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The DEVELOPMENT of URBAN INFRASTRUCTURE for INDUSTRIAL LOCATION in  
EAST AFRICA

- Towards an Operational Methodology for the Integration of  
Economic and Physical Planning

by  
Michael Safier

MAKERE INSTITUTE of SOCIAL RESEARCH

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# The DEVELOPMENT of URBAN INFRASTRUCTURE for INDUSTRIAL LOCATION in E. AFRICA

## I: The Project

This paper presents a project proposal and procedures for the investigation of costs of providing urban land and related infrastructural services for manufacturing industry in a selected number of locations throughout E.Africa. The aim of the project is to provide the empirical data and analysis that would enable a first partial estimation of costs external to the industrial enterprise/sector development that might be subject to minimisation by the adoption of a programming procedure aimed at an optimal or near-optimal scheduling of investment in urban land and facilities for industry over the E.African region. A secondary purpose of such an exercise would be to try and evaluate the present procedures whereby national, regional, and urban economic and physical planning are now undertaken and determine how these procedures could be modified in order to take account of relevant data and analysis produced at one level and apposite to another. This project has grown out of a number of related enquiries and a background of theoretical modifications which will be outlined in part II; the analytical method of approach which seems to be most suitable to the task is given in part III; some empirical work giving some initial information on the E.African situation is presented in part IV; and a summary of the further investigations proposed is then given in the last part V.

## II: The Problem

The general problem as I see it was stated in the first of a series of papers previous to this, namely,

" the theoretical problem - to find a (systematic) connection between the process of economic growth ... and the process by which prevailing geographic distributions of population and activity are altered as this growth takes place.

the practical problem - to create a (planning) framework within which national economic programming and local physical planning can be joined together in a mutually supporting manner.

I there suggested that the problem should be treated conceptually as the identification of interrelationships between a system and a set of sub-systems of the economy in process of structural transformation, and their respective spatial organisation. In particular, out of a variety of possible aspects of this general problem, and sub-systems of the economy in their spatial dimension, I chose to concentrate on two which seemed to me likely to become more closely interconnected as development proceeded viz. the system of industrialisation and that of urbanisation. These systems come together in mutual interaction mediated by among other things their respective evolution in terms of spatial organisation. My hope is to extend further certain trends in theoretical work, and certain movements in planning activities in order to probe more deeply and with some policy relevance into this evolution.

There are three fields of theoretical work and planning activity which can be pinpointed as the starting points for subsequent elaboration, namely,

- industrial complex location theory and planning
- urban land development theory and planning and,
- regional growth pole theory and regional planning

Each of these fields has been subject to tendencies in the direction of a more generalised formulation of theoretical and practical propositions which when suitably extended bring each into close enough contact with the other for an attempt at bridge-building such as is here attempted.

The beginnings of a theory of industrial location were very closely related to existing micro-economic market competition and marginal cost formulations. From Weber to Hoover the tradition of locational analysis was centred around the determination of a 'least cost' or 'maximum profit'

calculus for the individual firm or producer, taking into account principally transport trade-off between raw materials and markets with the addition of labour cost differentials and 'agglomeration economies'. The subsequent<sup>3</sup> development of theory under the impetus of recent writers in the field has been to 'generalise' the classical analysis to cover both more location factors and more producing units. Thus we have now more elaborate analysis of some principal elements formerly covered by the umbrella of 'agglomeration economies' on the one hand; and a more elaborate examination of the<sup>4</sup> optimization conditions for a related group of individual plants on the other. A further, and decisive, trend has appeared in the theoretical writings of those economists and others in the centrally planned economies, and in some developing areas, who have<sup>5</sup> considered the problem of optimal location for an entire industrial sector. In doing so they have had to enlarge their frame of reference even further, not only to take in 'urbanisation economies' but to consider the whole question of allocating investment for the urban populations that will be attendant on the development of industrial sector concentrations in a given area. At this point they meet the approaching interests of other fields. This macro-economic level of locational analysis is closely paralleled by the current planning concern, which is in process of shifting from the situation in which location was treated as a separate and 'independent' problem in the analysis of a given industrial project<sup>6</sup>, to that in which locational distributions are treated as an integral part of programming along with technology and scale of enterprises.<sup>7</sup>

