APPROPRIATE TECHNOLOGY: AN EMPIRICAL STUDY OF BICYCLE MANUFACTURING IN MALAYSIA

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I. INTRODUCTION

THE dramatic recovery of Western Europe after the end of the Second World War brought with it the widely held notion that, in order to alleviate the problems of poverty and mass unemployment encountered in developing countries, rapid industrialization utilizing the latest technologies developed in industrialized countries should play a key role in the economic development of these nations [4] [15]. However, by the dawn of the 1970s, it became apparent that this strategy was not bringing the miracles anticipated. Two decades of rapid industrial growth has led merely to the creation of a small, albeit prosperous, modern sector juxtaposed upon a far broader traditional sector subsisting at poverty level. The promise of massive job opportunities, as a consequence of industrialization, never materialized. There is overwhelming evidence that this is mainly because of the fact that the technologies, which formed the basis of industrialization in developing countries, were the capital-intensive ones developed by the high-wage industrialized nations [2] [3] [18]. Such technologies, after transfer to developing countries, were never able to generate the massive income generating opportunities anticipated.

In an urgent effort to try to rectify this developmental mishap, the concept of "appropriate" technology[1] was pioneered by the ILO [5], and a number of other researchers [2] [11] [16] in the early 1970s. The main thrust of research in this direction has been the recognition that "modern" technologies transferred from the industrialized countries may not be suitable to the receiving developing countries, not only from the viewpoint of inadequate employment generation, but also from the viewpoint of inducing misallocation of scarce resources leading oftentimes to political instability [1]. Given this premise, it is then essential for developing countries to conduct extensive research—empirical or theoretical—to

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[1] "Appropriate" is the epithet now used most commonly, perhaps because of its intrinsic ambiguity, in preference to others such as "indigenous," "progressive," "labor-intensive," "self-reliant," and "intermediate."

determine the types of technologies most appropriate to their environment. One way of pursuing such research is to examine the set of currently available techniques for a particular product (or process), and out of this evaluation identify a technique which is most appropriate with respect to an accepted set of criteria.[2] In this study we perform such an investigation for bicycle manufacturing in Malaysia. Bicycle is the most common form of transport equipment in Malaysian households. It is owned by about 50 per cent of families with income below M$99[3] per month and about 75 per cent of families with income between M$100–M$299 per month [9]. Hopefully, conclusions from this study would offer policy implications for the promotion of appropriate technologies in not only this important sector, but also in the other sectors where the manufacturing techniques are similar, e.g., metal fabrication and general engineering industries.

II. CRITERIA FOR EVALUATION OF APPROPRIATE TECHNOLOGY

Morawetz defines appropriate technology "as the set of techniques which makes optimum use of available resources in a given environment. For each process or project, it is the technology which maximizes social welfare if factor prices are shadow priced" [12, p. 517]. The definition implies that a technically efficient technology is not necessarily an appropriate technology because the price and availability of limited resources, and the social welfare function should eventually determine the set of appropriate technologies. The definition, however, leaves social welfare function undefined. Though it would be relatively simple to offer a rigorous definition of the social welfare function; it is however difficult to operationalize from Morawetz's concept of appropriate technology to arrive at a set of criteria for the evaluation of appropriate technology.[4] Thus instead of operationalizing Morawetz's definition, we utilize Eckaus's approach which states that the only criteria for evaluating the "appropriateness" of technological discussions is with reference to the general goals of development [3, p. 37]. This assumes that the group social welfare function is as enunciated in the development goals, and appropriate technologies are technologies which can enhance (and not retard) the achievement of these goals. The principal development goal of Malaysia is eradication of poverty with a reduction in inequality of income distribution [10, Chap. 9]. Within the extent of this goal, this means that the whole range of technologies which produce different qualities of bicycles should

[2] The criteria adopted for this study will be specified and justified later (in Section II). Actually this research approach ignores the possibility of developing new appropriate technologies. Such a possibility is held by some economists which believes in "investment in knowledge" (see, for example, [6] [19]). However, we believe that for stable technologies, it is possible to identify an appropriate technology by evaluating the set of currently available techniques. For the product chosen for this study, namely the bicycle, the manufacturing technology is relatively stable. Hence the methodology is justified.

[3] The monetary unit used in this paper is the Malaysian dollar. As at the end of 1978, the conversion rate is US$1.00=M$2.20.

[4] See Sen [17, p. 7] for discussions on the difficulties involved in operationalizing any rigorous definition of the social welfare function.

be examined. Relevant characteristics are investment and labor intensities, scale of operation, simplicity of operation and repair, appropriateness of product, and use of locally produced inputs (raw materials and machinery) [18, p. 98]. From this examination, it may be possible to identify a current technology (or an improved version of a current technology) which comes closest to being an appropriate technology—in the sense of enhancing the achievement of the goal of poverty eradication. However, before we proceed to evaluate the bicycle manufacturing technologies currently available in Malaysia, we shall briefly describe the present state of the Malaysian bicycle industry. This would provide a good basis upon which the technologies can be evaluated.

III. THE MALAYSIAN BICYCLE INDUSTRY

There are a number of bicycle types, of which the general roadster is the most common. The component requirement of a typical roadster is presented in Table I. From the table it can be seen that the frame, fork, mudguard, handle-bar, chain guard, luggage carrier, and stand require raw material inputs consisting mainly of steel tubes and sheets, and require relatively simple manufacturing processes of cutting, grinding, thread forming, pressing and bending, and welding. These parts can be produced by most well-equipped workshops. The other parts require a higher level of technology, since they involve more sophisticated machineries working on semi-finished inputs like high carbon steel. They are generally produced by specialized firms.

