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Combined Micro-Ergonomics, Macroergonomics and Systems Study of the Application and Internalization of Waitro-Developed Best Management Practices by Research and Technology Organizations

MOHAMMED-AMINU SANDA

MASTER OF SCIENCE PROGRAMME
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Department of Human Work Sciences
Division of Industrial Work Environment

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COMBINED MICRO-ERGONOMICS, MACROERGONOMICS AND SYSTEMS STUDY OF THE APPLICATION AND INTERNALIZATION OF WAITRO-DEVELOPED BEST MANAGEMENT PRACTICES BY RESEARCH AND TECHNOLOGY ORGANIZATIONS

By

MOHAMMED-AMINU SANDA

(Guest Scholar, Swedish Institute)

PROJECT REPORT
Master of Science, Ergonomics

Department of Human Work Sciences
Division of Industrial Ergonomics
Luleå University of Technology
Sweden

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Mohammed-Aminu Sanda

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ABSTRACT

According to the World Association of Industrial and Technology Organizations (WAITRO), it had become obvious over the years that the key impediment to successful performance of Research and Technology Organizations (RTO) is often not technology, but management. Hence, WAITRO benchmarked 10 management practices for application by the RTOs (Mengu and Grier, 1999), but which most of them could not successfully use and internalise. Thus this study was conducted with the purpose of identifying the environmental factors, which constrained the RTOs' benchmarks implementation efforts, and also ways to remediate them, using a combined micro-ergonomics, macroergonomics and systems study approach. A two-way experimental design approach was used. Mail survey, using "self-completion" questionnaire was carried out among RTOs in 8 industrially developing countries. Activity analysis, based on observations, interviews, and "future workshops" was also carried out on 3 RTOs in Ghana. The results showed that the external environmental factors which constrained the RTOs' efforts in using and internalising the WAITRO benchmarks included the prevailing socio-economic and legal frameworks, influence of consumer and market forces, the political atmosphere, the operating climate, the subsystem (operating system) stability, the existing communication interfaces within the RTO's organizational structure, as well as between the RTO and the surrounding environment, the educational background (qualification) of its staff, and the decision-making approach. Influences of these environmental factors were also found to exist, irrespective of whether the benchmarks are adopted, adapted or were implemented using other processes by the RTOs. The extent to which these external environmental factors inhibited the efforts of individual RTOs was also found to be dependent on the level of contradictions existing in the RTO's activity systems, from the perspectives of some or all of its historical and environmental contexts, goals and objectives, institutional rules, divisions of labour instruments and materials, as well as its social dimensions.

1. BACKGROUND

1.1. THE WORLD ASSOCIATION OF INDUSTRIAL AND TECHNOLOGICAL RESEARCH ASSOCIATION (WAITRO) BEST PRACTICE PROJECT.

WAITRO is an international Non-Governmental Association comprising two hundred (200) Research and Technology Organizations (RTOs) spread over eighty-five (85) countries in all parts of the world. Founded in 1970 at the initiative of the United Nations, WAITRO serves as a vehicle for the development, adaptation and exchange of ideas on technology management and the application of technology for sustainable socio-economic development. It also assists in technological capability building in member institutes in the developing countries. WAITRO members are RTOs active in industrial research or organizations supporting and promoting technological development.

1.1.1. The Role of RTOs in the Development of Small and Medium- Scale Enterprises.

Small and Medium- Scale Enterprises (SMEs) have been recognised as critical in the economic and social development of most countries. They are especially important for their role in job creation with low investment, regional development, as suppliers to large companies, entrepreneurship development, and in case of new technology-based firms, innovation of new products and processes. In recent years, most governments have undertaken special schemes to develop and strengthen SMEs. These assistance schemes have focused on both the formation of new SMEs as well as on assistance to existing SMEs. Assistance has included all facets of their operations, including financing, marketing, manufacturing, engineering, quality, and human resource development, among others. The mechanisms and the schemes used are very different and vary in their degree of success. However, there was no indication as to whether aspects of these assistances were oriented to address issues related to the SME's external operating environments. In many instances, SMEs are assisted by RTOs.

The RTOs provide technical and business extension services, testing facilities, problem solving services as well as Research and Development assistance to SMEs. It has been recognized (Mengu and Grier, 1999) that the ability of RTOs to serve SMEs effectively is an important determinant of the success of SMEs in meeting the competitive challenge of the marketplace. According to Mengu and Grier (1999), it is clear that, irrespective of government policies, SMEs cannot attain their full potential without improvements in their ability to access, absorb, adapt, and exploit new technologies and business techniques. In this context, RTOs can play an important role in making this happen. However, they must provide services to SMEs with the highest level of effectiveness and efficiency to best enhance SME capacity to innovate and ultimately to improve their competitiveness and sustainability (Mengu and Grier, 1999).

1.1.2. The WAITRO Project Objective.

According to Mengu and Grier (1999), it has become obvious over the years that key impediment to successful RTO performance is often not technology, but management. The situation has escalated in recent years as governments have, for a variety of reasons, reduced funding to RTOs. Against this background, WAITRO identified '…a tremendous opportunity to assist its members to improve their capabilities to serve industry by assembling a body of knowledge that would provide the information that the RTOs need to re-structure their management systems' (Mengu and Grier, 1999). An international collaborative research project was thus launched with the objective of identifying, benchmarking, and documenting successful RTO practices (best practices and underlying principles) and assisting RTOs in the implementation of these principles and practices, so that they can serve their clients better.

1.1.3. Highlights of the Research Findings.

Mengu and Grier (1999) stated the following as the key lessons learnt:

a) Best Practices can be Transferred across National and Organizational Boundaries.

The findings of the three WAITRO study teams regarding best management practices have been amazingly consistent, especially considering the differences in culture, industrial strength, and economic wealth of the regions studied. This observation strongly underscores the fact that RTO management problems are basically similar in all countries, especially problems of low patronage from local industry, reduction in official government support, recruitment and retention of qualified staff, as well as commercialisation of research findings. The main differences tend to lie in the higher degree of gravity of these problems in poorer countries. This commonality of basic problems on the other hand strengthens the belief that best practices can be easily adapted from one RTO situation to another, taking into account pertinent local conditions.

b) A Reliable Management Information System (MIS) is a Prerequisite for Implementing Best Practices in an RTO.

Another major observation from the study was the generally poor availability of information in most RTOs. A vast majority of RTOs have no systematic method for collecting, storing and utilizing basic data that measure performance (e.g. revenue, costs, and production, among others). On the whole, information was considerably better in North America and Europe than in Africa and Asia for cultural and technological reasons. Quantitative data are very important for benchmarking studies since they provide the basis for making conclusive judgements on performance differences. Thus in the WAITRO study, it was possible to arrive at conclusions with more certainty in RTOs with better MIS. It is therefore important to stress that a reliable

MIS is a prerequisite for undertaking a successful benchmarking study, and hence for implementing an RTO transformation project.

c) Best Management Practices are not the Sole Preserve of RTOs in Rich Countries.

It was observed that, although RTOs in North America, Europe and the industrialized countries in Asia, were generally more successful overall, they were not the exclusive sources of best practices. Many interesting and effective practices were found in RTOs in developing countries. This was especially true in the case of RTOs that were client focused, but were constrained by government rules and regulations. They found ways to meet client needs in spite of obstacles placed in their way by governmental bureaucracy. Indeed, many RTOs in the developing countries have a wealth of knowledge and best practices in dealing with the small and micro enterprises in the formal sectors of the national economy.

d) Focusing on Clients Needs is the Number One Best Practice.

The overwhelming lesson from the study is that RTOs must be client-focused if they are to achieve the purposes for which they were created. The research, technology transfer, testing, and information dissemination activities they conduct must be addressing industry's needs. Every identifiable functional aspect of the RTO's management system (e.g. governance, organizational management, project management, capability building, among others) must be structured in such a way that it enhances the capability of the RTO to meet the technological needs of its client industry.

e) He Who Pays the Piper, Calls the Tune

Funding plays a pivotal role in an RTO's orientation. Those RTOs that receive more than half of their money directly from industry, or in a manner that its use is controlled by industry, become industry-focused. They conduct work that is respected and valued by industry. Industry will even fight for their continued existence. However, those that receive more than half of their money from government without any mechanism whereby industry directs or

influences the work conducted by the RTO, are not valued by industry. These RTOs lose touch with the needs of their potential target group since there is no mechanism to drive the interaction. Even if the RTO is conducting research that could be relevant to industry, most industries do not consider it to be of any value, because they do not know about the work.

1.2. THE WAITRO BEST PRACTICE MODEL

Studies of RTO functions by Mengu and Grier (1999) in the European Union and elsewhere reveal a great deal of consensus regarding their underlying business principles and the practices used in their daily interaction with client enterprises. A number of RTOs within the European Union have developed networks for the exchange of business principles and best practices of their daily operation as a means for strengthening management capabilities. WAITRO saw the potential to build on this approach through the use of "benchmarking" to establish which of the variety of practices could be considered as "best practice". In order to promote the use of best practices in RTO management, WAITRO conducted an extensive research into management practices of more than sixty (60) RTOs as well as other organizations that support RTOs, in thirty-one (31) countries and came up with a much deeper understanding of why some RTOs are successful whilst others are not. Furthermore, the information and knowledge gained has been used directly to assist some RTO leaders in their effort to institute change in their organizations' practices (Mengu and Grier, 1999). The WAITRO methodology for deriving best practices combines two approaches. The first approach involves case studies, which involve investigating, understanding and describing the context of an organization's practices. The second approach involves benchmarking, which defines processes, practices and performance indicators for measuring which practices are most successful in meeting the RTO's objectives. According to Mengu and Grier (1999), the practices identified are categorized under ten (10) management process areas, which were

further divided into several sub-processes (see appendix A). Using relevant performance indicators, all the practices identified within the RTO are then labeled as "best practice" (first choice), "good practice" (acceptable choice), or "bad practice" (to be avoided). An overview of the RTO Best Practices (Mengu and Grier, 1999) is given in appendix B. The tools developed have targeted RTOs that provide technical and business extension services, testing facilities, problem-solving services and research and development assistance to industry, especially those in the small-scale and medium-scale enterprises (SME) sector. According to Mengu and Grier (1999), these tools can also be modified accordingly to suit the needs of academic and other types of RTOs, and in more generic form, other types of organizations.

1.3. GOAL

The goal of this project is that, environmental factors preventing RTOs from using and internalizing the WAITRO's "Best Management Practices" are identified.

1.4. PURPOSE

The purpose is to ensure that sources of both internal and external environmental constraints are identified, in order to allow for future development of remediation actions to assist RTOs successfully use the best management practices (benchmarks), and thus improve upon their operational performances and output efficiencies, to the benefit of;

i. small-scale and medium Scale enterprises,
ii. their national technological needs.

1.5. AIMS AND OBJECTIVES

The aim of this research is to use a combined micro-ergonomics, macroergonomics and systems approach to find out the possible environmental factors, that inhibits some of the RTOs from adopting and internalizing the best management practices compiled by WAITRO, and which was supposed to result in their operational effectiveness and performance improvement. The research will be carried out using the hypothesized model shown in figure 3 [chapter three], which is to relate the influence of specific external environmental factors to different levels of work organization and system. The research is expected to result in the identification of appropriate interventions for the adaptation and application of the WAITRO benchmarks by the non-performing RTOs. Effectiveness of these RTOs will result in them providing the expected quality services to the SMEs (who are the direct utilizers of RTOs' products and services), and hence improve the profitability of their operations. The specific objectives of the research are as follows:

i. Study and understand the operational systems adopted by the RTO before, during and after the application of the selected WAITRO benchmark(s);

ii. Use macroergonomic strategies and systems design approaches to identify and establish the possible environmental factors/constraints which prevented the RTOs from adopting and internalizing the WAITRO Benchmark(s); and

iii. Identify and recommend appropriate macroergonomic solution(s) to remove the prevailing obstacles and thus promote the application of the benchmarks among the Research and Technology Organizations (RTOs).

2. LITERATURE REVIEW

2.1. THE CONCEPT OF BENCHMARKING

Benchmarking as defined in Mengu and Grier (1999) is "the process of continuously measuring and comparing an organization, product or process against leaders anywhere in the world to gain information, which will help the organization take action to improve its performance. According to Mengu and Grier (1999), benchmarking is a powerful tool that has been used to transform organizations. It is currently being used to assist many companies to improve to meet the ever-changing demands being placed on them by their client competitive environment. The application of benchmarking to identify best management practices for RTOs would provide them with the knowledge they need to help improve their performance (Mengu and Grier, 1999).

2.2. RTO MODEL

Research and Technology Organizations (RTOs) exist in different contexts and are established for a wide variety of purposes. In order to establish a common understanding of the basic structure and functions of an RTO, Mengu and Grier (1999) stated that a systematic methodology that categorized the management operations of an RTO into major process areas was developed. The processes were further divided into sub-processes (see appendix A), which provided the basis for deriving the daily operational practices used by the RTO to fulfill its functions. From the perspectives of Mengu and Grier (1999), an RTO is created from the desire of a society or political unit to address the technological needs of its industry. This society has cultural and industrial characteristics that affect how the RTO is structured, how it operates and, for the most part, is the market for the RTOs services. According to Mengu and Grier (1999), the market consists of:

i. Clients (those that pay for services from an RTO);
ii. Beneficiaries (those that receive services from the RTO, but the cost of the services is paid by another party); and
iii. Funders (those that provide funds to pay things they believe should be done, but are not the direct recipient of the RTO's services).

2.3. PITFALLS OF TRADITIONAL APPROACHES TO WORK SYSTEM DESIGN.

Designers are known to incorporate technology into some form of hardware or software to achieve some desired purpose. The designer usually focuses initially on functionality (i.e. what machine can do), and then worries about human functions. Usually, the extent to which those who must operate or maintain the hardware or software are considered accounts for the skills, knowledge, and training that will be required. However, these factors are not always considered from an ergonomics standpoint. As a result, the intrinsic motivational aspects of jobs, psychosocial characteristics of the workforce, and other related work system design factors rarely are considered. Yet, these are the very factors that can significantly improve work system effectiveness. There is a widely acknowledged relationship between ergonomics inputs to design and the level of performance. Thus the earlier the input of professional ergonomists in the design process, the greater the impact on system effectiveness (Hendrick and Kleiner, 2001). According to Ruth (1993), when employees are not actively involved throughout the planning and implementation processes, the result is often a poorly designed work system and a lack of employee commitment. Ruth (1993) explained that in the task interpretation process, the worker has to be able to involve his personal prerequisites such as experience, skills and physical constitution, as well as his/her context as part of social systems inside and outside the organization. According to Ruth (1993), the worker has to, additionally solve all the problems that were not taken care of, or were misinterpreted, when

management designed the task. As such, employees even frequently display overt or passive-aggressive resistance to the changes. Hendrick and Kleiner (2001) observed that when a technology-centred approach is taken (even if employees are brought in at all), it is only after the work system changes have been designed, and employees' role is merely to conduct usability test. When employees find serious problems with the changes (as often happens), cost and schedule considerations prevent any major redesign to eliminate or maximize the deficiencies. Given that most of the so-called re-engineering efforts of the early 1990s used a technology-centred approach, it is not surprising that most of them have been unsuccessful (Hendrick and Kleiner, 2001). A technology-centred approach often leads to treating those who will operate and maintain the system as impersonal components. The focus is normally on assigning to the "machine" any functions or tasks that its technology enables it to perform. What is left over is assigned to the operators and maintainers. As a result, the function and task allocation process fails to consider the characteristics of the workforce and related external environmental factors (Ruth, 1993; Hendrick and Kleiner, 2001). Typically, the consequence is a poorly designed work system that fails to make effective use of its human resources. In this respect, Ruth (1993) had pointed out that, in systems design it is essential to be aware that technological development has a human origin.

2.4. SYSTEMS DESIGN AND MACROERGONOMIC THEORY

According to Hendrick (1986), macroergonomics is the study and design of jobs, organizational strategy, organizational structure, incentive systems, and training programmes, in conjunction with the technology. Macroergonomics evolved from socio-technical systems theory (Cherns, 1976; 1987; Trist and Murray, 1993; Taylor and Felten, 1993), and is focused on designing these features of the organization so that human skills and abilities are effectively used to achieve personal and organizational goals (Majchrzak, 2001). According to

Hendrick (1991), ergonomics can be defined in terms of its unique technology as the development and application of human-system interface technology. At the macro or over-all systems level is the organization-machine interface technology or macroergonomics (Hendrick, 1996). In this respect, the technology of human factors in organization design and management, according to Hendrick (1994), can be thought of as the technology of macroergonomics. Based on this perspective, macroergonomics has been defined conceptually as a top-down socio-technical systems approach to the design of organizational and work system structures, and to related jobs and human-machine, human-environment, and human-software interfaces (Hendrick, 1986; 1991). Although top-down conceptually, Hendrick (1996) indicated that it is important to realize that, in actual application, it involves participation at all organizational levels. According to Ruth (1993), a more holistic approach to ergonomics is needed, focusing on decision-making in the planning and design process of the whole system, on the macro as well as on the micro levels. In this respect, the design of a production system forms an important part in the design of the whole production system, which begins when management, in their strategic planning continuously has to register signals from the surrounding environment (society and market) as well as identify reasons for change. Ruth (1993) further emphasized that during the translation process; decisions are arrived at upon which tasks are going to be performed by machines (technological tasks) and which by people (human tasks). Judging from systems design and ergonomics viewpoint, Ruth (1993) indicated the obviousness that this division of tasks is a determinant precondition for the formation of good working conditions. In this respect, Helander (1997) sees ergonomics and human factors as applying the knowledge of human abilities and limitations to the design of systems, organizations, jobs, machines, tools, and consumer products for safe, efficient, and comfortable use. Critical to the success of many organizations today is an ability to rapidly redesign their market and customer needs change. Not only must the specific human factors of

a particular workstation be redesigned rapidly, but the macroergonomics of an organization needs to be rapidly redesigned as well.