The beginnings of a theory of urban land use and development were closely related to two related disciplinary offshoots; the formulations of urban land economics concerning the trade off between accessibility, rentability and intensity of use, and the formulation of urban ecology concerning the relation between urban growth, socioeconomic status, and segregation of land use. These investigations were and still are primarily concerned with the micro-economic and social adjustments taking place among individual land uses in single cities, as these cities grow and differentiate themselves. They have been joined by another group of works treating of the 'economic base' of the individual urban area, which have grafted a more macro-economic orientation with aggregate supply and demand factors onto the previous detailed studies; at the same time the picture has been reconstituted by the attempt of geographers to pull together the external and internal activity patterns of cities and towns through the 'central place' theory.<sup>9</sup> Again a further and decisive trend has appeared with the investigation of whole 'systems' of cities and the 'urban hierarchy' often with special reference to the developing countries, where attempts are made to explain the generation of aggregate urban growth and its allocation in space.<sup>10</sup> A closely parallel evolution has taken place in urban land planning. Beginning with a central concern with the allocation of land within the urban area among competing uses on the basis of zoning and density regulations, such planning has progressed to a more sophisticated<sup>11</sup> formulation of complete physical 'master plans' for overall urban growth. This interest has been further extended, especially in some of the centrally planned economies and some developing countries as well as in mixed market economies to the planning of clusters of urban centres - 'new towns' and 'metropolitan area' planning - and even to policy formulation for the encouragement of changes in a national system of cities.<sup>12</sup> At this point the transition of interest into other fields is clearly marked.

The theory and planning of regional development has passed more quickly from considerations of a single area or region vis-a-vis the rest of the world, deriving its impetus from international trade theory,<sup>13</sup> to consideration of a national economy as represented by its regional specialisations and interregional exchanges, with particular reference to area differentiation during the course of national development.<sup>14</sup> Initial emphasis on the problems of resource-base development, backward or problem areas, and congested metropolitan regions, has been broadened out into a

more generalised concern for the appropriate allocation of efforts amongst regions bearing in mind some stated goals of national priority for area development. The importance of industrial and urban development in this context needs little repetition.

Yet both in theory and planning practice much integrative work remains to be accomplished. In order to provide a more satisfactory framework for the understanding and policy-making needed in developing areas, there are at least three areas of critical importance to be examined. These three are all parts of a higher-order theme which is the determination of the dynamics of the system whereby industrial location and urban growth become coalesced. That is to say, how it comes about that the industrial and urban subsystems become progressively interdependent upon one another forming eventually into a single new system of 'urban-industrial' concentration which attracts to itself the greater proportion of subsequent urban and industrial expansion. The three areas of special interest are,

- a. the evolution and consolidation of industrial interlinkage forming the basis for urban concentration on an 'input-output' basis
- b. the development and consolidation of industrial sector servicing as the basis for urban concentration on an 'external economies' basis
- c. the evolution and consolidation of industrial facilities capacity as the basis of urban concentration on an 'social overhead investment' basis.

Each of these special areas related to one facet of the general problem of interpreting and directing the progress of integrated regional urban industrial foci of growth. Of the three it is the first two that have been given the most thorough by no means exhaustive treatment. The third facet of the problem has been little broached as yet, and forms the central focus of the present project.