At present there are only two large bicycle manufacturers in Malaysia; namely the internationally well-known Raleigh Bicycle and Far East Metal Works, an indigenous firm. There are, however, a number of ancillary firms manufacturing some parts of components of a bicycle. Though no complete listing of these establishments exist, attempts made to identify them through the directory of manufacturing establishments, the yellow pages, and the bicycle dealer associations have revealed a total of eleven of these firms.[5] These firms are spread out rather evenly over the whole country.

In terms of components manufactured it can be seen from Table I that all components with the exception of crank and chain wheel, hubs, pedal, and bell are manufactured by the ancillary firms. The ancillary firms do not market their own brands of bicycles. They merely manufacture bicycle components and sell them either to the two large manufacturers (hence the name "ancillary") or to the bicycle dealers for the replacement market. The tariff levied on imported bicycle (completed set) as at 1978 is M$60 per set. On imported component parts the tariff varies according to the parts—ranging from M$20.00 on one body frame to M$1.00 on parts of brake system. The total tax on all the parts (levied separately) for a bicycle amounts to M$74. The tariff schedule offers uniformly high protection on all components, e.g., M$20 for a body frame and M$15 for a luggage carrier. Though in the short-run this may benefit the local

[5] It should be noted that the number of bicycle establishments as recorded in [8] includes manufacturers of tricycles and trishaws as well.

TABLE I

MAIN COMPONENTS OF A TYPICAL ROADSTER BICYCLE

	Component	Raw Material Requirements	Manufacturing Processes	Number of Ancillary Firms† Manufacturing Item
1.	Body frame	Steel tube and joints	1. Tube cutting 2. Grinding and deburring 3. Thread forming 4. Pressing, reaming, and bending 5. Welding and brazing 6. Polishing and painting	3
2.	Fork	Steel tube	As for body frame	3
3.	Mudguard	Steel sheet	As for body frame but sheet cutting instead of tube cutting	2
4.	Crank, chain wheel, and chain	High carbon steel	Specialized machineries*	3 (chain only)
5.	Handle-bars	Steel tube, steel lever, and rubber handle grip	As for frame together with electroplating (nickel and chromium plating)	3
6.	Brakes	Steel lever, brake shoes	Specialized machineries*	2
7.	Hubs, spokes and nipples, and rims	High carbon steel sheet and wire	Specialized machineries*	4 (spoke and nipples, and rims)
8.	Saddles	Steel wire for springs, leather	Specialized machineries*	2
9.	Pedals	Dust caps and pyramid full rubber	Specialized machineries*	—
10.	Chain guard	Steel sheets	As for mudguard	3
11.	Luggage carriers	Steel tubes and sheets	As for mudguard	3
12.	Stand	Steel tubes and sheets	As for mudguard	3
13.	Bell	High carbon steel	Specialized machineries*	—
14.	Tyre and inner tubes	Rubber, canvas, and steel wire	Specialized machineries*	4
15.	Other accessories, e.g., lock, lamp, etc.	Miscellaneous	Specialized machineries*	6

* For details of the machineries and processes, see [20].

† Most firms manufacture more than one item.

bicycle manufacturers, in the long run it is unlikely to stimulate them to be export-oriented even in components in which the local firms have strong international comparative advantages in terms of factor endowment.

Up to 1969 the domestic bicycle industry remained a relatively small sector—generating a value added at market prices of only about M$0.4 million, and

TABLE II
DOMESTIC MARKET FOR NEW BICYCLES

Year	Domestic Market for New Bicycles (Units)
1968	100,000
1969	105,000
1970	110,000
1971	115,000
1972	120,000
1973	127,000
1974	134,000
1975	141,000
1976	158,000
1977	165,000
1978	172,000
1979 and beyond	Increase at a rate of 8,000 units per annum

Source: Private interviews with Raleigh (Malaysia) and Malaysian Bicycle Dealers Association.

an employment of less than 200 people [8, various years]. However, the commencement of Raleigh (Malaysia) increased the value added to about M$1.6 million in 1969 and M$2.4 million in 1972, or about M$2.0 million per annum for the three years immediately after its establishment. The employment also increased to about 390 in 1969 and 500 in 1972. The labor productivity in the bicycle sector hovered around M$2,600 to M$2,900 per worker up to 1967; after 1967 it increased to between M$4,000 to M$5,400 per worker. This is, however, still significantly below the 1968 average labor productivity of M$5,179 per worker in the transport and communication sector [7, p. 285]. This is not surprising since the Malaysian transport sector is dominated by the more investment intensive automobile assemblers.

Unlike motor vehicles, ownership of bicycles requires no official registration. Estimation of the domestic market for bicycles, hence, has to be on the basis of its relationship to the economic environment and past sales. The Malaysian Bicycle Dealers Association's estimate of the domestic market for bicycles is as given in Table II.

The minimum economic size for a bicycle plant that manufactures the simple pressed and bent parts, and purchase the other components from ancillary firms, is about 25,000 units per annum [20, Chap. 6]. From Table II, it can be seen that the domestic market is more than sufficient to cater to the two large bicycle manufacturers currently operating. In fact there appears to be room for the viable existence of about two more bicycle plants. The minimum economic size for a specialized plant producing high-technology components like crank and chain wheel, hubs, and pedal is about 100,000 units per annum [20, Chap. 7]. Hence it would seem from Table II that, even with a market share of about half the domestic market, ancillary firms producing these specialized components can be viably established in the country.

