BKC bogie wagon which have now largely been upgraded to the OHS BOX/BOXN bogie-type standard suitable for high-speed haulage of coal, iron and other bulk; the standard CRT 4-wheeler covered wagon used for conveying foodgrains and cement, which is being upgraded now to the covered high-capacity BCX/BCN bogie-type standard suitable for watertight haulage of general freight; the open hopper-type BT bogie wagon with bottom discharge facilities which is being replaced by the upgraded BOBS/BOBX bogie wagon suitable for quick discharge of both ballast and ores; the OLS K wagon which has largely been replaced by the BOY bogie wagon suitable for ore shipment; the TPGL 4-wheeler tank wagon for haulage of POL, edible oils and molasses, which is now being upgraded to the BPTN bogie-type standard; the BFR well-wagon for haulage of overdimensional or extra-heavy freight and machinery consignments; and two variants of the platform wagon, including the BRH flatwagon suitable for the transport of steel rails and bars, and the BFKI flatwagon now being used for carriage of international ISO containers on the CONCOR [Container Corporation of India] door-to-door service. As the KC and CRT wagons decline in number, IR is heading towards the eventual replacement of the 4-wheel FWU standard by the 8-wheel bogie wagon standard which permits reliable traffic transit at much higher trainspeeds.[16]

At this level of disaggregation, the changing composition of the IR wagonfleet also reveals the commodity preferences of its freight operations. Except for standard covered BCX/BCN wagons which can be used the transporting nearly all categories of general freight, all other wagons in the IR wagonfleet handle specialised traffic. Growing complexity of the wagonfleet thus preordains technical rather than spatial diversification in IR freight services by progressively tying them to the needs of captive freight.

4.3.2 IR Special Wagonfleet

Indication of change in the proportionate breakup of the IR wagonfleet under special wagon categories had been provided earlier in Table 4.1, alongside figures for the growth in the number of wagons online. Covered standard wagons still constituted more than half of the IR wagonfleet in the 1980s, although acquisition of wagons of this type had decelerated during the period reviewed. At the end of the 7FYP in 1989-90, the proportion of covered standard wagons in the IR fleet declined to less than 50 percent for the first time over nearly four decades of planning, with the trend having continued since. On the other hand, wagons of the OHS design have been in high demand for carriage of mechanically-loaded coal and other bulk-freight for which sharply increasing tonnage trends had been noted earlier. The proportion of such wagons in the IR wagonfleet rose from around a quarter to a third of total online wagons between the 1950s and the mid-

1990s. Since the average loading capacities on these wagons have been upgraded through design modifications while average trainloads have also increased following the modernisation of IR traction, inference can validly be drawn that the increases in IR bulk tonnages noted in the previous chapter are more than proportionate to the growth in OHS-type wagons. Also, with longer and heavier rakes being hauled on IR trunk routes today, it also appears likely that the actual intensity of use of railway track for freighting purposes has actually declined, even as tonnage-freight has increased.

These peculiar features in IR freight and freight-capacity patterns draw attention to the traffic impact of special wagons in the IR wagonfleet. Quite obviously, increasing returns and high traffic elasticities are at play here. Wagons utilising specialised technology designed around the transportation and handling needs of special freight improve the throughput of captive freight on the IR network as they have done elsewhere. They have thus been critical input in improving freight efficiency on the IR network. However, this improvement also has paradoxical consequences since, after the movement of traffic in rakeloads and the quickening of transits, it creates significant slack on IR track and on other sections of the IR freight network which can only be filled if adequate capital is also being committed to the expansion of other freight services.

LIST: Design Specifications of IR Special Wagons

BOX	: High sided open bogie wagons with side discharge arrangement for transportation of coal & other bulk items
BOXN	: High-sided bogie open wagon with improved components like cast-steel bogies, high tensile couplers, cartridge taper roller bearings, air brakes etc., enabling greater trailing loads, for transportation of bulk commodities like coal, iron ore, etc.
TPGL	: Tank wagons for transportation of liquid consignments like petroleum products, molasses, vegetable oils, etc
BTPN	: Upgraded tank wagons for liquid consignments like petroleum products, molasses and vegetable oils
BOBS\BOBX	: Open Hopper wagons with bottom-discharge arrangements for transportation of ballast, ores, etc.
BOY	: Low sided open bogie wagons for transportation of ores, etc.
BRH	: Flat-wagons for transportation of nails, steel bars, etc
BFU	: Well-wagons for transportation of over-dimensional and heavy machinery consignments
CA\BCA	: Wagons designed for the transportation of cattle
CRT	: Water-tight 4-wheeler covered wagons with higher load-capacity for transportation of general goods
BCX	: Water-tight covered wagons for transportation of foodgrains, cement, etc.
BCN	: Water-tight covered bogie wagons with cast-steel bogie, cartridge-taper roller bearings and air brake
BFKI	: Flat-wagons to carry containers for door-to-door service

Table 4.3: Technical Specifications of BG Special Wagons on the Indian Railways

Wagon-Type	*Wheelbase*	Gross Weight Tonnes *[T]*	Tare Weight Tonnes *[T]*	Maximum Loading Capacity *[T]*	Length over buffers *[mm]*	*Maximum Speeds* Empty *[kmph]*	Loaded *[kmph]*
BOX	*Bogie*	81.30	25.20	56.10	13716	75	75
BOXN	*Bogie*	81.28	21.47	58.81	10713	80	90
TPGL	*Fixed-axle*	31.17	11.17	20.10	8382	75	75
BTPN	*Bogie*	81.28	27	54.28	12420	*n.a*	*n.a*
BOBS	*Bogie*	91.44	30.23	61.21	11638	*M32* *NM40*	*M48* *NM56*
BOBX	*Bogie*	91.70	27.70	63.80	11596	56	56
BOY	*Bogie*	90.60	20.20	70.40	11930	65	65
BRH	*Bogie*	81.30	23.90	57.40	14998	75	75
BFU	*Bogie*	*n.a*	*n.a*	50-183	*upto* 27560	*n.a*	*n.a*
CA/BCA	*Fixed-axle*	*n.a*	*n.a*	*n.a*	*n.a*	*n.a*	*n.a*
BFR	*Bogie*	81.30	23.90	57.40	14998	75	75
CRT	*Fixed-axle*	40.64	13.40	27.54	8824	75	75
BCX	*Bogie*	81.28	28.98	52.80	15710	75	75
BFKI	*Bogie*	*n.a*	*n.a*	*n.a*	*n.a*	*n.a*	*n.a*

Source: Adapted from *IRYB 1983-84*, p41, and *IRYB*, other years, Directorate of Statistics & Economics, Railway Board, Ministry of Railways, Government of India, and RFFC [1993], 1(21):658, *Annexure 21-0*

A brief description of the principal special wagon-types that currently serve the IR freight network has been provided in the list, and their technical specifications in Table 4.3. The composition of the IR wagonfleet by different wagon-types reported earlier [*see Table 4.1*] can thus be related to their freight purpose and their technical characteristics including tare and loading weights. It may be noted that the introduction of special wagon designs by IR were a periodic technological response to the industrial and traffic priorities of specific FYPs. Hence, modification of the standard OHS design to adapt it to the specific carriage of coal and iron ore began during the 2FYP. The OHS BOX-type wagon was inducted into railway operations in 1959-60, and was quickly followed by the technologically-advanced BOXN design. Other open wagon hopper designs like the BOBS introduced during the 2FYP in 1957-58, and the BOBX introduced after the 3FYP in 1966-67, featured special bottom-discharge systems to facilitate quick discharge of ores at metallurgical plants as well as railway ballast.[17] The proportion of these open hopper-type wagons in the IR wagonfleet rose rapidly during the 3FYP period commensurately with the expansion in mining and metallurgical capacity. Through the 4FYP, the rise in the OHS wagonfleet was more gradual and a peak proportion of 15.6 percent of total IR wagons online was reached in 1973-74. Although the proportion slipped through the rest of the decade, it began to rise again during the 1980s so that, by 1994-95, OHS wagons represented 16.5 percent of online IR wagons. Low-sided OLS wagons have traditionally recorded a smaller presence in the IR wagonfleet and underwent proportionate decline during the early FYPs. However, introduction of the specialised BOY variant in 1973-74 for exclusive carriage of iron ore again raised their proportionate presence in the IR wagonfleet to 3.4 percent in 1984-85 and 3.9 percent in 1994-95.

Comparisons between the freighting efficiency of OHS and OLS wagon-designs can be made in terms of payloading capacities and running speeds. The comparision gives some idea of the efficiency basis for wagon specialisation. For instance, while the OLS BOY with lower tare weight of 20.2T and higher payload capacity of 70.4T appears a better choice in terms of payload-to-tare weight ratios, the more ubiquitous BOX design with the higher tare weight of 25.2T and lower payload capacity of 56.1T offers the advantage of faster transits at upto 75kmph, against 65kmph for the BOY wagon. With maximum running speeds of 90kmph, the BOXN wagon is superlative to either of these. The table also shows that the proportion of departmental wagons that cater to IR's internal freight needs has declined from as high as 5 percent of the online wagonfleet in 1950-51 to around 3 percent in 1994-95. The principal cause of this has been the phasing-out of steam traction which has greatly reduced the need for departmental shipment of coal. It is also obvious from the table that departmental freighting capacity has remained relatively stable over the period under review and has consequently declined in proportionate terms, the apparent percentage rise in departmental wagons since 1992-93 having accompanied an absolute decline in the total online wagon numbers.

Logical limits exist nevertheless in making a comparative assessment of wagonfleet proportions, since the changes in percentage of special wagons have occurred over an extended period when the total size of the online IR wagonfleet has risen and then declined. Correct interpretation of the proportions after the 1970s becomes particularly difficult because of the sharp fall in wagon numbers brought on by the decline in wagon renewals. Considering the extended life of a railway wagon as a durable capital asset, it would still be safe to say though, that the overall changes in special wagon proportions reflect the increasing presence of younger-aged and technologically superior wagon stocks, while the declining presence of standard covered wagons represents the physical obsolescence of old stock. This is borne out also by the rising trend in average wagon capacity and consequently the overall increase in IR freighting capacity observed in Table 4.2. Again because of the long-lived nature of wagon assets, IR are apparently in the throes of a capital transition from old technology to new technology. It is another matter that the choice of technology adopted has transformed the commodity-composition of railway freight while creating significant slacks within the IR system.

Evidence of system shrinkage and the existence of slacks can also be deduced from comparing gauge-wise composition of the IR wagonfleet by wagon-types. This comparison is made between the 6FYP and 8FYP periods and therefore assumes additional importance in view of the decision taken during the 6FYP to gradually phase out IR's MG and NG railway operations. Table 4.4 therefore provides a point-to-point comparison of gauge-wise IR wagonfleets between 1983-84 and 1994-95. Although downgradation of light gauge railway operations after the 6FYP has led to the disappearance of gauge-wise breakup figures for wagon-types from IR's public statistics for recent years, comparison of overall stock position between the periods provides sufficient indication that drawing down of composite MG and NG wagonfleets by 60 percent in the interregnum has been the principal reason behind the shortage of covered wagons for carrying general freight on the IR network. Conversely, since special-wagon categories are less present on MG and NG networks, their rising proportion within the IR wagonfleet is attributable as much to the decline of MG and NG wagon numbers as to increased BG acquisition. While such rising proportions explain IR's increasing orientation towards bulk-freight following the 6FYP in the 1980s and 1990s, they also partially mask a decline that has taken place in the spatial spread of IR's general freight services following the downgrading of MG feeder-freight operations.

Table 4.4: Gauge-wise Changes in IR Special Wagonfleet
1983-84 to 1994-95

	Total Wagons	% Covered Wagons	%OHS Wagons	%OLS Wagons	%Special Wagons	%Departmental Wagons
[1983-84]						
Broad-Gauge	293152	49.3	31.3	3.1	13.3	3.0
Metre-Gauge	76981	63.2	17.9	1.7	12.7	4.5
Narrow-Gauge	4623	51.7	*nil*	34.9	10.9	2.5
IR Wagonfleet	374757	52.2	28.1	3.2	13.2	3.3
[1994-95]						
Broad-Gauge	246000	*n.a*	*n.a*	*n.a*	*n.a*	*n.a*
Metre-Gauge	33000	*n.a*	*n.a*	*n.a*	*n.a*	*n.a*
Narrow-Gauge	1000	*n.a*	*n.a*	*n.a*	*n.a*	*n.a*
IR Wagonfleet	280000	41.8	33.9	3.9	16.4	3.8

Source:*IRYB 1983-84* & *IRYB 1994-95*, Directorate of Statistics & Economics, Railway Board, Ministry of Railways, Government of India, New Delhi

Table 4.5: Special Wagon Stocks on IR
1983-84 to 1994-95

Wagon Type	Freight Category	Wagons 1983-84 BG	Wagons 1983-84 MG	Wagons 1986-87 BG	Wagons 1986-87 MG	Wagons 1989-90 BG	Wagons 1989-90 MG	Wagons 1994-95 BG	Wagons 1994-95 MG
BOX	Bulk-freight	51276	..	50747	..	49408	..	36618	*n.a*
BOXN	Bulk-freight	3579	..	13263	..	26225	..	42739	*n.a*
TPGL	POL	30666	4900	30649	4569	34037	4577	2435 *	*n.a*
BOBS/BOBX	Ores	2547	..e	2352	..	2431	..	2510	*n.a*
BOY	Ores	895	..	837	..	899	..	810	*n.a*
BRH	Steel	7107	..	7715	..	7661	..	*n.a*	*n.a*
BFU	Machinery	448	138	417	130	419	130	*n.a*	*n.a*
CA/BCA	Cattle	4957	1546	4015	1195	2994	1081	*n.a*	*n.a*
CRT	General	20838	..	20584	..	20373	..	*n.a*	*n.a*
BCX	General	17987	..	18947	..	18970	..	18546	*n.a*
BCN	General	...	...	...	...	...	...	15582	*n.a*
BFKI	Containers	318	8	322	8	323	8	*n.a*	*n.a*

Source: Adapted from *IRYB*, various years, Directorate of Statistics & Economics, Railway Board, Ministry of Railways, Government of India, New Delhi

*Note: *BG figures in 1994-95 are for the upgraded BTPN design. TPGL strength for the year is unavailable.*

Although Table 4.1 had shown that general-purpose covered wagons still comprise by far the largest proportion of the IR wagonfleet, thus revealing the original orientation of IR towards the transportation of general freight, the proportion of special wagons has steadily increased with the specialisation towards bulk-freight. This is evident from 3.2 percent rise in the proportion of special wagons between the periods above. Although breakup figures for 1994-95 are not carried by the public statistics, rendering gauge-wise comparison impossible, attention is still drawn to the process of internal change within IR represented in selective draw-downs of the gauge-wise wagonfleet. The character of the internal change within IR's special wagonfleet becomes much clearer from Table 4.5 where the wagon-types are sorted by freight categories.

