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## **A Proposed Framework for Environmental Regulation in Urban Areas with a Specific Reference to Yanbu Industrial City, Saudi Arabia**

**Dr. Anis ur Rahmaan**  
College of Environmental Design  
King Abdulaziz University  
P.O. Box 9027, Jeddah, Saudi Arabia

**ABSTRACT:** This paper is comprised of three parts. Part one is conceptual and attempts to formulate a framework for environmental regulation in urban areas. Part two progressively discusses the applicability of the framework in case of urban areas of countries at large which are passing through various development phases. Part three, being empirical in nature, tests the applicability of the framework in the Yunbu Industrial City, Saudi Arabia.

### **1. INTRODUCTION**

Historically, despite its importance, urban environmental aspects had been assigned very low priority and continued to be neglected by various private and public agencies due to the following three main reasons:

- (i) traditionally, the developmental emphasis has been on consumption rather than on conservation of physical resources;
- (ii) there has been a lack of civic awareness at individual level; and
- (iii) a paucity of public responsibility, resulting in an inadequate provision of public and institutional controls for the maintenance of a desirable urban environment.

As a consequence, the upkeep of the urban environment beyond the four walls of individual homes had been no one's responsibility. The problems were further compounded as the human civilization entered a new phase of secondary economic activities, leading to industrial pollution and over congestion in the residential quarters of the cities. However, with the passage of time, emphasis on urban environmental concerns has been gaining significance, both in private as well as public sectors. The alleviation of adverse effects of these concerns needs a comprehensive approach, statutory and innovative measures, and concerted efforts by a multiplicity of public and private institutions.

## **2. A PROPOSED FRAMEWORK FOR ENVIRONMENTAL REGULATION**

Environmental regulation is a multi-institutional, multi-facet and hierarchical phenomenon. A holistic idea about the extent of its coverage can be formed by interfacing various environmental concerns requiring regulation with the salient aspects and measures of environmental regulation. The salient environmental concerns which need to be regulated may be enumerated as: (i) sewerage and drainage, (ii) solid waste, (iii) water pollution, (iv) industrial waste, (v) smoke and odor, (vi) noise and vibration, and (vii) conservation areas. Whereas the salient aspects and measures of environment regulation may be identified as: (i) regulative emphasis, (ii) nature of controls, (iii) control regulations, (iv) institutional status, (v) operational level(s), (vi) sources of finance, (vii) implementation attitudes, and (viii) the method of monitoring. The following sections briefly describe the eight matrices formed by interfacing the aforementioned environmental concerns and regulative measures as shown in figure 1.

### **2.1 Regulative Emphasis**

Regulative emphasis, being one of the basic aspects of environmental regulation, plays a very important and far reaching role in determining the nature of controls, their modus operandi and the complexion of the environment per se. This is dependant on the priority assigned to a particular environmental concern and the financial resources available in a social system. The regulative emphasis could broadly be classified in three types, viz., preventive, curative, and remedial. Although the preventive emphasis is best because it is less expensive and long lasting, yet this approach has its limitations. It is best suited for the prospective new developments. However, the existing environmental problems can only be rectified by resorting to expensive curative or remedial measures, such as in the case of sewerage and drainage, and solid waste disposal. In case of financial stringencies, the remedial measures are preferred because they are less expensive than the curative measures. Under the ideal conditions, a simultaneous pursuit of preventive and curative emphases will lead to the best results in the old as well as new urban developments (fig. 1-a). Likewise, water pollution needs an all out preventive emphasis rather than a compromised remedial emphasis. Similarly, the conservation areas' management needs a preventive emphasis, because, unlike development, conservation needs to be sustained on a continuous basis. The environmental concerns such as industrial waste, smoke, odor, noise and vibrations could be tackled more effectively at their very sources by resorting to preventive emphasis.