In terms of marketing network both Raleigh and Far East market their bicycles in "completely knocked down" packs to bicycle dealers spread throughout the country. These dealers in turn sell the bicycles to the retailers (bicycle shops), either in assembled form or in knocked down packs, to be assembled by the retailers. In general, the Raleigh brands are retailed in the range of M$200–M$240 per unit, the Far East brands in the range M$150–M$180 per unit, while the local brands (assembled by bicycle retailers from purchased components) are anywhere in the range of M$100–M$150. The bicycle ancillary firms also market their components and parts produced through the formal marketing system. They sell their components to the bicycle dealers, who in turn sell them to the retailers for both the new and replacement market. With respect to market share, the bicycle dealers association estimated that as at the end of 1978, Raleigh and Far East each has captured about 35 per cent to 40 per cent of the market. The remaining 20 per cent to 30 per cent is shared by the other brands.

IV. BICYCLE MANUFACTURING TECHNOLOGIES

In this section we will focus our discussion on comparing the manufacturing techniques of Raleigh (a foreign-based firm) and Far East, as well as those used by the local bicycle component manufacturers. The essence of the comparison is "modern" manufacturing technique (i.e., those used by Raleigh) and less "modern" techniques (i.e., those used by Far East and other local establishments).

The bicycle manufactured by both Raleigh and Far East includes some self-manufactured components and some components which are purchased from external suppliers—locally as well as abroad. Table III presents the details of the origin of the components that are used in the Raleigh and Far East bicycles. The table also lists the components manufactured by six local bicycle-component firms. These six local bicycle-component firms are fairly representative of the bicycle ancillary industry and hence should be sufficient for the purpose of generalization regarding the ancillary sector.

The manufacturing techniques used by Raleigh, Far East, and the relevant ancillary firms are summarized in Table IV. We can compare these techniques on technical, economic, and organizational grounds. Since all the relevant firms produce essentially similar items, such comparisons do reflect the relative state of the manufacturing processes.

A. *Technical Comparison*

From Table IV it can be seen that technically Raleigh and non-Raleigh manufacturing techniques can be compared in terms of input materials, the basic machining operations (cutting, filing, bending, pressing, and threading), the joining operation, the finishing operation, and quality control.

All *input materials* utilized by Raleigh are imported from its parent company in United Kingdom. For the non-Raleigh firms, the majority of the input mate-

TABLE III
BICYCLE COMPONENTS MANUFACTURED BY PRIMARY FIRMS AND ANCILLARY COMPONENT FIRMS

Bicycle Components	Primary Firms		Local Bicycle Component Manufacturer*					
	Raleigh	Far East	Tan Lian	Sin Heng	Joo & Co.	Gree Lee	Batu Pahat	Arm-strong
1. Body frame	SM	SM					×	
2. Front fork	SM	SM	×				×	
3. Mudguard	P–UK	P–Lo	×					
4. Crank	P–UK	P–J&T						
5. Chain wheel	P–UK	P–J&T						
6. Chain	P–Lo	P–Lo						
7. Pedal	P–UK	P–J&T						
8. Handle-bar	SM	SM					×	
9. Handle-bar grip	P–UK	P–J&T						
10. Brake system	P–UK	P–J&T						
11. Hub (front and back)	P–UK	P–J&T						
12. Spokes and nipples	P–Lo	P–Lo		×				×
13. Rims	P–Lo	SM						
14. Saddle	P–Lo	P–J&T	×					
15. Chain guard	SM	P–Lo	×			×		
16. Luggage carrier	P–UK	P–Lo			×	×	×	
17. Bicycle stand	P–UK	P–J&T			×	×		
18. Tyre and tube	P–Lo	P–Lo						
19. Rugs (joints)	P–UK	SM						
20. Rear reflector	P–UK	P–J&T						
21. Bell	P–UK	P–J&T						
22. Locks	P–UK	P–J&T			×	×	×	
23. Lamp	P							
24. Pump	P–UK	P–J&T						

Note: SM—self-manufactured, P–UK—purchased from United Kingdom, P–Lo—purchased locally, P–J&T—purchased from Japan and Taiwan.
* Only manufacture those items marked ×.

rials are purchased locally (e.g., steel tubes, bolts and nuts, etc.). These materials may be of acceptable quality, but are unlikely to be as high quality as the Raleigh materials. Specialized items like high-carbon steel sheets are imported from Japan or Taiwan.

In the case of Raleigh the *basic machining operations* of cutting, filing, bending, pressing, and threading utilize very little manual efforts. All operations are performed automatically by equipment. These operations are performed semi-automatically in the non-Raleigh firms. More manual efforts are involved, although the finished components tend to be less consistent in quality than that of Raleigh's.

In Raleigh, all *joints* are welded using a spot-welding machine. The joints are also brazed in a dip-braze furnace, resulting in joints which are not susceptible to corrosion. In the case of the non-Raleigh firms the joints are welded using manual oxy-acetylene gas welding sets. The quality of the welding, in this case, depends on the ability and experience of the welder and, on the average, may be of lower quality than that done using a spot-welding machine. Further the joints are not brazed, and hence are more susceptible to corrosion.