The table reveals that the improved BOXN design is the main wagon-type being inducted into the IR wagonfleet after the policy changes of the early 1980s, and growing numbers have been acquired in the period since. Net additions of this wagon-type to the BG wagonfleet over the 11-year period between 1983-84 and 1994-95 amount to nearly 0.4 lakh units. The corresponding decrement in the fleet of OHS BOX wagons for which the BOXN wagon has been designed as a replacement is just under 0.15 lakh units. Over the same period, there has also been acquisition of over 0.15 lakh BCN covered wagons, which are eventually to replace the older BCX covered wagon. Acquisition of BCX wagons over the period has thus been correspondingly low at only 582 wagons in aggregate, and BCX fleet strength after the 7FYP period has actually fallen by 424 units. Of the older standard fixed-axle designs, the CRT wagon is seen to have maintained a fleet strength of just over 0.2 lakh units while the TPGL wagonfleet uptil the end of the 7FYP stayed at around 0.3 lakh units. The increase in the flatwagon fleet of the BRH and BFKI type over the 1980s should also be noted, although the slower rise for BFKI reflects on the slow progress of containerisation on the IR freight network. Fleet-levels of the older BOBS/BOBX wagon-type and the improved BOY variant have also remained virtually constant over the period and there has only been marginal increase in the BFU type. Fleet specialisation on IR's MG network remains confined to TPGL and CA/BCA wagons, both of which have declined in numbers.

Considering that each of these wagon-types is intended to carry a specific type of freight, the internal capacity relocation that has occurred within the IR network after the 5FYP becomes apparent. With only BOX/BOXN and TPGL/BTPN wagonfleets showing a marked increase, IR have become increasingly specialised towards the carriage of energy-freight. The fleet of BOBS/BOBX and BOY wagons which carries downstream freight flows from the mineral sector has remained constant, although the BRH wagonfleet which serves the downstream transportation needs of the steel sector has risen moderately over the period. Fleet levels of BFU wagons which serve the specialised transportation needs of heavy engineering industry have also remained stagnant. Further downstream in the economy, the fleet of CRT and BCX covered wagons that carry general freight has remained virtually stagnant over the period. The only notable addition to general freight capacity has been made by the introduction of the improved BCN covered wagon. Even so, the presence of covered wagons in the IR wagonfleet has declined overall, as noted in Table 4.1 earlier, while the progress of containerisation has been slow. Quite clearly, IR's increasing commitment towards the carriage of coal freight has reduced its ability to handle general freight.

Gradual alteration, reflecting both current traffic availability and IR current traffic priorities, has also occurred in the relative proportions of different special wagon technologies. Thus the highest proportion of IR's new acquisitions has been of BOXN special wagons which were first introduced in 1982 during the 6FYP to facilitate efficient and high-speed carriage of coal and iron ore. These have generally replaced the older BOX design which is also of older technological vintage. Similarly, while the presence of TPGL tankwagons has been sustained on both BG and MG networks by the ubiquitous need to transport POL products to every corner of the country to feed IR's principal competitors *i.e.* the roadways, the recent stress has been on the induction of the BTPN design which is of most recent vintage. Clearly IR's choices in this respect have been driven by the dependability of these traffic streams, as much as by national energy priorities, and have enabled IR to maintain freight capacity in coal, iron ore and POL traffic. Again, the sharp decline in general-freight capacity resulting from inadequate replacement of old *standard* 4-wheeler covered wagons after they have become outmoded is reinforced by non-induction of BCX and BCN wagons of newer vintage on a sufficient scale, revealing IR's reluctance to invest on a freight sector with dwindling traffic streams. The decline in IR's CA/BCA wagonfleet, being both relative and absolute, features the gradual phasing out by IR of traffic stream which was an important constituent of intergauge freight-flow across BG and MG networks.

Although the gradual innovation of special wagon designs signifies the modernisation of IR traffic operations and increased operational efficiency, it has certain pitfalls. Principal among them has been the increasing number of empty wagon-kilometres being run by IR today[18] because of capacity inflexibility on the freighting unit or railway wagon. While the incidence of empty wagon haulage adds to wagon turnaround times, frittering away the efficiency-gains from faster and higher-capacity haulage, it diminishes the ultimate gains from the induction of upgraded railway technology because of incompatibility between freighting capacity and freighting needs. This aspect will be examined further in the present chapter. Certain other technological problems that arise in association with technological specialisation have also been witnessed on IR. Whenever the mixing of wagons of different vintages occurs on IR goods-rakes, the surfeit of old twin-axled wagons equipped with plain rather than tapered bearings causes overheating of bearing blocks and locking of axles, known in railway terminology as 'hot-boxes'.[19] This problem multiplies when mixed rakes are hauled at high speed under diesel or electric traction. Wagons with hot-boxes while on the run then have to be detached from the rakes between terminals, obstructing the even flow of traffic. To circumvent such problems, the IR freight system is being compelled by the new traction technologies to run increasing numbers of modernised

BG wagons, and more recently, to run block rakes rather than mixed rakes. The technological consequence is that large units of composite freighting capacity are assembled on the rake, which cannot carry anything other than special freight and can only be handled at fixed terminal points which have mass loading and unloading facilities. Hence the flows of freight becomes increasingly one-way resulting in substantial losses of general-freight and revenue. Large sections of the IR network which have neither the line-capacity nor the handling and traction facilities to handle heavy block rakes are progressively neglected leading to virtual route-shrinkage and crowding on the mainline corridors. In sequence, IR is further compelled to shrink its freight-focus to the spasmodic flows of bulk-freight while the thinner trickle of general freight migrates to the roadways.

While this appears to be the general tenor of technical events that have influenced the trends witnessed in the IR wagonfleet, certain principal areas emerge for further empirical investigation in the present study. The first would relate to whether this course of events was *traffic-driven* and hence inevitable, leading eventually to the decline in the infrastructural importance of IR as far as the forward linkages of transportation are concerned. The next would relate to whether the events were *profit-driven* as a result of decreased infrastructural support from the state and hence required that an efficiency choice be made by IR. A third area would relate to whether the events were *technology-driven* and hence resulted from the lack of appropriate innovatory responses from the monolithic state-owned Indian railways to the emerging freight situation in the country. These fundamental questions and the issues relating to them shall be approached at different points in the investigation. The overview of the problem of IR freight capacity provided by the present section draws specific attention to the domestic wagon industry in India which, because of its position upstream of the backward linkages of the Indian railway system, provides an immediate mirror to the upstream consequences of changing freight emphasis on the railways.

4.4 Railway Technology and the Wagon Industry in India

The continuing primacy of railways on the Indian freight transportation system owes much more to the nature and economic command of the bulk commodities that IR handles than to IR's command over market-share. While between 1951 and 1995, the share of IR in internal freight transportation has declined relatively from 89 percent to 40 percent of total freight traffic,[20] its freight handling in terms of tonnages has risen rapidly because of increasing weight-to-volume and weight-to-distance ratios. Although freight demand can be quantified in its macro sense by the freight tonnages that need to be transported and the distances that need to be covered, the demand for freight services from IR in practical settings is not manifested in either form. Rather, freight consigners indent IR commercial authorities at the originating points with their requirement of the number and specification of wagons that need to be provided, and their desired delivery schedules. If this wagon capacity becomes available within a reasonable waiting time at the loading and transhipment points along the route of the consignment, transportation of the consignment is contracted.[21]

Both micro and macro manifestations of freight demand are relevant to the evaluation of IR freight operations. Viewed in a longterm infrastructural context, IR performance indices of tonnages-originating and net tonne-kilometerages have consistently pointed to the growing capacity-constraints of the system. It would not however be adequate methodologically to identify infrastructural lacunae only in terms of the existence of transportation bottlenecks at a given point of time. The problem needs to be studied in a longer dynamic timeframe since the response to infrastructural change does not occur in the short term.

In the light of the patterns of emphasis that have existed in the FYPs, growth of core industrial freight flows on the IR network are not unexpected. A critical rate exists nevertheless, at which incremental freighting capacity should be added each year if the total transportation capacity of the system is to be maintained at dynamically optimum levels. This increment is measured by the net capital addition to freighting capacity over and above the investment involved in replacing overaged assets. In micro settings available freighting capacity on the railways is determined by the availability of wagons online. Thus in growth contexts, the accurate projection of wagon-demands and adequate procurement of wagons by IR, and commensurate production and supply of wagons by industry all become individually important for the even provision of railway freighting services across different production levels in the economy. A component of this dynamic procedure that has seldom received due attention during transportation planning in India is efficient growth of the wagon industry.

As physical movers of freight, railway wagons reflect intricately the forward and backward linkages of railway development. While enhancing the resource flows for downstream production activity, they also widen the field for technological experimentation by the railways and for the application of engineering innovations to improve the freight effort. Despite this importance, anomalies prevail between the organisation of wagon and coach manufacture in India. While wagons are still supplied by several medium-sized engineering units in the private and public sector principally clustered around Calcutta, manufacture of railway coaches is undertaken at IR's own departmental establishments, namely the Integral Coach Factory [ICF] established in 1955 during the 1FYP at Chennai in Tamilnadu, and the more recent the Railway Coach Factory [RCF] established in 1988 during the 8FYP at Kapurthala in Punjab.[22] The need for coaches to be manufactured departmentally has been rooted in the high technical standards needed to ensure safe carriage for railway passengers and has generally required a higher import content. Another departmental unit of IR involved in manufacture of critical ancillaries for wagon and coach manufacture which have substituted certain imports is the Wheel and Axle Plant [WAP] established near Bangalore in Karnataka in 1977 during the 5FYP.[23] Thus while wagon production is located fairly close to the Indian steel and mineral belt, manufacture of coaches and wheelsets involves considerable freighting leads for departmental consignments of steel while moulding the character of trunk operations conducted at principal IR nodes. The three departmental plants represent huge backward-linked investments on the part of IR in order to create economies of scale for coach construction and have since led to the rapid development of coaching technology on the IR system.

A critical link in this technology chain is also provided departmentally by IR's Railway Designs & Standards Organisation [RDSO] which was formed during the 2FYP with its headquarters at Lucknow, Uttar Pradesh, in 1957. Formation of RDSO merged the resources of two older railway mechanical and structural design establishments, namely the Central Standards Office [CSO] that had been established in 1930, and the Railway Testing & Research Centre [RTRC] set up in 1952 just after planning commenced in India.[24] As its acronym would suggest, RDSO provides and tests standard engineering design specifications for railway construction and equipment, while also developing new railway technologies through departmental R&D. Hence in its conception, RDSO is the spearhead for mechanical and engineering innovation on the IR system, providing advanced design technologies for induction into IR track, rolling stock, traction and signalling. The advanced IR wagon designs examined earlier have all originated from RDSO.[25]

Because of such anomalies of organisation, while the technological economies of scale in coach manufacturing are internal to IR and flow within the respective departmental establishments, the wagon-producing units [WPUs] continue to undertake contracted fabrication of wagons with their critical inputs being manufactured elsewhere. Consequently the technological economies of scale still elude them.

4.4.1 The Historical Evolution of Wagon Manufacture

The system of awarding contracts for wagon fabrication is intimately associated with the history of railways in India. Many firms that were or are still in the business are identified with the names of British contractors who had built the Indian railways. The origins of these firms lay in the contracting methods adopted by railway companies while constructing the railway network for India during the 19th century.[26] Several contracting firms involved in laying the permanent way and its structures had subcontracted foundry-work during plate-laying and the construction of railway structures while the major routes were being laid. By doing so, they were able to put their excess capacity and engineering expertise to profitable use during slack periods, allowing retention of labour and personnel. Minor fabrication work had thus already commenced in India during the period of railway construction. An expansion in its scale occurred when major bridgeworks were being undertaken. While the main bridging contracts awarded to engineering firms in Britain directly benefited the British ferrous metal industry, an avenue was opened in India for erstwhile railway contractors to subcontract the assembly of large prefabricated iron bridge sections, thus reducing the volume-to-cost ratios for heavy metallurgical components that had to be transported from Britain. As is quite evident, it was only through subcontracting and fabrication that British engineering industry could in fact participate in railway construction far away in India. Although in this sense, the subcontracting system was backward-linked to the construction of railways, the nature of innovation it involved was mainly organisational since the backward linkage still flowed unimpeded to metalworks and engineering firms in Britain.[27]

Because of the subcontracting system, fabrication thus remained essentially of a low-technology nature since there was neither need for transfer of plant or technology.[28] Consequently, entry was open to all railway contractors who had accumulated a minimum of stores and capital. Availability of cheap labour also encouraged manual fabrication methods at piece-rates which made the direct importation of assemblies uncompetitive. Even greater economies of scale obtained where unit-sizes of assemblies were smaller, such as during the fabrication of wooden bodywork for early railway coaches and wagons. Hence while the fabricating firms grew to appreciable size, they remained contract suppliers rather than manufacturers. Subcontracting also worked to the advantage of railway and engineering companies whose responsibilities were reduced to supervision of the contracted works, and received a further boost during the period of railway cost-cutting and State construction between 1869-1882 when construction in India was undertaken departmentally by the Public Works Department [PWD].[29] The system has remained institutionalised in India till the present day in the modes by which many PWD and railway works are still executed.

Unlike in other countries including Britain, the domestic backward linkages from Indian railway construction were thus confined mainly to simple fabrication and civil works. While this limited the infrastructural impact of the railways on the evolution of Indian engineering and metallurgical industry, it also perpetuated certain other peculiarities within the railway system. Often noted among these was the pronounced preference of the Indian railways for wrought iron and riveted-steel construction, witnessed in the preponderance of metalwork at railway stations and in the earlier bridges of the IR system. Although technological justification offered for using riveted bridgeworks at the time made references to the sizes of Indian rivers to be forded,[30] this mode of bridge construction also continued to sustain the manufacture of pre-assemblies in Britain before their fabrication in India, long after the railway revolution in Britain was over. The contracting system thus considerably influenced pre-Independence bridge design in India, where some of the largest bridges constructed since have favoured ferro-concrete to girder-steel engineering, avoiding the enormous recurring costs still incurred in refitting, regirdering and repainting the old railway bridges of the IR system.[31] It emerges quite clearly therefore that while railway construction in India showed typically strong backward linkages to the metallurgical and engineering industries, little of these applied within India.