The relevance of this enquiry for current conditions in E.Africa is not hard to demonstrate. All three territories are in the midst of a quite significant industrial expansion which since 1960 has triplicated many originally unique manufacturing enterprises. The national plans now in force, just prepared and in the process of beginning preparation, all have substantial industrial investment programmes included. Above and beyond these the E.African Community has for the first time in the chequered history of interstate co-operation and integration, an operational arm in the industrial field, the EADB, which with the assistance of the U.N. the IBRD and other agencies is seeking to establish a regional programme of industrial development. Each of the three governments has at one time or another by word or deed indicated that it has policy preferences for industrial location, but none has as yet elaborated a coherent location strategy. As things stand now the relevant decisions are part political and part adventitious, but in each case certain specific areas stand out as likely foci for future manufacturing expansion and can be reviewed as such. While the EADB has not as yet had the time or the priority to take under the industrial investment programme consideration for the possibilities of regional location strategies, this is no doubt a subject that will demand attention when the sector potential in each territory has been initially established. At the present time there is mounting evidence that independent decisions on plant location are raising total costs of industrial establishment by imposing additional avoidable investments for complementary public service commitments.

Equally, all three territories are in the midst of a rapid urbanisation which has probably nearly doubled the population living in cities and towns since 1950. In each territory the established town planning organisations have been trying to cope with the influx of people and activities into the urban areas, on the whole with only qualified success, largely due to the inadequacy of the legislative and organisational framework in which they have to operate. All the six largest urban centres @ Nairobi, Kampala,

Dar es Salaam, Mombassa, Jinja and Arusha - have or are having elaborate 'master plans' prepared for them, which, with a number of specialist studies in some cases, have included very large capital investment proposals covering periods up to the end of the present century. In all cases however the analysis of economic base prospects for such centres has yet to be adequately accomplished, while the capital budgeting for their investment programmes has still somehow to be fitted into the broader framework of national economic planning and priorities. There is again, ample evidence of severe limitations on any effective land planning in such circumstances, where schemes are being drawn up without either the discipline or the assistance of definite economic and investment forecasts - and nowhere is the case more critical than in the field of industrial development, upon which so much else in urban planning is said to hinge.

Finally, all three territories have established programmes of regional planning and development. In all cases these were commenced as extensions to the already established physical planning organisations, but now in one case the latter have relinquished the tasks to the national planning office and in another case joint arrangements are in process of being worked out between the two. While a number of countrywide and more limited regional surveys have been made, and some criteria formulated for future regional distributions of activities and facilities, there is as yet no established regional strategy, though in one case a regionalisation of the plan has been attempted. In all cases a considerable emphasis is being placed on 'development from below' with the setting up of planning committees at district and regional levels. As yet however there is a glaring lacunae in this arrangement since none of the larger urban centres seems to qualify for a planning organ on the equivalent basis. Insofar as regional development programmes are likely in one way or another to add an extra dimension to the issues of urban development planning, and since industrial location is a prime factor in most regional development schemes, it would seem necessary and desirable to move towards closer integration between the three fields of endeavour. There is in addition the question of joint regional planning strategies activated through the EADB.

In this context the examination of potential costs of urban infrastructure (SOC) related to alternative patterns of industrial location would seem to offer a half-way house at least towards the pooling of ideas and concerns between those dealing with policies in the industrial, urban and regional fields. How this is to be done in terms of an analytical methodology is answered in the following section.

### III: The Approach

The approach which is suggested here is centred on the analysis of economic and physical elements in the demand for and supply of urban land and services for the location of manufacturing industry. The availability over a period of time of suitable quantities and qualities of land which is properly located and serviced by transport and utility systems, readily and reasonably obtainable, is clearly important from the point of view of establishing urban industry on any large scale. In most developing countries there has been little appreciation however of the significance of prime industrial land reservation on a systematic scheduled basis. In many urban areas suitable land is severely limited in areas, often being encroached upon by alternative uses, rapidly increasing in value and price, haphazardly located with respect to central area access and utility terminal facilities, and sometimes widely separated from workers residential areas, with the exception of uncontrolled 'squatter' developments. The objectives of a more explicit programming of investment in urban industrial land and facilities are therefore,