TABLE IV

MANUFACTURING OPERATIONS USED BY RALEIGH (MALAYSIA), FAR EAST, AND ANCILLARY FIRMS

Item	Raleigh Manufacturing Operations	Far East Manufacturing Operations	Typical Ancillary Firm Manufacturing Operations
Body frame and front fork	1. Cut tube to size, file ends, and cut threads on ends (automatic) 2. Join tubes using lugs (manual) 3. Weld and braze joints (semi-automatic) 4. Electrostatized paint applied by dipping, then components are stove enamelled	1. Cut tube to size, file ends, and cut thread (semi-automatic) 2. Join tubes using lugs (manual) 3. Weld joints (manual) 4. Paint components using ordinary paint and spray system	Same as Far East except paint is applied manually instead of the spray system
Handle-bar	1. Cut tube to size, bend tube, and then cut threads (automatic) 2. Join tubes (manual) 3. Weld and braze joints (semi-automatic) 4. Chrome (to acceptable Raleigh standard) handle-bar (automatic)	1. Cut tube to size, bend tube, and cut threads (semi-automatic) 2. Join tubes (manual) 3. Weld joints (manual) 4. Chrome handle-bar (automatic)	Same as Far East
Chain guard	1. Cut sheet to size and press to appropriate shape (automatic) 2. Join all parts (manual) 3. Weld and braze joints (semi-automatic) 4. Electrostatized paint applied by dipping; components are then stove enamelled	Not manufactured	1. Cut sheet to appropriate size (semi-automatic), press to right shape (automatic) 2. Join all parts (manual) 3. Weld joints (manual) 4. Paint component manually
Rims	Not manufactured	1. Cut sheet to length, bend and form sheet to circular shape (automatic) 2. Weld ends (automatic)	Not manufactured

Raleigh's *finishing operations* are, in general better than that of non-Raleigh. For paint finish, Raleigh uses electrostatized paint applied by dipping. The primer coat is stove-baked for greater corrosion resistance and more even finish. Far East uses non-electrostatized paint applied via a spray system, while in the case of the ancillary firms the paint is applied to the components manually.

Raleigh maintains a very rigorous policy of *quality control*. All components—self-manufactured as well as locally purchased—are subjected to continuous testing by the parent company. Each completed bicycle must be able to sustain 258 hours of continuous use under Raleigh specified conditions. On the other hand, both Far East and the ancillary firms do not have a very rigorous quality control policy. Parts are generally subjected to visual inspection, but not mechanical testing.

In summary it can be said that Raleigh's technical quality is geared towards meeting its own very high international standards, while that of the non-Raleigh firms are more directed towards meeting the demand and standard of the domestic market.

B. *Economic Comparison*

A detailed micro-level comparison of the mechanism of the techniques is difficult. However, in Table V we provide a number of economic indicators to compare the performance of the manufacturing techniques.

In terms of investment,[6] Raleigh has the largest current value followed by Far East. The current value of investment of a bicycle ancillary firm is typically small, being less than M$1 million. In terms of employment both Far East and Raleigh have about 200 workers each. The workforce in the other firms is generally small, being less than 100 workers each.

In terms of the intensity indicators Table V shows that there is a clear distinction between Raleigh and the non-Raleigh firms. Raleigh uses an investment per labor of M$46,000 while that for non-Raleigh firms varies between M$27,000 to M$8,000. Table V also shows that Raleigh's value added per labor of M$13,000 is double or triple that of the other firms which varies between M$5,500 to M$1,300. This clearly indicates that Raleigh's technique is more investment intensive. This enables it to generate a value added per labor far higher than the other bicycle firms. In terms of value added per dollar investment, there is also a significant difference between Raleigh and non-Raleigh firms, the value being 0.29 for Raleigh and between 0.15 to 0.20 for the non-Raleigh firms.

Given that the firms in this study work only on a one-shift basis, and each have an approximately equal number of holidays, the degree of capacity utilization for Raleigh and non-Raleigh firms is about the same (see Table V). The higher

[6] In this paper investment will be used in place of capital. This is to overcome all the objections of capital as a concept of factor input (see [18]). Further, since the equipment utilized by all the firms are of the same vintage, and have almost the same expected life-span, the current replacement cost is used instead of the annual equivalent replacement cost.

TABLE V

ECONOMIC INDICATORS OF RALEIGH AND NON-RALEIGH MANUFACTURING FIRMS

Indicator [a]	Raleigh	Non-Raleigh Firms					
		Far East	Tan Lian	Sin Heng	Joo & Co.	Gree Lee	Batu Pahat
1. Current value of investment (M$ million) (I)[b]	8.9	5.6	2.2	0.2	0.4	0.3	0.8
2. Employment (L)	194	210	81	20	23	39	49
3. I/L (M$ per person)	46,000	27,000	27,000	10,000	17,000	8,000	17,000
4. Value added (VA)/L (M$ per person)[c]	13,000	5,500	5,000	2,000	3,500	1,300	2,700
5. VA/I	0.29	0.20	0.18	0.20	0.20	0.16	0.15
6. Value of imported components/VA	2.2	0.6	0.6	0.5	0.4	0.4	0.6
7. Value of local purchased components/VA	0.8	0.6	0.4	0.5	0.6	0.6	0.4
8. Capacity utilization rate (%)[d]	56.0	56.0	56.0	50.0	50.0	56.0	50.0
9. Advertising expense/VA	0.04	0.008	0.005	0.001	0.001	0.002	0.002
10. Average annual production (in 1,000 bicycles)	50.0	50.0	—	—	—	—	—

Source: Based upon private interviews with the relevant firms and their annual reports.

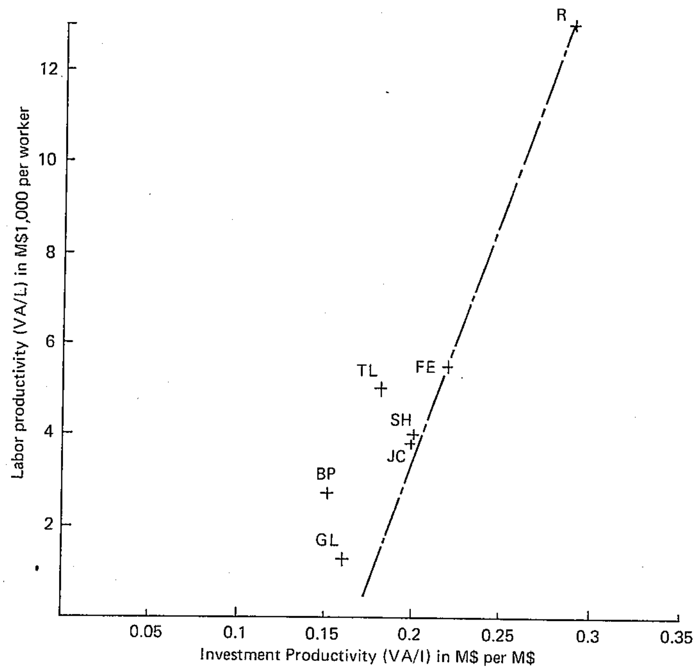
[a] The relevant base period is December 31, 1978.