It would appear that clustered location of the wagon fabricating units around Calcutta is an inheritance from the same historical factors. Trade and industry during British rule had mainly concentrated in the port hinterland of the city, giving Calcutta its commercial dominance over other port cities during the pre-Independence period. Even after commercial setbacks over the period of WWII, nearly 40 percent or 7.06MT of the aggregate shipping tonnages of 18.35MT in India during 1947-48 accrued from Calcutta port, against 29 percent from the port at Bombay.[32] Early foreign mercantile presence had been attracted to the hinterland by its vast trade in cotton piecegoods. After the EIC presence had been consolidated into possession by the Battle of Plassey in 1757, British investment gradually switched from trade into production activities which began to yield sizeable commodity exports of opium, indigo, tea and jute. The region was well-served by natural waterways. Discovery of coal at Raniganj and iron ore and manganese deposits close by added the potential for developing ferrous metal industry within the hinterland.[33] The result was that the headworks of the Indian railways were located at Calcutta. Vastly larger shipping tonnages rising to 10.10MT in 1912-13 were being handled at the port during the period when metal structurals imported for the railways were still landed at Calcutta. In 1909, the Tata Iron & Steel Company [TISCO] founded at Sakchi, 243km from Calcutta, stepped in to close this breach by making steel for the Indian rail lines and was followed shortly after by the Indian Iron & Steel Company [IISCO] set up at Burnpur in 1918. Finally, the establishment of the Tata Engineering & Locomotive Company [TELCO] at Jamshedpur in 1945 opened the British monopoly on the supply of railway equipment and engineering materials to direct Indian competition.[34] The proximity of coal, iron & steel and engineering facilities accelerated industrial development in neighbourhood of Calcutta, allowing old foundry units to diversify into wagon fabrication in a classic manifestation of the railway-mining-metallurgical-engineering industrial linkage. Till the present day, these regional advantages account for the persisting locational pattern of the Indian wagon industry.

The move of railway subcontracting firms into wagon production however took some time to accomplish. Old modes of wagon manufacture on the Indian railways had merely involved the building of wooden trucks on imported underassemblies and wheelbases. With the growth of traffic initially being slow and no regular replacement needs having arisen, no immediate need was felt for upgrading wagon technology. Hence although the steel wagon had already been inducted on the British railways and an all-steel design approved in 1908 for use on the Indian railways, its widespread use on the Indian network had to wait until fleet depreciation rose to significant levels during WWI. Systematic manufacture of railway wagons was thus not undertaken in India before WWI. The Indian wagon industry was brought into being when the accumulated wagon shortfall led to Government notification in 1918 guaranteeing the annual purchase of a minimum number of railway wagons from domestic sources, provided their offer price did not exceed the import price of wagons.[35] The Indian Standard Wagon Company was formed immediately after this notification, and was soon joined by other enterprises.

Little progress could be made initially in the face of price-competition from British manufacturers. Thus in 1924, the government accorded approval to a Tariff Board scheme providing for protection to the nascent Indian wagon industry. With subsidies being provided under the scheme between 1924-27, the older guarantee of purchase was withdrawn since the industry had been afforded protection. On receipt of the production subsidies, it had become possible by 1927 to construct steel wagons in India at a competitive price in India, provided sufficient volumes were involved. Even so, the continuous railway orders necessary to sustain domestic wagon production were not always forthcoming, and complaints also arose that the railway companies were still needlessly directing their orders to manufacturers abroad. More serious difficulties arose after the railways announced in 1927 that they had surplus freighting capacity and would need to scale down wagon orders drastically. The Tariff Board then proposed while lifting protection subsidies, that all wagon orders should henceforth be placed with the domestic industry. In spite of the recommendation, little enhancement in wagon orders occurred and the industry continued to remain in a depressed state till Independence.[36] Ironically, the situation since then has not improved fundamentally, and the wagon industry still operates under severe constraints that originate from erratic wagon orders and consequently high levels of inventories.

4.4.2 Wagon Technology Initiatives under the Plans

At the time they were incorporated into IR, railways in India were quickly nearing technological obsolescence but still depended largely on imports for engineering, rolling stock, structural and technical requirements. Steam was the sole mode of traction, except on the suburban line at Bombay where DC electric traction had just been introduced.[37] The CR fixed-axle wagon of 1908 design vintage with a loading capacity that was barely double its tare-weight composed the standard BG freight stock, with only a limited number of bogie wagons being available for transportation of rails and special freight. Although IR had inherited an extensive network of 54,694 route-km, even its best BG trunk lines were single-track and used light 44.64kg rail with fishplate joints fastened by dog-spikes or keys on wooden sleepers at a low density of 1300 to the kilometre. Consequently, maximum axle loads on such lines were restricted to less than 16.5T which limited the capacity to handle freight. Signalling on the network was still done manually using semaphore. Track interlocking was rudimentary, and the vast majority of stations had hand-operated points with Standard I track which restricted approaching trains to speeds of under 50kmph. Telecommunication between most stations on the network was by morse code.[38] The IR system at Independence was thus overdue for technological renewal.

Planning initiated this renewal by parts, seeking to maintain a balance between the need for railway modernisation and the growth of domestic technological capability to match the rising flows of freight expected from economic expansion. As a consequence, the growth of physical stock on the IR system since 1950-51 has been tied to the development path of India's economy. Rolling stock changes over the period since provide partial evidence that the stress has been on technological renewal rather than mere expansion of numbers. In the case of traction, while the total locomotive fleet declined from 8209 to 6919 units between 1950-51 and 1994-95, its steam component fell from 99 percent to just over 5 percent. The slack was mostly taken up by progressive dieselisation of the system with 1.9 diesel traction units being added *pro rata* for every additional electric unit.[39] Technological renewal is more difficult to visualise from consolidated figures for non-tractive rolling stock, where passenger coaching units multiplied overall from 19,168 to 30,3006 units over the identical period. Similarly, the online wagonfleet has increased from 205,596 to 291,360 units after having touched peak levels of over 4 lakh units in 1980-81.[40] Nevertheless, the changes in the composition of IR wagon stock that have been examined previously reveal the technological nature of such growth.

High order of growth was also witnessed in the IR workforce from 9.14 lakh personnel to 16.02 lakh personnel over the period reviewed. With increase in the number of service points being implied by the addition of nearly 10,000 route-km and by growth in the number of railway stations from 5976 to 7056 over the period,[41] this would imply the continuance of high levels of labour-intensity in IR operations. This is in sharp contrast to the path chosen by other railway systems like the US railroads which also had a very high proportion of single-track lines but resorted instead to route development and early mechanisation in order to carry ever-increasing freight loads.[42]

4.4.3 Wagon Manufacture through the Plans

At the commencement of the 1FYP, there were four wagon producing units [WPUs] in the country, namely Indian Standard Wagon Ltd. at Burnpur, Jessop & Co. and Braithwaite & Co. at Calcutta, and Burn & Co. at Howrah - all locations in and around the same vicinity. With government deciding to leave the fabrication of wagons to the private sector while expanding wagon orders in order to rejuvenate IR, rapid proliferation took place and by the 2FYP, there were 13 WPUs operating in the private sector with total licensed production capacity of 26,000 wagons p.a. While steady wagon orders from IR over the 2FYP and the 3FYP kept the WPUs in good financial health, economic recession in the mid-1960s and consequent cuts in wagon orders after 1966-67 caused industrial turmoil, and many WPUs were ultimately faced with closure. The earliest to shut down were Saxby & Farmer, Braithwaite and Indian Standard Wagon, which were followed by Britannia Engineering and a few others over the late-1960s and early-1970s. Braithwaite, Indian Standard Wagon, Jessop, Burn & Company as well as two other WPUs that had been set up in Bihar were subsequently taken over by the government and turned into PSUs.[43] Continuing uncertainty regarding the IR demand for wagons has since then saddled the Indian wagon industry and its ancillary units with chronic excess capacity. A study of the evolution of the industry over the planning era will shed light on this position.

In 1951, total production capacity at the 4 WPUs then in existence - namely Indian Standard Wagon Ltd. and the Jessop, Burn and Braithwaite companies, was just 6000 wagons p.a., while another 3925 wagons were fabricated over the year at different departmental workshops of the railways and at other engineering firms located in West Bengal, Bihar, Maharashtra and Punjab.[44] Although the 1FYP target for wagonfleet augmentation was set at 30,000 units, actual production exceeded this by 11,966 wagons because of the replacement of overaged stock. The annual requirement of 25,000 wagons p.a. projected for the 2FYP exceeded current domestic capacity, and led to the establishment of four new WPUs in West Bengal and Maharashtra, with another engineering unit at Chennai (then Madras) being licensed to assemble 5000 imported wagons p.a.[45] Because of the addition of imports, production exceeded licensed capacity by 10 percent in the second year of 2FYP. Because of subsequent shrinkage in IR orders the position could not be sustained , so that while capacity utilisation at the end of the 2FYP had fallen short of 50 percent, the number of WPUs had also declined leaving only larger-sized WPUs in the fray.

Reduced wagon production over the 2FYP had also been caused by shortages of steel. Hence while wagon acquisition over the 3FYP inclusive of replacement allowance was projected at over 1.17 lakh units, emphasis was also laid on the induction of BOX wagons that would enhance the freighting capacity for coal, iron ore and other critical minerals. Additional production capacity was therefore created through the licensing of new WPUs to raise the aggregate production capacity of the industry to 33,500 wagons p.a. Steel supply to the WPUs also improved considerably after the outputs from the new integrated steel plants [ISPs] in the public sector came onstream.[46] Production of wagons consequently increased from the low of 7634 wagons in 1960-61 to 23,600 wagons by the end of the 3FYP, with capacity utilisation over the period rising from under 35 percent to over 66 percent. But following the industrial recession after 1966-67, production levels nose-dived to an average of just over 11,000 wagons p.a. till the end of the 1970s and capacity utilisation averaged well under 40 percent. The nadir was witnessed in 1971-72, when total production was just 7010 wagons and capacity utilisation had fallen to 24 percent. Existence of idle capacity on this scale proved the undoing of several WPUs which began to leave the wagon industry after the 4FYP. The sustained industrial crisis was precipitated when the current traffic squeeze being faced by IR caused them to prune wagon orders drastically. Even though freight realisations by IR have maintained a rise in tonnage and traffic terms through most of the period since the 3FYP, no pickup occurred in wagon orders till the end of the 7FYP.

Table 4.6: Production and Capacity-Utilisation in the Railway Wagon Industry in India 1955-56 to 1987-88

FYP & Years	Wagon Producing Units	Licensed Capacity in Wagons *p.a*	Wagons actually Produced	% Licensed Capacity Utilisation	Average Production per WPU	Average Idle Capacity per WPU
2FYP						
1955-56	10	14560	13500	92.7	1350	106
1956-57	10	14560	16019	110	1602	-146
1957-58	8	20135	16956	84.2	2120	397
1958-59	8	20135	13515	66.7	1689	828
1959-60	9	20255	10077	49.7	1120	1131
3FYP						
1960-61	11	22155	7634	34.4	694	1320
1961-62	11	26000	10530	40.5	957	1406
1962-63	15	26472	18100	68.3	1207	558
1963-64	15	26472	19300	73	1287	478
1964-65	15	35534	23600	66.4	1573	796
Annual Plans						
1965-66	15	29409	24983	85	1666	295
1966-67	15	30409	16683	55	1112	915
1967-68	16	30409	13783	45.3	861	1039
1968-69	16	29940	15248	51	953	918
4FYP						
1969-70	16	32819	13214	40.2	826	1225
1970-71	16	32819	10489	32	656	1396
1971-72	16	33869	8010	23.6	501	1616
1972-73	16	33969	9721	28.6	608	1516
1973-74	16	33869	11500	34	719	1398
5FYP						
1974-75	16	33869	9205	27.2	575	1542
1975-76	16	30625	12233	40	765	1150
1976-77	13	30625	11920	39	917	1439
1977-78	13	30600	13072	42.7	1006	1348
1978-79	13	29540	11047	37.3	850	1423
Plan Holiday						
1979-80	13	29540	12541	42.4	965	1308
6FYP						
1980-81	13	29540	13000	44	1000	1272
1981-82	14	31585	13050	41.3	932	1324
1982-83	14	31585	13561	43	969	1287
1983-84	14	31585	13996	44.3	1000	1256
1984-85	14	31585	13110	41.5	936	1320
7FYP						
1985-86	14	31585	9530	30.1	681	1575
1986-87	14	31585	18140	57.4	1296	960
1987-88	14	31585	12800	40.5	914	1342

Source: Adapted from H.L.Chandhok [1990]: *Indian Database: The Economy: Annual Time-Series Data*, vol2, The Policy Group, UM Books, New Delhi; *figures for subsequent plan years unavailable*

The positions indicated by Table 4.6 amply reveal the persisting difficulties of the Indian wagon industry arising from excess capacity. While the way out would be to increase the offtake of wagons by IR, this solution appears a far cry now after changes in planning philosophy have considerably reduced capital allocations to IR and left the onus for mobilising funds to the railways themselves.

4.4.4 Current Status and Organisation of the Indian Wagon Industry

The Indian wagon industry presently comprises 13 WPUs, of which 6 are in the public sector and 7 in the private sector. The largest number of WPUs are located in the eastern region in or around the state of West Bengal, for the historical reasons already described above. These are Braithwaite and Jessop at Calcutta, Indian Standard Wagon at Howrah, Burn Standard at Howrah and Burnpur, and Bharat Wagons at Mokameh in Bihar, all of which are old private units now run in the public sector. Texmaco is another large WPU located near Calcutta which has remained in private hands. Two WPUs are located in the northern region, namely Hindustan General Industries at Delhi, and Modern Industries at Ghaziabad, Uttar Pradesh, while another two, namely Binny Engineering and Southern Structurals, are clustered around Chennai in the southern region. The central region has a solitary WPU, namely Central India Machinery Manufacturing Company [CIMMCO] which is located at Bharatpur in the state of Madhya Pradesh.