- to assist in the attraction and accodation of an adequate industrial and economic base for a given urban area
- to ensure that prime industrial land is readily available at a reasonable cost in service and development charges

- to design the location and servicing of industrial areas in such a manner as to minimize 'disturbance' costs to other urban activities
- to design the expansion necessary to accommodate new industry when needed in such a manner as to minimize investment costs of expanded development

It once again the last of these objectives which is our main concern here since it gives the link between the problems of providing industrial areas in a given urban areas and the problem of optimising the location of industrial expansion on a national basis in respect of required overall investments in urban infrastructure. The link itself is fogged by the application of a form of urban industrial planning derived from 'threshold' analysis, pioneered in Poland and other centrally planned economies, and now spreading to other areas outside. <sup>20</sup>

This analysis is best described as turning attention away from the urban area as a holistic unit to be understood and planned for as an independent whole, in favour of a conception of it as a more or less well integrated collection of 'activity systems' inhabiting a continuum of settlement (spatial) organisation. Thus the almost insuperable difficulty of identifying benefits as well as costs in urban development, which makes optimum size city theory so slippery to operationalise, is avoided. It is a method of analysis which allows the direct translation of relevant local physical conditions into effects on national and regional economic considerations and vice versa by determining the optimum sequence in which urban area expansion both within and between cities should be scheduled.

Its general starting point is the delimitation of an urban area as a space of activities and residences bounded by means of some accepted performance standard relating to commuting. Within this space it is possible to recognise three sets of constraints on the immediate and costless use of land for urban (and industrial) expansion. These three sets of constraints are associated with three types of cost for overcoming them which will be at some point nonlinear or 'discontinuous at the margin - that point being the 'threshold' so-called. The situation may be summarised as below:

Constraint	Costs	Threshold	Description
land	amelioration	Physical	eg. swamp drainage
form	conversion	Structural	eg. slum clearance
facilities	extension	Capacity	eg. new resovion

Thus there will be a space within a given defined urban area where 'normal' costs of land development for industry, etc., will obtain. At some point in the expansion of the urban area however one or more of the above constraints will be felt, to overcome the 'threshold' of which will entail non-normal costs usually of a quite disproportionate kind in order to mount an operation of establish a new facility where distinct economies of scale and indivisibilities of technical operation are entailed. It is therefore possible if such thresholds can be determined in advance for a given urban area to programme the expansion of that area so that it proceeds for as long as possible within the threshold lines, only incurring disproportionate investment when other alternatives have been exhausted.

The net result of such analysis is to enable the costs of urban expansion to betray where major obstacles are being encountered in physical terms and translate these into economic reckoning on a quantitative basis. In this way it is possible to achieve a number of steps towards the better integration of local physical and national economic planning, viz.,

- a. by enabling the estimation of successive threshold constraints, the analysis allows the programming of an optimal sequence of development which will assist in the reconciliation of relatively long-term physical plans with relatively short-term economic planning
- b. by establishing the relative severity and exact nature of threshold constraints, the analysis allows the determination of optimum density standards for urban development bearing in mind the opportunity costs of exceeding the threshold margin

- c. by enabling the calculation of the area available for development within the major constraining thresholds, the analysis makes possible the logical progression of detailed master plans covering consecutive periods of threshold limitation and transcendence
- d. by the same token as in c., the analysis allows the optimal sequence of satellite or 'new town' development depending on a trade-off between urban expansion, infilling or duplication of functions
- e. by establishing the nature and incidence of threshold capacities for urban areas on a comparable and quantified basis, the analysis allows the optimal scheduling of investment in activities to be located over a given time period in places where the minimum amount of net additional investment will be required.

It is on this basis that I propose to examine the implications of alternative patterns of location for new industrial plants among a number of urban areas in E.Africa, to see by historical and technical survey what can be said about the incidence of 'net additional investment' is likely to be. In a sense I am simply augmenting the orthodox procedures of urban planning and economic programming by extending the first to cover the whole region of E.Africa and the second to cover in a coherent fashion the whole complex of industrial-cum-urban development.