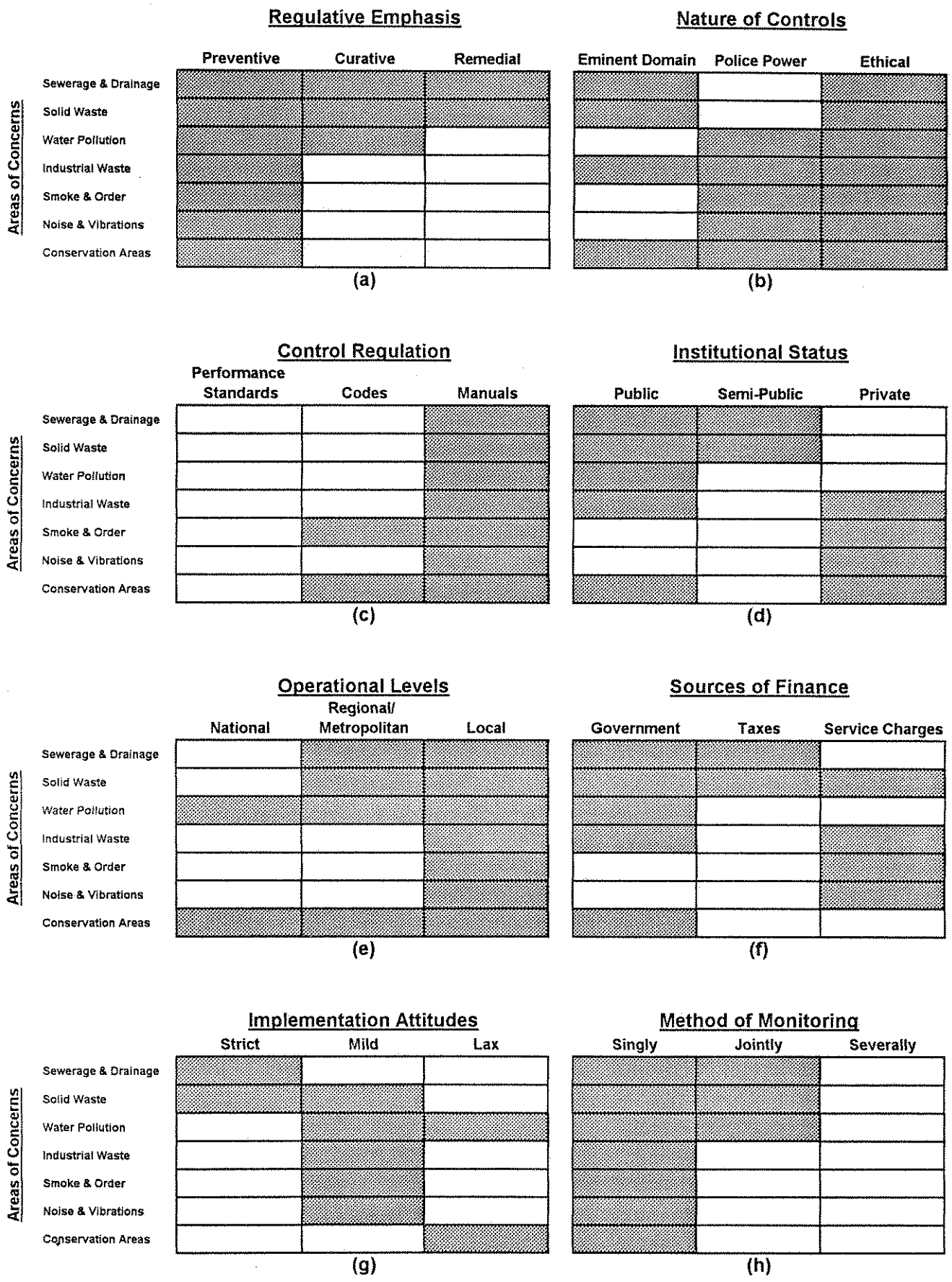


Figure 1: A Proposed Framework for Environmental Regulation

## **2.2 Nature of Controls**

Various environmental concerns (fig.1-b) can be regulated by using different land-use controls, viz., (i) the power of eminent domain, (ii) police power, and /or (ii) community ethics. The power of eminent domain authorizes the municipal authorities to acquire or take private property for a public purpose by paying just compensation to its owner(s) [1]. Police power controls land development under zoning, sub-division regulations, and innovative development concepts like the planned unit development and transfer of development rights [2]. These control measures include the locational aspects of various land-uses, their lot sizes, setbacks, height and bulk of buildings. Some communities such as the city of Houston, USA, which does not have zoning per se, control their land use development under their prevalent community ethics.

## **2.3 Control Regulations.**

Environmental control regulations may also be divided into three types, namely, performance standards, manuals, and codes (fig. 1-e). The performance standards deal with the minimum requirements or maximum allowable limits for the effects [3] of various environmental concerns such as sewerage and drainage, solid waste, smoke, odor, noise, and vibrations. These standards for various environmental concerns are relatively stable because they are set internationally in accordance with their safe human tolerance levels [4]. The codes lay down “administrative regulations, residential space standards, bylaws for life safety, stipulations regarding structural design, rules for electrical installations, regulations for ventilation, acoustics and plumbing services such as water supply, drainage and sanitation” [5]. Codes do change with time from one country to another depending on their socioeconomic and climatic conditions and level of prevalent technology. Because the application of performance standard require technical skill and often some expensive equipment, most of the urban communities have tended to prefer the more traditional “specification standard” approach [6].

## **2.4 Institutional Status**

Generally speaking, various environmental concerns, due to their intrinsic requirements, need to be regulated and managed by public or semi-public or private institutions as indicated in figure 1(d). For example, sewerage and drainage and solid waste disposal, due to their extensive spatial coverage and economies of scale are best regulated and managed by public or semi-public institutions. Likewise, the underground or surface water pollution needs an all out public

involvement. Also, the industrial waste treatment, alleviation of smoke, smell and noise nuisances could best be controlled at their respective origins by the private sector with the exception that in case of new towns, industrial waste water could partially be taken care of by a public sector institution. Conservation areas can best be handled at the public level with private involvement.

## **2.5 Operational Level(s)**

Each of the salient environmental concern shown in figure 1(e) can be most effectively operationalized at the specific level(s) which are most appropriate to their functional domains, viz., national, regional / metropolitan, and local. For instance, sewage and drainage, and solid waste disposal can best be tackled at the regional/ metropolitan and local levels, whereas, the issues related to water pollution and conservation areas' management can be more appropriately dealt with at the national, regional and metropolitan levels. Likewise, the problems of industrial waste, smoke, smell and noise, being most space specific, can be more effectively dealt with at the local level.

## **2.6 Sources of Finance**

Availability of adequate financial resources is one of the essential prerequisite for successful implementation of any environmental regulation program. The three main sources of finances are the government, the taxes, and the service charges. With the increased awareness about the enhancement of the environment, finances do sometimes become available from philanthropic sources or government incentive programs. Sewerage and drainage projects are normally financed either directly by the government sources or through taxes levied by the municipal or water and sewerage authorities. The solid waste collection could be financed by any of the three sources as shown in figure 1(f). Water pollution projects and conservation areas have to be financed by federal or state government because of their extensive nature and vulnerability, respectively.

## **2.7 Implementation Attitudes**

Implementation of any environmental enhancement program is a function of the priorities assigned to them by the decision makers. These priorities in turn get reflected in the attitudes held by various social systems about different environmental concerns. These attitudes have been and are at great variance in different urban areas. They also change with time due to socioeconomic

and technologic changes from strict to mild and from mild to lax (fig. 1-g). Generally speaking, the attitudes of various communities have been quite strict about sewerage and drainage, and solid waste, due to its high nuisance value. The communal attitudes about water pollution and conservation areas appear to range from mild to lax. However most of the communities appear to be more concerned about industrial waste, smoke, odor, noise, and vibrations than the conservation areas.