[b] Computed from an appreciation rate of 10 per cent per annum based on cost at time of purchase. Time of purchase of machinery and cost were extracted from the relevant company annual reports. This item also includes working capital which is estimated to be the difference between current asset and current liability.

[c] Labor productivity is computed in M$ per worker rather than bicycles per worker. This is because the firms manufacture only parts of a bicycle, and it is not possible to compare their output on the basis of units of bicycles.

[d] Based upon a 100 per cent capacity of 16 working hours per day for 290 working days per year.

Fig. 1. Relative Efficiency of Bicycle Manufacturing Techniques of Different Firms



Note: R—Raleigh; FE—Far East; TL—Tan Lian; SH—Sin Heng; JC—Joo & Co.; GL—Gree Lee; and BP—Batu Pahat.

investment productivity, for Raleigh cannot, therefore, be explained by a higher capacity utilization rate. Since the age of Raleigh equipment is not very different from that of non-Raleigh equipment, it is also unlikely that non-Raleigh equipment would have deteriorated so much (vis-à-vis Raleigh equipment) as to cause a drastic decline in its equipment productivity. Further, since bicycle manufacturing technology is a relatively stable and open technology, it is highly unlikely that Raleigh could have used more productive methods of working on the equipment without the non-Raleigh firms coming to know about them and using these methods themselves. Hence the only likely explanation for Raleigh's higher investment productivity seems to be its ability to capitalize on its international image, and collect monopolistic rent on its products in the form of higher prices (i.e., higher than that justified by its better quality).[7]

It is also evident from Table V that the techniques of some firms are more efficient (with respect to labor and investment productivity) than the others. Figure 1 presents the plot of labor productivity against investment productivity. From the figure it can be seen that techniques used by Raleigh and Far East

[7] As was mentioned in Section II, Raleigh bicycles are more expensive than other brands of bicycles. See also [2, Chap. 1] for a further elaboration of this tendency of large multinationals.

can be considered as efficient. Techniques used by the other firms all lie to the north-west corner of the line joined by Raleigh and Far East and are therefore inferior. However the positions of Sin Heng and Joo & Co. are just off the efficient line. Their techniques are therefore, "almost" efficient.

In terms of purchase of input materials and components, Table V shows that, while there is no significant difference between Raleigh and non-Raleigh firms in terms of value of local components purchased per dollar of value added, there is a significant difference between the two groups of firms with respect to value of imported component per dollar of value added. Raleigh uses about M$2.1 of imported component per dollar of internal value added, while the average for the non-Raleigh firms is only about M$0.60. With respect to total cost of purchased parts and components, Raleigh uses about M$3.0 worth of externally manufactured components to every M$1.0 worth of internal value added, while that of non-Raleigh firms is about M$1.0 externally manufactured components to M$1.0 internal value added. The high value of imported components (and hence total externally purchased components) may be accounted for by the fact that Raleigh imported components are more expensive than imported components utilized by non-Raleigh firms.

C. *Organizational and Marketing Differences*

Besides being more investment-intensive, Raleigh also differs from the non-Raleigh firms in organizational structure and administration. These differences are listed in Table VI.

Raleigh is essentially a foreign controlled firm. Decision making are vested in the hands of a number of expatriates seconded from the parent company. All the non-Raleigh firms are operated as Malaysian privately-owned limited companies. Except for Far East, non-Raleigh firms do not employ university graduates on its management team. In fact, except for Far East, there is no separation between the owner and the chief executive in the other non-Raleigh firms. In these cases the owner is also the chief executive.

In general the employees of Raleigh is better paid[8] than employees of the non-Raleigh firms. The average wage of a direct Raleigh employee is M$400 per month, compared to M$300 per month for that of Far East and about M$200 per month for that of the other firms. Non-Raleigh firms (other than Far East) experience a high labor turnover rate. On the other hand, there is a very low rate of labor turnover in Raleigh. This may be attributed to its relatively high wage rate, as well as the existence of a formal training program for its employees. The labor turnover rate for Far East is intermediate between that of Raleigh and the other non-Raleigh firms.

[8] This may be a reflection of the higher labor productivity of Raleigh firms. It is difficult to compare the skill levels of Raleigh workforce with that of the other firms. No formal vocational qualification is required of process workers before they are hired and generally every process worker is expected to learn "on the job." However, only Raleigh has a formal in-plant training scheme for its hired workers. In so far as wage can be a measure of a worker's experience, then one can conclude that Raleigh workers are generally more experienced than those in the non-Raleigh establishments.