2.4.1. Socio-Technical System Theory

According to Hendrick and Kleiner (2001), the socio-technical system model of work systems was empirically developed in the late 1940s and 1950s by Trist and Bamforth (1951), and their colleagues at the Tavistock Institute of Human Relations in the United Kingdom. Follow-up research by Katz and Kahn (1966) as well as others, served to confirm and refine the model. This model views organizations as transformative agencies. They transform inputs into outputs. Hendrick and Kleiner (2001) indicated that socio-technical systems bring three elements to bear on this process. These include a technological subsystem, personal subsystem, and work system design consisting of an organizational structure and process. These three elements interact with one another and the external environment on which the organization depends for its survival and success. These models can be used as macroergonomics tools in analyzing and developing or modifying the design of a given work system.

2.5. EFFECTIVE WORK SYSTEMS DESIGN.

According to DeGreene (1973), effective work system design requires "joint design" of the technical and personal subsystems. Thus in ergonomics terms, joint design requires a "human-centred approach. In terms of functional task allocation, Bailey (1989) refers to it as a humanized task approach. Based on the pitfalls noted in section 2.3 above, several criteria, as outlined below, can be established for selecting an effective work system design approach (Hendrick and Kleiner, 2001).

2.5.1. Joint Design.

This approach should be "human-centred". Rather than designing the technological subsystem and requiring the personnel subsystem to conform to it, the approach should require design of both subsystems concurrently. Further, it should allow for extensive employee participation throughout the design process.

2.5.2. Humanized Task Approach.

The function and task allocation process should first consider whether there is a need for a human to perform a given function or task before allocating functions to either humans or machines. Implicit in this criterion is a systematic consideration of the professionalism (education and training), cultural, and psychosocial characteristics of the personnel subsystem.

2.5.3. Considering the Organization's Socio-technical Characteristics.

This approach should systematically evaluate the organization's socio-technical system characteristics, and then integrate them into the work system design.

2.6. RELEVANCE OF MACROERGONOMICS IN WORK AND SYSTEMS DESIGN.

Hendrick and Kleiner (2001) have emphasized that macroergonomics fulfils all three criteria as outlined in section 2.5 above, because, it is a top-down socio-technical systems approach to work system design, and the carry-through of the overall work system design to the design of human-job, human-machine, and humans-software interfaces. Macroergonomics is human-centred, because it systematically considers the worker's professional and psychosocial characteristics in designing the work system and then carries the work system design through to the ergonomic design of specific jobs and related software and hardware interfaces. In this context, Hendrick and Kleiner (2001) explained that integral to this human-centred design process is joint design of the technical and personnel subsystems, using a humanized task

approach in allocating functions and tasks. As such, Noro and Imada (1991) have established that a primary methodology of macroergonomics, and one that many macroergonomics practitioners consider necessary to ensure success is “Participatory Ergonomics”. Participatory ergonomics is a methodology that involves employees at all organizational levels in the design process (including function and task allocation).

2.7. SYSTEMS THEORY AND ORGANIZATIONAL SYNERGISM

A widely accepted view among system theorist and researchers is that all complex systems are synergistic. According to Hendrick and Kleiner (2001), the whole is not equal to the simple sum of its parts. Because organizations are complex systems, they too should be synergistic. Theoretically, because of this synergism, certain circumstances should tend to occur in complex work systems (Hendrick, 1994), as described below.

a) When work system structures and processes are grossly incompatible with their socio-technical system characteristics, and/or jobs and human-system interfaces are incompatible with the organization’s structure, the whole is less than the sum of its parts. Under these conditions, the following can be expected.
   i. Productivity, especially quality of production, to be relatively deficient;
   ii. Accident rates and lost-time injuries to be relatively high, and adherence to safety standards and procedures poor;
   iii. Motivation and related aspects of job satisfaction and perceived quality of work life (for example, psychosocial comfort and stress) to be relatively poor.

b) When a work system has been designed effectively from a macroergonomics perspective, and that effort has been carried through to the micro-ergonomics design of jobs and human-machine, and human-software interfaces, then the work system design is harmonized. As a result, synergistic functioning becomes possible, and the various system

effectiveness criteria, such as productivity, safety, employee satisfaction, commitment, and perceived quality of work life, will be much greater than the simple sum of the parts.

c) Implications for The Potential of Organizations – assuming that these first two theoretical propositions are true, then macroergonomics has the potential to greatly improve productivity, safety, health, employee motivation and commitment, and the quality of work life. In the early 1990s, Hendrick theorized that instead of the 10 % - 25 % improvements in these system effectiveness measures that many ergonomists have experienced from successful micro-ergonomics (human-machine interactions) interventions, one should see improvements of 60 % - 90 % or more (Hendrick, 1994).

2.7.1. Organizational Design and Management.

Shahnavaz (2002) has pointed out that organizational hierarchy and the down-flow of authority within organizations are common practices in Industrial Developing Countries (IDCs), and such values as democracy, empowerment, or power sharing in decision-making, which are regarded as key issues in modern management for proper utilization of human resources (with regard to intelligence, creativity, problem-solving potential, and ingenuity), do not agree with the cultural sense of hierarchical power. According to Shahnavaz (2002), '...feudal system of social hierarchy and its value system are widely practiced in most industrial workplaces. This makes, for example, the participatory management approach (which is regarded as essential for the new production mode of flexible specialization and a motivated workforce) a difficult endeavour'. Shahnavaz (2002) however, acknowledged that there are reports (such as Ketchum, 1984) that confirmed the desirability of introducing autonomous work systems in these cultures. Additionally, research evidence (Helali and Shahnavaz, 1996, 1998) has shown that if a proper approach is adapted, many firms in IDCs also are eager to make use of these macroergonomics finding. According to Shahnavaz (2002), an organization is a social structure wherein employees play a decisive role in

improving its performance. Furthermore, 'decision making and action should be concentrated in the heart of the operation to reduce the risk and duration of system failure and to better utilize resources as well as increase system reliability and availability' (Shahnavaz, 2002). Since organizational change is a difficult, time consuming, and expensive process, Shahnavaz (1998) noted that cultural factors, including the way people interact with each other in an organization and commit themselves to organizational goals, are complex matters that have significant bearing on the success of an organizational change. In this respect, Shahnavaz (2002) indicated the necessity of matching management methods and techniques to the local conditions. According to Shahnavaz (2002), societal and organizational culture-based differences should be considered when designing or introducing change in an organization, and further mentioned De Lisi (1990) as indicating that networking capabilities will not be realized unless the networks fit the existing organizational culture.

2.7.2. Technology Absorption Capacity.

When ergonomic consideration is to be given credence in the process of technology transfer, Shahnavaz (2002) has emphasized that the level of ergonomic awareness by the technology supplier and receiver firms, as well as their commitment to ergonomic issues, will greatly influence their decision regarding how appropriately transferred technology will be put into effect, as illustrated in figure 1 below. Thus according to Shahnavaz (2002), '.....can be analyzed by closely examining the firm's characteristics and attitudes, because they generally reflect the firm's own micro-and macroergonomic conditions. The better the ergonomic conditions of a firm and the firmer its commitment to ergonomics (both at micro and macro levels), then the better the choice and utilization of technology, leading to a more appropriate technology transfer'. But Shahnavaz (1989) has intimated that even an "ergonomically designed product" (or system) made for a certain population cannot be used efficiently and safely by a different population in a diverse environment.

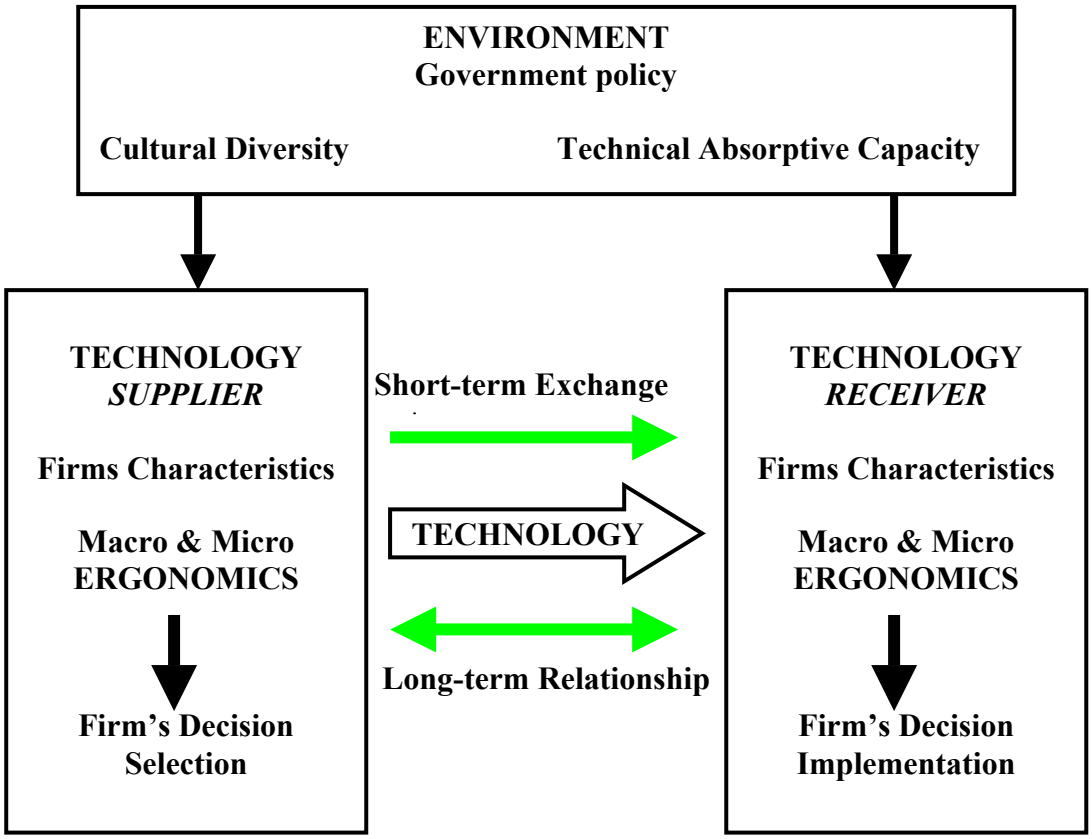


Figure 1: Technology supplier and receiver decision-making (Shahnavaz, 2002).

In the context of technology absorption capacity, Shahnavaz (2002) pointed out that one of the main problems for IDCs is their lacking of scientific and technological infrastructures and training facilities for improving the workforce's level of education, skill, and understanding of safe and effective operation, maintenance, and development of the imported technology. These are important, because according to Shahnavaz (2002), '..... technology will be absorbed better at the local environment if it is in harmony with its users and its operating environment'. Shahnavaz (2002) further emphasized that in some cases, adaptation of the imported technology to local conditions, or modification and correction of technology, may be required in order to make the technology more efficient and to minimize its negative effects.

2.8. LARGE-SCALE ORGANISATIONAL CHANGE.

Kleiner (2002a) has emphasized that macroergonomics presents a socio-technical frame work for the studies of both micro and macro issues which are associated with large-scale organizational change. Within this perspective, Kleiner (1996) indicated that performance is viewed as multi-dimensional and is characterized by multi-dimensional criteria and measures related to various checkpoints in the work system. In this context, Kleiner (1996) further asserted that large-scale change has been operationally defined as significant improvement (i.e. greater than 50 %) of one or more of these performance variables or less than 50 % improvement, but in a relatively short time span. Thus an important outcome of macroergonomic intervention, according to Hendrick (1995), is a culture change in which organizational culture is primarily defined by the organization's core values. According to Kleiner (2002a), it is important to note at the outset a simple, but profound assumption regarding large-scale organizational change and that it is valid change (i.e. the targeted change should be supportive of and aligned with the organization's purpose). 'Normally, structural changes support strategic changes and all strategic changes should be aligned with the organization's purpose. Given this, we can assume that most change will also result in some type of performance improvement and/or culture change' (Kleiner, 2002a). However, Kleiner (2002a) pointed out that there is the need to recognize the fact that many organizations pursue change that does not necessarily meet these criteria. In some organizations, according to Kleiner (2002a), the "programme of the month" characterizes the culture, and hence over time, employees learn to meet each new programme with skepticism or resistance. Thus Kleiner (2002a) stated that 'one of the ironies in an organization undergoing invalid change is that, to the managers facilitators, the change can feel valid (i.e. in attempting to get employees to change behaviours and attitudes, the resistance encountered can be physically stimulating)'.

2.8.1. External Environmental Characteristics.

According to Hendrick and Kleiner (2001), the very survival of organizations depends on their ability to adapt to their external environment. In terms of open systems theory, organizations require monitoring and feedback mechanisms to follow and sense changes in their relevant task environments and a capacity to make responsive adjustments. Relevant task environments refer to that part of the firm's external environment that can positively or negatively influence the organization's effectiveness (i.e. the organization's critical constituencies). Kleiner (2002b) further characterized external environment to consist of those forces that enter an organization, and to which the organization must respond. In this perspective, Kleiner (2002b) affirmed that 'the work system can treat its external environment as a source of inspiration or provocation..... In the former scenario, the work system is positively motivated by the dynamics or challenges in the environment and is proactive in response. In the latter, work systems are reactionary and negatively disposed to their environments'. As a general principle, Kleiner (2002b) viewed the external environment as the most influential component in work design.

2.8.2. Types of External Environments.

Examining field studies of 92 industrial firms in five underdeveloped countries (Argentina, Brazil, India, Philippines, and Uruguay); Negandhi (1977) identified five types of external environments that significantly affect organizational functioning. These are as follows:

a). Socio-economic.

Particularly the degree of stability of the socio-economic environment, nature of the competition, and availability of materials and qualified workers;

b). Educational

The availability of facilities and programmes for employees or potential employees in the local region, and the educational level and aspirations of workers;

c). Political

The degree of stability at all governmental levels and the government's attitudes toward business (i.e. friendliness versus hostility), labour (friendliness versus hostility), and control of prices;

d). Cultural

Social status and caste system in the community, values and attitudes of employees and their families toward work, management, and the nature of trade unions and union-management relationships;

e). Legal.

Degree of legal controls, restrictions, and compliance requirements.

Out of the 92 industrial firms, Negandhi (1977) pointed out that 47 were American subsidiaries whilst the remaining 45 were comparable local firms. Each of the American subsidiaries was paired with the local firm on the basis of products, technology, number of employees, sales volume, and investment. Based on the findings, Negandhi (1977) gave the following propositions as indicative of the relationships among the external environmental variables and the planning process.

i. The greater the degree of economic and political instability, the lesser the likelihood that the private industrial enterprise will undertake long-range planning in a systematic manner;
ii. The greater the degree of governmental controls on prices and the availability of raw materials, the lesser the likelihood that the firm will undertake long-range planning;
iii. The greater the governmental "hostility" toward the business community, the lesser the likelihood that the firm will undertake long-range planning in a systematic manner;

iv. The higher the degree of competition, the greater will be the need for long-range planning by the individual firm; and
v. All other factors being the same, the greater the firm's score on the management philosophy variable, the greater will be the firm's concern for long-range planning.

Hendrick and Kleiner (2001) indicated that the relevant task environments are different for each organization with respect to type, qualitative nature, and importance. The particular weighted combination of relevant task environments constitutes its specific task environment. A major determinant of an organization's specific environment is its domain, or the range of products or services offered, and market share (Robbins, 1983). Domain is important, because it determines the point at which the organization depends on its specific task environment (Thompson, 1967). A second determinant of an organization's specific task environment is its stakeholders (Hendrick and Kleiner, 2001). These include the firm's stockholders, lenders, members of the organization, customers, users, governmental agencies, and the local community(s). Each has an effect in the organization. Thus in Negandhi's studies, various elements of management process or practices were considered as intervening variables. Some of the most important of these elements, according to Negandhi (1977) were as follows:

i. Planning orientations (long-range versus short-range);
ii. Participation in planning and general decision-making;
iii. Scope of controls and control process;
iv. Leadership style, organization (centralization-decentralization aspects);
v. Techniques and methods used in selecting and promoting employees as well as high-level manpower development programmes.

Negandhi's analysis suggested that the American subsidiaries in all five underdeveloped countries were better managed than their local counterparts. Negandhi (1977) explained that the local firms which were categorized as "Most Sophisticated Management Policy" were more like the American subsidiaries in their management practices, whilst some of the American subsidiaries, which were categorized as "Somewhat Progressive Management Philosophy", were closer to the closer firms. Simply put, Negandhi (1977) pointed out that an independent variable of management philosophy has had considerable bearings on the firm's management practices, but only to some extent did environmental factors affect management practice elements. Comparing the two philosophies, Negandhi (1977) found out that the firms with "Somewhat Progressive Management Philosophy" were most affected. In the same light, Negandhi (1977) pointed out that a few of the elements of management practices where environmental factors have had greater influence were singled out. These included:

i. Long-range planning in a systematic manner;
ii. The degree of decentralization in decision-making;
iii. Leadership style; and
iv. Scope of control.

2.8.3. Environmental Uncertainty.

From the viewpoint of Duncan (1972), of particular importance to work system design is the fact that all specific task environments vary along two highly critical dimensions (i.e. change and complexity). Degree of change refers to the extent to which a given task environment is dynamic as opposed to it remaining stable over time. The degree of complexity refers to whether the components of an organization's specific task environment are many; as opposed to few in number (i.e. does the company interact with few or many government agencies, customers, suppliers, and competitors). These two environmental dimensions of change and

complexity combine to determine the environmental uncertainty of an organization. Based on studies of 20 English and Scottish industrial firms, Burns and Stalker (1961) found that the type of work system structure that worked best in a relatively stable and simple organizational environment was very different from that required for a more dynamic and complex environment. For stable, simple environments, mechanistic structures worked best. mechanistic work systems are characterized by high vertical and horizontal differentiation, formalization, and centralization (Hendrick and Kleiner, 2001). They typically have routine tasks and programmed behaviours, and cannot respond to change quickly. A strong emphasis is placed on stability and control. For dynamic, complex environments, organic structures worked best. These are characterized by flexibility and quick adaptability. Organic works systems emphasize the following:

i. Lateral, rather than vertical communication;
ii. Influence, based on knowledge and expertise, rather than position and authority;
iii. Information exchange rather than directives from above;
iv. Conflict resolution by interaction rather than by superiors; and
v. Relatively, loosely defined responsibilities.