## **2.8 Method of Monitoring**

Although the need for evaluation, follow-up and monitoring, of the environmental concerns on a continuous basis hardly need any emphasis, yet it is quite often neglected or ignored. Monitoring may be done singly, or jointly by more than one agency, or severally by different agencies as shown in figure 1(h). The priority assigned to the monitoring appears to be not only a function of implementation attitudes shown in figure 1(g) but also of the regulative emphasis assigned (fig. 1-a) to various environmental concerns in a social system. It seems, that sewerage and drainage, solid waste disposal and water pollution get monitored either singly or jointly, whereas the environmental concerns such as industrial waste, smoke, odor and noise often get monitored by a single agency at best, and perhaps none at worst. The method, wherein the various environmental concerns would get monitored severally, appears to be mostly non-existent at present; or in other words it reflects the absence of the situation wherein various agencies would be monitoring the same environmental concern separately at the same time.

## **3. APPLICABILITY OF THE FRAMEWORK TO COUNTRIES AT LARGE**

Response to the various environmental concerns identified in the framework shown in figure 1, may be different in different countries depending on the degree of technological progress, the nature of transitional phase of civilization and the consequential sociophysical indicators prevalent in them [7,8]. However, before exploring the extent of applicability of the framework to various countries, it is necessary to classify them in terms of their level and nature of development. Figure 2 makes an *a-priori* attempt to classify the various countries in the context of their relative level of technological progress, and the transitional phase of civilization they are passing through. The transitional phases, shown in figure 2, are based on Fourastie's [9] concept which contends that the current era is a "transitory period" in the history of mankind during which societies successively transform from "traditional" (agriculture based) to "secondary" (industrial

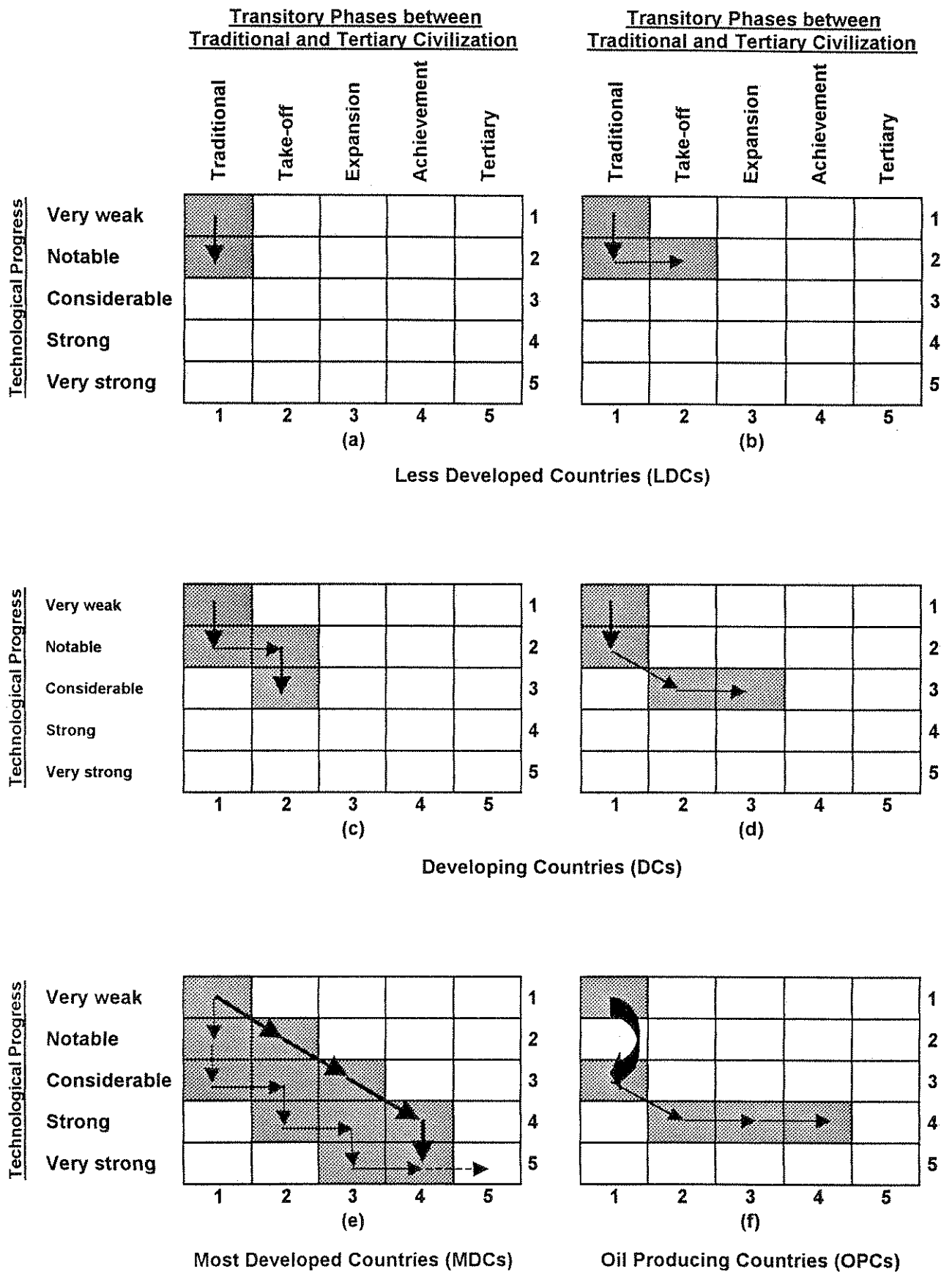


Figure 2: Various Types of Countries and their Development Dynamics

based), and from secondary to “tertiary” (service occupation based) civilization. In keeping with this concept Fourastie has divided the transitory period into three phases according to the job generation capacity of primary, secondary and tertiary sectors of economy. Fourastie calls them “take off”, “expansion”, and “achievement” phases.