TABLE VI

ORGANIZATIONAL CHARACTERISTICS OF RALEIGH AND NON-RALEIGH FIRMS

Characteristic	Raleigh	Non-Raleigh Firms					
		Far East	Tan Lian	Sin Heng	Joo & Co.	Gree Lee	Batu Pahat
1. Year of establishment	1968	1959	Pre-1959	1968	Post-1970	1968	1965
2. Legal structure of company	Public Co.	Private Ltd.	Private Ltd.	Private Ltd.	Private Ltd.	Private Ltd.	Private Ltd.
3. Rate of university graduates in workforce (%)	5.1	1.4	0.0	0.0	0.0	0.0	0.0
4. Average wage of direct workforce (M$ per month)	400	300	250	200	200	200	200
5. Existence of a formal training program for workforce	Yes	No	No	No	No	No	No
6. Main origin (by country) of equipment	U.K.	Japan	Taiwan	Taiwan	Taiwan, Japan	Taiwan, Japan	Taiwan, Germany
7. Was company given pioneer status?	Yes	No	No	No	No	No	No
8. Was company given loans by public agencies?	No	Yes	Yes	No	Yes	No	Yes
9. Location of establishment	I.A.	I.A.	R.A.	R.A.	I.A.	R.A.	R.A.
10. Rate of factory space used as residence (%)	0.0	0.0	50.0	0.0	0.0	30.0	30.0

Source: Based upon private interviews with the relevant firms and their annual reports.
Note: I.A.—industrial area; R.A.—residential area.

Another major difference between Raleigh and non-Raleigh firms is the major emphasis in which Raleigh places on the quality and image of its brand of bicycles. This message of superior quality is constantly conveyed to the public through constant advertisement campaigns in the newspapers and sports magazines. Table V shows that Raleigh uses M$0.40 of advertising expense for every dollar of value added which is far higher than that of the other firms. The marketing strategy of Raleigh is impressing upon the potential buyer that the higher quality more than justifies the higher retailer price. The marketing strategy of non-Raleigh firms (especially Far East) is one of selling a product at a cheap price.

D. *Appropriate Technology*

From the perspective of Morawetz [12] and Eckaus's [3] definition of appropriate technology and Stewart's [18] list of desired characteristics in appropriate technology, the above discussions indicate clearly that with respect to the Malaysian development goals, Raleigh technology may not be the most appropriate bicycle technology. An improved version of Far East technology (with improvements in quality control, and finishing operations) may be the more "appropriate" technology for bicycle manufacturing in Malaysia. The reasons for this observation are as follows.

(1) It is a relatively efficient technique in the sense that no other techniques currently available in the country can achieve the same level of labor productivity with the same or less level of investment productivity.

(2) Amongst the bicycle manufacturing techniques, its value of investment intensity is intermediate—it being between the highly investment intensive Raleigh technique and the highly labor intensive (but inefficient) techniques of the bicycle ancillary firms. In relation to the industrial sector as a whole, this technique's requirement for investment seems to be reasonable in the sense that it is far below the investment intensity of sectors which are obviously investment-intensive (e.g., petrochemicals) and above sectors which are obviously labor intensive (e.g., footwear manufacture).[9] Thus its demand on the country's investment (a limited resource) seems to be consistent in relation to its ability to generate jobs.

(3) In terms of scale of operation requirement, that required by Far East[10] is not beyond the reach of the currently smaller firms or that of the larger ancillary firms. In terms of organizational requirement it is certainly not beyond the ability of the entrepreneurs who run the ancillary firms, since the basic style of organization is the same. Further, with respect to skill requirement of the workforce, the types of skill workers required are not far above the skill level of the workers in the present ancillary firms. All in all, this technique seems to be readily adoptable by local entrepreneurs.

9 See Lim [7, p. 285]. Actually Lim used value added per employee as the surrogate measure for capital intensity. Based on his computations, in 1968 the value added for the transport equipment sector is M$5,179, M$102,717 for the petroleum sector, and M$2,212 for footwear manufacture.

10 This assumes that a smaller scale of operation of the Far East-type technique is not feasible. Actually this may be too conservative an assumption, but for the purpose of argument it is safer.

(4) The Far East-type of technology manufactures a product which can meet the basic need of reliable transportation at a price acceptable to the low income families.[11] For these families bicycle is the only feasible form of family-owned transportation mode. This technology is, therefore, consistent with the nation's developmental priority which is eradication of poverty.

(5) There is a great potential for bicycles manufactured by Far East-type techniques. Far East brands now constitute about 35 per cent of the domestic bicycle market, in spite of Raleigh's well coordinated advertising strategy. With a more coordinated marketing and advertising campaign, bicycles manufactured by Far East-type technique can make an even bigger inroad into the domestic market.

It should be noted that the suggested appropriate technology, which is a slightly improved version of Far East technique, is one based on new equipment.[12] The characteristic that makes it appropriate is essentially the substitution of labor in the machine-peripheral activities [14]. For example, in the cutting/filing/threading operation for body frame manufacture, the tube length is manually adjusted instead of being done by machine. The basic "core" machine activities upon which the basic reliability of the product depends, is basically similar to that of Raleigh (the most investment-intensive technique).

Further, it should be pointed out that Far East-type technique has been identified as appropriate only on the basis of evaluation of techniques currently available. It may very well be a more appropriate technology for bicycle manufacturing can be developed through new and intensive research and development efforts. This, however, may not be forthcoming in the foreseeable future since bicycle manufacturing techniques are relatively stable and are not likely to be easily affected by new innovations.

V. POVERTY PATTERN AND APPROPRIATE TECHNOLOGY

In this section, we briefly discuss the poverty pattern in the Malaysian income, and then examine how the utilization of an appropriate technology for bicycle manufacturing will be consistent with the government's developmental goal of eradication of poverty by uplifting the standard of living of the lowest income group of the population.

A. *Malaysian Poverty Pattern*

In terms of absolute number of poverty households,[13] Table VII shows that the total number of poverty households increased from 791,800 in 1970 to 835,100

[11] At M$150 per bicycle, it is between one to two month's household salary of an average low income household.

[12] Not second-hand equipment as was the case of some technologies in early Japan [6] [13]. It is generally felt that a technology based on old equipment is not likely to be appropriate, since it can create many problems with respect to spare parts, maintenance, and product quality.