As their locational history has also revealed, WPUs in the eastern region are favourably situated close to collieries at Raniganj, Solanpur and Asansol and near major metallurgical plants such as TISCO, IISCO and the Durgapur Steel Plant [DSP] under the Steel Authority of India Limited [SAIL]. They also lie within the largest cluster of engineering industry in eastern India. Like most other heavy industrial units, they are also strategically located close to major sources of power from the State Electricity Board [SEB], the Damodar Valley Corporation [DVC] and the National Thermal Power Corporation [NTPC], and in an area where the advantages of hiring technically proficient labour can easily be reaped. The port facility at Calcutta offers them an additional advantage unavailable to other WPUs except those at Chennai. All locational factors governing their situation therefore point towards lowest costs being incurred in procuring basic raw materials. On the same criteria, the WPUs elsewhere are located at a comparative disadvantage.

In spite of possessing such advantages and being backward-linked to the development of the IR freight system after the FYPs, it seems remarkable that the WPUs in the eastern region and the Indian wagon industry as a whole should be in such persisting distress. To understand the reasons, an exploration needs to be made of the internal economics of the wagon industry, including its production structure and its production planning processes.

4.4.4a Production Structure

The semi-finished inputs required for wagon manufacture are mostly metallurgical in nature, comprising grey iron, steel castings, wheel and axle sets, sleeper bars, spring steel, etc. As in all other heavy engineering units, coal and power are the most important accessory inputs. However the resemblance ends there. Wagon production is labour-intensive in nature and does not require sophisticated plant and equipment, since the WPUs depend principally on IR for the supply and freighting of critical materials, including technical components. An exceptional organisational feature of the Indian wagon industry is the system of contracted manufacture. Wagon-building contracts are essentially fabrication contracts in which the entire requirement of steel and most major technical components are supplied by IR to the WPUs free of cost. Although prior to the mid-1970s the WPUs undertook supply contracts rather than fabrication contracts, they were still being supplied free wheelsets by IR. Most technical inputs required by WPUs are now domestically produced, except for the cast-steel bogies imported since the 6FYP as part of the programme for modernising IR. Free inputs supplied to the WPUs under fabrication contracts include wheelsets, roller bearings, cast-steel bogies, central buffer couplers, air-brake equipment and laminated bearing springs, which are either manufactured departmentally at IR workshops or by ancillary units located close to the WPUs.

Canalisation of free-supply technical inputs to the WPUs is undertaken for economic reasons. Through IR's leverage with SAIL and with component-suppliers, procurements of steel can be made at ex-factory rather than stockyard prices while favourable prices can be negotiated for major wagon components and subassemblies, resulting also in considerable savings on the attendant taxes and duties. Because of reliable multisourcing, component-purchases can be scheduled according to wagon production schedules, thus lowering inventories. Finally, the procedure economises on component imports by ensuring that these occur only after domestic production has been full utilised.

The value of free-supply components constitutes around 65 percent of the total cost of a BOXN wagon, and proportions for other wagons do not differ very much from this. The free-supply system thus lowers working capital requirements at the WPUs, which would otherwise have had to mobilise under commercial terms. Supply of free capital inputs by IR to independent WPUs implies that wagon production is jointly organised by the buyer and the sellers, giving the wagon market a unique character where the pricing of wagons by the WPUs has to impute shadow costs for the free inputs received from IR.

As the most basic of required inputs, supply of steel is arranged centrally by IR on the basis of indents placed at Calcutta since most major WPUs are located around the city. Free supply of steel to the WPUs in the form of steelplate, structurals and flats, and hot and cold-rolled sheets comprises a major portion of IR's total requirement of steel for non-track purposes. Thus out of approximately 3.5 lakh tonnes of steel drawn annually by IR as non-track material, as much as 35 to 40 percent is routed into wagon production.[47] Timely provision of other free-supply inputs by IR in concordance with wagon production schedules also holds great importance for avoiding the stabling of incomplete wagons at the WPUs. Thus the efficiency of wagon production rests in a large part on the efficiency achieved by IR in planning the bulk procurement of inputs required for wagon manufacture in advance and in coordinating their distribution to WPUs. Quite obviously, advance planning of such nature rests on IR's advance planning of wagon requirements.

4.4.4b Production Planning and Materials Management

Planning and procurement of free supply inputs by IR is carried out under the supervision of the Railway Board. This involves initial formulation of wagon production plans for the year, as the basis for estimating input requirements. Lead times for the procurement of indigenous inputs are around 9 months, and rise to 10-12 months for imports. Hence unless wagon production plans are finalised at least a year ahead, difficulties can arise in arranging timely supply of inputs to the WPUs. Apart from physical factors, the size of the production plan also depends on the appropriation made in the Railway Budget towards current wagon-acquisition, which has only a 3-month production lead. To circumvent coordination difficulties, a tentative wagon production plan, subject to ± 30% revision depending on funds committed by the Budget, is framed in advance to raise the lead time for production planning and the procurement of technical inputs to around 12 months.

Input requirements for the financial year are estimated after debiting inventories already lying with the WPUs and input supplies outstanding against previous purchase orders or stabled wagons, if any. A margin is then added to the input estimates to cover the inputs required by wagons to be supplied before the commencement of the financial year, and to maintain buffer stocks of imported inputs at a level adequate for 3 month's production at the WPUs. Due to the very large quantities in which free-supply items are required, IR usually places parallel contracts with several suppliers. These include an escalation clause which leave it to IR's discretion to raise the supply quantity if necessary, to make up for default on the part of certain component-suppliers.

Tenders for the net requirement of indigenously-manufactured inputs are floated about 9 months prior to start of the financial year. Additional lead time of 3 months is provided for input imports to allow for opening of LOCs, potential shipment delays, ocean-transit times, port clearances and so on. Precise assessment of the future production trends of indigenous inputs helps to prevent unnecessary imports. Sporadic problems can arise nevertheless, as when precise production estimates of 20T wheelsets at Durgapur Steel Plant [DSP] could not be made, and subsequent failure on the part of DSP to meet its supply commitment created major stabling problems for the WPUs. After the changeover to 23.2T wheelsets since the 6FYP and their departmental production by WAP at Bangalore, this particular problem has eased.

Before the supply of free inputs can be undertaken by IR, annual wagon production quotas have to be allotted to different WPUs. In order to deal collectively with IR, WPUs in both public and private sectors have grouped themselves since 1973 under a joint-sector consortium called Wagon India Limited [WIL]. WIL negotiates wagon procurement levels and input-supply positions with IR and allocates wagon orders and design specifications between individual WPUs. Each WPU then has to produce the specified wagons from its quota of free-supply inputs and its own resources.

The overall supply position of free-supply inputs against the wagon production plan is closely monitored at IR and WIL. Detailed monthwise production plans for different wagon-types to be produced at each WPU are prepared by WIL, on the basis of which free-supply inputs are allocated to the concerned WPU. Monthly input quotas are jointly decided between the WPUs, WIL, the ancillary component producers and RDSO. While assigning non-departmental input quotas, consideration is given to the past performance of the ancillary, proximity of the ancillary unit to the WPU, and also to any preference that the WPU may have for a particular supplier. Where ancillary components are manufactured within the WPUs, as happens in case of Texmaco, Burn Standard and CIMMCO, the free-supply ancillary inputs required by them for wagon production are allocated internally to avoid additional transportation. If the total input quantity on offer from component suppliers exceeds the combined current requirement of the WPUs, the excess supply is allocated between WPUs in accordance with their input requirements for the subsequent month.[48] But in spite all such management procedures aiming at market coordination, mismatch in the input flows from IR to the WPUs are a common affair and many wagons have to be stabled by the WPUs in an unfinished condition.

4.5 Structural Peculiarities of the Indian Wagon Market

The production of railway wagons in India thus has certain exceptional features. Under its mode of organisation, the WPUs still undertake fabrication contracts at the instance of IR, rather than manufacture in its full industrial sense. Although this system has historical roots which were explored earlier, the shape it has acquired since has been directed by the transportation planning process. After a degree of centralisation on the Indian railways had been brought into being in the pre-Independence period by the recommendations of the Acworth Committee and by the takeover of several companies under repurchase clauses, the task of standardising railway technology had devolved upon the CSO set up in 1930.[49] Till planning started in India, the purpose of central railway institutions had been to formulate civil and mechanical standards for Indian railway engineering and to ensure that imported and indigenously-acquired railway equipment met such standards before induction. The pace of acquisition till Independence had nevertheless been slow. After nationalisation of the railways, the responsibility for funding technological renewal devolved more strongly upon the state. Facing technological limitations within the existing IR system, the FYPs thus initiated phased replacement of railway technology under a concept of macro efficiency. Since the key to this lay in the indigenous development of strategic technological capability, the plans sought to preserve economies of scale for railway R&D by creating specialist research institutions such as RTRC and later the RDSO. With the major capital costs of technological design and development thus being borne by IR's own departmental units, it was possible to develop and test new IR designs and specifications indigenously in keeping with the broader plan focus on import substitution. Greater difficulties were faced however while creating facilities for their indigenous manufacture. Consequently, capacity for the manufacture of strategic and high-technology railway inventory such as traction equipment or advanced bogie coaches had to be created from scratch by setting up departmental production units such as the Chittaranjan Locomotive Works [CLW] in 1948 near Asansol in West Bengal or later the ICF at Chennai. Again on the principle of economies of scale, it was decided that fabrication of a comparatively low-technology product such as a wagon body could be farmed out to medium private-sector engineering units where such capacity already existed, by providing their requirement of advanced critical inputs such as brake equipment or cast-steel bogies from the upstream strategic capability that was being created in the public sector.

While this arrangement had an efficiency logic of its own by minimising waste during the creation of advanced technological capability, it told differently upon the manufacturing economics of IR coaches versus wagon units. Built to high safety standards, the all-welded integral coaches were manufactured departmentally, thus involving internal costing rather than pricing principles during their acquisition by IR. The rate of acquisition of railway wagons, which were being fabricated externally, depended instead on the pricing economics of the WPUs. The dynamic behaviour of the wagon market thereafter is quite simple to understand if cognisance is taken of IR's presence in the market as a sole buyer and the presence of several WPUs as common producers and sellers of an undiifferentiated low-technology product with no alternative uses. As long as FYP funds were flowing for freight capacity expansion, expanding conditions existed in the wagon market allowing a reasonable margin of profit for existing WPUs and accommodating the entry of newer ones. No entry-barriers as such existed in terms of technological capability, since the wagon technology was supplied by IR rather than being created by the WPU. Hence the only features of the market that influenced the new entry were the locational economics of wagon production, which in ordinary situations would have ensured that the wagon industry remained in areas where it was locationally served. Initially it did, as the expanding wagon market brought many more WPUs into business in and around Calcutta. Nevertheless, their sustained presence within the market required stability and regularity in wagon orders from IR. This was not a peculiarity of the market structure but a peculiarity of the railway wagon as a product, since identical needs for maintaining stability in wagon orders had been articulated by the nascent Indian wagon industry as early as the 1920s, as noted earlier. The inevitable result of the cutbacks in IR wagon orders following the 3FYP was excess capacity, and consequently, price-competition between WPUs forcing the closure of many after the economy had been hit by deep recession. While the closures were a means for market equilibration through a rather ruthless shedding of capacity, the short-term response of the state was to take over sick WPUs and to try to put them back on their feet again with capital support. What the WPUs really needed to tackle their dire situation at the time were infusions of technological capability rather than of capital.

What role was played by the IR transportation policy in the emerging situation ? Quite clearly, the attention of the FYPs and consequently of IR policy remained on the preservation of internal technological economies of scale. As a part of its focus on PSU-led industrial revival, the 4FYP sought improvement of IR freighting capacity through technological solutions such as line conversion and the improvement of traction, necessitating the upgradation of IR wagon technology in order to improve the freighting capability for coal which was crucial to the revival of core-sector activity. Rather shortsightedly, the problems that had confronted the WPUs uptil then were ascribed to poor management rather than to poor technological capability. It became increasingly the practice to locate new public-sector production and technology units well away from the eastern steel belt, compounding the transportation bottlenecks being encountered by IR while also destroying the locational economics of wagon production. IR was able to activate this process because of the departmental nature of its production and supply of critical inputs, which allowed it to locate units as crucial as WAP far away in Karnataka, nullifying locational economies through policies like freight equalisation[50] that ensured equal transportation charges for critical industrial freight regardless of the freight leads that were involved.[51] The obvious corollary that followed was the establishment of new public-sector WPUs in areas entirely unsuited to their location, such as Delhi or Madhya Pradesh.

As long as the tendering system was being followed for wagon acquisition by IR, locational economies still exerted some influence on the offer prices of wagons and hence on the order volumes that went to each WPU. Two factors appear to have undone this. The strategic thrust on the upgradation of wagon technology to 8-wheeler BOXN standards greatly increased the critical content in wagon manufacture, including a high fraction of specialised imports such as cast-steel bogies. To maintain and optimise the flow of these, it became incumbent upon IR to canalise supplies to the WPUs giving IR a greater organisational role in the manufacture of their wagons. Since already there was an apprehension that the high prices of Indian wagon were lowering their acquisition below the rates at which freighting capacity needed to be augmented, wagon pricing came under close scrutiny by IR.[52] Both market structure and the contract system of wagon manufacture followed by IR played a role here. With the full costs of wagon manufacture never being apparent because of the presence of free-supply inputs, there was a tendency to substitute pricing principles by costing principles during such scrutiny. In this, IR tended to be guided by the experience of departmental production of integral coaches where similar high-technology inputs were also used. Consequently, what was overlooked during the costing scrutiny were the economies of scale and the high capital-intensity of coach manufacture, unlike wagon manufacture which required minimum plant and was highly labour-intensive. While on pricing grounds, the WPUs came under unjustified criticism, IR's decision to also canalise the supplies of steel further destroyed the locational economies of wagon production by ensuring that a WPU located anywhere in the country could price its wagons on labour alone, turning the wagon supply contracts into fabrication contracts. While this squared up production costs for wagons supplied from any part of the country, it also gave IR an ultimate pricing stranglehold on the wagon industry in India, while adding considerably to the leads and tonnages of departmental freight.