Accordingly, organic work systems have low vertical differentiation and formalization and decentralized tactical decision-making. Similar findings were implicit in Emery and Trist's (1965) analyses of the effects of environmental stability on socio-technical systems. A common characteristic of complex specific task environments is that, organizations usually develop specialized units to deal with particular parts of the environment. Lawrence and Lorsch (1969) conducted field studies to determine what type of work system design was best for coping with different economic and market environments. They studied companies in various industries (e.g. food, plastics, and containers), which varied considerably, in their degree of environmental uncertainty. Based on their studies, Lawrence and Lorsch (1969)

identified five major variables that can be assessed regarding sub-unit environments to determine the optimal degree of horizontal differentiation. These are as follows:

i. Uncertainty of information (i.e. low, moderate or high);
ii. Time span of feedback (i.e. short, medium or long);
iii. Pattern of goal orientation (i.e. focus of tasks);
iv. Pattern of time orientation (i.e. short, medium or long); and
v. Pattern of interpersonal relationships (i.e. task or social).

In general, the more dissimilar the functions on one or more of these dimensions, the stronger the likelihood that the functions should be differentiated into separate sub-units (i.e. departmentalised) for effective functioning (Hendrick and Kleiner, 2001). Lawrence and Lorsch (1969) also found that the greater the differentiation, the greater the need for integrating mechanisms, and that the level of environmental uncertainty was of foremost importance in selecting the structure appropriate for effective functioning. Sub-units with more stable environments (e.g. production), tended to have high formalization, whereas those operating in less predictable environments (e.g. research and development), had low formalization. Lawrence and Lorsch (1969) research is particularly important to macroergonomics, because it demonstrates that whenever an organization's design does not fit its mission, external environment or resources, its functioning is likely to suffer. Citing their own experience, Hendrick and Kleiner (2001) indicated that the gaps between work system design and environmental expectations are often gaps of perception. To deal with these gaps, communication interfaces need to be developed between sub-environmental personnel and the organization. Specifically, the macroergonomist designs or redesigns interfaces among the organizational system and relevant sub-environments to improve communication and decision-making. Hendrick and Kleiner (2001) referred to these interfaces as organization (or work system) – environment interfaces.

2.9. ORGANIZATIONAL CULTURE AND CLIMATE

Glendon (2001) has asserted that confusion continues between the uses of the terms "Culture" and "Climate". Glendon (2001) pointed out that climate is regarded as a more superficial concept than culture, being descriptive of important aspects of the current state of an organization. Culture is often seen as being long-term and strategic, whilst climate is perceived as short-term, even tough they are often used interchangeably. According to Glendon (2001) whilst there is a strong relationship between them, organizational climate refers essentially to the perceived quality of an organization's internal environments in which employee attitudes and perceptions feature prominently. Scaled dimensional measures are the most popular means of measuring organizational climate, and many have been devised. Dimensions typically assessed include autonomy, cohesion, trust, pressure, support, recognition, fairness, and innovation. A typical 3-level classification of organizational culture embodies relatively accessible, intermediate and deep levels. According to Glendon (2001), the most accessible level refers to observable behaviours and associated norms. The intermediate level includes attitudes and perceptions, which are not directly observable, but which may either be inferred from behaviours or assessed through questioning. At the deepest level are core values, which are much less readily assessed. Other key dimensions of organizational culture that have been identified include depth, breadth, progression, strength, pervasiveness, direction and localization (Warring and Glendon, 1998). Organizational climate measures can access certain components of the dimensions of organizational culture across a limited range (e.g. those relating to member attitudes, beliefs, and perceptions, as well as cultural breadth at the time a survey is undertaken and perhaps a little in the past as well). Glendon (2001), however, affirms that organizational culture change is generally taken to occur over a period of years, and the time frame for assessing culture must reflect this important time dimension. This differentiation is of relative importance when judged from

macroergonomics perspectives. Judging from the perspectives of systems quality, Leino and Matilla (2001), have therefore, made the following recommendations, which was based on their studies of ergonomics in total quality management.

i. Total quality management regards the entire business process from supplier to customer. Therefore, it must consider all elements of a company's processes and dimensions of quality, including ergonomics;
ii. The integration of management systems for quality, environment, occupational safety and health, and ergonomics has become actual where companies implement two or more management systems simultaneously;
iii. The integration of management systems has proved to be beneficial. Both modern safety and quality management emphasize the pro-active approach in planning, organization and measurement. An integral system combines diverse management systems with quality management, improves the company's performance and save time, work and money;
iv. System integration is a continuous process, which needs to be evaluated at regular intervals. The Malcolm Baldridge National Quality Award is an assessment method that can be used for monitoring and reviewing the integrated TQM system. The assessment criteria could be developed to cover also ergonomic issues; and
v. It has been proved that ergonomic work conditions support product quality as well as human performance.

2.9.1. Work Environment Consequences and Planning of Change.

According to Ruth (1993), in each planning process decisions are taken which tend to have a determinative influence on the working conditions of human beings. Those involved in the planning process (i.e. managers, economists, designers, engineers, technicians, architects, administrators, and researchers) are only to a limited extent aware of these consequences when

they develop foundations for decision-making and also when they take decisions on what they think are other matters. In this respect, Ruth (1993, 2002) indicated that future working environments are being designed through decisions which were not intended to affect working environment matters, but rather focus on new products, new production methods, economic savings, new training programmes, or new technology. In other words 'by a planning process that "unintentionally" plans the working environment' (Ruth, 1993, 2002). According to Ruth (1991), such "Unintentional Planning" of the working environment has its origin in the traditions, methods, knowledge, and ways of thinking, habits, and attitudes among actors taking part in the planning process. Human work activity is normally not a dimensioning factor in their models and calculation programmes (Ruth, 1991). In order to be able to obtain a breakthrough for inclusion of working environment matters in the planning process, Ruth (1993, 2002) indicated the necessity to put forward human-related function criteria in each step of the industrial planning process. It then becomes a question of making these criteria influence the decision-making in the different on-going analysis and development process. In other words 'it is a matter of giving impulses to key actors in the planning process, raising their level of consciousness of consequences, and thereby influencing the actors' train of thoughts and ways of action' (Ruth, 1993, 2002). In this context, Ruth and Ruth-Balaganskaya (2000) indicated that a similar strategy is important in achieving a functioning planning process regarding an industry's impact on the external environment by taking into account ecological considerations, and by combining both efforts.

2.9.2. Environment Focused Planning and Design Methodology.

According to Ruth (1993), managers of industries, as part of strategic planning, have to continuously register signals from the surrounding environment (society and market) and identify "reasons for change. Based on this perspective, Ruth (1993, 2002) indicated that the

initial stage of systems design then could be described as asking a number of preconditioned questions derived from reasons for change, such as sampled below.

i. What is going to be produced?
ii. Which raw material and which resources are available? and
iii. Which are the goals of the production?

The answers to such questions, according to Ruth (1993, 2002) can be regarded as "process criteria", which have to be translated into the design of a suitable technology and organization for production. Decisions are taken about which tasks are going to be performed by people (i.e. human tasks) and by machines (i.e. technological tasks) during this translation. It should be obvious that this division of tasks is a determinant precondition for the formation of good working conditions (Ruth, 1993 and 2002). The procedure can be compared to the casting of a theatre play (production) as emphasized by Ruth (1993) in which the roles to be played by human actors (people) and non-human actors (technology/machines) are clearly outlined. The problem according to Ruth (1993, 2002) is that the non-human actors tend to get the best part (i.e. people are being used for such tasks that machines will not perform very well). The main reason for this mistake (Ruth, 1993 and 2002) is that the concept of human work activity in the design process is based on the managers' conception and description of tasks (i.e. the human work and the working methods that managers think have to be carried out in order to handle a specific technology to fulfill the criteria). Ruth (1993, 2002) explained that what the workers really have to do, in order to get the process to function, depends on the workers' interpretation of the tasks and turning them into work activity. Thus in the task interpretation process, Ruth (1993, 2002) stated that '……. the worker has to involve his/her personal prerequisites, such as experience, skills and physical constitution as well as his/her personal desires and social context inside and outside the company'. Also '…the worker must consider his/her interaction with the technological part of the production system and solve all the

problems that were not taken care of, or were misinterpreted when management designed tasks and engineers designed technology (Ruth, 1993 and 2002). This planning model, according to Ruth (1993, 2002), can be used to achieve good working environment, by asking which working conditions and work contents are desirable, prior to performing the role division between technological tasks and human tasks. 'However, a sustainable outcome of a change process can only be achieved if the problem owners are involved and the planning of change is based on a valid analysis of their activity' Ruth (1993, 2002).

2.9.3. Assessment and Remediation through Activity Analysis and Participative Planning.

Traditionally, attempts to improve work environment problems have tended to focus on specific factors such as noise, lighting, chemical exposure, heavy workload, monotonous work, and organizational structure among others. Though it is necessary for measures regarding problems to such factors to be taken, Ruth (1993, 2002) indicated that since factors can never be isolated in the work situation, it is necessary to find methods that make it possible to study inter-related effects of change. 'Otherwise, one risk to introduce what could be called "Improvement Deteriorations" when trying to solve problems related to single factors' (Ruth, 1993 and 2002). According to Ruth (1993, 2002), in all work situations, there is one common denominator, which is the "Human Work Activity". In this respect, activity analysis should be the basis in all studies of working conditions and remediation activities. 'If it is known how problems related to a single factor are related to the work activity, it is more probable to find proper solutions. It is also quite important not only to look for problems. Knowledge about what is functioning well in the system and positive properties that should not be lost when introducing change, should have high priority' (Ruth, 1993 and 2002).

2.9.4. Activity Analysis.

Human activity, according to Ruth (1993, 2002), includes a set of interacting dimensions that all have to be taken into consideration when performing activity analysis. These sets of interacting dimensions, which are illustrated in the model shown in figure 2 below depicts the following (Ruth, 1993 and 2002).

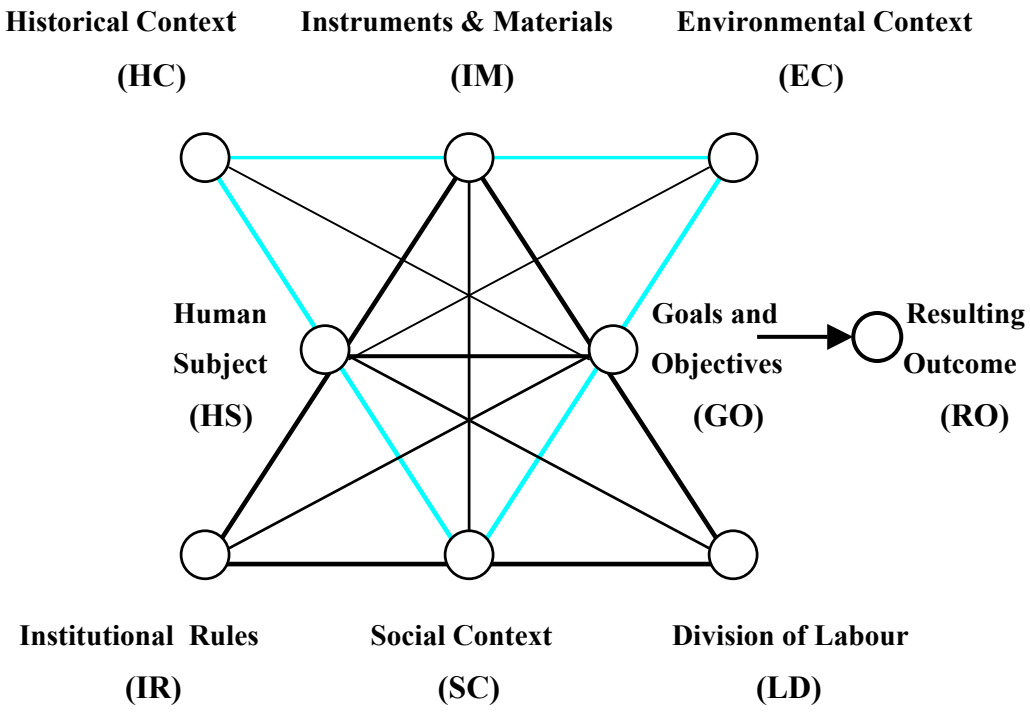


Figure 2: Dimensions of human activity [model based on Engestrom (1987) with further development by Ruth (1993, 2002).

Where;

a). Human Subject (HS).

An active human subject that may be an individual or a group of individuals engaged in the same activity. Since activity analysis can be performed at any scale level, the subject can be an individual worker, or small group (micro level), but also a division (medium level), and a whole company or even community and upwards (macro level).

b). Goals and Objectives (GO).

The goals, purposes and objectives of the subject by performing the activity, where one obvious objective is to achieve a desired outcome regarding the main productive purpose, but where, additionally, a whole set of personal and other goals usually are present. This dimension is an important part of the subject's task interpretations.

c). Resulting Outcome (RO).

The resulting outcomes of the activity, which may differ considerably from desired outcomes, mainly due to the presence of contradictions in the activity system.

d). Instruments and Materials (IM).

The instruments and materials used by the subject to perform the activity. This can be, raw material, tools, components, equipment, technological artefacts (like machines, transport systems, computers), and safety protective devices among others. But the instrument dimension also includes money, theoretical models, other human actors, information and technology among others (i.e. everything that is needed or useful for the subject when performing the activity).

e). Institutional Rules (IR).

The institutions like formal and informal rules that influence the activity. This dimension includes legislation, agreements, regulations and internal rules at company and workplace level, but also shared values, attitudes and "hidden agendas" related to work culture.

f). Division of Labour (LD).

The principles of labour division between human actors involved in or interacting with the activity and the task division between human and non-human actors will also influence the activity. This dimension also includes decision-making structures and power relations in the activity system.

g). Social Context (SC).

The social context will be present at different levels depending on who is the subject; if the subject is an individual, it will be the closest group and upwards in the organization, for subjects at manager level or the whole organization, it will be the surrounding society, and the market among others. In this case, the subordinate staff will be instruments of the activity system. Regardless of level, for an individual subject, the social component also includes the personal social connections of the individual.

h). Environmental Context (EC).

The environmental context (i.e. the physical environment in which the activity takes place and the natural environment with which the activity interacts. Like for the social dimensions, the environment dimension will be present at different levels depending on who are the subjects and the scale level of the activity.

i). Historical Context (HC).

The historical context of the activity. No human activity is independent of its history.

According to Ruth (1993, 2002), none of the above-listed dimensions can be excluded from the analysis, and for each dimension, specific methods can be used to analyze its constituents and their influence on the system. Ruth (1993, 2002) further indicated that the three contextual dimensions (i.e. SC, EC, and HC) have a strong influence on the formation of all the other dimensions. As such, complex activity systems can be analysed as a network of interacting sub-activities (all shaped like the model), down to the activity of individual subjects, where outcome of one sub-activity generates, for instance, instruments, and institutions for another. According to Ruth (1993, 2002), the generality of the dimensions mean that the model can be used as a tool not only to assess working environment consequences. Since anthropogenic impact is a major cause of environmental problems in general, analysis of human activity

should be a naturally included component also, for instance in environmental impact assessment.

2.9.5. Analysis of Contradictions.

According to Ruth (1993, 2002), identification of contradictions is an important part of activity analysis since they are indicators of malfunctions, and which could also be used as "springboards" to change the system. Ruth (1993, 2002) outlined three ways through which contradictions can occur. These are as follows:

i. Inside one single dimension of an activity system;
ii. Between different dimensions of the same activity system; and
iii. Between different interacting activity systems of an activity network.

Hence contradiction analysis is important in order to avoid systems collapse or change in undesired directions, and when used as "springboard", a well-defined contradiction can become a powerful tool to overcome resistance to change, since no successful change process can occur without involving the human key actors of the system who are the problem owners (Ruth, 1993 and 2002).

2.10. FIELD RESEARCH METHODOLOGICAL TRADE-OFFS AND CONSIDERATIONS IN MACROERGONOMICS

According to Kleiner (2002b), surveys of natural work teams or others in organizations can be beneficial, as illustrated in table 1 below. Kleiner (2002b) further asserted that causal information is not obtained through survey research, but correlation and other summary data are possible and useful (for example, the researcher can compare organizations and/or groups through the administration of the same instrument. Alternatively, longitudinal affective changes can be evaluated within groups).

2.10.1. Surveys.

According to Kleiner (2002b), surveys have been quite useful at the front end of empirical studies to identify appropriate constructs or factors for further investigation in macroergonomic research, whilst at the back end, surveys can be used to poll a population to which a study is attempting to generalise in order to validate a laboratory result.

Table 1: Research methods with associated trade-offs (Kleiner, 2002b)

METHODS	ADVANTAGES	DISADVANTAGES
Survey	• Easy to administer. • Correlation statistical inquiry. • Identifies research variables	• Correlation statistical data • Attitudinal data. • Self-report data.
Laboratory Experiment Student Subjects	• Cause and effect statistical inquiry. • Access to subjects. • Internal Validity.	• External validity. • Time consuming
Laboratory Experiment Expert Subjects	• Cause and effect statistical inquiry. • Internal validity.	• Subject reliability. • Time consuming.
Quasi-Experimental Field study	• External validity.	• Internal validity.

Relative to other methods, as specified in table 1, surveys are inexpensive and straightforward to administer, but Kleiner (2002b) indicated the existence of some disadvantages, which include several reliability and validity risks. '...reliability and validity of self-report data can be compromised with a poorly designed or administered survey. Also, response sample sizes above 50 % are difficult to achieve' (Kleiner, 2002b).

2.10.2. Case Study.

Case studies are inherently multi-method, typically involving observation, interviewing and analysis of documents and records. Robson (1993) emphasised that if the main concern of a research is understanding what is happening in a specific context, and if one can get access to, and co-operation from the people involved, then one must do a case study. According to Robson (1993), case study can be taken as a strategy for doing research, which involves an empirical investigation of a particular contemporary phenomenon within its real life context, using multiple sources of evidence. The contemporary phenomenon, in other words, the "case", can be anything. In this respect, Robson (1993) forewarned that '..... an experiment or a survey is not only an experiment or a survey, but also, necessarily, a "case" of an investigation, which might profitably be considered as such'. Thus case studies have sufficient flexibility to incorporate piloting within the study of the case itself (Robson, 1993; page 301).