[13] The poverty line income is that income necessary to cover minimum nutritional requirements and essential non-food expenses to sustain a decent standard of living [10, p. 160].

TABLE VII

PENINSULAR MALAYSIA: POOR HOUSEHOLDS BY RURAL AND URBAN STRATA, 1970–90

Strata	1970		1975		1980		1990	
	Total Poor Households (1,000)	% of Total Households	Total Poor Households (1,000)	% of Total Households	Total Poor Households (1,000)	% of Total Households	Total Poor Households (1,000)	% of Total Households
Rural	705.9	58.7	729.9	54.1	646.7	43.1	388.9	23.0
Urban	85.9	21.3	105.2	19.0	121.6	15.8	125.0	9.1
Total	791.8	49.3	835.1	43.9	768.3	33.8	513.9	16.7

Source: [10, p. 73].

in 1975. In 1975, it was estimated that the incidence of poverty occurred in 54.1 per cent of the rural households but only 19.0 per cent of the urban households. The incidence of poverty among rural households is particularly high, and current government developmental strategies aimed at reducing the number of poor households to 43.1 per cent of the rural households and 15.8 per cent of the urban households in 1980, and to 23.0 per cent and 9.1 per cent of the rural and urban households respectively in 1990. In terms of absolute numbers, the plan call for the reduction of poor households to 768,300 in 1980 and 513,900 in 1990.[14]

Given the great emphasis of the government to uplift the level of income of the poorest income group to that above the poverty line, there will be a higher and higher proportion of the population which will be above the poverty line but still below the medium and high income line by the end of the various developmental plans.

In 1967–68 (see Table VIII) 55.3 per cent of the households earned incomes of less than M$100 per month, which is the generally accepted poverty line for 1968.[15] About 35.7 per cent of the households earned between M$100 to M$299 per month, which corresponds to the households above poverty line but below the medium or high income levels. From Table VIII it can be seen that bicycle is the major item of consumer durables owned by these two groups of households. For families in poverty and just above poverty categories bicycle is an extremely important piece of family consumer durable. It is owned by about half of the families in the poverty category and about three-quarters of the families in the just above poverty category. Hence if the governmental targets, as set out in Table VII, for the eradication of poverty are achieved there will be a tremendous increase in demand for bicycles. Given this expected large increase in natural demand for such bicycles, it is not only socially desirable but also consistent

14 It is not the intention of this paper to evaluate the feasibility (or otherwise) of the achievement of these targets. Hence these targets are accepted at their face values.

15 The *1967–68 Socio-Economic Sample Survey* [9] defined income to be cash income. This generally understates income of the low income groups, since these groups generally supplement their cash income with home produced food crops, transfer payment from relatives, etc.

TABLE VIII

OWNERSHIP OF CONSUMER DURABLES BY HOUSEHOLD INCOME

Type of Household Item	% of Households with Following Household Income (M$/Month) Owning*			
	M$1–99	M$100–299	M$300–749	M$750 and Above
Motorcar	0.3	5.2	45.7	78.9
Motorcycle/scooter	2.8	17.8	24.8	10.2
Bicycle	47.1	72.3	59.7	37.8
Telephone	0.1	1.8	14.5	50.1
Radio	23.1	53.4	80.8	84.5
Television	0.3	7.0	39.5	43.3
Refrigerator	0.3	5.2	46.3	83.1
Electric fan	0.8	13.6	57.7	86.0
Air-conditioner	0.1	0.2	1.5	19.1
Sewing machine	22.4	57.9	79.6	69.1
Total households in income group (1,000)	899.2	580.6	115.1	30.2
% of total households	55.3	35.7	7.1	1.9

Source: [9].
* Income here is defined to be cash income.

with the overall objective of the upliftment of the living conditions of the poor, that government policies on the bicycle sector should be directed towards the growth of manufacturing establishments utilizing the appropriate technology, i.e., Far East-type technology which is efficient yet not too highly investment-intensive.

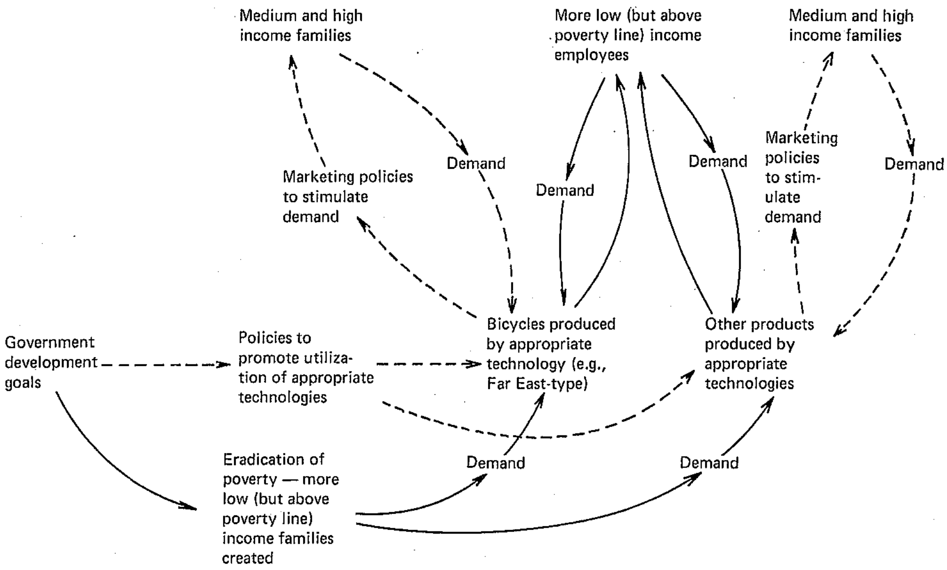
B. *Appropriate Technology and Employment Generation*