Under such circumstances, the tendering system became untenable since with a major part of their hidden costs being absorbed by IR during the supply of free inputs, it gave newer WPUs with updated plant a pricing advantage. Thus in an exercise of countervailing power in the monopsonistic market, the WPUs banded together under WIL institutionalising the disappearance of the economies of location from the Indian wagon industry. Certain pitfalls have continued in the present system, because of the perpetuation of the contract system for fabrication of wagons. Inefficiency on the part of IR in procuring and delivering free-supply inputs translates into production inefficiency on the part of the WPUs. Although this adds additional costs to wagon manufacture, IR does not carry the liability for these. By contrast, late procurement and supply of vital inputs to IR's own departmental production units imposes direct liability on IR costs. Given this situation, the coordination problems faced by the wagon industry in India appear to be rooted in the size of the wagon-procurement quotas fixed by IR, since it is these that are the real determinant of wagon production levels, rather than industrial costs and prices.

4.5.1 Problems of Allocative Efficiency

Vis-a-vis the markets faced by other engineering industries, the market for wagons is thus atypical. The main points of distinction are the monopsonistic nature of the market, the existence of production by quota, the bifurcation of wagon production into the high-technology manufacture of components and low-technology fabrication, and the consequent limitations on the economies of scale and location. The volume of wagon supply thus depends on total orders received from IR and the production quotas set by WIL for the WPUs.

Facing a predetermined demand situation, the principal operational objective of the WPUs becomes the minimisation of production costs, which because of the free-supply of upto 65 percent of their high-technology inputs, are essentially labour costs. It needs to be examined whether in a market possessed of such oddness, the WPUs can efficiently allocate resources, meet product specifications and price wagons economically.

Although monopsonistic, the behaviour of the market is influenced to a certain degree by the fact that as PSUs, both the *buyer* or IR and the *sellers* or public-sector WPUs are supported on public money and are consequently afforded protection by the state. On its production side, the market structure assumes a collusive oligopolistic character with cartelisation of the WPUs under WIL. Thus the wagon production targets for the WPUs are allocated exogenously by quota rather than by market forces. In such circumstances, the resource allocation decisions of the WPUs lose some of their constraints. The WPUs actually operate in a protected market, with that protection being provided directly by IR through free supply-inputs and indirectly by the guarantee of purchase on orders placed through WIL. Most interestingly, because the free-supply of inputs makes IR a participant in wagon manufacture, the market for wagons also becomes something of a *buyer-seller* cartel. In such a market situation, with imperfect market elements in both its buying and selling segments, uncertainties arising from organisational lapses, erratic order-placements, or capital shortages of any kind destroy production incentives for the WPUs. This imperfection of the wagon market directly derives from the concept of macro efficiency embodied in the FYPs. What is being dynamically optimised through the resultant market procedure is the flow of high-technology to the IR system. In practice however, the physical production of wagons cannot be optimised through the pricing mechanism because the infrastructural character of plan investment on IR technology results in autonomous rather than price-determined wagon demand on the part of IR.

Nonexistence of data on the complete cost-structure of the wagon industry becomes an impediment to the direct analysis of allocative efficiency in the WPUs. A compensation can nevertheless be made by dealing with the issue from the demand side, *i.e.* in terms of the factors that determine the IR demand for wagons. It may be noted that the size of wagon procurement orders received from IR *prima facie* determines both the cost and profit structures of wagon production, and hence also the fate of the Indian wagon industry. As production levels at the WPUs depend on advance orders received from IR and involve the assembly of technical inputs including those supplied free of cost by IR, any *post facto* revision of wagon orders resulting from IR hindsights over the 12-month lead period places the WPUs into a precarious position.

Allocation of wagon procurement orders received from IR is made among the WPUs by WIL on the basis of their licensed capacity as well as their average and best production performances over the previous 10 years. However the *installed* capacity at each WPU, which depends on actual plant, equipment and labour employment, may not conform dynamically to the capacity licensed by government. This is particularly in view of the chronic shortage of orders which has afflicted the wagon industry since the end of the 3FYP. Another factor that dynamically determines currently installed capacity at each WPU is the technological specification of wagons which are to be built. This has become increasingly important since the 6FYP, as IR wagon specifications since then have been tailored to the new BOXN standard, requiring the use of cast-steel bogies and welded construction in place of the FWU wheelsets and rivetted construction that were sought earlier. Similarly, the gradual phasing out of IR's MG operations and the non-replacement of MG wagon stock have also forced the writing-off of substantial fabrication capacity. Although the overall technology requirement at the WPUs is low, the consequent level of technological obsolescence in tooling, handling equipment and labour skills is particularly high. With the bulk of the wagon offtake by IR since then being of BOXN wagons, the capacity installed years back by the WPUs for the assembly of older wagon designs has become irrelevant.

4.5.2 Problems of Wagon Pricing

Pricing in the Indian wagon industry acquires a critical dimension, since because of the anomalies of market structure, the supply variable behaves differently from traditional price theory. This is primarily because the work contracted by IR remains confined to workmanship, *i.e.* to the conversion by the WPUs of raw materials and technical inputs procured by IR. As such, the free-supply content of a wagon becomes the dominant factor in determining its price.

Till the 4FYP, free-supply content in a wagon was confined to wheelsets, bearings and couplers. Wagon prices at the time were determined by negotiation over the initial tenders submitted by the WPUs, thus taking indirect cognisance of the comparative price offerings of different WPUs.[53] Pricing problems began to surface when low wagon orders and resulting excess capacity manoeuvred IR into a position to dictate prices and terms to the WPUs. While the revenue margins required for the WPUs to carry underutilised capacity and manpower inventories were no longer available, there was also hardly any scope for internal capital formation to modernise their plant and equipment inventories.[54] As wagon manufacture under the contract system was entirely skill-based and tied the WPUs to the use of capital inputs supplied by IR, no internal economies of scale had been created through which they could diversify into other areas of engineering manufacture by developing new product lines. While the formation of WIL was mainly intended to allow wagon prices to be fixed between IR and the wagon industry on a mutually favourable basis, the procedure adopted by IR for canalising inputs to the WPUs was intended to standardise capital costs between WPUs. Consequently the revenue margins earned by the WPUs now crystallised around their ability to lower the labour costs of wagon fabrication, without creating incentives for internal capital formation in order to raise labour productivity. Retention of labour-intensive methods of wagon fabrication without renewal of plant also made it increasingly difficult tor the WPUs to implement the new quality standards sought by IR for upgraded wagons without affecting turnover rates.

Pricing of wagons since then has been carried out on the basis of labour content, both in terms of total labour hours and labour rates using the BOXC wagon as the representative wagon-type.[55] Appropriate yardsticks for labour and labour-rate content were set up through an independent study commissioned through the National Industries Development Corporation [NIDC], which worked out the magnitudes involved on the basis of averaged actuals at the larger WPUs. With allowance for overheads and for longterm escalation, these measures were then applied uniformly across all WPUs. Following the introduction of the cast-steel design specification just before the 6FYP, the BOXN wagon soon became the standard wagon-type. Basing their proposal on existing BOXC principles IR initially offered labour-content of 3200 hours for BOXN wagons, which was unacceptable to the WPUs because of numerous manufacturing differences between the two designs and the different proportions of welding and rivetting required. The dispute had to be referred for arbitration in 1982 to the Bureau of Industrial Costs and Prices [BICP]. While new labour benchmarks were approved after detailed study by the BICP of the manufacturing parameters at major WPUs, IR continues to contend that the BICP rates are too high, basing its assessment on conditions at its departmental manufacturing units.[56]

4.5.3 Changing Face of the Indian Wagon Industry

Technological shifts within the wagon construction process that have arisen from the modernisation of wagon design have necessitated a change in the nature and skill-level of the labour embodied in a wagon. The additional industrial costs that arise from this are not directly captured by the labour-hour content of wagon manufacture, and there is no alternative way in which the WPUs can fully absorb such costs since they engage in undiversified production. While technological backwardness within the wagon industry limits the possibilities for increasing labour productivity and thereby keep the labour content of wagon manufacture unduly high, the uncertainties in wagon demand that have been consistently encountered by the WPUs leave them little justification for initiating a technological modernisation plan.

It would appear therefore that the present organisation of wagon manufacture in India has been too focused on short-term production planning and quota assignment to allow the creation of longterm technological economies of scale that have been a prominent part of the traditional backward linkage of engineering industry with the railways. Had positive thinking developed among the WPUs and IR, the benefits from such backward linkages could conceivably have flowed to both of them. Two features of the present market organisation appear to impede this. One is the inability of IR to shed the departmental mindset of the 19th century railways displayed by adherence to the contract system as a substitute for direct market interaction with engineering industry. The second is the metamorphosis that transportation planning in its infrastructural sense has undergone to fit the short-term contexts of wagon production planning. At the root of both problems lies the overall shortage of capital allocations which have afflicted IR since the 3FYP. In their absence, IR have been increasingly forced to resort to cost cutting as a means for internal resource generation, sacrificing the longterm infrastructural development of the wagon industry and hence their own development of freighting capacity. The cartelisation of the wagon industry through the creation of WIL has been an exercise in countervailing power. While protecting the WPUs in the short term, WIL restricts open competition between them which would have allowed locational economies to come into play that are the forerunners of technological economies in engineering industry. Meanwhile, the system negotiated between WIL and IR in order to standardise input costs becomes the basis for doing away with transportation and locational advantages and kills the technological initiative that could rescue the Indian wagon industry.

The situation of the wagon industry has not changed materially even after the 6FYP decision to focus exclusively on BG renewal. After an initial pickup, wagon orders again crashed towards the end of the plan and remained depressed thereafter until the early-1990s. A crash again occurred soon after the 8FYP got underway. While the cause of these reductions in wagon orders lie again in the shortage of capital funds for railway development, which since the 6FYP have had to be raised increasingly through market borrowing, IR have routinely maintained since the 3FYP, while slashing wagon orders, that wagonfleet levels are adequate to lift existing freight. Since the burden of inventorising unclaimed wagons consequently falls on the WPUs and further reduces their effective capacity-utilisation, this claim of fleet adequacy has been increasingly questioned by the wagon industry, on the grounds that the decreasing projections of wagon requirements made over successive FYPs imply that not even wagon replacements are being met. There are also frequent complaints from several quarters, including major clients of IR in the coal and cement sectors, about the inability of IR to provide wagons as required. It is believed as a consequence, that despite the immense growth in freight demand over the planning era, wagon availability on the IR network has not increased materially from the levels that existed at the end of the 3FYP, creating a tremendous infrastructural bottleneck for the economy.

Table 4.7: Trends in Wagon Production and IR Wagonfleet over the Planning Period 1950-51 to 1994-95

Period	*Years*	IR Online Wagonfleet by Period	Wagons Production by Period	Net Addition of Wagons by Period	*Difference [Net Addition - Production]*
1950-51	*1950-51*	205596	-	-	-
1FYP	*1951-52 to 1955-56*	240756	13500	35160	*-21660*
2FYP	*1956-57 to 1960-61*	307907	64201	67151	*-2950*
3FYP	*1961-62 to 1965-66*	370019	96513	62112	*34401*
Annual Plans	*1966-67 to 1968-69*	381685	45714	11666	*34048*
4FYP	*1969-70 to 1973-74*	388366	52934	6681	*46253*
5FYP	*1974-75 to 1978-79*	401885	57477	13519	*43958*
Plan Holiday	*1979-80*	405185	23588	3300	*20288*
6FYP	*1980-81 to 1984-85*	365392	66717	-39793	*106510*
7FYP	*1985-86 to 1989-90*	349661	65770	-15731	*81501*
Interplan	*1990-91 to 1991-92*	346394	50200	-3267	*n.a*
8FYP*[part]*	*1992-93 to 1996-97*	291360	*n.a*	-55034	*n.a*

Source: Computed from Tables 4.2 and 4.6 above

Table 4.7 illustrates the slowdown in wagon acquisitions that has occurred over the planning era. At the commencement of the period, capacity installed for the indigenous production of wagons was woefully short of wagon demand, so that uptil the 3FYP the balance of wagons required by IR were still being imported. Because of the proliferation of WPUs and the addition of a substantial amount of capacity over the early FYPs, wagon production rose to substantial levels during the 3FYP obviating the need for wagon imports. Since domestic production exceeded the net wagon addition to the IR wagonfleet during the 3FYP, over 35 percent of indigenous production went into the replacement of overaged stock. Through the 4FYP and 5FYP, ever increasing proportions of indigenous production were absorbed in wagon replacement so that only about 13 percent of domestic wagon production during the 4FYP and only 24 percent during the 5FYP represented net augmentation of the wagonfleet. After the conclusion of the 1970s, there was a total reversal in trend so that indigenous wagon production levels were inadequate even to cover wagon replacement needs, leading to massive shedding of wagon stock. Although, as seen earlier, this was at least partly the result of the decision during the 6FYP to modernise the IR wagonfleet and to phase out MG freight stock, the contention of the wagon industry that the present level of wagon orders by IR are inadequate even to maintain current freighting capacity appears to be well taken. While it had been seen earlier that the decline in wagon numbers has been more than compensated by the increase in tonnage freighting capacity of the IR wagonfleet, the gain in tonnage terms is not an exact substitute for the draw-down in wagon numbers since it is specialised towards the carriage of bulk-freight. In truth therefore, there has been a steep erosion in IR's ability to meet freight demands in their micro sense and to provide wagons of the right specification in desired numbers to regular consigners of freight. It also appears likely that the loss of IR market share in general freight is the inevitable result of such a trend.

It is not surprising therefore to find the wagon industry in India facing such dire straits. A few larger WPUs such as Texmaco of CIMMCO had seen the writing on the wall in good time and diversified into other product lines to utilise idle capacity. Texmaco today produces a wide range textile machinery, boilers and pressure vessels, road rollers, steel structurals, and mill machinery, etc.[57] Most public sector WPUs were at a gross disadvantage because of capital shortages similar to those that have afflicted IR. Large WPUs like Burn Standard, with separate units at Howrah and Burnpur, also suffer the brunt of inventorisation losses because of their large production volumes.[58] As many as 323 unfinished wagons had to be stabled in 1985 because of the cancellation of orders by IR and non-supply of the requisite technical inputs.[59] Among the worst sufferers are the ancillary industries which have very little capital to spare and depend almost entirely on the WPUs for job-work. It has been estimated that upto 1.5 lakh workers employed in the WPUs and ancillaries in West Bengal have been adversely affected.[60] Thus instability in IR wagon orders has lain deep at the root of industrial recession in the state.