Among the types of case studies listed by Robson (1993) are studies of organizations and institutions, such as firms, workplaces, schools, trade unions among others.

The possible foci, in this context, include the following:

i. Best practice;
ii. Policy implementation and evaluation;
iii. Industrial relations;

iv. Management and organizational issues;

v. Organizational cultures; and

vi. Process of change and adaptation.

2.11. FUTURE WORKSHOP

Future Workshop (FW) is a well-developed method for the identification of problems and for developing feasible and acceptable solutions for improvement. It is a socio-pedagogic method for the identification of a common problem, development of a vision, ideas and action plan among a group of people concerned. The method was first introduced by the future scientist Robert Jungk from Germany in 1984. Later on, it has been spread successfully to the Scandinavian countries, and it is now widely used as a participatory intervention method. According to Helali and Shahnavaz (1998), the practical prerequisite for running a successful FW is a well motivated participating group, a flexible and informal condition as well as two experienced and neutral workshop leaders. Helali and Shahnavaz (1998) have utilized FW to identify various management problems, and to develop vision, ideas and action plan for improvement. FW is a well-structured process with five defined phases as listed below (Helali and Shahnavaz, 1998).

2.11.1. Preparation Phase.

This phase defines a clear, short and challenging 'theme' for the workshop, acceptable to all participants.

2.11.2. Experience Phase.

This phase [which is a new technique specifically developed by Professor Shahnavaz of Luleå University of Technology in Sweden] highlights all problems (small or large), experienced by participants with regards to the workshop's theme. Participants are made to concentrate on

only the “NEGATIVE” side of the theme with the view that what is good doesn’t need to be changed.

2.11.3. Phantasy Phase.

This phase is to come out of the daily limitations that usually lead to restraint, traditional thinking and acting. This is due to the fact that people have many ideas that have never been expressed or formulated because they were framed in what they believe was right and possible. In fantasia, everything is possible. There are no barriers, no economic, personal, technical or organisational limitations. The idea is to develop future visions that had enough power to solve all the critical problems that the group is working with.

2.11.4. Strategy Phase.

In this phase, all the expressed fantasies are run through with the aim of finding all the barriers regarding the realisation of the fantasies. Participants discuss whether any of the barriers could be removed, and if yes, how and when? A programme/plan for change is then prepared in order to see the realisation of the fantasies decided upon.

2.11.5. Action Phase.

A complete report containing all the critical problems, fantasies as well as programmes/plans proposed by the participants is prepared at this phase. This report can then become a future resource for ideas and actions, and an acknowledgement (feedback) for participants to see how hard, intensive and creative they have worked.

3. APPRAISAL OF REVIEWED LITERATURE AND DEVELOPMENT OF RESEARCH HYPOTHESIS

3.1. APPRAISAL OF REVIEWED LITERATURE

The effectiveness of benchmarking as a powerful tool for transforming organizations was clearly established by Mengu and Grier (1999). Despite this, it was apparent from the reviewed literature that the approach for the application of benchmarking to identify best management practices for Research and Technology Organizations (RTOs), which was supposed to provide them with the knowledge they need to help improve their performance failed to take into consideration factors related to the RTOs' operating external environments. These factors might have resulted as a result of the existence of contradictions in the various dimensions of the RTOs' operations. By virtue of this observation, I can infer that the various assistances offered to the RTOs did not cover resources for the remediation of the contradictions in their activities, and which could result in overcoming any form of external environmental constraints that the RTOs might encounter in their operations.

I view the recommended model by Mengu and Grier (1999) as having its strength in trying to address issues relating to the RTOs operating climate. Yet it showed elements of weakness by its inability to identify the RTOs organizational climate and culture as well as their work climate and culture as separate elements of their systems functionality. This is supported by the assertion by Mengu and Grier (1999) that the cultural and industrial characteristics affect how an RTO is structured, how it operates and for the most part, the market for the RTO's services. This view, in my opinion, appears to be reminiscent of traditional approaches to improving organizational functionality with its consequence of not worrying about the human functions until later. The weakness of this approach was clearly established in the reviewed

literature as apparently key to the pitfall of the traditional approach to work system design, as discussed in section 2.3. The reviewed work of Negandhi (1977) clearly established a base for the possible external environmental factors to consider, taking into consideration the variations in the prevailing environments among the five (5) different countries covered. Though Negandhi (1977) stated that only to some extent did environmental factors affect management practice element, he clearly pointed out that a few of the elements of management practices where environmental factors have had greater influence were singled out. This, in my view calls for a broader consideration of the other remaining elements of management practices, so as to establish whether they may add some significant influence to the findings of Negandhi (1997).

Based on the above observations, several remediation approaches towards improving the functionality of organizations were highlighted in the literature reviewed. Qualifications to these approaches by the several authors cited were from the perspectives of either macroergonomics or systems ergonomics. This tends to create the impression that macroergonomics approach and systems approach differ. I found this to be deceptive, since it is clear from the literature that elements in these two approaches are the same, and in fact, macroergonomics appears to be a key component of systems ergonomics. Key to these are the several criteria outlined in section 2.5, by Hendrick and Kleiner (2001) and further discussed in sections 2.7, 2.8, and 2.9, which addresses issues relating to joint design using humanized task approach by considering the organization's socio-technical characteristics.

Useful points in the adaption of humanized task approach were also discussed by Ruth (1993, 2002) in sections 2.9.1, 2.9.2 and 2.9.3. These clearly identified important elements in work organization and systems design, which are key in attempts to find solutions to existing

problems, such as identified with the WAITRO model. Some of the important issues addressed include those on organizational design and management as well as technology absorption capacity of organizations, from the perspectives of technology transfers by Shahnavaz (2002) in sections 2.7.1 and 2.7.2 respectively. Useful strategies were also provided by Ruth (1993, 2002) as discussed in sections 2.9.1, 2.9.2 and 2.9.3. These included the ability of being able to differentiate between prevailing work and organizational environments by understanding the consequences of the system environment and making plans for change. In this respect, I view the discussion in section 2.9 by Glendon (2001) to clear the apparent confusion that persists in the use of the terminologies "culture" and "climate", in work organization and system design contexts, by distinguishing between them as useful and relevant. The model on the relationship expected between a technology supplier and receiver, shown in figure 1, also gives a good guide as to the type of relationship expected to exist between an organization and its external environment, but it falls short of establishing the required interaction, with respect to short-term relationship.

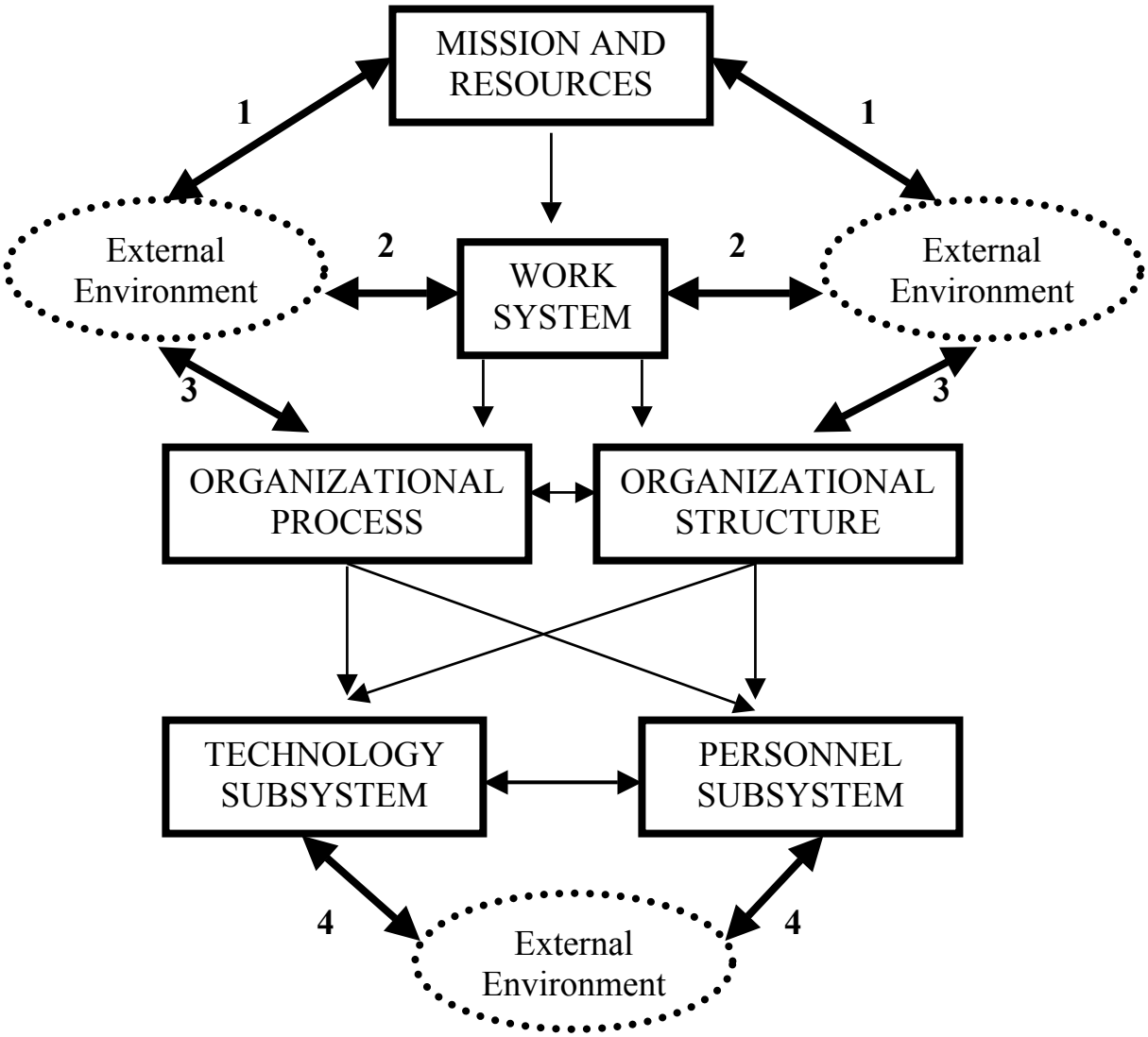
An important strategy for conducting Activity Analysis in organizations was also outlined by Ruth (1993, 2002) in section 2.9.4. The model described in figure 2 on dimensions of human activity appears to provide a useful guide to conducting a thorough organizational systems analysis and establishing potential key elements required for effective functionality of work organizations. I also view the field methodological strategies described by Helali and Shahnavaz (1998) and Ruth (1993, 2002) as very useful in the identification of organizational problems. Whilst the Future Workshop methods (Helali and Shahnavaz, 1998) use subjective opinions as indicators, the Activity Analysis (Ruth, 1993 and 2002) uses the system, subject and environment interactions as indicator. The technique of allowing participants in the FW to concentrate on only the negative aspect of the workshop theme seems to be in the right

direction as a focused control measure, since all the positive aspects of the theme are known and appreciated by all.

Lastly, the reviewed literature established the importance of systems theory and organizational synergism. Hendrick's (1994) two theories as stated in section 2.7 gave an indication that macroergonomics has the potential to greatly improve productivity, safety, health, employee motivation and commitment, and the quality of work life. Though Hendrick theorized that instead of the 10 % - 25 % improvements in the stated systems effectiveness measures that many Ergonomist have experienced from successful micro-ergonomics interventions, one should see improvements of 60 % - 90 % or more. In my opinion, the path to this change, whether transitional or simultaneous, will tend to have a great influence on Hendricks (1994) assertion. Achieving this improvement, in my view, will require a simultaneous change approach (i.e. both micro-ergonomic and macroergonomic) by conducting a thorough assessment of the work organization and system design through the conduction of both the Future Workshop and Activity Analysis. I see these two methodologies, by virtue of their overall inclusiveness, as standing out to identify simultaneously the micro-ergonomic and macroergonomic changes to be required in the work organization and system design of respective RTO's. This, in my opinion, could result in the requisite internalization of the WAITRO "Best Management Practices" by the RTOs, in order for them to see the 60 % - 90 % or more positive changes suggested by Hendricks (1994).

3.2. RESEARCH HYPOTHESIS

As observed in section 3.1 above, benchmarking has been proved to be a very effective method for improving work practices, but the inhibiting factors that prevent the success of benchmarking, especially in work organization and systems, has not been fully established (Mengu and Grier, 1999). RTOs have been encouraged to use the benchmarking methods (sampled from other successful RTOs and compiled by WAITRO) using the WAITRO implementation model as guide. Yet, most RTOs have been unable to adopt and internalize these best management practices. Failure to adopt such best management practice maybe be due to lack of adequate financial or intellectual resources to effect change, or a result of old-fashioned organizational cultural practices. Based on the appraisal of the reviewed literature and specifically the findings of Negandhi (1977) as well as the recommendations from Ruth (1993, 2002), Shahnavaz (2002), Hendrick and Kleiner (2001) as well as Lawrence and Lorsch (1969) among others, an effective macroergonomics model should relate organizations' work systems to their external environment. This implies that both the personnel subsystem (organizational structure) and technological subsystems (organizational process) should be linked by a communication interface to enhance communication and decision-making within the organization. Based on these observations, and to construct a simple, but yet holistic guide for approaching work organization and system design, from the perspective of this research, I have developed the model shown in figure 3, which is hypothesized to provide a systems and combined micro-ergonomics and marcroergonomics base for assessing work organization and systems design. The model identifies the systems activity elements to be analyzed for the existence of possible activity contradictions, and also the possible external factors to consider in assessing the work organization and system design constraints faced by the Research and Technology Organizations (RTOs).



EXTERNAL ENVIRONMENTAL FACTORS

1 = Political, Socio-economic and Legal factors, Consumers and Market Forces.

2 = Communication Interfaces and Decision-making.

3 = Educational Background, Culture and Climate factors, e.g. autonomy, cohesion, trust, pressure, support, recognition, fairness and innovation.

4 = Subsystem Stability (e.g. production, level of formalization and participation).

Figure 3: Hypothesized Systems and combined Micro- and Macroergonomics Assessment Model for improving Work Organization and System Design (by author).

4. METHODS AND INSTRUMENTS

4.1. RESEARCH DESIGN.

This is a descriptive evaluation type of research, which required the undertaking of both retrospective and contemporaneous studies. A two-way design approach was used. Firstly, general data was gathered by administering "self-completion" questionnaire to selected members of WAITRO in the industrial developing countries through a mail survey. Secondly, a case study, involving activity analysis was conducted on the operations of three (3) Research Institutes under the Council for Scientific and Industrial Research (CSIR) in Ghana. These are the Food Research Institute (FRI), Science and Technology Policy Research Institute (STEPRI), and Institute for Industrial Research (IIR).

4.2. INFORMATION SOURCED.

Both primary and secondary information relating to the following were gathered:

4.2.1. Primary Information.

This was gathered through a mail survey in order to assess the understanding and interpretations accorded the WAITRO Benchmark model by the different RTOs. The following information was gathered:

i. Implementation approach tried by the different RTOs;

ii. Perceptions on the model's workability in prevailing environment.

iii. Possible environmental constraints encountered or identified.

iv. Attempts made to overcome the constraints.

4.2.2. Secondary Information.

These were obtained from the field studies carried out in Ghana through the conduction of Future Workshop [Helali and Shahnavaz, (1998)], Activity Analysis [(Ruth, 1993 and 2002)] and Structured Interview. The following information was gathered:

i. Prevailing work organization and system at the sources of the benchmark methods.
ii. Prevailing work organization and system at the CSIR and the sampled RTOs applying the benchmark methods.
iii. Prevailing work organization and system at the CSIR and the sampled RTOs before the adoption of the benchmarks.
iv. The benchmark implementation plans and procedure adopted by the CSIR and the sampled RTOs.
v. The operational plans and procedure for the work processes replaced by the benchmarks at the CSIR.
vi. Perception of the CSIR staff, including the management, on the success of the benchmarks as compared to the processes being replaced.
vii. The number of organizational and system changes that had taken place within the CSIR, and the Staff's (including the management) reactive opinions on these changes, as well as the results obtained.
vii. Relationship between the CSIR staff and the management before and during the benchmarking process.
viii. Perception of collaborating SME managers on the CSIR's operations and non-effectiveness.

4.3. METHOD AND INSTRUMENTS FOR COLLECTION OF INFORMATION.

Information was gathered from RTO's in the industrially developing countries through the following mediums.

4.3.1. Methods.

"Self-completion" questionnaire (see Appendix C) to provide primary qualitative data was administered on the managers of the selected RTOs through the WAITRO Secretariat in the form of a Mail Survey. This was followed by field studies comprising the conduction of Future Workshop and the application of Activity Analysis techniques (using structured interview) to acquire the secondary qualitative data.

a). Mail Survey

The aim of the survey is to help understand the possible influence of prevailing external environmental characteristics on the variety of interpretations given to same benchmark issues (as outlined in the WAITRO model) by the different RTOs due to the cultural variation. It is also to help establish a base on the adaptability of the benchmarks in the different operating environments. "Self-completion questionnaire of same content would be used. This would provide the flexibility of incorporating piloting within the study itself as indicated by Robson (1993).

b). Future Workshop

This was conducted at the FRI and STEPRI in Ghana, based on the techniques of Helali and Shahnavaz (1998). Each of the participants (those involved in the transformation process) was made to briefly, describe a concrete problem that he/she has experienced during the benchmark implementation process. All statements were repeatedly written (exactly as they are expressed) until no one had any more critical problems. Thereafter, participants were made to vote, with each participant being allocated seven (7) votes to be given to the most serious problems, of which two are to receive three (3) votes each and the remaining one receiving

only one (1) vote. After calculating the votes, the listed problems were written in order of their received votes. Thereafter, the main topics that covered all the problems and which had received high rankings were defined. This was followed by a list of problems that belonged to each specific topic. Later, participants were asked to verify if their expressed problems were under the correct topic.

c). Activity Analysis.