#### IV: Data

The two related kinds of information required on which to work the above analysis are a series of prospective industrial investments giving relevant data on concomittant requirements for urban land and services; and a series of urban 'facility profiles' including data on capacities and structure of industrial services and land. Previous investigations have revealed something of the magnitude and urgency of the current E.African situation in regard to urban industrial programming even looking at a very partial and incomplete set of data that have so far been accumulated.

What follows is a listing of a representative sample of large - scale manufacturing industry established in E.Africa, and which by now could be posited as likely to be duplicated ( or equivalent investment made) in more than one urban centre over the next decade. Only three items of data relating to direct infrastructure requirements, and one relating to indirect requirements (employment) are given in each case. This data was collected from technical personel of the plants concerned on the spot but must be regarded as variable in quality and accuracy. (see Tb. 1.)

After this I present a sample of information concerning the main urban areas covering some relevant aspects of their capacities to absorb greater demands for industrial land and servicing. Again these data are the result of first hand investigation, but would have to be converted into cost estimates for added capacity in each case. They do however provide a first summary indication of points of strength and weakness as a guide to further elaboration later. (see Tb. 2.)

Table 1. Industrial Land and Infrastructure Requirements

ISIC No.	Description	Employment	Power Cns. ('000 kwhs)	Water Cns. ('000 galls)	Land (acres)
201	Meat Canning	1000	1200	50	5
211	Brewery	400	1000	14	11
231	Cotton Textiles	315	130	11	20
271	Paper 'waste' Mill	55		5	4
311	Fertilisers	250	20000	1	6
319	Pharmasuiticals	55	50	.3	1
334	Cement	550	9000	3	34
341	Steel Mill	200	19000	295	52
350	Steel Sheets	150	300	1	5

Table 2. Industrial Land and Infrastructure Capacities

Urban Area	Total Area (sq.mls.)	Approx Dev' (%)	Industrial Area D.C.C. Area (mls) Total Occ. (acres) (%)	Power Cns Total Ind. (m. kwhs)	Water Supply Cap. Cns. (m. galls)
Nairobi	35	85	1-3 800	65 240	12
Kampala	8	85	1-3 435	75 63 20	9 5
Dar	32	50	2-5 730	40 53 20	
Mombasa	80	15	1 435	85 72 39	8 2
			3-5 540	65	
Jinja	11	55	1 -3 1080	40 126 117	3 2
-Njeru	8	8	2 -3 190		
Arusha	11		2 350	10 5 1	1 .5
Thika	5	5	1 365	55 78 70	1 .5



V: Plan

The plan of operations for the implementation of the project can be outlined quite simply but without galloping away from some of the main difficulties involved. It consists of two parts, namely data collection and data processing, for which different time and place horizons are permissible. The part of collection is estimated to take about nine months and must be conducted in the field in E.Africa. The second part should take perhaps half as long, and could be carried out away from E.Africa.

The data required are of two principal sorts. On the one hand there is required a listing of large-scale industrial investment projects for the setting up of manufacturing plants in E.Africa. The information needed would be the nature of the project relevant to demands for land and a range of urban services. Such information is available from two groups of sources. On the one hand there are the enterprises already established in E.Africa. These enterprises can yield valuable information on the actual requirements and their satisfaction for many recently undertaken investments and also provide data on new investment anticipated in the near future. On the other hand there are those organisations of the E.African governments and those international agencies actively persuading and preparing to implement industrial investment possibilities in E.Africa. From the U.D.C., the EADB and other sources it should be possible to gain a notion of the range of industrial projects and their hypothetical requirements for infrastructure in the short to medium-term future.