At the end of the 7FYP, the Planning Commission and the Railway Board volunteered to make amends, committing IR to the placement of advance orders spread over three consecutive years, amounting to four-fifths of the total estimated procurement of wagons. The procurement target for the 8FYP was also raised to around 1.5 lakh FWUs in accordance with the projection of freight movement.[61] This decision however had no visible effect on the frequent downscaling of wagon orders, so that the final procurement of wagons over the 8FYP fell short by about 55,000 units, with merely 9000 wagons being acquired during 1994-95 and 14,370 in 1995-96 against more than 25,000 in the first year of the 8FYP. Apprehension about potential traffic bottlenecks arising from the dearth of wagons caused another spurt in wagon orders to 30,000 units in the last year of the 8FYP, but even this was downsized later to 23,000 wagons.[62] This typical sequence has in fact characterised the placement of wagon orders throughout most of the planning period.

Only of late has there been indirect admission by IR of the true nature and extent of freight capacity shortages that exist on the IR network. To increase the availability of wagons to major railway clients users without having to mobilise new capital funds, IR first launched the Own Your Wagon [OYW] scheme towards the end of the 6FYP in 1985.[63] The scheme anticipated that railway clients might be persuaded to lease-finance the acquisition of BOX or BCN covered wagons suitable for the carriage of general freight on the guarantee of assured fulfilment of wagon needs as and when indented by the client and an accompanying freight rebate. The scheme however soon fell through because of the lack of client interest. The OYW scheme as relaunched in 1992 substituted the payment of 14.5 percent p.a. as leasing charges in place of the freight rebate on general wagons supplied by clients as full rakes and allowed for the payment of lumpsum freight charges by clients who supplied their own special wagons.[64] The new scheme also proposed concessional rates for return consignments mobilised by the owners, in principle conceding the wagon owner the right to run an independent one-way freight service on the payment of reduced charges to IR.[65] There was some response to this scheme in 1996-97 when major producers of cement, fertilisers and petroleum resorted to the OYW scheme to procure around 5000 wagons after they had been hit by acute wagon shortages. While leasing schemes could potentially bail out the Indian wagon industry from its present straits by allowing wagon orders to be received from a wider clientele, a lot would depend on the willingness of major IR clients to commit funds to the leasing of entire wagon rakes.

Several important issues are thus thrown up by the exploration of the wagon industry in India. Many of the travails faced by WPUs arise from their being in a protected market without being assured of wagon orders on a sufficient scale. The structure of this market is neither conducive to short-term productive efficiency nor to longterm internal capital formation within the wagon industry. Although the major WPUs have been operating for a period of 50 years or more, none of them can be said to have shown evidence of having gained from the backward linkage with the railways. Rather, the financial stringency that has hit IR ever since the downsizing of FYP grants has migrated into the uncertainties faced by the WPUs since the late-1960s. Uncertainties of this kind have further limited the creation of technological economies of scale in the Indian wagon industry. Since the vicissitudes of the industry have arisen from inability or reluctance on the part of IR to make realistic projections of fleet replacement and acquisition demands since the 3FYP, the process by which such projections are made will be explored in the next chapter. The larger issue about the effect that wagon shortages have had on the efficiency of IR's freight operations is the subject of more immediate attention.

4.6 Freight Efficiency & the Utilisation of IR Wagons

Along with passenger transfers, transportation involves the shifting of freight-flows, the volumes of which are indicators as well as determinants of economic development. Although passenger transportation also has infrastructural features when it is associated with the movement of migrant or commuting labour, by far the most important infrastructural dimension of transportation relates to the movement of freight. Besides ordinary trade consignments that enter the general-freight flow in piecemeal units, large industrial and manufacturing establishments depend on the cyclic supply of railway wagons to feed their production processes and to carry away distributive flows. Hence the slowing down or speeding up of transportation has tremendous infrastructural implications. In practice, the speed at which freight flows is jointly by the freight consigners and transporters. Client establishments can be prompt or slow when loading or receiving consignments, depending on speed of their industrial operations, managerial ability and work organisation. Conversely, the speed or slowness with which the consignment is able to pass between origin and destination determines the pace at which production and distributive activity may be conducted by the client.

4.6.1 Running Efficiency of IR Wagons

A conceptual measure of the efficiency of use of the IR wagonfleet can be devised around the average lead distance covered by a railway wagon over normal hours of use per day. In railway statistics, this is represented in ratio-terms by the wagon-kilometres run per wagon-day, where the wagon-day is analogous to the man-day concept used in labour economics. Although there is an efficiency-limit on the hours over which a mechanical asset may be utilised without inducing undue wear and tear, the duration of the average wagon-day may show secular increase if more traffic begins to materialise than was previously available. Freight shortages can on the other hand effectively restrict the duration of the wagon-day. When gauging the efficiency with which railway wagons are being utilised, it is important also to assess whether the hours over which a wagon is in daily use are actually being spent on track, or at railway sidings and marshalling yards. Hence the wagon-day statistic measures the actual running hours of use per wagon. Congestion factors such as the unavailability of track or traction can also limit the wagon-day. Under present conditions, the length of the wagon-day for the average IR wagon is around 4.8hrs,[66] having risen since the 1970s because of increased bulkfreight-handling efficiency as well as the general growth of traffic demand. Over the fixed duration of a wagon-day, the efficiency of a running wagon measured in wagon-km depends on the running speeds of freight trains and the nature of impediments encountered on transit corridors during the wagon run. As a composite statistic, the ratio of wagon-km run per wagon-day thus describes wagon utilisation efficiency in both its aspects, namely the effective duration for which a wagon is available for daily running, and the average kilometre-distance covered during its daily run.

Table 4.8 reveals that the average run of a standard BG wagon per wagon-day on the IR network has more than doubled from the once-lowly 62.3km at the commencement of the planning period to 138.5km mid-way through the 8FYP, placing IR quite favourably between the 1993 achievements of 45.9km on SNCF and 158.2km on the Japanese Railways.(*see ch2*) However the path along which this increase has been achieved has seldom been smooth. Consequently, periods of sharp improvement from the starting average to 74.5km and 76.9km levels are noticed between the 1FYP and 2FYP respectively, and again in the rise from 73.4km at the commencement of the 6FYP eventually to 138.5km at the end of the review period, while a hiatus appears over the 20-year duration spanning the 1960s and 1970s. The initial efficiency setbacks occurred through the 3FYP, when non-materialisation of adequate freight led to traffic slack and wagon underutilisation. After the crisis had deepened while excess wagon capacity was being worked off during the mid-1960s, the 4FYP set the road to recovery through plan-induced buoyancy in freight traffic. The aberrant performance of the Indian freight sector following the combined externalities of the first oil crisis and the Railway Strike of 1974 also precipitated a steep descent in wagon-running efficiency to 67.2km in 1973-74. Traffic uncertainty continued through the second oil crisis into the starting years of the 6FYP, before recovery was made. Another smart increase in wagon-running efficiency from the 90.8km level occurred following the commencement of the 7FYP, but running-efficiency figures had clustered around

110km at the close of the decade and did not surpass this till the 8FYP commenced in 1992-93.

Table 4.8: Efficiency of Wagon Utilisation on the Indian Railways 1950-51 to 1994-95

Year	[Annualised] Net Tonne-km perTonne of Wagon Capacity BG	MG	Wagon-km per Wagon-day BG	MG	Net Tonne-km per Wagon-day BG	MG
1950-51	11833	9021	62.3	50.2	710	304
1955-56	14790	8497	74.5	45.9	885	332
1960-61	16558	10125	76.9	51.6	998	405
1965-66	15567	12255	73.2	60.1	940	510
1970-71	15117	12583	73.4	58.4	908	524
1971-72	15626	13003	74.1	58.8	935	540
1970-71	15717	13225	74.4	60.0	953	552
1973-74	13950	11574	67.2	50.8	837	482
1974-75	15186	11876	70.3	53.7	907	528
1975-76	16412	12313	76.8	56.4	982	545
1976-77	16754	12843	81.2	58.1	1019	570
1977-78	17259	12764	81.9	57.5	1045	570
1978-79	*n.a.*	*n.a.*	75.9	52.7	976	543
1979-80	*n.a.*	*n.a.*	73.3	49.7	972	534
1980-81	16285	11013	73.4	58.4	986	522
1981-82	18366	12227	83.7	56.4	1112	538
1982-83	18455	13091	86.4	47.3	1123	576
1983-84	18349	13068	88.7	47.9	1112	577
1984-85	18942	12567	90.8	50.3	1150	565
1985-86	21165	15197	97.8	58.8	1296	677
1986-87	23326	15878	106.6	64.4	1420	703
1987-88	24084	16649	109.9	64.6	1449	731
1988-89	24107	17330	113.0	66.3	1453	763
1989-90	23617	18478	112.1	68.2	1428	810
1990-91	23418	18629	110.5	69.7	1407	810
1991-92	23940	19806	113.2	70.6	1439	855
1992-93	24184	18786	116.4	71.2	1457	824
1993-94	25009	18098	125.0	64.5	1506	773
1994-95	25358	16414	138.5	59.0	1590	684

Source: *IRYB*, various years, Directorate of Statistics & Economics, Railway Board, Ministry of Railways, Government of India, New Delhi
Note: *Computations are for standard FWU units*

In the face of uncertain traffic trends, the extent of improvement in IR wagon-running efficiency might be considered remarkable, with wagon utilisation during the 1980s apparently picking up where the 1950s had left off. But the earlier analysis of factors like train running speeds and track-utilisation intensity (*see ch3*), and of changes in IR freight traffic and wagonfleet composition would colour such interpretation. It should be recalled therefore that both traffic complexion as well as the extent of wagon specialisation on IR have undergone vast change between the 1950s and the 1980s, with bulk-freight having now become virtually the sole constituent of IR freight. Because of the larger loading-unit sizes involved, bulk traffic has a natural tendency to run in full trainloads over longer lead-distances. Thus in standard circumstances, the average BG wagon today is likely to be of the BOXN design carrying a full wagonload of mechanically-loaded coal in a block rake made up of other similar coal wagons, and to be traversing a longer lead between the coal pithead and a cement, steel or power plant. While this metamorphosis has increased the running efficiency of IR wagons for the same technical reasons which have made railways across the world efficient carriers of bulk-freight in full trainloads (*cf.*SNCF *see ch2*), it also implies the withering away of other IR freight operations and severe circumscription of the infrastructural role of railways in a nation that has been witnessing sharp escalation in transportation needs. Ultimately, the technical metamorphosis has also told on the financial health of IR because of the loss of their high-rated traffic segments. The focus on bulk traffic since the 1980s has been part of deliberate planning policy. Having been induced through radical changes in wagonfleet composition, it has brought about radical improvements in wagon efficiency. However its costs in infrastructural terms remain uncertain.

Related efficiency-analysis can also be made of tonnage-loading on IR wagons, taking due note of the increasing wagonfleet specialisation which has raised aggregate IR freighting capacity even as wagon numbers declined. The appropriate measure of freight efficiency in this context is provided by the ratio that IR net tonne-kilometre traffic bears to freighting capacity available on the IR wagonfleet. When assessed comparatively in per-wagon terms, the statistic evaluates the efficiency-gains in tonnage and traffic realisation against every tonne of carrying capacity available on the IR wagonfleet. The traffic lead factor stays implicitly present, as the ratio of net tonne-km to originating tonnages in aggregate terms would define average traffic leads. Since the wagon-efficiency index in this case is formulated relative to each tonne of available wagon capacity, it remains neutral to longterm upgradations in wagon design.

It was noted above that while running-efficiency of the IR wagonfleet increased phenomenally over the planning period, it traversed through three distinct growth phases. Prior analysis of IR operational trends over the period [*see ch2*] had also shown that although the initial growth of traffic leads reflected freight response on the part of IR to the expansion of the national market, subsequent changes were dictated increasingly by the rising tonnages of specified bulk-freight. Such trends would also have significant bearing on the interpretation of traffic-efficiency gains realised per tonne of wagon capacity by IR, because of the freight specialisation that has occurred within the IR wagonfleet. Thus while rising traffic realisation in *pro rata* terms could alternately reflect fuller utilisation of IR freighting capacity or increasing journey leads, a bias towards seemingly high ratio values would be inbuilt by higher wagon capacity and bulk-freight specialisation. The average net tonne-kilometre run per tonne of originating freight has increased considerably over the planning period. However as noticed in the table, the trend defined in terms of tonne-km realisations vis-a-vis the increased loading capacity of the IR wagonfleet is not one of uniform rise, but reflects more or less the pattern noted for wagon-efficiency per wagon-day, which showed efficiency increases in the 1950s and again from the 1980s, with a hiatus in between. However the rate of escalation in tonne-km realisations has been markedly higher - at least uptil the 1980s - because of increasing average leads, and only thereafter represents a true gain in loading-efficiency.

The trends could be explained as follows. During the first two FYPs and for some time into the 3FYP, IR made substantial gains in wagon loading-efficiency because of the rise in traffic during the period of capacity-led growth. Since continuation of such traffic trends depended on the continued growth of PSU-based traffic, which did not realise the growth targets of the 3FYP, slippages occurred in wagon-loading efficiency because of the materialisation of excess freighting capacity. Instead of waiting for traffic to revive, the policy reaction was however to shift into a demand-management regime which scaled increases in freight capacity to prior growth achieved in traffic - under the possible rationale of maintaining wagon-loading efficiency and the commercial position of IR. Although the objective in itself was unexceptionable, the means adopted to achieve it negated the all-round developmental role that IR had played hitherto, because of the reduction in traffic focus to specific freight which could offer fuller wagon-loading, fuller trainloads and secure freight turnovers. This revision in planning policy, which coloured the thinking behind the 4FYP and appeared to take full effect over the 5FYP, led to the capture of other freight by the roadways during the plateau period of the 1970s, coincident with the decline in wagon efficiency. As an ultimate solution to both commmercial problems and transportation bottlenecks, the decision was taken to specialise IR freighting capacity towards the carriage of bulk-freight. Over the 1980s and after, IR returned better operational results as well as improved wagon-loading efficiency mainly on account of the reduced freight-mix and specialised wagonfleet. But the increase in wagon specialisation also reduced IR capability to handle general freight and thus involved further passive surrender of this category of traffic to alternate transport modes. As such, while the improved wagon efficiency statistics of the later period vouch for the improvement in technical viability of IR operations, they veil the narrowing of IR's infrastructural role. Although the process of economic development and market expansion continues today, the railways in India are thus less inclined to influence its magnitude and direction, except through the direct forward linkages of the few bulk-freight commodities that they now carry.