This was conducted with referencing to the dimensions of human activity model (Ruth, 1993 and 2002) as expressed in figure 3 of chapter two. During this analysis, the following methods were applied in qualitative data gathering.

i. Administering of questionnaire through mail on sampled RTO Managers in the developing countries.
ii. Abstraction (from available records at the cooperating benchmark-implementing RTO and also the Benchmark source).
iii. Structured interview with the Directors of the FRI, STEPRI, and IIR in Ghana.
iv. Conduction of activity analysis through work study at the FRI, STEPRI, and IIR in Ghana. The descriptive observation technique (Robson, 1993) would be adapted.

4.3.2. Instruments/Tools.

The instruments used for the research are as follows:

i. "Self-completion" questionnaire involving both closed and open-ended questions as well as scaled responses. (Appendix C).
ii. Structured questions for interview conduction. (Appendix D).
iii. Voice Tape Recorder (for the interview).
iv. Visual documentation (photographs)
v. Flip Charts.
vi. Descriptive observation.

4.4. ANALYSIS OF INFORMATION.

The information gathered were analyzed from the perspective of a descriptive statistical evaluation process, using the hypothesized macroergonomic and systems assessment model (see figure 3 in chapter three) as well as the activity analysis model. Firstly, information from the mail survey was used to identify dominating factors based on cumulative similarity of responses. Secondly, analysis of contradiction was performed using the activity study results from the field studies in Ghana and the outcomes were related to the collated survey responses.

5. RESULTS ANALYSIS

5.1. ANALYSIS OF RESPONSES FROM SURVEY QUESTIONNAIRE

Results from the mail survey relates to responses obtained from amongst RTOs located in East Africa, West Africa, Southern Africa, Asia and The West Indies. The distribution of the respective responses by RTO's from eight (8) different countries, namely, Jamaica, Ghana Trinidad & Tobago, Tanzania, Zimbabwe, South Africa, Taiwan, and Sri Lanka to the several organizational issues raised in the survey questionnaire are as outlined below. Sampling on the RTO's individual opinions on some significant statements relating to "Best Management Practices" gave the following outcomes, as outlined in table 2 below.

i. All the RTOs agreed to the fact that best management practice could be transferred across organizational and national boundaries.

ii. On the observation that best management practices are not the preserve of RTO's in rich countries, four (4) of the respondents agreed strongly. One (2) respondent agreed, but two (2) RTOs did not agree to that observation.

iii. Almost all the eight (8) RTOs indicated their strong agreement to the observation that focusing on clients needs is the number one best practice.

iv. Regarding the assertion that RTOs receiving more than half of their funds directly from industry become industry focused, all the eight (8) respondents indicated their agreement with three (4) agreeing strongly.

With respect to client specification, seven (7) RTOs indicated that they deal with all categories of clients (i.e. small-scale to large scale industries). One (1) did not give its client specification.

Table 2: Respondents Stands on Four key "Best Management Practices" Observations.

RTO	POSITIONS ON "BEST PRACTICES" SIGNIFICANT STATEMENTS			
	Best Practice can be Transferred across Organizational and National Boundaries	**Best Management Practices are not the Preserve of RTOs in Rich Countries**	**Focus on Clients Needs is the Number One Best Practice**	**RTOs receiving more than Half their Funds Directly from Industry Become Industry-Focused**
CARIRI	Agree	Strongly Agree	Strongly Agree	Agree
TIRDO	Agree	Strongly Agree	Strongly Agree	Strongly Agree
SIRDC	Strongly Agree	Do not Agree	Strongly Agree	Strongly Agree
NERDC	Agree	Agree	Strongly Agree	Agree
TAIWAN	Agree	Do not Agree	Strongly Agree	Agree
CSIR (SA)	Agree	Strongly Agree	Agree	Agree
STEPRI	Agree	Strongly Agree	Strongly Agree	Strongly Agree
SRC	Agree	Agree	Strongly Agree	Strongly Agree

5.1.1. Response Pattern for Perceived External Environmental Factors.

This analysis was conducted from the perspectives of the defined RTO process and sub-process (*see Appendix A, page 107-113),* and the corresponding overview of the RTO "Best Practices" *(see Appendix B, page 114-118)* by Menu and Grier (1999), as well as the listed external environmental factors in the hypothesized combined micro-and macroergonomics, and systems assessment model *(see figure 3, page 44).* The external environmental factors whose influences served as major constraints included factors such as *socio-economic and legal* (SEL), *consumer and market forces* (CMF), *political* (P), *communication interface* (CI), *education background* (EB), *culture and climate* (CC), *subsystem stability* (SS), and *decision-making* (DM). The distributions, marked by the points in figure 4 below, shows the response pattern on the perceived effects of external environmental factors on the change process implementation efforts of the RTOs. The lines linking the various points in the figure allows for easy tracing of the distribution variations among the RTOs of each of the respective factors for all the listed "Best Practices". The distribution gives the number of respondents (RTOs) who were affected by the same environmental factors for each of the ten (10) different "Best Practices" implemented. It showed that seven (7) of the eight (8) RTOs experienced constraints relating to CMF in the implementation of the practice on "RTO Services". Similarly, seven (7) RTOs were also affected by CC in the implementations of practices on both "Organizational Management" and six (6) RTOs on "Networking". six (6) RTOs were affected by the following factors. CC in the implementation of "Governance" CMF in the implementation of "Business Development", DM in the implementation of both "Organizational Management" and "Policy and Programming", as well as CI in the implementation of best practice on "Networking". Five (5) RTOs were affected by EB in the implementation of "Personnel Management", P in the implementation of "Policy and Programming", SEL and CC in the implementation of "Governance". Four (4) RTOs were

affected by CI on the practice of "Governance", whilst only one (1) RTO was affected by EB in the implementation of "Policy and Programming".

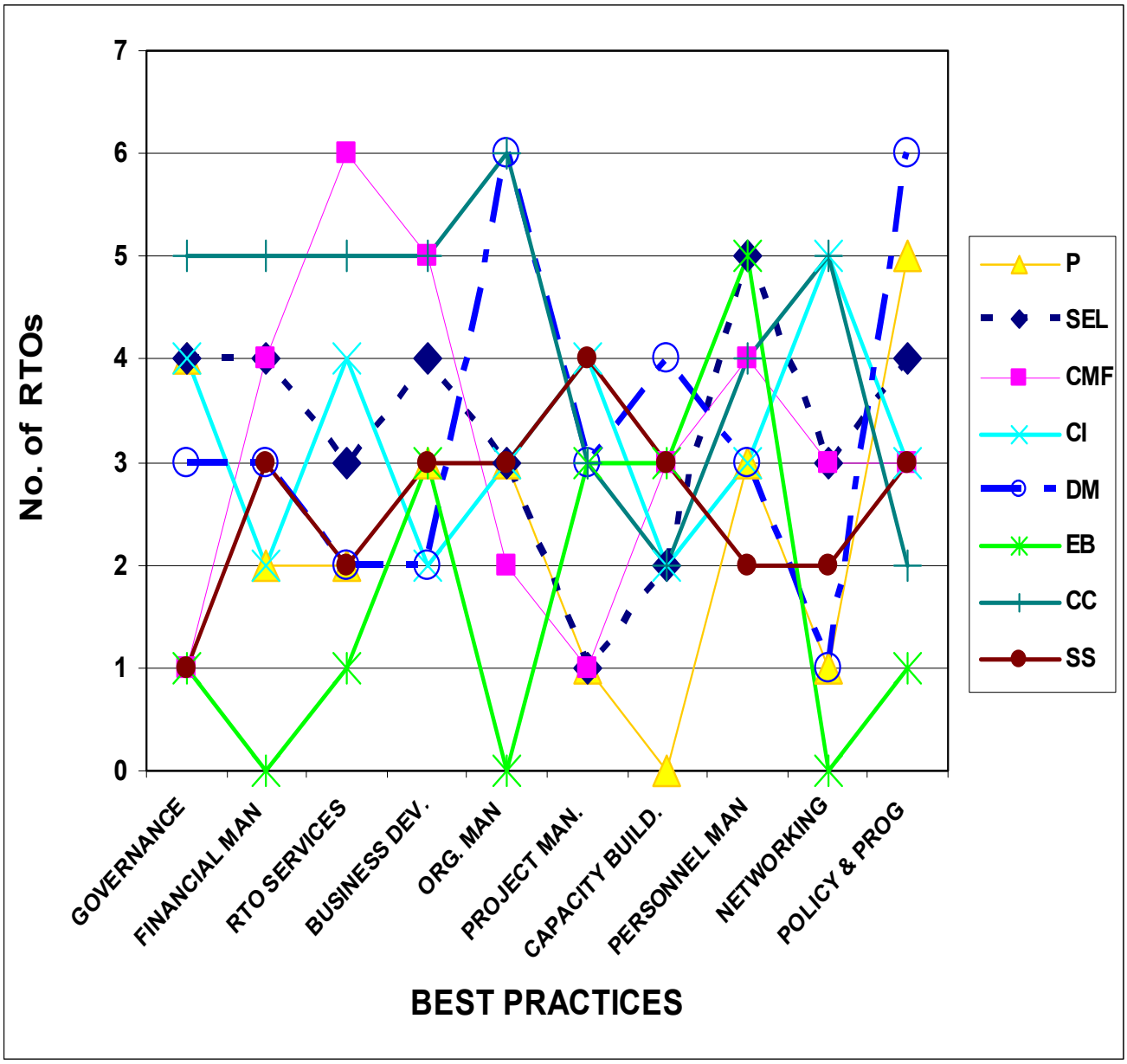


Figure 4: Distribution of environmental constraints on RTOs best practice implementation.

Four (4) RTOs were affected by SEL, whilst five (5) were affected by CMF and CC on the practice of "Financial Management". Five (5) RTOs were also affected by the following environmental factors - CC and SEL on the practice of "RTO Services", CC on "Business Development", SS on "Project Management", and SEL, on "Personnel Management". Four (4) RTOs were affected by CI on "Project Management", EB on "Capacity Building", CI and CMF on "Personnel Management", as well as CMF on "Policy and Programming". Four (4) RTOs were affected by the influences of P on "Governance". Similarly, four (4) RTOs were also affected by CI on "RTO Services". Three (3) RTOs were affected by SS on the best practices of "Governance", "Financial Management" and "RTO Services" respectively. Four RTOs were affected by SEL and three (3) were affected by EB on the practice of "Business Development Four (4) RTOs were also affected by SS and SEL, whilst three (3) were affected by CI on "Organizational Management", similarly, four (4) were affected by CC and three (3) by EB on "Project Management". Four RTOs were, in turn, affected by DM and SS whilst three (3) were also affected by CMF and CI on "Capacity Building". Four (4) RTOs were constrained by DM and CC whilst three (3) were affected by SS on the implementation of both "Personnel Management" and "Policy and Programming" best practices. Three (3) RTOs were affected by the influences of DM, whilst two (2) were affected by CMF on the best practice of "Governance". Similarly three (3) RTOs were affected by DM, whilst two (2) were affected by CI on the practice of "Financial Management". Only two (2) RTOs were affected by the influences of SS and P on the practice of "RTO Services". Three (3) RTOs were also affected by SEL and P, and whilst two (2) were affected by CI on "Business Development". Similarly three (3) RTOs were affected by P, with two (2) RTOs being affected by CMF on the best practice of "Organizational Development". Only two (2) RTOs were affected by the influence of CI on "Project Management". Three (3) RTOs were also affected by the effect of P on "Personnel Management". Three (3) RTOs were affected by

CMF and two (2) by SS on “Networking”. Similarly, Three (3) RTOs were affected by CI, and two (2) RTOs by CC on “Policy and Programming”. Only two RTOs experienced the influence of P on “Financial Management”, DM on “RTO Services”, as well as SEL and CC on “Capacity Building.

The following external environmental factors were experienced by one (1) of the eight (8) RTOs:- EB and SS on the best practice of “Governance”, EB on both “RTO Services” and “Policy and Programming”, P and DM on the practice of “Networking”, CMF and SEL on “Project Management”, and lastly P on “Project Management”.

The analysis showed that the impact of the external environmental factors CMF, CC, P, SEL, DM, and EB tend to be the common dominating factors experienced by almost all the eight (8) respondents in their attempts at implementing the different “best practices”. These were complemented by the influences of CI and SS frameworks. Despite its strong influence, EB was observed to have no impact in the implementations of such practices as Organizational Management, Financial Management, and Networking. In the same context, P was observed to have had no influence on the implementations of practices on Capacity Building. It must be emphasized that variations existed on the influences of these external environmental constraints on the implementation efforts of individual RTOs. Table 3 below gives the profiles of the specific environmental constraints perceived to have affected the implementation of specific best practices by each of the eight (8) RTOs.

Table 3: The RTOs perceived external environmental constraints on specific "Best Practices".

RTO	PERCEIVED EXTERNAL ENVIRONMENTAL FACTORS AFFECTING BEST PRACTICES ON									
	Governance	Financial Management	RTO Services	Business Development	Organization Management	Project Management	Capacity Building	Personnel Management	Networking	Policy & Programming
CARIRI	P SEL	SEL CMF CC	CMF CC SS	P SEL CMF CC	CMF CI DM CC	CMF CI DM SS	SEL CMF CI DM	P SEL CMF CI DM EB SS	SEL CMF CI DM CC	P SEL CMF CI DM
TIRDO	SEL CI CC	SEL CMF CC SS	SEL CMF CC	SEL EB CC	CC	EB	CMF CI	SEL EB	CC SS	DM
STEPRI	SEL CMF CC	SEL	SEL CMF	CMF DM	SEL CC SS	CC SS	CI EB SS	CI DM SS	CI CC	SEL CMF SS
SIRDC	P CI DM EB CC	P CMF DM CC SS	P CMF DM EB CC SS	P CMF CI DM EB CC SS	P SEL DM CC SS	CI DM EB CC SS	DM EB CC SS	DM EB CC SS	SEL CI CC	P SEL CMF DM CC SS

Table 3 (continued).

RTOs	PERCEIVED EXTERNAL ENVIRONMENTAL FACTORS AFFECTING BEST PRACTICES ON									
	Governance	**Financial Management**	**RTO Services**	**Business Development**	**Organization Management**	**Project Management**	**Capacity Building**	**Personnel Management**	**Networking**	**Policy & Programming**
NERDC	CI	CMF	CI	CMF	DM	EB	EB	DM	CI	P
TAIWAN	SEL CMF DM CC	SEL CI	SEL CMF CI	SEL CMF EB	CI DM CC	SEL CI	CMF DM EB	SEL CMF CI EB CC	CMF CC	P DM
CSIR (SA)	P CI CC SS	CI DM CC SS	P SEL CMF CI CC	CI CC SS	P SEL CMF CI DM CC SS	CI CC SS	SS	P SEL CMF CI EB CC	CI CC SS	P SEL CMF CI DM CC SS
SRC	P SEL DM CC	P SEL DM CC	CMF CI DM CC	P SEL CMF DM CC SS	P SEL DM CC SS	P DM CC SS	SEL DM CC SS	P SEL DM CC	SEL CMF CI	SEL CI DM EB SS

5.1.2. Number of Transformations Experienced by RTOs.

The number of organizational and/or work system transformations (operational changes) experienced by the respondent RTOs since the year 1990 is shown in figure 5 below. The distribution shows that out of the eight (8) respondents, three (3) RTOs have experienced more than 5 transformations since the year 1990. One (1) RTO had 4 transformations whilst two (2) RTOs had 3 transformations. Basically, the distribution clearly indicated that six (6) RTOs out of the eight (8) respondent RTOs have had 3 or more transformations since the year 1990.

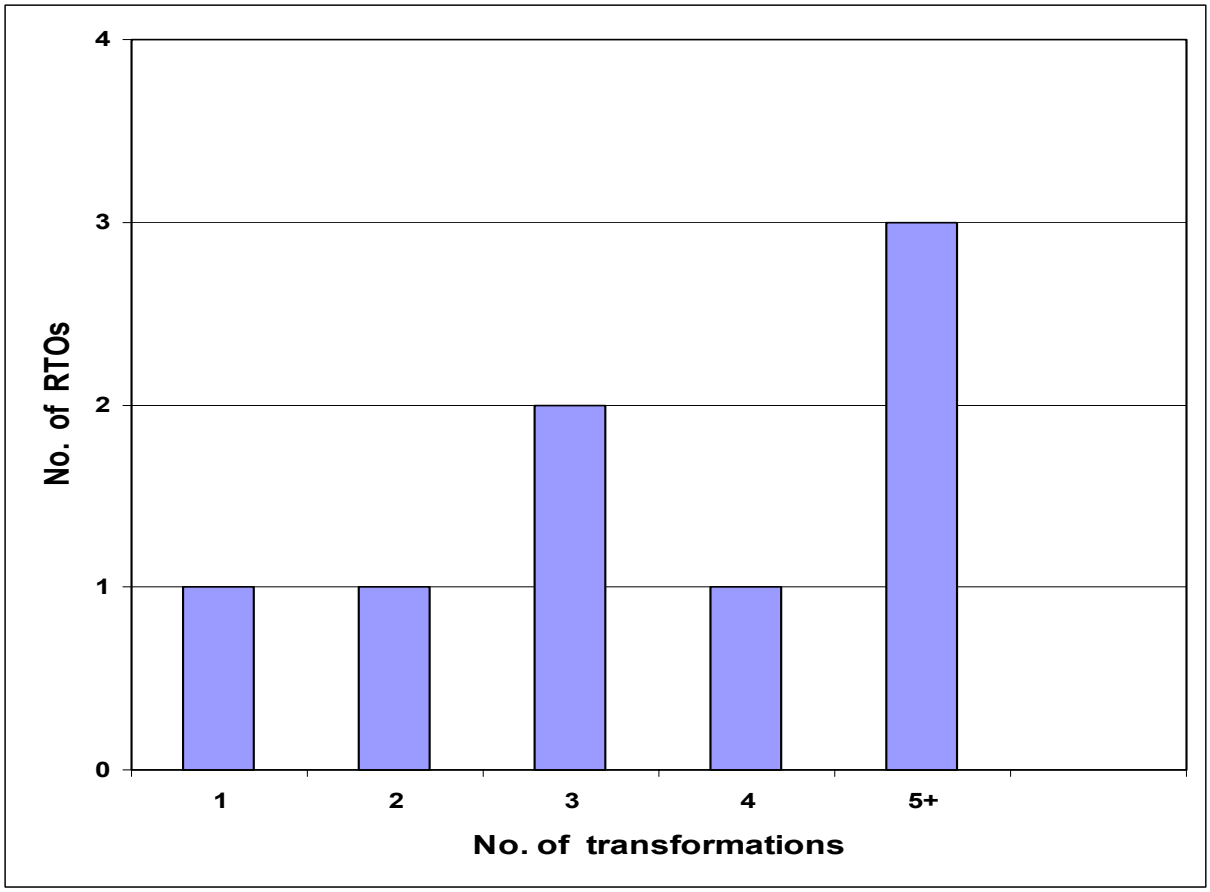


Figure 5: Distribution for the number of transformations undergone by the RTOs since the year 1990.