The speed with which a country traverses its journey through various transitional phases of human civilization has been taken as a measure of its development dynamics. Viewed in this context, vertical arrows (fig.2) would indicate a slow or sluggish rate of development; diagonal arrows would indicate moderately fast developmental rate, and horizontal arrows would stand for very fast pace of development. This methodology leads to the identification of a number of salient typologies of countries which are being summed up in the following sections.

### **3.1 Less Developed Countries**

The development pattern of these countries has been indicated in figures 2(a) and 2(b). The socioeconomic characteristics of these countries are highly traditional with a predominance of labor force in the primary sector. These countries could be characterized by poor resources, low level of technology, low literacy rate [10], and relatively an inefficient transportation system. Due to very low level of development and urbanization, their physical development pattern is nodal [11]. These countries are trying to embark on the development track rather sluggishly. As these communities are in the incipient stage of industrialization, the environmental concerns are mostly confined to sewerage, drainage and solid waste disposal. Other than the remediation of these environmental concerns, these countries mainly need preventive steps both to forestall the anticipated environmental problems and to arrest the growth of the existing ones.

### **3.2 Developing Countries**

The development process of these countries has been shown in figure 2(c) and 2(d). Even though the educational level continues to be low and population pressure quite high, these countries have a better balance of payments situation due to surplus primary produce. As a consequence, these countries can afford to bring medium level technology from abroad to augment their developmental program which continues to be predominantly labor intensive. Environmental regulation mainly remains the responsibility of the public sector which is not fully equipped to undertake the job satisfactorily. Due to low level of urbanization, the operational level is still local [12]. Despite the “century skipping objectives” [13] of their leaders, the development



dynamics of these countries is subdued by population pressure, dualistic technology, and lack of financial resources. As a consequence, they become over-urbanized in relation to their economic development[14]. Their physical development is primarily nodal and tends to exhibit metropolitan tendencies[15]. Environmental regulations are implemented under police power which have preventive emphasis with mild or lax implementation attitudes. Curative and remedial measures are somewhat unaffordable in these countries due to financial constraints.

### 3.3 Most Developed Countries

Figure 2(e) outlines the developmental journey traversed by the most Developed Countries (MDCs). These countries may broadly be divided in two categories. Countries in the first category, like the Western European countries, embarked on their developmental journey much earlier in time. Development in these countries kept pace with the sequential development of technology that brought in its wake urbanization due to structural changes in the employment pattern. Developmental route of these countries has been indicated by thin arrows in figure 2(e). They took relatively longer time to develop as the technology was being used while it was being developed. Countries in the second category, like Japan, embarked on their developmental journey at a later point in time. The developmental track traced out by these countries has been indicated by thick arrows in figure 2(e). Because of the availability of advanced technology, their rate of development was relatively faster than the countries in the first category [16]. Both the categories of developed countries appear to be in Fourastie's "achievement phase"[17], represented by cell  $C_{54}$ . Some of these countries could even be termed as post-industrial societies and are well on their way to Tertiary Civilization, represented by cell  $C_{55}$ . Due to high level of urbanization their physical development pattern has progressively changed from nodal to metropolitan and is already exhibiting diffusive tendencies of a conurbation [18].

The development of the countries in the first category brought in its wake large scale wastage of natural resources, and blighted urban areas. In these countries, the awareness about the environmental concerns came too late, viz., when the situation had gone beyond the preventive stage and needed a very expensive curative and remedial measures. As a consequence, they had to adopt measures such as the development of satellite towns to take the "over spill" from the blighted and over congested cities. As compared to these, the situation in the countries in the second category is not as bad because their development came about in an era of incipency

of environmental awareness. The environmental regulatory measures are at great variance in each of these countries and would require a detailed analysis and synthesis on a case by case basis.

### **3.4 Oil Producing Countries**

The development pattern of oil producing countries is unique and highly dynamic as highlighted in figure 2(f). Due to their oil wealth and acute shortage of manpower, these countries resorted to capital intensive techniques. In contrast to the experience of western industrialized countries, which had to “develop and use” the technology, these countries had the luxury of “selecting and using” the best available technology. As a result, these countries even by-passed the long route composed of time consuming sequential steps which took European countries centuries to traverse, viz., these countries leaped from cell  $C_{11}$  to  $C_{31}$  (fig 2-f). Due to very fast structural changes in sectoral employment and the resultant accelerative rise in the urbanization level in these countries, the aggregative and diffusive tendencies of physical development appear to have dawned ahead of time. As a result these countries are experiencing concurrent evolution and emergence of nodal, aggregative and diffusive tendencies of physical development [19].

These countries have neither been the victim of smoke and squalor like the nineteenth century industrial cities of Britain nor have they suffered from the social disintegration due to the massive development of socially segregated suburbs like the American cities [20]. As a matter of fact, the urban development of these countries came about in an era of environmental awareness when the emphasis had already shifted from indiscriminate consumption to conservation of natural resources. As a consequence, the environmental concerns in their existing urban areas, being mostly “new towns intown” [21] are of much less magnitude than those in the developed countries; also the new towns in these countries have been planned and developed in the context of much stricter environmental standards and are subject to continuous monitoring.