On the other hand, data is required on the present and possible future capacities of the larger urban centres likely to become locations for a major portion of the anticipated industrial investment. What is principally required are data on the following aspects of urban servicing:

- power supply
- water supply
- sewerage and effluent disposal
- telecommunications
- land availability
- road access
- rail access

For most of these elements in the situation a number of different items of information are required. These are:

- total current capacity
- estimated cost of increasing this capacity (at equivalent standard)
- area presently serviced
- cost of extending area serviced (to accommodate new industrial areas)
- cost of redevelopment and greater intensity of land use (for industry)

This combination of elements and characteristics requires two main lines of attack. On the one hand again, much information can be secured from central technical agencies such as the U.E.B. or E.A.R.&H. or E.C.A.P.&T. and Public Works Depts. On the other it will require careful and quite lengthy study on the spot in order to be able to identify in sufficient detail the nature and incidence of the various thresholds and their relation to potential industrial areas within and outside them. The intention at this stage is to cover as wide a cross section of urban areas as possible in order to check results against as wide a sample as can be reasonably investigated. The urban areas that have been chosen are in large measure the same as those previously investigated. They are:

Uganda - Kampala	Kenya - Nairobi	Tanzania - Dar es Salaam
Jinja	Mombasa	Tanga
Mbale	Nakuru	Moshi
Teroro	Eldoret	Arusha
	Kisumu	Mwanza
	Thika	

Some of the major problems involved in collection and assessment of information in this field revolve around the difficulties of defining and identifying capacity limits, distinguishing 'normal' from 'threshold' costs in systems extension, and including special provision for quality differentials. These kinds of difficulties can be illustrated from each of the major infrastructural elements included in the proposed survey.

While it will be usually possible to estimate the limiting capacity of an electricity sub-station, a water pumping station, a sewerage treatment works, an automatic telephone exchange and a railway station yard, there will be in each case a considerable variation in efficiency of work depending on the nature of peak loading. In the case of a road network the estimation of capacity for critical link routes is even more hazardous. Finally of course the capacity of industrial land will depend on density of occupation and standards of building and setback etc, laid down by the existing physical planning regulations. The difficulty of specifying when an extension constitutes a threshold in terms of the main utility systems and for transportation is probably solvable only if some distinction is created between different capacities of the given system. Such a distinction would attempt to separate 'mainline' from 'distributor' elements in the reticulation system for water and sewerage, power and communications; primary from distributor roads and branch lines from service spurs in the case of rail access. The most involved analysis is caused by difficulties in separating out quality differentials that are significant in servicing. While electricity may appear as a fairly homogenous commodity neither water nor sewerage systems can be treated as always providing the same output. In terms of industrial servicing for example there are the distinctions, important in estimating the cost of terminal facilities, between water for drinking and water for cooling purposes, and between sewerage which can be safely treated in sewage lagoons and industrial effluent which requires a full chemical treatment plant. The quality of industrial land and of the existing road and rail systems must also be recognised as variable in the face of some specific industrial requirements, but in these cases the problems of quality are much related to problems of capacity and extension. Tarmac roads and branch lines are not economic under conditions of little or irregular usage.

Despite these difficulties, it should be possible to arrive at some relevant orders of magnitude for the threshold costs of expansion at different urban centres for a range of possible industrial investments. The second part of the project will be to use this data to calculate a series of capacity profiles for each place and to process the matching industrial infrastructure requirements in such a way as to arrive at certain critical points where the 'shifting' of a plant or plants between one centre and another would significantly affect the total expenditure in terms of threshold investments for the region as a whole. What we would have would be a set of modified 'transportation' programming models for the allocation of plant requirements amongst facility capacities for each place, and in some manner which has yet to be finalised to superimpose these upon one another to derive for each centre its most crucial constraints for different total outputs of manufacturing. While the search for an 'optimal' solution via the computer is one aspect of the exercise however, it is not thought to be the only satisfactory outcome. Long before the final processing stage is reached it is hoped to throw up many significant facts about specific situations in which investment is about to be contemplated, both in the way of new manufacturing plant and new urban infrastructure.

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