5.1.3. Decision Sources for "Best Practice" Implementation.

The influence of key actors in taking decisions on best practice implementation among the RTOs is indicated in figure 6 below.

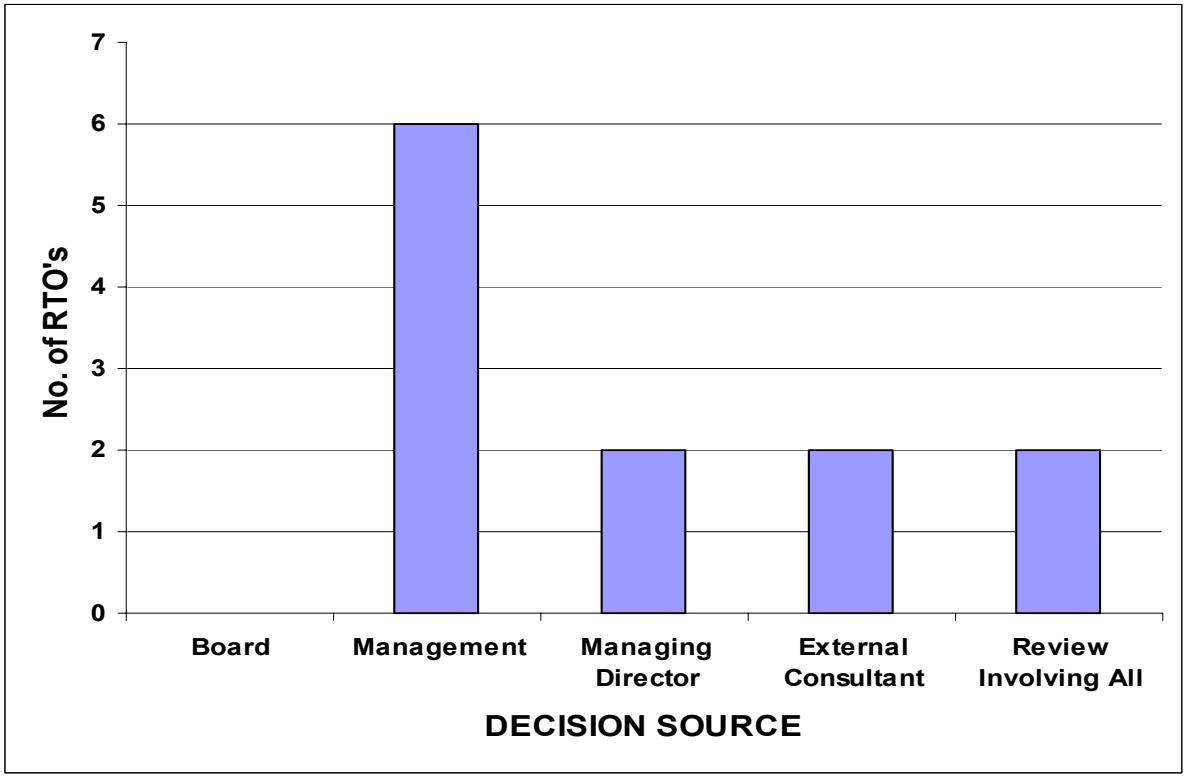


Figure 6: Distribution of Decision sources for implementation of change process.

Six (6) RTOs identified the decision source to be their management (mostly comprising the Director and his deputies, Divisional Heads and staff representatives), whilst two (2) RTOs cited the Managing Director as the source. Another two (2) cited the source to be external consultants. Only two (2) RTOs cited the decision source to be a derivative of a general review involving all (i.e. participatory approach involving both direct and indirect actors related to the organization, such as management, government, external consultants, clients and donors, among others). The reason for this was to give an impulse to all these key actors in the planning process, by raising their consciousness about the "Best Practice" implementation consequences, thereby influencing their train of thoughts and way of action as pointed out by

Ruth (1993 and 2002), in order to achieve a functioning planning process regarding the RTO's impact on its external environment (Ruth and Ruth-Balaganskaya, 2000). Generally, the distribution pattern points to the fact that, for most RTOs, the decision sources for the "Best Practice" implementation are likely to be the management. It also appears that decision from a general review involving all key actors associated with an RTO occurs rarely.

5.1.4. Ratings on some key Factors Influencing "Best Practice" Implementation.

Distributions on the ratings for the RTOs management information systems (MIS), and also the knowledge level of the RTOs' staff, clients and stakeholders regarding the best practice implementation are shown by the marked points in figure 7 below. The lines linking the various points in the figure allows for easy tracing of the distribution variations among the RTOs of each of the respective factors for the listed key implementation factors.

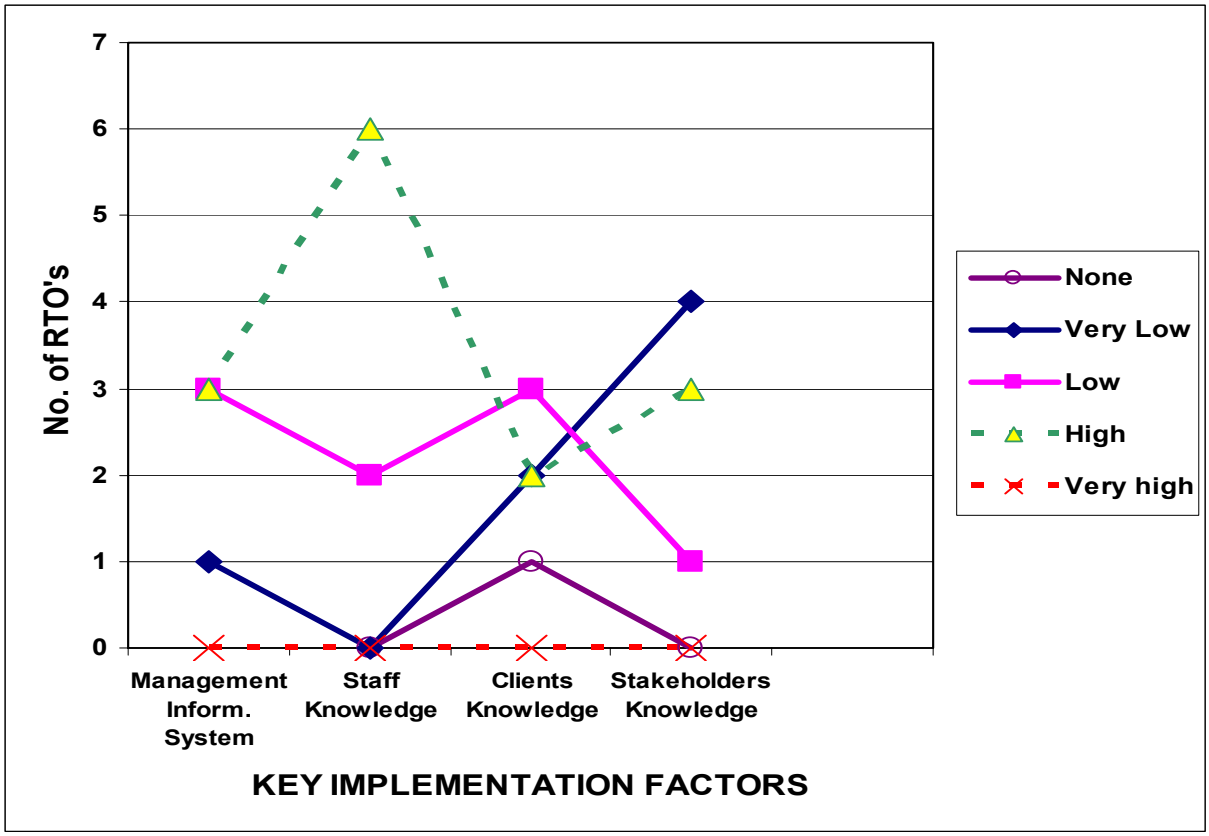


Figure 7: Distribution of implementation ratings for management information system level, and staff, clients and stakeholders knowledge.

These four (4) factors seem to impact either positively or negatively on the influence of the CI external environmental constraint. The figure established the number of RTOs which have the same ratings for each of the four (4) different factors which were considered to play significant roles in the implementation of the "Best Practices". The ratings depicted the quality and/or standard of the RTOs MIS during the "Best Practices" implementation, and also the knowledge level of the RTOs staff, clients and stakeholders (such as Government, Donors, and share-holders, among others) about the "Best Practice" being implemented.

The distribution pattern indicated that, with respect to the management information system (MIS), three (3) RTOs indicated high rating whilst another three (3) rated low, with one (1) RTO rating it very low. One (1) RTO did not provide its rating. Basically, the distribution shows that only three (3) out of the eight (8) respondents possessed effective MIS. Regarding staff knowledge, six (6) RTOs rated it high. Only two (2) RTOs gave an indication of low staff knowledge. Two (2) RTOs gave high ratings for their clients knowledge, but three (3) RTOs indicated their clients knowledge as low whilst two (2) others rated theirs as very low. The implication being that out of the eight (8) respondents, five (5) rated the knowledge of their clients on their best practice implementation as low , whilst one (1) indicted that its clients have no knowledge and understanding of the changes it was pursuing.. The individual ratings by each of the eight (8) respondent RTOs for their MIS and the knowledge levels of their key actors are shown in table 4 *(see page 63)*.

5.1.5. Level of Cooperation from Key Actors.

The distribution for the level of cooperation received by the respondent RTOs' from some key actors whose actions could directly or indirectly impact either positively or negatively on the RTOs best practice implementation are shown by the marked points in figure 8 below. The lines linking the various points in the figure allows for easy tracing of the distribution

variations among the RTOs of each of the respective key implementation actors. The distribution shows the number of RTOs which received the same levels of cooperation (i.e. the magnitude or extent of the preparedness to offer support and/or assistance towards the realisation of the best practice implementation, and also willingness to operate within the context of the best practices being implemented) from such key actors as their Boards, clients, staff, government, other stakeholders (such as external donors and shareholders) as well as their competitors.

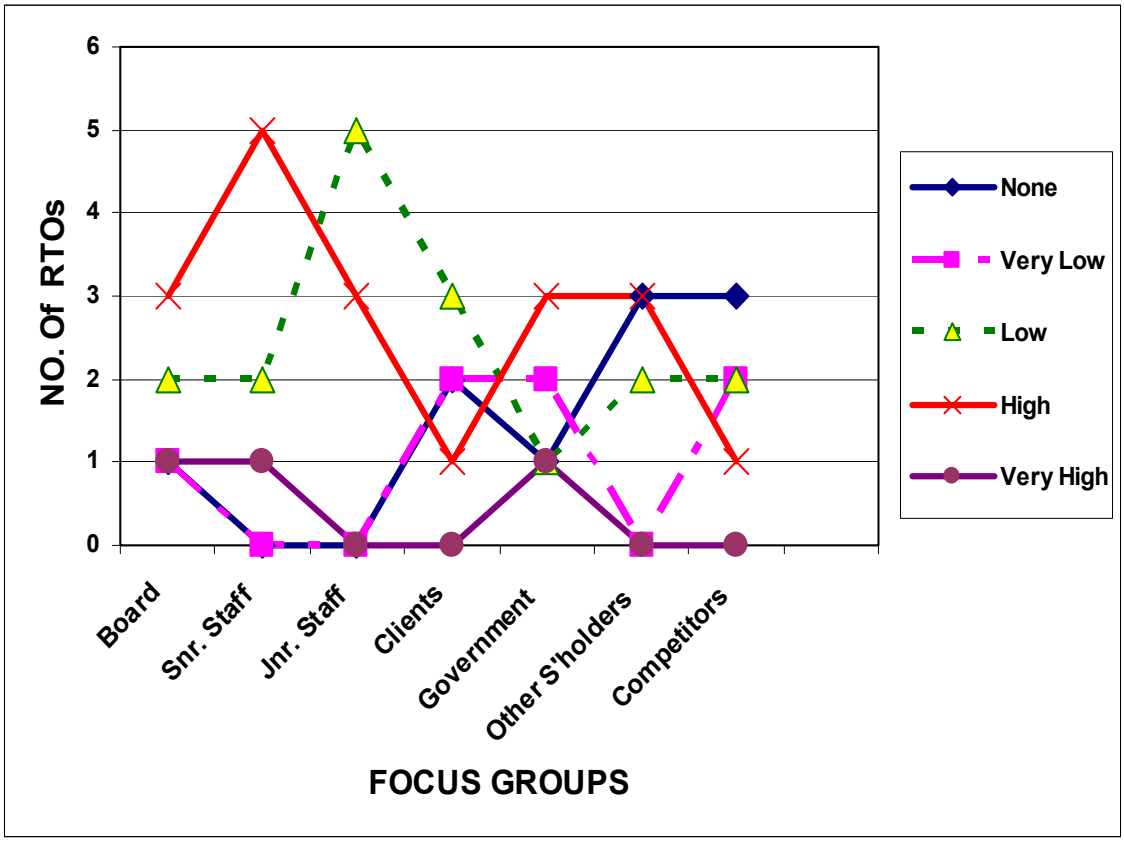


Figure 8: Distribution for the level of implementation cooperation from key actors.

On the distribution pattern, only one (1) RTO gave an indication of a very high level of cooperation from its board, with three (3) others citing the level as high. However, two (2) RTOs classified the cooperation as low whilst one (1) RTO classified it as very low. Only one (1) RTO received no cooperation from the board. Generally, four (4) out of the eight (8)

respondents received high support from their boards. Concerning the senior staff, one (1) RTO indicated very high cooperation whilst five (5) others rated theirs as high. Only two (2) RTOs indicated low cooperation. The overall implication is that majority of the RTOs received high cooperation from their senior staff. Regarding junior staff, five (5) RTOs indicated receiving low cooperation, with the remaining three (3) citing high cooperation. Basically, it could be inferred that a majority of the RTOs received low cooperation from their junior staff in the best practice implementation. With respect to cooperation from clients, two (2) RTOs indicated receiving no cooperation at all. Three (3) RTOs viewed it as low whilst two (2) others cited it as very low. Only one (1) RTO indicated high cooperation. The general implication is that almost all the RTOs received low cooperation from their clients. Concerning government's level of cooperation, one (1) RTO viewed it as very high with another rating it as high. One (1) RTO noted the cooperation as low, whilst two (2) RTOs rated it as very low. Only one (1) RTO gave an indication of receiving no cooperation from the government at all. On the relationship with other stakeholders (such as donors/funding agencies, and share-holders, among others), three (3) RTOs pointed to the non-receipt of cooperation at all, whilst two (2) others noted the level as very low. On the other hand, three (3) RTOs classified the cooperation with stakeholders as high. On the average, the cooperation received by the RTOs from other stakeholders can be classified as relatively very weak. Lastly, on the relationship with competitors (organizations providing similar services and/or end-products, as well as targeting same clients), three (3) RTOs did not receive cooperation at all. Two (2) RTOs classified the cooperation received from their competitors as very low, whilst two (2) others rated it as low. Only one (1) RTO indicated high cooperation with competitors. Generally, it could be inferred that the magnitude of cooperation RTOs receive from their competitors is very low. The specific ratings for cooperation received by each of the eight (8) respondent RTOs are shown in table 4 below

Table 4: Individual RTOs ratings for management information system, as well as key actors knowledge and cooperation in the "Best Practice" implementation.

RTOs	MANAGEMENT INFO. SYSTEM	BOARD'S COOPERATION	COMPETITORS' COOPERATION	GOVERNMENT'S COOPERATION	STAFF			CLIENTS		OTHER STAKE-HOLDERS	
					Knowledge	Junior Staff Cooperation	Senior Staff Cooperation	Knowledge	Cooperation	Knowledge	Cooperation
CARIRI	-	Very Low	Very Low	Low	Low	Low	Low	Very Low	Very Low	Very Low	Low
TIRDO	Low	High	Low	High	High	Low	High	Low	Low	Low	High
SIRDC	Low	None	None	None	High	High	High	Very Low	None	Very Low	None
NERDC	High	High	Low	High	High	Low	High	Low	Low	High	High
TAIWAN	High	Low	Very Low	High	High	Low	High	High	Low	High	Low
CSIR (SA)	High	High	None	Very Low	High	Low	High	Low	Very Low	Very Low	None
STEPRI	Low	Very High	High	Very High	High	High	Very High	High	High	High	High
SRC	-	Low	None	Very Low	Low	High	Low	None	None	Very Low	None

5.1.6. Recorded Progress Using "Adopted Practices".

The progress ratings (i.e. classification of the level of improvement attained in operational performances and/or output and delivery efficiencies) for the best management practices which were "adopted" (i.e. implemented using recommended methodology) by some of the RTOs are shown by the marked points in figure 9 below. The lines linking the various points in the figure allows for easy tracing of the distribution variations among the RTOs of each of the respective implementation ratings for each of the adopted "Best Practices".