## **4. ENVIRONMENTAL REGULATION IN THE YANBU INDUSTRIAL CITY**

This section will take a closer look at the environmental control measures adopted for the new Yanbu Industrial City. This section is comprised of two parts. Part one highlights the pertinent information about Yanbu, and part two reviews its environmental control measures in the context of the framework for environmental regulation developed in section two (fig. 1)

#### 4.1 The Salient Facts

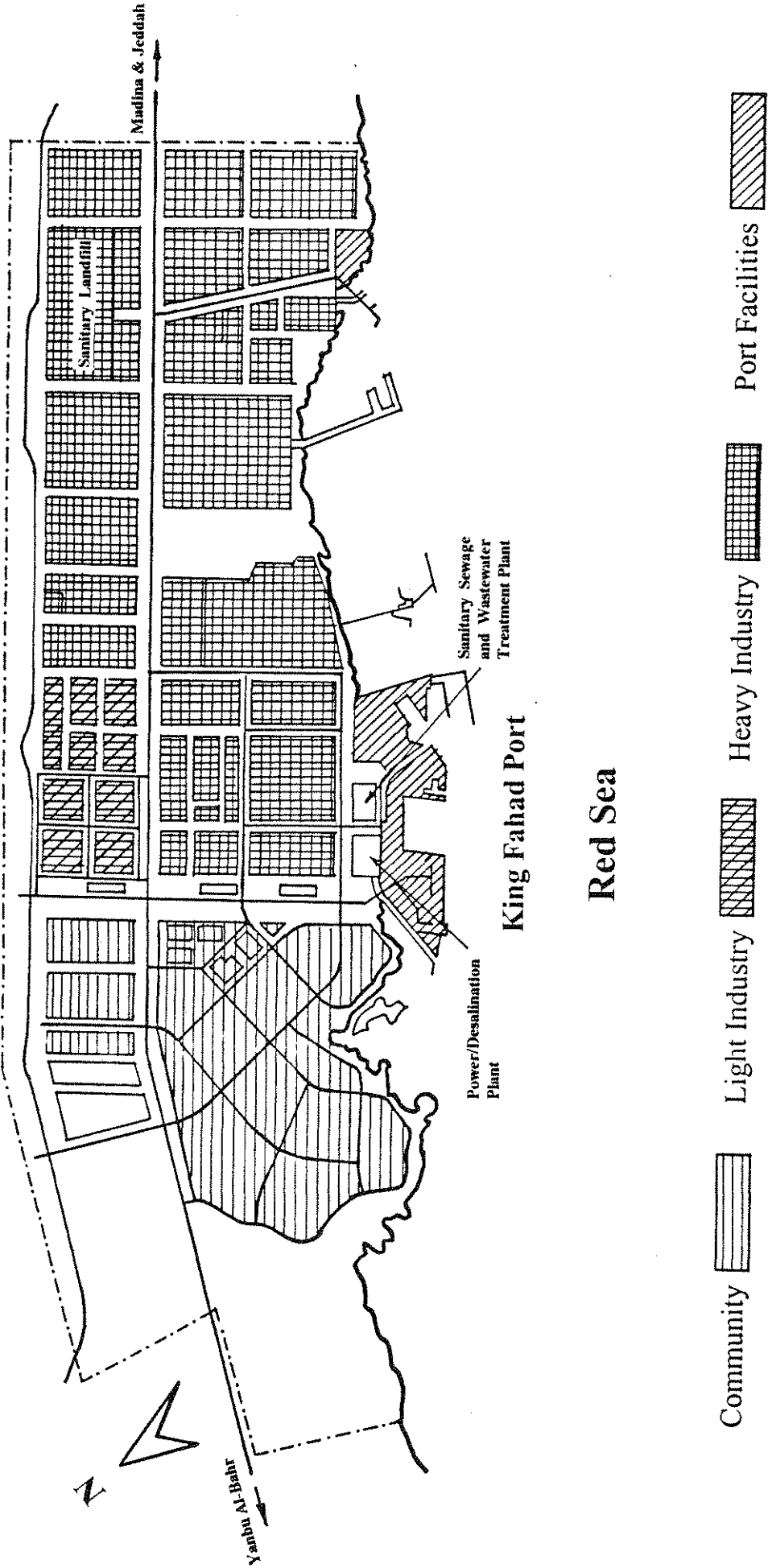
The industrial cities of Yanbu and Jubail, built from scratch in less than two decades (1976 through 1980s), are the first truly planned cities wherein the entire development process, comprising site selection, planning, construction and operation, was closely monitored on a continuous basis by a specially constituted Royal Commission for Jubail & Yanbu (RCJY) [22]. Having been developed in succession, Yanbu has an edge over Jubail in terms of its design, construction, operation and environmental quality because of the enriched experience gained in Jubail.

Yanbu is located on the Red Sea 350 kilometers northwest of Jeddah and forms the western terminus of the crucial cross-Kingdom crude oil and Natural Gas Liquids (NGL) pipelines [23]. The site covers an area of 185 square kilometers and enjoys 25 kilometers long shoreline that includes world famous coral reefs and is backed up by rugged Hejaz Mountains. The stretches of beach are interspersed with inlets and mangrove colonies [24].

Based on comprehensive site analysis and impact studies, the development plan attempted to capitalize the natural features and climatic conditions of the area. As an important first step, the industrial area was located downwind of the residential community, and was duly segregated from it by a buffer zone. Also, three prominent stands of mangroves were designated as conservation areas. These are most extensive stands along the Red Sea north of the Tropic of Cancer. They provide nursery grounds for fish and an important habitat for aquatic birds [25]. From cost-effective point of view, it was clear that one large patch of coral reef lying just off the proposed port area would be invaluable as a storm barrier. It was, therefore, considered imperative that the direct discharge of industrial wastes in the Red Sea must be completely controlled otherwise the chemical and thermal pollution would damage the structure of the coral reef which is a complex living community of plants and animals [26].

The Plan of Yanbu (figure 3) provides for a 880 hectare industrial park for primary, support, and service industries, and a residential area to accommodate more than 100,000 people. Fifteen major industries such as NGL Fractionation Plant, oil refineries, petrochemical plants are already catering for local and international demands. About 30 smaller manufacturing and support industries are also operational, while several more plants are being designed or constructed.