Another factor in the specialisation of the IR wagonfleet as earlier noted, is the gradual phasing out of MG freight operations. Recalling that the entire feeder network for BG trunklines had historically been built on this reduced gauge, reduction of freighting capacity on the MG network through the drawing down of its wagon and traction fleets would be likely to affect traffic viability on the network, particularly if railway policy dictated a simultaneous shift towards longer-lead traffic involving combined MG and BG haulage. Traffic shortfalls of this nature would be revealed in MG wagon-efficiency statistics.

Considering the MG wagon efficiency trends in the table associatively with the MG wagonfleet positions noted earlier [*see Table 4.2*], major departures from BG wagon-efficiency trends are seen over the planning period. Over the 1FYP and 2FYP when the MG wagonfleet grew at a higher incremental rate than the BG wagonfleet, MG wagon efficiency declined while BG efficiency rose. This divergence of trends would reflect the expansion of IR feeder operations over the initial planning phase, since traffic on the MG network did not necessarily materialise in efficient full-wagonloads because of its feeder character and its very different freight-mix. It might therefore be said that market expansion during the period of capacity-led freight planning was commensurate with the objectives of regional development even while it imposed social burdens on IR. Increased net tonne-km realisations followed the initial phase of wagonfleet development, revealing a trend towards subsequent traffic growth. The traffic failures of the 3FYP period mainly pertained to non-materialisation of PSU (*i.e.* bulk) traffic, which basically affected BG wagon efficiency. Such trends might therefore have warranted the continuation of the MG emphasis for feeder operations, because of the lower break-even for MG freight operations in low traffic-density conditions. However this did not occur. Instead, since the main IR losses had been incurred on BG operations, the subsequent FYPs sought to restrict the freighting capacity for non-bulk traffic while concentrating exclusively on increasing the efficiency of BG bulk-handling. Since this was succeeded by the net contraction of IR's MG freight services, it in fact further destroyed the viability of the MG freight network while also negating IR's infrastructural role.

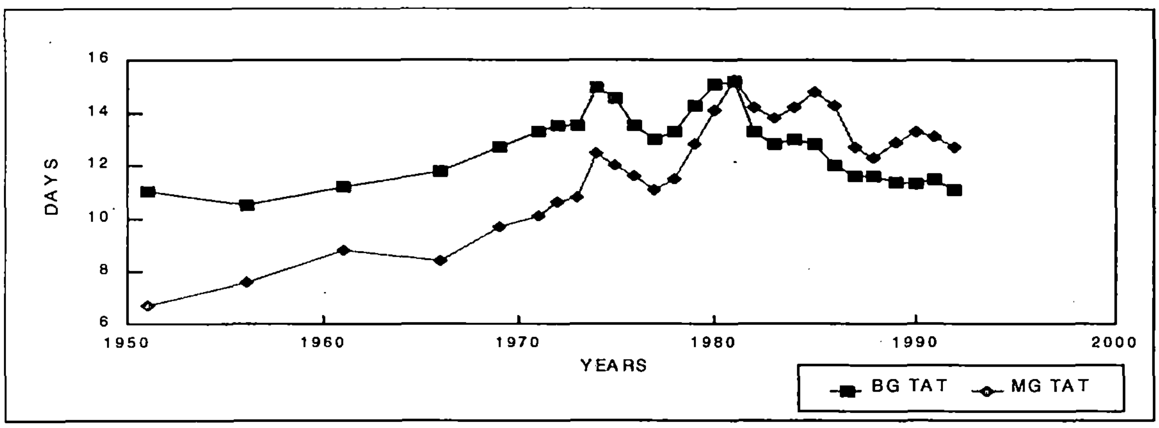
4.6.2 Efficiency of Wagon Turnaround

Another wagon-related measure of efficiency widely used to provide indication of the speed and efficiency of railway freight handling operations centres around the concept of *wagon turnaround.* Both at originating and terminal points, a railway wagon is subject to loading, unloading and transhipment of consignments, the speed of which along with the duration of the freighting journey determines the ultimate length of time before the wagon can set out again as part of a new rake. Thus the wagon turnaround time [TAT] measure assesses overall efficiency in railway freight operations, and subsumes *running* efficiency which depends on marshalling expertise, journey leads, track availability and average trainspeeds, and *handling* efficiency which depends on availability of adequate terminal space, manpower and freight handling equipment. Mechanisation of freight loading and unloading processes through use of conveyors, forklifts, etc., as widely adopted by advanced railway systems, or through wagon-design improvements on the open hopper system [OHS] which permit the quick discharge of coal and ore consignments, all contribute to the quickening of freight handling operations, but pose a tradeoff between the high capital costs of new facilities and the reductions in the unskilled workforce and savings on handling times that would ensue. While mechanisation at each existing railway terminal is unviable, it becomes a more viable option when the associated capital costs do not directly devolve upon the railways, such as at external terminals on private sidings built to handle the full-trainload consignments of major railway clients.

The importance of TAT as an indicator of wagon efficiency arises *a priori* from the desirability of loaded consignments being delivered within a reasonable time without being subjected to avoidable delays in movement. That increasing journey leads imply rising wagon TAT is foregone. However, close association of rising average journey leads on IR with the spatial growth of economic activity requires that *pure* efficiency indicators such as TAT be viewed from the development perspective also, beside their technical implications about the pace of IR wagon movements. The decisive role is played in this case by changes in the commodity-composition of IR freight. Since spatial multiplication of regional producing nodes which resulted in the compaction of economic activity (*see ch.3*) would also induce declining journey leads and shorter wagon turnarounds for a railway freight system that catered to a well diversified commodity-mix, increases in TAT under such idealised circumstances would be attributable only to equipment deficiencies and to operational inefficiency in the freighting activity. In more general circumstances, other factors coming into play would include the nature and quality of traction and track which ultimately determine the speed of freight transits, the extent of railway network congestion caused by parallel passenger operations, and the changes in freight composition induced by a shift to bulk-freight and full trainloads accompanied by the elimination of traffic smalls - all characteristically important for IR.

Fig 4.1 reveals the broad trends in BG and MG wagon turnarounds on IR over the planning period. Although the common pattern of both is of rising TAT uptil the end of the 1970s followed by a fall after 1980, the more noteworthy feature appears to be the positional switchover between BG and MG TATs with reference to that same year. BG turnarounds thus remain consistently higher than those for MG till the end of the 5FYP, whereupon, following the switchover, they undergo steeper and steadier declines than MG TAT until the end of the study period. Obvious underlying reasons would relate the switchover to bulk-freight trends during the late-1970s and 1980s which also implied directional change in IR freight traffic, and to the eventual downgrading of MG operations by IR. Reminder would be needed in this connection that the MG network was originally developed as a system of feeder lines to serve the main trunk operations of the railways in India. MG route-kilometerage, currently at 19,210km, constitutes less than a third of the IR network and is substantially lower than the BG route-kilometerage of 39,612km.[67] Freight journey leads are also generally lower on MG since they largely associate with auxiliary operations branching to and from the main BG route system. Even though these operations involve the additional component of intergauge transhipments, shorter wagon turnarounds on the MG network were still maintained in the initial period primarily because of the shorter leads that each MG wagon had to move. Hence the rise in MG wagon TATs over the planning period to levels that eventually exceeded those for BG indicates the greater technological inefficiency now afflicting freight operations on the MG network where wagons and technical facilities have undergone virtually no upgradation since the end of the 5FYP. As earlier seen, this has been part of a official policy package which recommends the capital-intensive alternative of gauge-conversion and adoption of the UNIGAUGE in order to improve BG freight efficiency, at heavy efficiency-cost to MG freight operations. With the available capacity to move general freight on the BG network also having been brought down by high levels of specialisation in the BG wagonfleet, a mismatch between freight availability in the regions served by IR's MG services and downstream BG freighting capacity has resulted, thus destroying the very feeder character for which the MG network had originally been designed.

***Figure* 4.1: Trends in BG and MG Wagon Turnaround on the IR Network**
1950-51 to 1991-92



Viewed from this perspective, a marked divide emerges between IR transportation planning approaches before and after the 6FYP, the change having largely been the outcome of the policy exercise on intermodal transportation planning that preceded the 6FYP. During the prior phase, wagon TAT increased for both BG and MG following the spatial dispersion of economic activity through the process of development and parallel expansion of BG and MG operations accompanied by spatial and technological upgradation of the IR network. Evidence of the rise in TAT being as representative of spreading development as of reduced wagon efficiency exists till at least the end of 5FYP in the concurrent increase of average freight leads from just 458km in 1947 to well over 700km by the end of the 1970s (*see ch.2*) - the increase deriving from the expansion of economic hinterlands as well as from the new need to freight bulk materials all over the country. The sharp increase exhibited by MG TAT however warrants independent consideration. While upgradation and modernisation of BG operations have remained key policy objectives over the entire planning period, it would appear that the continuous resource crunch faced by IR since the 3FYP selectively curtailed investment on MG rolling-stock renewals and upgradation of MG tracks and terminals till the point that freight-efficiency on the MG network began to decline at a much sharper rate than it did on the BG network. The resultant traffic instability made MG operations less relevant to freight efforts as a whole, as IR began to turn increasingly towards assured flows of BG freight. Eventually these sustained trends fuelled the argument for phasing out MG operations, as the conscious move towards bulk-traffic on the BG network escalated freight adaptation and the demand for modernised wagons which require longer-lead operation to run efficiently. While the overall decline in BG TAT after the 1970s can be attributed to the improvement of railway technology, the converse would hold for IR's MG operations. Reasoning on these lines would also tie in with the changing wagon acquisition trends observed earlier which have proved to be the undoing of the Indian wagon industry.

It would be useful also to collate the TAT patterns with the operational trends of IR freight over the FYPs that had been taken note of earlier. With augmentation of the transportation infrastructure leading to widening of the production and consumption base of the economy over the first three FYPs, the rise in wagon turnarounds initially matched rising freight leads. Till the 3FYP, simultaneous increases in the IR wagonfleet on both BG and MG networks occurred ahead of the actual manifestation of traffic demand. Since the upstream and downstream linkages emanating from the expansion of IR infrastructure provided spatially distributed freight gains, the initial rise evident in BG and MG TATs is not wholly inconsistent with the context of an expanding economy. However, as the recessionary phase set in after the 3FYP, the excess capacity created previously took toll of operational efficiency in IR freight movements. The setback to average IR freight leads from nonmaterialisation of adequate bulk traffic during the 3FYP also had a spillover effect on wagon TATs which remained sluggish around the time. When freight buoyancy during the 4FYP partially overcame the recession with the recovery of bulk-freight also working towards raising average IR traffic leads, prevailing physical shortages of rolling stock combined to increase BG TATs substantially from 13.5 days to 15 days, and MG TATs from 10.6 days to 12.5 days between 1971-72 and 1973-74. IR freight efficiency was however sharply affected by the twin oil crises and the Railway Strike of 1974 as originating tonnages alternately fell, rose and then fell again, the intermediate increase being caused by commencement of the 5FYP which improved traffic realisation temporarily. Although average freight leads grew almost continuously, wagon-efficiency responded to the traffic upswing with a reduction in turnarounds on both gauges. Such improvements however proved shortlived as wagon TATs again began to climb after the second oil crisis to reach alltime-high levels of 15.2 days on BG and 15.3 days on MG in 1980-81 with the start of the 6FYP, accompanying a sharp rise in average freight lead to 754km, the highest over three planning decades.

The possible underpinnings for this uncertain turn of events during the 1970s lay in a shift in the composition of freight traffic arising from the inability of IR to meet the wagon demands of non-bulk traffic because of fleet shortfalls. Freight policy shifts that occurred over the 1980s then increased wagon-efficiency and brought about declines in wagon TAT with those for BG being most marked, because they took conscious stock of *de facto* changes in the railway freight complexion as a consequence of the oil crises, which were institutionalised in the new policy on intermodal transport coordination recommended in 1980 by the National Transport Policy Committee [NTPC]. To meet the projected policy target of carrying 435-468 billion tonne-km of freight by the end of the century, IR was now required to concentrate on increasing the operational efficiency of BG freight operations. Thus while BG TATs declined sharply with the new focus on special categories of traffic that originated in full trainloads and were carried on block rakes to drastically shorten the time expended in marshalling and terminal operations, efficiency on the MG network failed to recover after the 6FYP. It may also be noted that while cyclicity in average freight leads and wagon turnarounds was absent during the prior phase, it has been a notable feature in IR freight patterns since the first oil shock. While freight policy changes since the 6FYP have partially stabilised the amplitude of cycles in BG wagon-efficiency, the cycles in MG wagon-efficiency continue unabated.

4.6.3 Tractive & Loading Efficiency on IR

Other indicators of the efficiency of railway asset-utilisation such as average freight trainspeeds and trainloads, which are intimately associated with the running-efficiency of railway freight operations, shed light on certain interesting aspects of wagon turnarounds on IR. Both indicators relate to the efficiency of traction, since improvements in the power of tractive units allow both train running speeds as well as the haulage capacity of rakes to be progressively raised. Figures for average railway freight trainspeeds however subsume halting delays and hence may vary considerably from the maximum speeds achieved on freight-hauls, if running-efficiency is low. With the gradual phasing out of steam traction over the planning period, the importance of diesel and electric traction has grown enormously - electrification of 12,266km of track having been completed by 1995 and 57 percent of BG gross tonne-km freight traffic now being accounted for by the electrified BG high-density network [HDN].[68] Thus while the average speeds of steam-hauled freight trains have declined continuously over the planning period from a high of 15.8kmph in 1956, as evident from Table 4.9, average overall speeds of BG freight trains over all tractive modes have risen from 17.4kmph in 1950-51 to 23.6kmph in 1994-95, reflecting the change in the composition of IR traction.