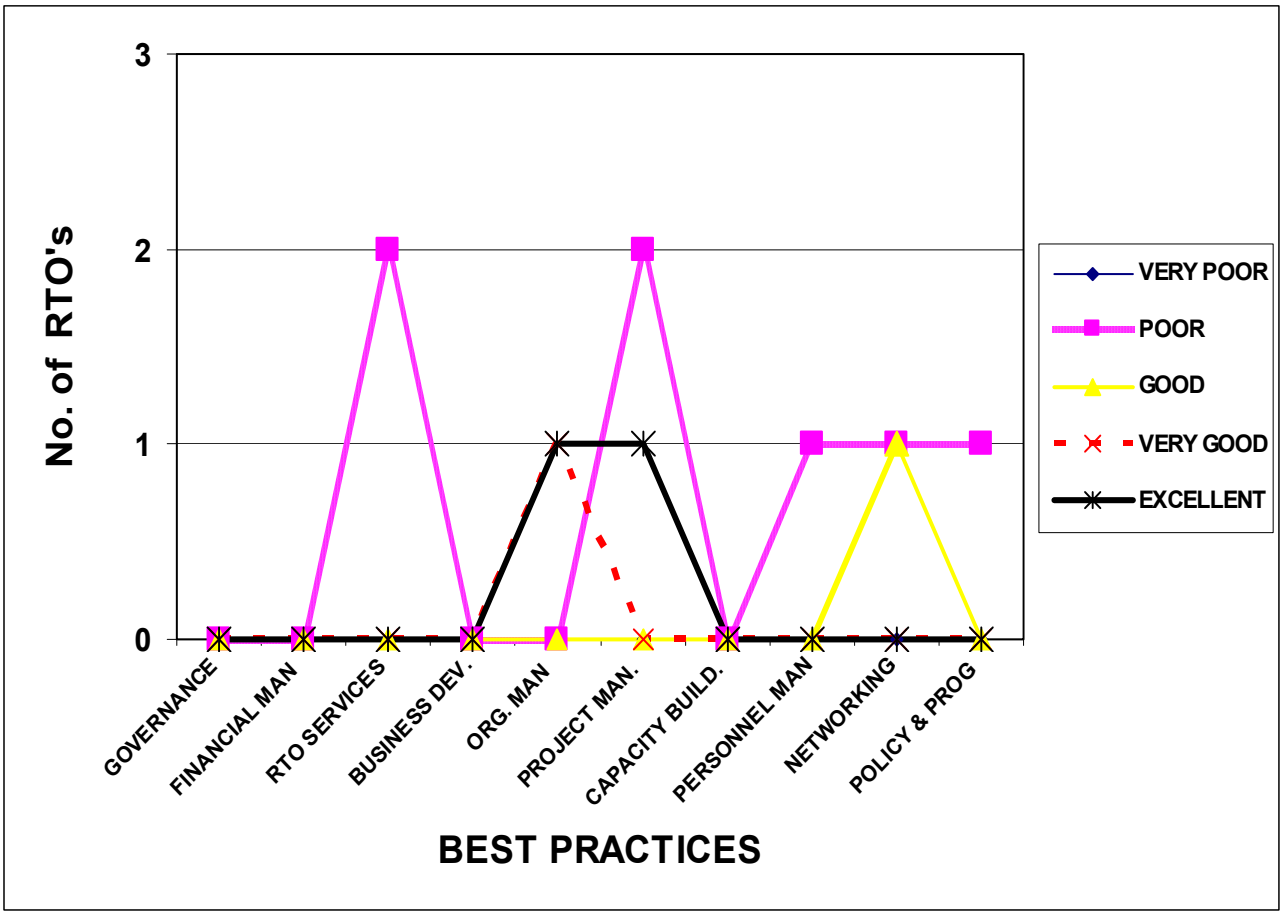


Figure 9: Distribution for progress made by adopting best practices.

The best practice for "RTO Services" was adopted by two (2) RTOs and they both reported poor progress. The practice for "Organizational Management" was adopted by only one RTO with a reported excellent progress. Out of three (3) RTOs who adopted the practice for

"Project Management", one (1) reported excellent progress whilst the remaining two (2) rated the progress made as poor. Only one (1) RTO reported the adoption of the best practice for "Personnel Management" and reported the progress made as poor. The best practice for "Networking" was also adopted by one (1) RTO with the rated progress as poor, and so was the practice for "Policy and Programming". The specific best practices "adopted" by the individual RTOs and the corresponding progress ratings for each are shown in table 5 *(see page 68)*.

5.1.7. Recorded Progress using "Adapted Practices"

Distribution on progress ratings for best practices which were "adapted" (i.e. implemented using recommended methodology, but with some elements of modifications) by the RTOs are shown by the marked points in figure 10 below.

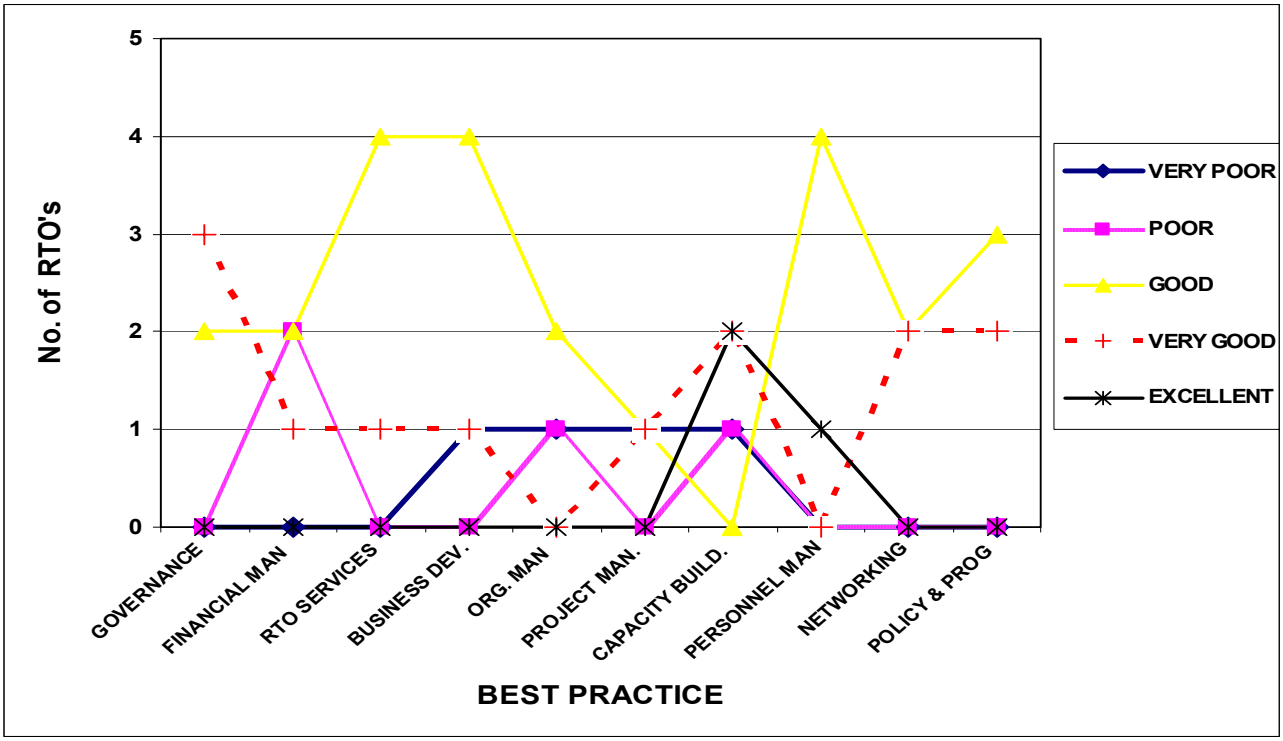


Figure 10: Distribution for progress made by adapting best practices.

The lines linking the various points in the figure allows for easy tracing of the distribution

variations among the RTOs of each of the respective implementation ratings for each of the adapted "Best Practices". The distribution showed that each of the ten best management practices was adapted. The ratings established that out of five (5) RTOs who adapted the best practice on "Governance", three (3) rated the progress as very good whilst the other two (2) also gave the rating as good. Five (5) RTOs also adapted the best practice on "Financial Management". One (1) rated the progress as very good, two (2) rated it as good, and two (2) others also rated the progress as poor. Five (5) RTOs adapted the best practice on "RTO Services" with one (1) RTO rating progress as very good, whilst the remaining four (4) RTOs rated it as good. The practice on "Business Development" was adapted by five (5) RTOs with three (3) rating the progress as very good whilst the other two (2) rated the progress as good. With respect to the best practice on "Organizational Management", two (2) out of the four (4) RTOs who adapted it rated progress made as good. One (1) RTOs gave the rating as poor whilst the remaining one (1) RTO rated progress as very poor. For the three (3) RTOs who adapted the practice on "Project Management", one (1) gave the progress rating as very good. Another rated the progress as good, whilst one (1) rated it as very poor. Six (6) RTOs adapted the practice on "Capacity Building". Two (2) rated the progress as excellent whilst another two (2) rated it as very good. For the remaining two (2) RTOs, one (1) rated the progress as poor and the other rated it as very poor. With respect to the best practice on "Personnel Management", five (5) RTOs adapted it. One (1) RTO rated the progress made as excellent with the remaining four (4) RTOs rating the progress as good. The best practice on "Networking" was adapted by four (4) RTOs, with three (3) rating the progress as very good, and one (1) rating it as good. Similarly, four (4) RTOs adapted the practice on "Policy and Programming". Three (3) reported the progress as very good, and one (1) cited it as good. The specific best practices "adapted" by the individual RTOs and the corresponding progress ratings for each are shown in table 5 *(see page 68)*.

5.1.8. Recorded Progress using "Other Processes".

Progress ratings for best practices implemented using other processes (neither adopted nor adapted) are shown by the marked points in figure 11 below. The lines linking the various points in the figure allows for easy tracing of the distribution variations among the RTOs of each of the respective implementation ratings for each of the "Best Practices".

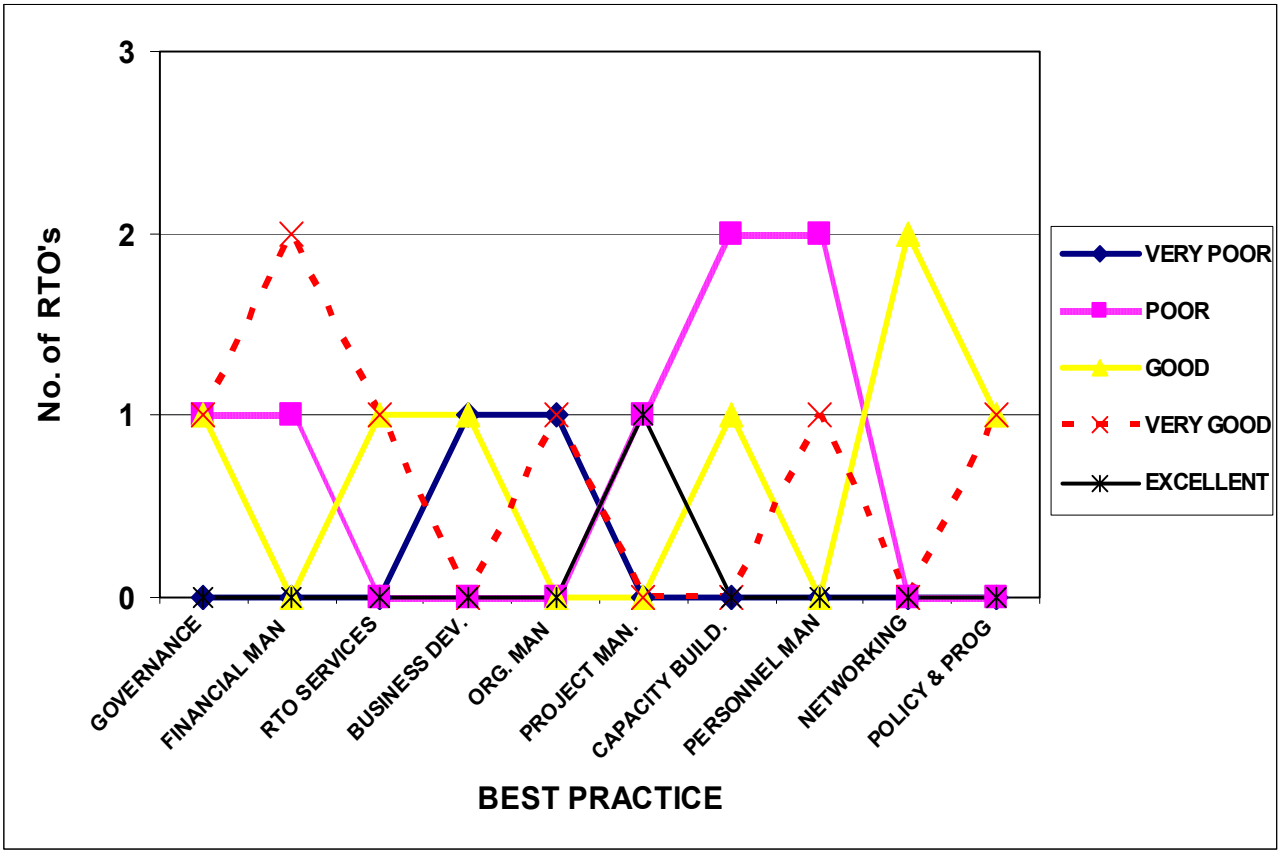


Figure 11: Distribution for progress made by using other process.

Two (2) RTOs used other processes for "Governance". One (1) rated progress as very good whilst the other gave the rating as good. For "Financial Management", three (3) RTOs were involved, with two (2) of them reporting progress as very good whilst one (1) rated the progress as poor. With respect to "RTO Services", the two (2) RTOs involved cited the

progress ratings as very good and good respectively. Two (2) RTOs used other processes for "Business Development". One (1) rated the progress as good whilst the other rated it as very poor. Similarly, two (2) RTOs were involved with "Organizational Management" with one rating the progress as very good, and the other rating it as very poor. Three (3) RTOs approached "Project Management" through other processes. One of them rated the progress as excellent, another rated it as poor whilst the third rated it as very poor. Three (3) RTOs were also involved with "Capacity Building". One (1) rated the progress as good whilst two (2) rated it as poor. Similarly, there were three (3) RTOs involved with "Personnel Management" with one (1) rating the progress as very good, and the remaining two (2) rating it as poor. Two (2) RTOs used other processes for "Networking" and both rated the progress as good. In the same vein, two (2) RTOs used other processes for "Policy and Programming" with one (1) rating progress as very good, and the other rating it as good. The specific best practices implemented by the individual RTOs using "other processes" and the corresponding progress ratings for each are shown in table 5 (see page 68). It is significant to note from the table that one (1) RTO used this approach for all the "Best Practices" implemented with remarkable encouraging progress ratings. Also, one (1) RTO used this approach for the implementation of the best practice on "Business Development", but did not provide the requisite progress rating.

Table 5: Approaches used in "Best Practices" Implementation, and Progress Ratings by RTOs.

RTOs	**IMPLEMENTATION APPROACH USED FOR THE BEST PRACTICES (Progress Ratings in Italics)** Note: ADA = Adapted; ADO = Adopted; OP = Other Process									
	Governance	**Financial Management**	**RTO Services**	**Business Development**	**Organization Management**	**Project Management**	**Capacity Building**	**Personnel Management**	**Networking**	**Policy & Programming**
CARIRI	OP *Good*	OP *Poor*	ADA *Good*	ADA *Very Good*	ADA *Good*	OP *Poor*	OP *Good*	ADA *Good*	ADA *Very Good*	ADA *Good*
TIRDO	ADA *Good*	ADA *Good*	OP *Good*	ADA *Very Poor*	ADA *Very Poor*	ADA *Good*	ADA *Good*	ADA *Very Poor*	ADA *Good*	ADA *Good*
SIRDC	OP *Poor*	ADA *Poor*	ADA *Good*	ADA *Good*	OP *Very Poor*	ADO *Poor*	ADA *Very Poor*	ADO *Poor*	ADO *Poor*	ADO *Poor*
NERDC	ADA *Good*	ADA *Good*	ADO *Poor*	OP *-*	ADA *Good*	ADO *Poor*	ADA *Very Good*	ADA *Good*	ADO *Good*	ADA *Very Good*
TAIWAN	ADA *Very Good*	ADA *Very Good*	ADA *Very Good*	ADA *Very Good*	ADO *Excel-lent*	ADO *Excel-lent*	ADA *Very Good*	ADA *Excel-lent*	ADA *Very Good*	ADA *Very Good*
CSIR (SA)	OP *Very Good*	OP *Very Good*	OP *Very Good*	OP *Good*	OP *Very Good*	OP *Excel-lent*	OP *Poor*	OP *Poor*	OP *Good*	OP *Good*
STEPRI	ADA *Excel-lent*	OP *Excel-lent*	ADA *Very Good*	ADA *Very Good*	ADO *Excel-lent*	ADA *Excel-lent*	ADA *Excel-lent*	OP *Excel-lent*	OP *Very Good*	OP *Excel-lent*
SRC	ADA *Very Good*	ADA *Poor*	ADA *Good*	ADA *Good*	ADA *Poor*	ADA *Very Poor*	ADA *Very Poor*	ADA *Good*	ADA *Good*	ADA *Good*

5.1.9. Summary of Best Practice Implementation Approaches by the Respondent RTOs.

With reference to table 4 above, it was observed that for the implementation of the best practice on *"Governance"*, five (5) RTOs "adapted" it whilst the remaining three (3) RTOs used "other processes". There was no "adoption" for this practice. In the case of *"Financial Management"*, five (5) RTOs "adapted" it with the remaining three (3) RTOs using "other processes". There was also no "adoption" of this practice. Five (5) RTOs "adapted" the practice on *"RTO Services"* whilst two (2) RTOs used "other processes". Only one (1) RTO "adopted the practice. The practice on *"Business Development"* was "adapted" by six (6) RTOs whilst the remaining two (2) RTOs used "other processes". This practice was also not "adopted". With respect to the best practice on *"Organizational Management"*, four (4) RTOs "adapted" it. Two (2) RTOs also used "other processes" whilst the remaining two (2) RTOs "adopted" the practice. The practice on *"Project Management"* was "adapted by three (3) RTOs, whilst two (2) others used "other processes". Three (3) RTOs "adopted the practice. None of the RTOs "adopted" the practice on *"Capacity Building"*. It was "adapted by six (6) RTOs with the remaining two (2) RTOs using "other processes. Regarding the implementation of the best practice on *"Personnel Management"*, five (5) RTOs "adapted" it. Two (2) RTOs used "other processes" whilst the remaining one (1) RTO "adopted the practice. The practice on *Networking"* was adapted by four (4) RTOs, whilst two (2) RTOs used "other processes". The remaining two (2) RTOs "adopted it. With respect to the best practice on *"Policy and Programming"*, it was "adapted by five (5) RTOs whilst two (2) others used "other processes". Only one (1) RTO "adopted the practice. Generally, one (1) RTO entirely used "other processes" and another also entirely used "adaption in their respective best practices implementation. The remaining six (6) respondent RTOs "adapted" between four (4) and nine (9) of the ten (10) listed "best practices". Practices which were "adopted" ranged between one (1) and four (4), and so were the practices for which "other processes" were used.