The community which is comprised of 14 residential neighborhoods (*Haiis*) incorporates best of both the western technology and the traditional Arab and Islamic values. Each neighborhood has been designed to be self-contained with air conditioned housing units,



**Figure 3: The layout Plan of the New Industrial City of Yanbu**  
 Source: Royal Commission for Jubail and Yanbu

recreational and religious facilities as well as convenience shopping areas. A circular bay, framed by parks, cultural facilities, main mosque, commercial, office and government buildings, will create a vibrant hub for the day-to-day civic and business activities of the city. An initial construction of 9,300 housing units and a *haji* for single status labor was accomplished by the Royal Commission during Third Five Year Plan (1980-85). An additional 15,300 villas, town houses and apartments will be constructed by private sector under the supervision of Royal Commission [27]. The decorous landscaping has earned Yanbu Industrial City a nationwide reputation as a garden community. The city abounds with green belts, parks, and public squares - all attractively landscaped with palms, acacias, and bougainvillea.

By and large, the Royal Commission for Jubail and Yanbu can boast of having achieved simultaneously the two divergent objectives of industrial development and a clean environment best suited for human habitation and recreation. This claim is borne out by the fact that the records show that the quality of ambient air and ground water has remained high since Yanbu's earliest days. Red Sea, the source of community's drinking water, is as unpolluted today as it was two decades ago. A further testimony to this claim is that Yanbu, together with its sister city of Jubail on the Arabian Gulf, has recently been the recipient of two major international awards in the field of environmental protection.

## **4.2 The Environmental Protection Measures**

This section reviews the environmental protection measures, currently adopted for Yanbu, in the context of the Framework for Environmental Regulation developed in the beginning of this study. The shaded cells in Figure 4, indicate the various regulative measures currently used in the Yanbu Industrial City in order to tackle various environmental concerns.

### **4.2.1 Regulative Emphasis**

The regulative emphasis (fig. 4-a) in Yanbu have been preventive rather than curative or remedial for all the environmental concerns. This approach is obviously cost-effective. Nonetheless, this type of approach can only be applied holistically in new towns from their inception. The situation in old towns is, however quite different from this as shown in Figure 1(a). Some of the environmental concerns in old towns may require all the three emphases, viz., preventive, curative and remedial; whereas, others may call for preventive and curative regulative

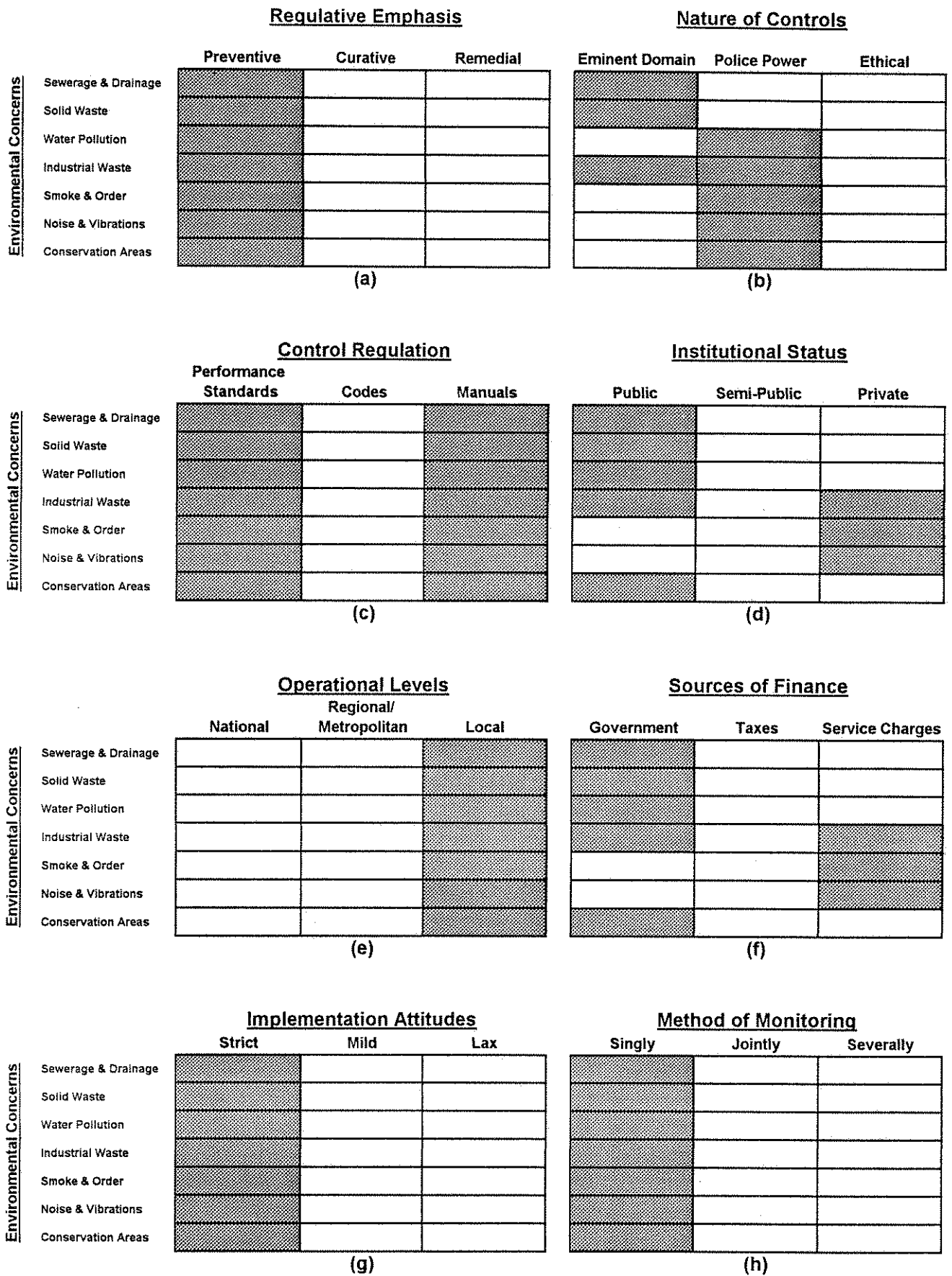


Figure 4: Application of the Proposed Framework for Environmental Regulation in the Yanbu Industrial City.