Table 4.9: Average Train Running Speeds by Traction and Gauge on the IR Freight Network 1950-51 to 1994-95

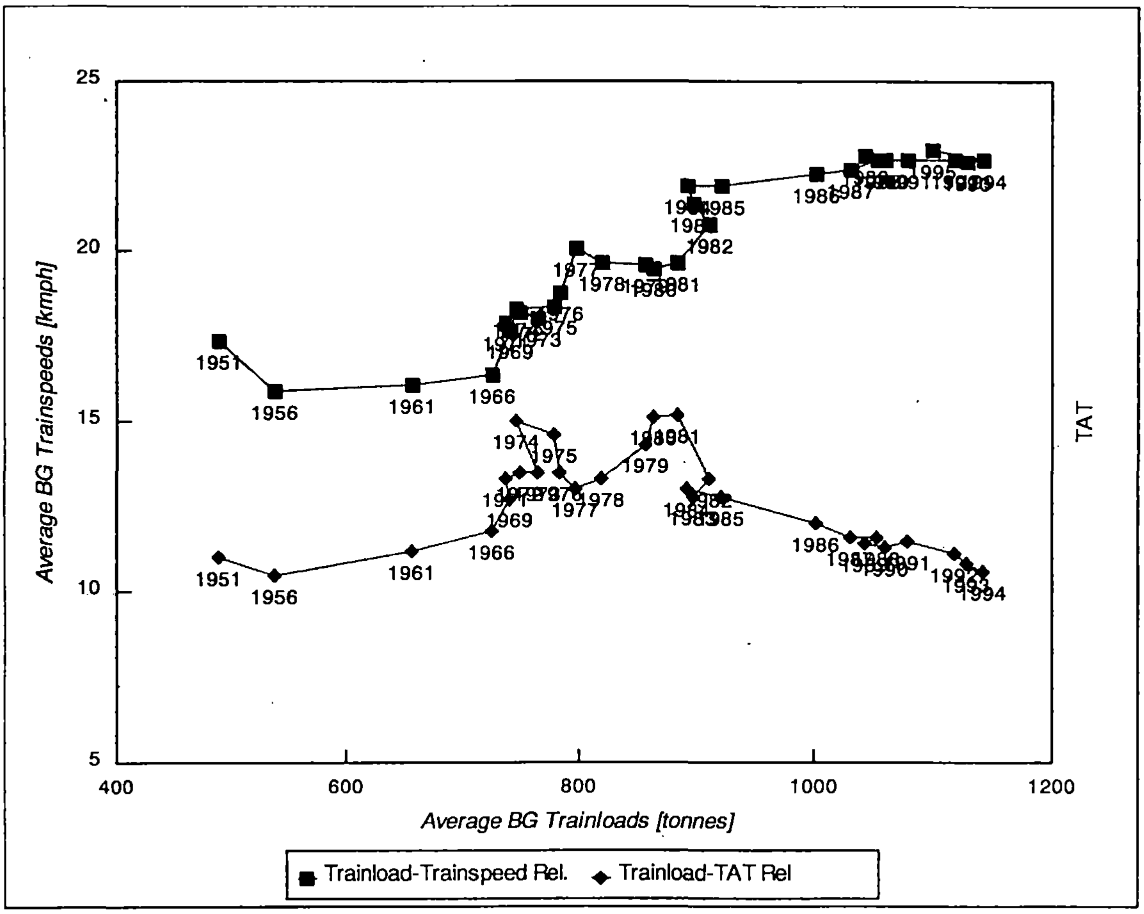
Year	BG Net Trainload *[Tonnes]*	MG Net Trainload *[Tonnes]*	BG Steam Traction *[kmph]*	BG Diesel Traction *[kmph]*	BG Electric Traction *[kmph]*	Average BG Train Speeds *[kmph]*	Average MG Train Speeds *[kmph]*
1950-51	489	185	17.1	-	20.8	17.4	15.0
1955-56	537	246	15.8	13.9	19.8	15.9	13.6
1960-61	656	298	15.6	22.2	19.5	16.1	13.7
1965-66	725	347	13.0	23.7	23.4	16.4	14.0
1968-69	739	362	12.1	22.9	25.5	17.7	14.9
1970-71	737	378	12.0	22.9	25.2	17.9	14.7
1971-72	748	391	11.8	22.8	24.2	18.2	14.9
1972-73	763	403	11.7	22.0	23.5	18.0	15.2
1973-74	745	408	11.8	22.2	22.5	18.3	15.5
1974-75	778	422	12.0	22.1	22.4	18.4	15.2
1975-76	782	413	11.9	22.1	23.5	18.8	14.9
1976-77	796	413	11.9	23.1	25.2	20.1	15.2
1977-78	818	423	11.5	22.2	24.7	19.7	15.0
1978-79	857	451	11.2	21.5	23.9	19.6	14.8
1979-80	863	467	10.8	21.1	23.4	19.5	14.8
1980-81	884	487	10.2	21.3	22.8	19.7	15.1
1981-82	911	508	9.6	22.5	23.1	20.8	16.1
1982-83	898	520	9.6	22.6	23.1	21.4	16.5
1983-84	892	539	9.5	22.7	23.7	21.9	17.0
1984-85	922	523	9.7	22.8	23.2	21.9	16.9
1985-86	1001	539	10.4	22.7	23.2	22.3	16.7
1986-87	1031	520	10.0	22.6	22.8	22.4	17.0
1987-88	1053	544	9.6	22.9	23.2	22.7	17.3
1988-89	1042	553	9.6	22.9	23.4	22.8	17.5
1989-90	1060	576	9.2	22.9	22.9	22.7	17.5
1990-91	1079	562	10.1	22.6	23.1	22.7	17.6
1991-92	1119	585	10.1	22.6	22.9	22.7	17.8
1992-93	1128	574	-	22.6	22.6	22.6	18.0
1993-94	1142	599	-	22.3	23.1	22.7	18.2
1994-95	1100	576	-	22.4	23.6	23.0	19.1

Source: *IRYB*, various years, Directorate of Statistics & Economics, Railway Board, Ministry of Railways, Government of India, New Delhi

Commencing with the 2FYP, the main technological thrust of IR towards electrification and traction improvement carried strongly into the 3FYP, by the end of which the average running speeds of electrified BG freight trains had risen from 19.8kmph to 23.4kmph and those for diesel-hauled trains from 13.9kmph to 23.7kmph. This increase in average trainspeeds was accompanied also by the raising of average BG net freight trainloads from 537T to 725T between 1955-56 and 1965-66. Running inefficiencies and traffic uncertainties in the subsequent period caused trainspeeds to hover uncertainly around these levels during the 1970s with overall BG trainspeeds being much lower, except in the single year 1976-77 when diesel, electric and overall BG freight trainspeeds recorded a sharp rise. Electrification has however bypassed MG, since of the total IR running-track network, the 19 percent which has has been electrified comprises 5 out of 7 major trunk routes connecting Mumbai, Calcutta, New Delhi and Chennai.[69] Changes in IR traffic composition over the 1980s have sustained rather than materially improved BG trainspeeds, indicating that technological improvements in traction have been geared towards raising average trainloads rather than average trainspeeds. Evidence of this is drawn from average BG net trainloads which increased from just around 800T in the late 1970s to well over 1000T by the end of the 1980s.

Another factor highly relevant to determination of average trainspeeds and overall IR freighting efficiency is the average payload transported on each freight rake. Comparison of net average trainloads with the average trainspeeds realised by IR on BG freight operations provides several interesting insights into other technical factors that ultimately reflect upon wagon TATs. It may be noted that while the average speeds of BG freight trains had already risen to 20kmph by the mid-1970s, they have since only increased marginally, with occasional dips. The attainment of higher freight trainspeeds could be attributed to progressive dieselisation and electrification on IR's BG routes as well as to increased freight handling efficiency, since they follow the reduction of halting delays as reflected in the associated TAT trends. Average IR trainloads have however also increased because of expansion in freighting capacity through wagon specialisation over the planning period. A comparative assessment is thus called for. Analysis of the interactivity of upgraded BG traction and wagon technology may be made from the crossplot of average BG trainloads, trainspeeds and BG wagon TAT over the planning period presented in Fig 4.2 below.

***Figure* 4.2: Crossrelation of Tractive-Efficiency and Wagon-Efficiency Trends on the BG Freight Network 1950-51 to 1994-95**



During the 1FYP when steam traction still dominated IR operations, average trainspeeds tended to decline as the net BG rake loads carried by IR increased. The focus on core industrialisation during the early planning phase and the consequent freight dominance of short-lead traffic routed from mining areas to the core industries helped in maintaining a low TAT despite the increase in freight tonnages till the end of the 3FYP. Since steam-based traction had not proved adequate to meet the mass transit needs of commodities like coal, a technological thrust towards the upgradation of tractive power was necessitated by the mid-1960s which increased BG trainspeeds much more sharply than trainloads. Nevertheless freight handling efficiency remained low, causing BG TAT to rise considerably as heavier trainloads were carried over the 1970s. The sharp increases in TAT during the two oil crises apparently arose from the need to transport vaster amounts of coal on IR's main trunk routes without realising adequate traffic on the return journey. Commodity substitution consequently occurred on BG freight operations, assisted by increasing specialisation of the IR wagonfleet. With the commercial performance of IR becoming progressively dependent on the realisation of bulk-freight, wild oscillations took place both in average BG trainspeeds and TAT uptil the end of the 6FYP. The apparent improvement in TAT thereafter was attained against sharply increasing average trainloads, without commensurate enhancement in average trainspeeds. It thus becomes quite obvious that the improved BG freight-handling efficiency embodied by the recent decline in TAT has not been achieved through major reduction in halting and other delays which would also have simultaneously raised the average running speeds achieved by BG freight trains, but rather through the increased trainloads freighted on specialised wagon rakes.This is in keeping with the inferences drawn earlier from the analysis of freighting capacity trends and wagon specialisation on IR's BG network.

Although the increase in wagon-utilisation efficiency achieved by IR over the planning decades in terms of tonnages transported and transit times has been fairly credible, it has been at the cost of rising haulage of empty special wagons. Reflection of the rising incidence of empty haulage is found in the fall in the net load of the goods trains.[70] Although the proportion of loaded wagon-km to total wagon-km has remained more or less stationary of the initial plan years, empty wagon-kms constituted nearly 34 percent of the wagon-km on BG and 30 percent on MG by 1976-77, owing to dynamic changes in the IR freight traffic pattern and in the composition of the specialised IR wagonfleet that carries this traffic. For instance, if coal is shipped to Punjab in the open wagons, it is not suitable to transport the ffodgrains that the region can offer for outward loading. To meet the demand for foodgrains loading, covered wagons are despatched to reach such commodities to the deficit areas. As a consequence, the open wagons return empty to the origin to be loaded once again with commodities suitable to be carried in open wagons and thus increasing the TAT.[71] Although the percentage of empty wagons online has increased only marginally to 34.9 in 1983-84,[72] it is evident from Table 4.9 that after a steady increase in the net load of the freight trains till 1981-82, there has been a sharp dip in the net load in the two years that followed recovering thereafter. But the 6FYP and the 7FYP witnessed a variability in the net loads indicating variations in the incidence in empty haulage.

4.7 Freight Capacity & the Transportation Infrastructure

While phased acquisition of rolling stock by IR over the period of each FYP constitutes a crucial link in matching the provision of freight service to the new demands for freight movement generated by the process of market expansion and planned economic development, the character and composition of railway wagon stock determine the units in which IR freight services can be provided and also the nature and quality of freight service available to each economic sector. Concurrently, the demand for wagons for freight movements is determined by the changing magnitude and composition of production and consumption demands within the economy, which in turn decide the magnitude and direction of commodity freight movement in the economy. Transportation bottlenecks can thus cause drastic demand and supply mismatches in the economic system, and lead to a slackening of the production impetus imparted by each FYP, because of shortage in the required freighting capacity and the consequent building up of inventories which can disrupt the country-wide flows of resources and outputs that generate balanced economic development. In further extension of this chain, either of the above circumstances can have crippling impacts on the Indian WPUs and on the operational performance of IR as a whole.

During the early phases of the planning era, planners in India had laid blanket emphasis on the augmentation of transportation infrastructure, in confidence that this would eventually lead to accelerated industrial growth. Towards this end, the planning effort also sought to expand basic industries like steel, chemicals industries, fuel and power and also establish the required machine-building capacity, so that the future requirements of industrialisation would be met within the relatively short period of one decade, mainly from the country's own internal resources.[73] It was also anticipated that the feedback signals emanating from the economy would require progressive investment on railway infrastructure, including upgraded railway technology and wagons, as well as phasing out of lumpy investment on the expansion of system capacity. However, the suggested approach began to show signs of coordination failure when the desired phasing of major industrial and infrastructure projects could not be achieved within the short time-horizon prescribed for this anticipated 'decade of development'. While the principal source for coordination failure were sectoral mismatches within the Indian economy, visible structural lacunae also appeared in the transportation infrastructure calling for serious thought to be given to the need for intermodal integration.

As diagnosed by the 9FYP review of past economic performance, the continuous decline in IR's freight share has primarily resulted from the inability of the railway system to grow proportionately with the increasing traffic demands of the Indian economy. The review also recognises that the resource constraints of the Government of India have been the principal reason for the under-funding of the state-owned railway system throughout the planning era, leading to chronic under-supply of IR freight services. Faced with the resulting capacity constraints, IR has been forced to narrow its freight focus to less contestable sectors of the freight market by specialising in bulk movements of materials for the core sector of the economy. While IR has been able to retain a major share of this captive freight market, it has been constantly losing ground in the high-rated non-bulk freight segment which caters to economic sectors that have historically shown intrinsically higher rates of growth.[74] Over the long period, this change in the IR freight policy stance has induced continuous slack within the Indian wagon industry, driving the WPUs to the brink of economic ruin.

Skewing of railway tariff policies in order to raise internal capital resources while cross-subsidising loss-making preferential freight and passenger operations, has led in recent years to unwarranted escalation in IR freight-tariff rates, beyond what the traffic will bear. While on the one hand, the privately-owned roadways sector has been able to aggressively contest the freight markets which are being progressively vacated by IR as a result of freight capacity constraints, the policies for deregulating the roadways adopted since the 1980s to compensate for the gradual phasing out of MG operations by IR have also rewarded private operators by liberal issuance of national permits, low licence charges and road taxes, as well as cheap bank finance and subsidised diesel costs, unduly increasing their ability to contest in the country's freight markets.[75] In such scenarios, the new IR tariff policies are proving suicidal, since they have even begun to drive away long-distance bulk-freight traffic into the hands of the roadways.

Thus a study of the crucial determinants of freighting capacity on the IR system acquires critical importance in the present context. The next chapter accordingly undertakes an analytical review of a gamut of related policy issues, including the planning needs of IR and the associated tariff and transport coordination policies enunciated in the reports of numerous expert committees constituted since Independence to suggest better ways of matching railway freight capacity to the projected freighting needs of the Indian economy. This is followed by an econometric exercise that seeks to identify the principal factors that have guided the decisions of IR managers on the addition of wagon capacity to the railway network.

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