The encouragement of the utilization of appropriate technology for bicycle manufacturing will, further, have the desirable effect of generating more employment opportunities than if the more investment-intensive Raleigh-type technology were encouraged. The current average annual production of both Raleigh and Far East is about 50,000 bicycles each. From the table of domestic demand (Table II) it can be seen that there will be scope for two more plants of the present Far East capacity by about 1981.[16] The required investment for these two plants, if the Far East-type technique is used, would be about M$11.2 million with an employment potential of over 420 workers. However, if the Raleigh-type technique is adopted for these two plants, the required investment is about M$16.8 million with an employment capacity of about 390 workers. Hence, with the Far East-type technique there would be an extra thirty jobs created. Further the surplus investment of M$5.6 million (i.e., M$16.8 million–M$11.2 million) can be invested in other sectors to create more employment.

The adoption of appropriate technique to produce bicycles demanded by the new low income (but above poverty level) households, created as a result of

16 The projected demand by 1981 is about 196,000 bicycles per year. Hence there will be enough scope for four bicycle plants of capacity of 50,000 units per year. Again we are making the conservative assumption that Far East-type technology requires at least a workforce of 200.

Fig. 2. The Appropriate Technology, Employment, and Income Diffusion Cycle



government development efforts, in turn produce a larger number of employees[17] who would be potential consumers of bicycles (and other products) produced by appropriate techniques. This cycle is represented by bold lines in Figure 2. The cycle in bold lines emphasizes the income diffusion aspect of appropriate technology utilization. Products manufactured by appropriate technologies efficiently meet the requirements of the low income groups and thus raise their standards of living. Further the utilization of appropriate technology in itself generates a larger number (compared to utilization of inappropriate technology) of industrial job opportunities, enabling more of those below the poverty line to be raised above it. Although the bicycle sector is a relatively small sector, together with the utilization of appropriate technology for the manufacture of other products, the incremental employment opportunities created would be substantial. This, in turn, would generate substantial consumption effect for appropriate products. This would result in the upliftment of the standard of living of a far larger number of poverty group than if inappropriate technology were used.

C. *Government Policies and Appropriate Technology*

Thus far we have been discussing the adoption of appropriate techniques by private entrepreneurs. From the viewpoint of social welfare there is also ample justification for adoption of government policies to promote the utilization of appropriate techniques by private entrepreneurs.

The current Malaysian scheme for promotion of industrialization, as incorpo-

[17] Larger than would be the case of the more investment-intensive Raleigh-technique is utilized. Further the wages of employees of firms using the appropriate technique would be lower than that of employees of firms which use the more investment-intensive type technique.

rated in the Investment Incentive Act of 1968 and the Investment Incentives (Amendment) Act of 1971, are aimed at promoting the growth of firms using technology which are either very investment-intensive or very labor-intensive [7, Chap. 12]. Appropriate technology generally have an intermediate degree of factor intensity [18]. Some fine-tuning of the incentives would seem necessary if appropriate technology is to be promoted. There need to be an incentive based on both the level of fixed investment and employment.[18] This would provide an opportunity for firms with medium levels of fixed investment and employment, as most appropriate technologies tend to be, to compete on the same footing as the more investment-intensive and the more labor-intensive firms. Further, much more research need to be done (or encouraged to be done) to determine the types of technology appropriate to the various industrial sectors. Since an appropriate technology is generally product specific, this requires a series of studies on different products, particularly the major products of the Malaysian economy.[19] Generalizations and conclusions can then be drawn on the pattern of appropriate technology; and this would be extremely helpful for the design of policies to promote appropriate technology.[20] The government can also help in providing consultancy services on appropriate marketing and advertising strategies to raise the image of the appropriate products close to the "ideal" desired by the consumers, besides the conventional areas of finance, technical operation, and management. In the case of bicycle manufacturing, this is particularly important. Image building of a transport mode through advertising is a very complex area, and large establishments in this sector[21] have done a great deal of research on this. The government could tap on this vast source of information, and advise potential future bicycle manufactures on their optimal advertising and marketing strategies.

The likely effects of these suggested deliberate efforts of government to promote appropriate technologies are shown as hatched lines in Figure 2. Policies aimed at the promotion of appropriate technologies would result in more appropriate products being produced. This can lead to more efficient satisfaction of the needs of the lower income groups, and their resultant improvement in standard of living. The consultancy services directed at product improvements and more effective marketing and advertising strategies would create more demand for the appropriate products, especially among the medium and high income

[18] It should be pointed out that under the present incentive scheme a firm cannot enjoy both the incentives based on fixed investment and those based on labor relief.

[19] These include processing of agricultural products, food and beverages, textiles and footwear, wood products, metal products and machinery manufacture and repair, and transport equipment.

[20] A ringing example of the usefulness of this sort of studies is contained in [2]. As was shown in Section III, bicycle manufacturing in Malaysia consists mainly of the basic machining operations of cutting, grinding, filing, threading, etc. Thus the findings of this study may also be applicable to other sectors with such activities, e.g., the metal working sector, general repairs and services, etc.

[21] Examples are the large automobile manufacturers (General Motors, Ford, Nissan, etc.) in the motorcar sector, the large two-wheeler manufacturers (Honda, Vespa, Raleigh, etc.) in the two-wheeler industry.

families. This in turn would lead to a more optimal utilization of resources among the firms manufacturing appropriate products, and would enable them hopefully to produce the appropriate products even more efficiently. The end result is a reinforcement of the income diffusion aspect of appropriate technology adoption. This would contribute towards fulfilling the government's stated goal of eradication of poverty by 1990.

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