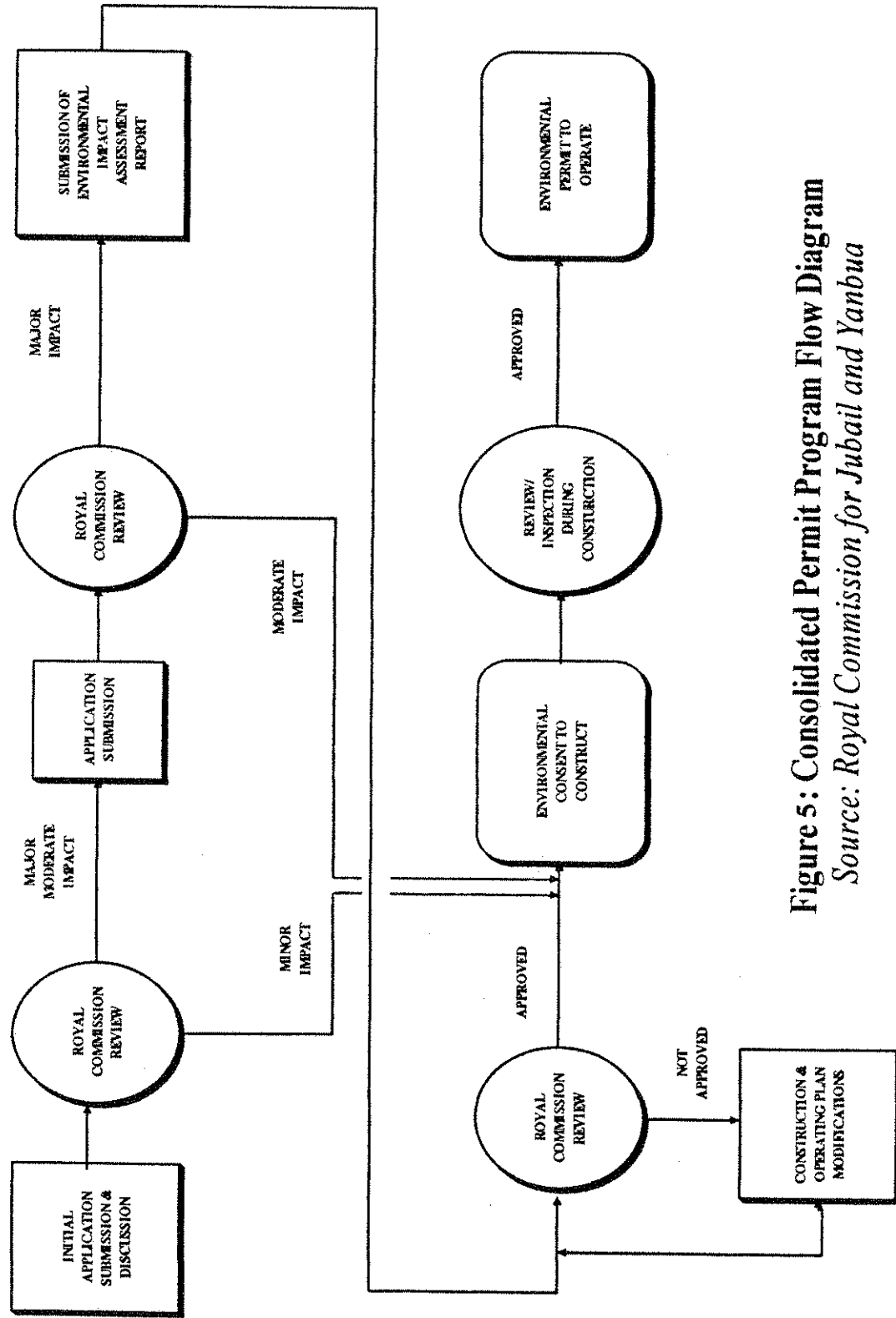
measures, and still others may only need preventive emphasis. As far as industrial development is concerned, the Royal Commission achieves compliance with its environmental standards and regulations primarily through a comprehensive environmental permit program. This Consolidated Permit Program (CPP), as it is called, governs all procedures associated with obtaining the certificates required to construct and operate an industrial facility at Yanbu as shown in figure 5. There are two distinct phases in the CPP process. The “Initial Application” phase, which applies to all industrial developers, determines if further steps must be taken to obtain an Environmental Permit to Operate. The “Application” phase of the CPP process establishes what those measures are. The need for additional steps is based on the project’s potential for adverse environmental impact during construction and operation, viz., major, moderate, or minor.

#### **4.2.2 Nature of Controls.**

Sewerage and drainage, and solid waste disposal system, have solely been established under the power of “eminent domain” (fig. 4-b). With the exception of the quality of Industrial Waste, which needs to be controlled or implemented through both, the “police power” as well as the power of “eminent domain”, all the other environmental concerns are being controlled through police power. Although the ethics of the inhabitants affect the environment, and in turn get affected by it, yet the “ethical control” per se has not been institutionalized in Yanbu, and therefore does not play any explicit role in controlling various environmental concerns like it does in the case of city of Houston, USA(fig. 1-b).

The Royal Commission has constructed sanitary waste water treatment plant employing state-of-the-art technology to produce high quality effluent which is consumed in landscape irrigation. Domestic solid waste and the nonhazardous industrial wastes are disposed of in Yanbu’s sanitary landfill. Yanbu is also a busy oil-shipping terminal, able to load over 4.5 million barrels of crude oil per day. To prevent the contamination of Red Sea by the discharge of oily ballast water, the Royal Commission has built a ballast water treatment plant capable to remove oil and grease down to 8 mg/l [28].

The industrial wastes are treated under both “eminent domain” and “police power”. The Royal Commission requires industries to pre-treat the wastes that fail to meet the established discharge criteria. Industrial wastewater is collected by a separate network of sewer lines connected with industrial wastewater treatment plant, located by the side of sanitary wastewater facility. Part of the treated effluent from industrial wastewater plant is reused in the industrial



**Figure 5: Consolidated Permit Program Flow Diagram**  
 Source: Royal Commission for Jubail and Yanbu



park. The Yanbu industries must also comply with regulations governing safe movement of hazardous wastes. Some of the industries store their hazardous wastes in their on-site storage or use temporary drum storage built on the sanitary landfill site. Others prefer to ship their hazardous wastes to Jubail where a modern waste management facility has been built to incinerate them. Environmental concerns such as water pollution, smoke, odor and noise are being controlled under police power by requiring the industries to abide by environmental regulations.

#### **4.2.3 Control Regulations.**

The Royal Commission has formulated an Environmental Protection Manual which is subject to up-dating from time to time. This manual incorporates the performance standards adopted by the Meteorology & Environment Protection Agency (MEPA). The provisions of this manual are applicable to all the environmental concerns as indicated in figure 4(c).

#### **4.2.4 Institutional Status**

Sewerage and drainage, solid waste disposal, and control of water pollution are being solely handled by a public sector agency as indicated in figure 4(d), whereas industrial waste is being handled by both public and private sectors. The performance standards for smoke, odor, noise have to be abided by the individual industrial units. Monitoring and regulation of various environmental concerns is currently being carried out by a Environmental Control Unit which is headed by a director. The Unit is comprised of a multi disciplinary team (such as a chemical engineer, marine biologist, meteorologist, chemist) and at present carries out environmental control operations with the help of a contractor who provides other needed specializations in the field of public health engineering, botany, zoology, climatology, computer modeling, etc. There are plans to further augment the Unit with the needed specializations so as to enable it to carry out the entire environmental control operation by its own staff.

#### **4.2.5 Operational Level**

All the environmental protection measures are being operationalized at the local level by the Royal Commission for Jubail and Yanbu which has established a full fledged department in Yanbu with various interactive units needed for the environmental protection (fig. 4-e).

#### **4.2.6 Sources of Finance**

With the exception of smoke, odor and noise related environmental concerns and to some extent treatment of industrial waste, the regulation of all the other concerns are being financed by the government as indicated in figure 4(f). The amount spent by the industrial units on the treatment of industrial waste and abatement of smoke, odor, and noise get implicitly passed on to the consumers as “service charges”.

#### **4.2.7 Implementation Attitudes**

The attitude of the Royal Commission is very strict in the implementation of environmental regulations(fig.4-g). The implementation process gets further augmented due to the fact that all the decisions are made locally by the Royal Commission in Yanbu.

#### **4.2.8 Method of Monitoring**

The Royal Commission is the sole agency which conducts surveillance monitoring to determine compliance with performance standards on regular basis (fig. 4-h). The monitoring programs are of two kinds viz., (i) ambient monitoring and (ii) source monitoring. Ambient monitoring helps ensure industries' compliance with environmental regulations and standards; and provides baseline data for use in trend predictions and planning strategies. Ambient monitoring covers meteorology; air, ground water, and sea water quality; and marine and terrestrial ecosystems. Whereas source monitoring is conducted at individual industrial site wherever air emissions and wastewater discharges occur. Industrial waste disposal practices are also closely monitored, especially when they concern hazardous wastes. To facilitate monitoring, the Environmental Control Unit maintains a modern environmental and public health laboratory which is fully equipped for rapid and accurate analysis.

In the event of a persistent violation of standards or a gross negligence or willful discharge that could cause severe environmental damage or economic hardship to the Industrial City, the Royal Commission may revoke the facility's permit to operate and temporarily stop the supply of essential services (e.g. Electricity, water) until appropriate remedial action is taken. As opposed to this, the Royal Commission also encourages the “Ideal Industrial Unit” by presenting it an “Environment Award” every three years.

## 5. CONCLUSIONS

The study leads to three salient conclusions. First, an interfacing of salient environmental concerns, such as shown in figure 1, with the various control measures and mechanisms yields a substantial number of possibilities. This set of possibilities could be used both as a check list to evaluate specific situations as well as to institute additional measures for their environmental enhancement.

Second, the environmental concerns and their regulative measures are an outcome of socioeconomic and physical characteristics of a country and its development dynamics. The development dynamics of a country can, in turn, be explained in terms of its technological progress in the temporal context and its journey through the various transitional phases of human civilization (figure 2). Viewed in this perspective, the realization of environmental regulation in today's most developed countries came the hard way, viz., the conditions had to get worst before they started getting better. The environmental concerns in less developed countries are mainly composed, in varying degrees, of sewerage, drainage and solid waste disposal. These countries have not made substantial advancement due to poverty and predominance of low level of technology. Although the environmental concerns in developing countries relate to the whole range of industrial and non-industrial developments, and are substantial in scale, yet the level of environmental awareness in these countries is higher than the developed countries had in their comparable stage of development. Nonetheless, these countries are unable to take adequate measures due to population pressure and lack of financial resources. The case of oil producing countries is unique. They embarked on their developmental journey with the latest technology at a later point in time when environmental awareness was already at its zenith. These countries have not only been bestowed with rich financial resources, but the scale of environmental problems is also much smaller due to scanty population and relatively newer developments.

Third, environmental regulation in new towns is more cost effective because it is based on "anticipatory prevention", and the nature of environmental control is proactive rather than reactive. The probe into the environmental protection effort of Yanbu reveals that besides the built-in design features, modern wastewater and solid waste disposal facilities, and a highly qualified monitoring team with well equipped laboratory, the introduction of a system of rewards and punishments has also motivated the various industrial enterprises to attain an exemplary level of environmental cleanliness.

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- [24] RCJY, *Yanbu Industrial City and the Environment*, Directorate General of Yanbu Project.
- [25] RCJY, *Environmental Protection Manual*, Vol. 1, Directorate General for Yanbu Project.
- [26] Ibid.
- [27] RCJY, Yanbu Al-Sinayah. op. cit.
- [28] RCJY, Yanbu Industrial City and the Environment, op. cit.