5.2. ANALYSIS OF ACTIVITIES AND CONTRADICTIONS FOR FOOD RESEARCH INSTITUTE.

Analysis of the activity assessment based on the observational results as well as those obtained from the structured interview and "Future Workshop" for the Food Research Institute (FRI) is highlighted below.

5.2.1. FRI's Activity Analysis.

The *Subject Dimension* for the analysis is represented by the whole institute (i.e. FRI). Results from the study of the institute's activity *(see Appendix E)* established that operations within the institute were managed by a vertical and hierarchical management structure with diffuse decision-making base *(Institutional Rules).* It was quite obvious that the Director of the institute does not have the requisite authority to operate independently. He operates under the oversight authority of a Deputy Director-General of the Council for Scientific and Industrial Research (CSIR), which is the general administrative authority of the research institute. Thus real power to influence activities lay beyond the capacities of the institute's Governing Bodies and/or the Directors. This has given credence to the lack of trust in the internal structures of the institute, which is compounded by the lack of operational transparency, ineffective communication and fear of intimidation from management by the staff *(Environmental Context).* The diffuse organization structures of the institutes were trailed to possible flaws in the "Act of Parliament", which established the institutes. Activities within the institute were managed by a vertical and hierarchical management structure with an observed problem of a non-effective communication system. Staff expectation on information feedback is grounded *(Social* and *Environmental Contexts)*. This explained the initial problem encountered in the organization of the "Future Workshop" component of the *present project* in the institute. This is because the Research staff has not been receiving feedback on other workshop activities they previously participated in. Correspondingly, the junior staff also appeared to be sidelined

on the institute's implementation of previous change programmes *(Division of Labour)*. The lack of adequate incentive to the staff, *as observed*, was corroborated during the *interview* to be due to the staff's continued dependence on inadequate government subsidies *(Historical Context)*. It also came out that a higher degree of disparity exists between senior research staff and their junior colleagues with respect to the availability of required instruments and materials for the performance of work activity *(Instruments and Materials)*. Instruments and materials for administrative work were highly inadequate as compared to those for scientific and research work (mostly obtained from donor funded projects). Junior staff continues to use poor facilities to conduct their daily activities, a situation which has been resulting in output delays which extend to affect the desired outputs of the research staff *(Resulting Outcome)*. This disparity was found to have resulted in the non-effectiveness of the junior staff within the context of the institutes' change process, which is a major drawback for the institute. The spill-over of the situation are undesired delays in the delivery of most of the institute's output due to the improper coordination between the technological and personnel subsystems *(Goals and Objectives)*. This situation might have resulted in the lack of trust within the organizational structure. The consequence being the observed lack of commitment, especially by the junior staff toward the attainment of the institutional objectives. This stands to explain the assertion during the *interview* that the workforce does not fully function in a way which tends to affect the institute's desired objectives of achieving a desired outcome regarding its main productive purposes. The implication being that there are indications of the workforce functioning in ways which might be incompatible with the institute's desired objectives. The consequent end results being a great negative impact on the overall output efficiency of the institute's activities. It also became quite clear that there were elements of constraints in the prevailing communication interfaces and decision-making process as relates to the institute's work system *(Division of Labour)*. These constraints were seen as spill over from the parent

body, (i.e. CSIR), which was perceived as having become a huge bureaucratic entity, and hence not operating in ways which could help the institute realize its expectations *(Goals and Objectives)*. One of the identified constraints was the attempt to introduce operational change processes that could result in the commercialisation of the institute's products and services *(Instruments and Materials)*. The communication interface constraint in this respect is the enforcement of the commercialisation process on the institute with its human resource not really understanding the fundamentals of this change process, especially as highlighted in the WAITRO report. This might have resulted from using a bad instrument (consultants) for preparing the enforcement.

5.2.2. Identified Contradictions within FRI's Activity System.

The analysis of contradictions within the existing activity dimensions of the FRI was conducted with reference to the "dimensions of activity" model *(see section 2.9.4, page 31)* and based on Ruth (1993 and 2002). The rationale was to help establish possible indicators of malfunctions within the institute's activity with respect to each of its dimensions, and/or between the different dimensions and/or between the different interacting activities of the entire FRI and other institutes forming the CSIR network. The "Subject Dimension" is represented by the whole FRI. The dimensions analysed included the following:- Goals and Objectives, Resulting Outcome, Instruments and materials, Institutional Rules, Division of Labour, Social Context, Environmental Context, and Historical Context.

The attempt to effect change by the institute within the context of its prevailing sub-system instability, as pointed out in section 5.2.1 above, resulted in varieties of hindrances. The failure to ensure the complete overhaul of the previous system prior to their translation to effect change has resulted in the corporate image of the FRI being defined within the context of its past existence *(Historical Context)*. This is by virtue of the fact that no organizational

activity can be completely independent of its history. The consequence being that the surrounding society continues to view the institute as a government entity whose services and/or output should be obtainable for free. This has given rise to a contradiction in the institute's historical context due to the possible failure to establish an efficient communication interface between the institute and the surrounding social environment *(Social Context)*. The fact that the society has not come to terms with the institute's new image was attributed to the government's failure to accord the institute favourable operational atmosphere, despite the expectation of the institute to generate 30 % of its income. An additional factor was the institute's failure in its drive to effectively reach out to the society, thus allowing its developed technologies to gather dust on the shelves. For example, as part of the change process at the FRI, its commercialisation efforts can be classified as not successful (*Goals and Objectives Dimension)*. This is because, the institute was given up to the year 2000 to be able to generate the required 30 % of their income, but as at the year 2002, the FRI has been able to generate only 6 % of its income (*Resulting Outcome Dimension)*. Thus the assertion that locally, there is no available market for the developed technology because the local entrepreneurs could not afford the cost, stands in clear contradiction to the earlier explanation. This gives a clear indication of contradictions within the institute's defined goals and objectives *(see Appendix E).* It also became quite clear that as a result of a new mandate for the institute to generate part of its revenue, networking between it and other institutes as well as collaboration with other organizations, both in the field of research and industry is non-existent. The consequence being that the other institutes delved into multiplicity of functions, including extended areas where the FRI has superior expertise and facility. This brings to the fore elements of contradictions within the FRI's social dimension *(Social Context).* The reason for the lack of effective collaboration and/or operational synergy with other institutes and organizations was traced to the issue of mistrust in the prevailing operating environment where there is lack of

"intellectual and property right laws" *(Institutional Rules),* which might prevent collaborating partners from undue exploitation of other institutes products by taking credit on them. This gives a clear example of prevailing contradictions within the labour division as well as the institutional rule dimensions of their activity. The end results being that the social environment, such as the market forces and the politics, tends to be unfavourable due to governments tendencies of giving less priority to issues relating to science and technology, in general. Additionally, this lack of synergy gave rise to contradiction in the institutes' goals and objectives dimensions.

5.2.3. Outcome of Future Workshop at FRI.

Judging from the "Future Workshop" results, which was held under the main theme *"FRI's Commercialization Efforts" (see Appendix H),* it was apparent that the deep-rooted contradictions within the social, environmental and historical contexts of the institute's activities formed the underlying influencing factor for the contextual contradictions identified with respects to the institute's goals and objectives, labour division, instruments and materials, as well as its institutional rules. It was obvious that these contradictions existed not only inside one single dimension of the institute's activity system, but also between different dimensions of the same activity system, as well as between different interacting activity systems of the activity network within the entire CSIR. Using the stated contradictions as tools for solution identification, the total of forty-one (41) problems *(see Appendix H, pages 146-148)* catalogued by the 17 staff members through the medium of participative planning in the "Future Workshop" clearly outlined the specific constraints within the institute's activity that might have resulted in the identified contradictions. The following are highlights of the workshop results.

a) Critical Problems Derived from Developed "Problems Catalogue"

The outcome of the voting by participants on the forty-one (41) problems catalogued showed that the following seven (7) problems and/or constraints were deemed to be critical.

i. Staff attitude.
ii. De-motivation of staff.
iii. Commercialisation concept not well understood.
iv. Lack of funds.
v. Lack of training.
vi. Management commitment.
vii. Marketing not aggressive.

b) Sub-themes Developed for the "Future Workshop" Main Theme.

Based on the above-listed critical problems and/or constraints, participants developed the following three (3) topics to serve as sub-themes for the workshop.

i. Reorientation of staff towards the commercialisation of activities and general attitude to work.
ii. Lack of commitment (with emphasis on training, funding, and staff demotivation).
iii. Marketing.

c) Phantasizing of Best Solutions.

Participants phantasized the best solutions which could help overcome the problems and/or constraints identified with the respective sub-themes by coming out of their daily limitations which usually lead to restraints, traditional thinking, and acting. As a result, many new ideas that the participants have in their unconsciousness popped up by after thinking over their daily limitations. Everything was considered to be possible with in this phase (i.e. no cultural barriers, and also no economic, personal, technical, and organizational limitations). Figure 12 below shows participants forming group 3 analysing the developed problem catalogue.

Figure 12: Participants in Group 3 analysing the developed problem catalogue prior to phantasizing solutions at the "Future Workshop" held at the FRI, Accra, Ghana.

The phantasies were discussed with regards to their abilities to solve one or more of the problems associated with the specific themes and disagreement was allowed and accepted. The phantasies developed for each of the specific sub-themes, which are viewed as "FUTURE VISIONS" that are supposed to have enough power to solve all the critical problems related to the identified contradictions in the institute's activity remediation are listed below. The participants further conducted a "*Desirability* (D) and *Possibility* (P)" assessment of the various alternate solutions which allowed for the practical choices of the most feasible ones.

- <u>Phantasized Solutions for the "Reorientation of staff towards commercialisation activities and general attitude to work".</u>

  i. Train staff on work ethics. *[D=100%; P=90%]*

  ii. Develop flowchart to show the inter-dependence of grades of staff and units. *[D=90%; P=80%]*

  iii. Indiscipline among the staff should not be tolerated, and offenders should be sanctioned. *[D=80%; P=70%]*

  iv. Establish best worker and discipline awards. *[D=80%; P=80%]*

v. Motivate staff with long service awards (example, 10 years and above).

[D=100%; P=80%]

vi. Senior members must set good examples, in terms of discipline and hard work. *[D=90%; P=90%]*

vii. Improve security and the environment (uniforms, record-keeping of visitors, landscaping of the environment). [*D=100%; P=60%]*

viii. Every staff to sign attendance book (both "in" and "out"). *[D=80%; P=80%]*

ix. Proper arrangement should be made before staff is recruited (such as office accommodation and job description). Such new staff should go through orientation and counselling from time to time. *[D=80%; P=70%]*.

x. Supervision should be improved at all levels. *[D=100%; P=100%]*

➢ <u>Phantasized Solutions to address "Lack of commitment"</u>

i. Management should have a programme for training of staff and must implement it.

[D=100%; P=80%]

ii. Training needs of staff should be identified on periodic basis (yearly).

[D=100%; P=100%]

- Use of equipment.
- New methods.
- Upgrading of professional skills.
- Attachment/secondment to industries.
- Within 3 years, each member of staff should have opportunity to attend refresher courses, attachment etc.

iv. Funds should be sourced and prioritised. *[D=1000%; P=80%]*

- Expenditure to be managed to avoid wastage of limited resources.
- Monitoring and auditing of purchases to ensure maximum benefits for services.

- Goods and services should be properly priced.
- Quick release of funds for commercial activities, and timely delivery of inputs.

v. Staff should be motivated by level of work done. *[D=70%; P=50%]*

- Certain staff in certain categories do not have stringent criteria for promotion (i.e. there should be different lines of progression for different categories of non-research staff. For example, a Chief Technical Officer in the mechanical workshop should not be equated to that in the laboratory where so many courses have to be taken before progression).
- Incentive should be given to staff that excel (e.g. long service awards – i.e. 5, 10, 15, 20 years etc.).
- Loans should be given to staff promptly, and easily accessible.
- Administrative support should be improved (e.g. delivery of services, such as maintenance work, requests, etc).
- Working environment should be improved (fans, air-conditions, common-room to relax during lunch).
- Electricity and water supply should be constant (e.g. generators should serve the purpose for which they are installed by the provision of fuel).

➢ <u>Phantasized Solutions for improving "Marketing".</u>

i. Serious conscientization of top management and staff in marketing. *[D=90%; P=90%]*

ii. Staff periodic orientation in marketing. [*D=90%; P=90%]*

iii. Research must address the marketing concept. *[D=90%; P=40%]*

iv. Institute must embark on aggressive promotional activity. *[D=90%; P=60%]*

v. Identifying products with competitive advantage. *[D=90%; P=50%]*

vi. Identifying potential clients *[D=90%; P=60%]*

vii. Developing strong linkages between FRI and industries. *[D=90%; P=80%]*

viii. Set achievable targets. *[D=90%; P=55%]*

ix. Establishing good customer relationship. *[D=90%; P=70%]*

x. Rewarding for exceptional performance or contribution. *[D=90%; P=50%]*

xi. Just-in-time delivery to clients. *[D=90%; P=70%]*

Figure 13 below shows participants who formed group one deliberating and assessing the various phantasies they had developed for one of the three workshop sub-themes.

Figure 13: Participants in Group 1 deliberating on their sub-theme at the "Future Workshop" at the FRI in Accra, Ghana.

d) <u>Strategies Developed to Realise Feasible Solutions (Phantasies).</u>

The participants discussed the two most feasible solutions proposed for each the sub-themes and collectively agreed on one solution for each to be realized. In this approach, the participants sought to find all the barriers that exist for the realization of theses solutions by taking into consideration the following factors;

- Economic,
- Technical;
- Organizational;
- Realities that are existing in the organization;
- Realities that exist in the society.

The Participants discussed in group basis as to whether any of the real barriers they identified could be removed. Afterwards, each group prepared a plan and/or a programme for change which could make it possible to achieve the solutions that the group has decided should be realized. The outcomes, with respect to each sub-theme are summarized below.

- Reorientation of Staff towards the Commercialisation of Activities and General Attitude to Work.

  i. Selected solution.

     - Train staff on work ethics.

  ii. Existing barriers.

      The following were identified as barriers to supervision within the system.

      - Indiscipline.
      - Insubordination.
      - Unfairness/favouritism.
      - Setting of bad examples.
      - Absence of mutual respect amongst staff.
      - Irresponsibility.
      - Absenteeism/lateness to work or meetings.

iii. Plan and/or Programme of Action.

The following actions were proposed as the required steps necessary for achieving the solution.

- Divisional/Unit "open" forum for informal discussion (at least once a quarter).
- Making use of communication skills and interactions with subordinates.
- Institution of socialization activities at Unit/Division level.
- Staff should be made familiar with conditions of service at all levels.
- Institute channels for complaints (e.g. suggestion box).
- Supervision at all levels should be encouraged to set good examples.

➢ Lack Of Commitment

i. Selected Solutions.

- Funds should be sourced and prioritised.
- Expenditure to be managed to avoid wastage of limited resources.
- Monitoring and auditing of purchases to ensure maximum benefits for services.
- Goods and services should be properly priced.
- Quick release of funds for commercial activities, and timely delivery of inputs.

ii. Existing Barriers.

The following were identified as the prevailing barriers.

- Lack of funds
- Untimely delivery of goods and services.
- Inability of clients to pay for products and services.
- Inadequate monitoring and auditing of purchases.
- Unavailability of inputs from suppliers.
- Transportation and financial problems.

iii. Actions to Remove Barriers.

The following actions were proposed for removing the existing barriers in the order in which they appear.

- Good business plan to convince funding agencies.
- Timely delivery as well as attitudinal change.
- Prices of goods and services must be affordable.
- Proper auditing.
- Better planning for the provision of inputs (i.e. advance and timely preparation of estimates).
- Better remuneration.

iv. Programme of Action.

The following action programme was recommended.

- Monthly review of commercial activities.
- Constant monitoring of daily activities (for determination of bottlenecks.
- Penalizing staff for non-conformity.

➢ Marketing.

i. Selected Solution.

- Developing strong linkages between FRI and industries.

ii. Plan and/or Programme of Action.

Aim : Sustaining Clients.

Objectives:

- Sustain already existing clients.
- Win 10 new clients annually.

- Increase revenue by 70 %.

Action:

- Visit to key clients twice every year by the Commercialisation and Information Division (CID) and the experts to discuss FRI's service provision.
- Invitation of key clients to FRI's "end of year" get-together.
- Visit to industries to prospect for clients.
- Participating at trade fairs and exhibition.
- Provision of updated brochures.

Figure 14 below shows participants in group two developing activity remediation strategies to some of the prevailing contradictions in the institute's activity system.

Figure 14: Participants in Group 2 developing strategies to overcome critical problems identified at the "Future Workshop" held at the FRI, Accra, Ghana.

Thus it is obvious from the above points that the seven (7) problems from the "problem catalogue", which were deemed to be critical relates to the various contradictions identified with the institute's activity. In this respect, they stand to serve as the starting points for

overcoming those contradictions found to be associated with the institute's historical, social and environmental contexts. Further indication of these is highlighted by the workshop sub-themes based on which several solutions were phantasized and their realistic application weighted through the use of the "desirability and possibility" model. Thus the solutions outlined above gave additional strength to the observed contradictions in the institute's activity analysis and as such, could provide the base for the institute's future activity remediation effort.

5.3. ANALYSIS OF ACTIVITIES AND CONTRADICTIONS FOR SCIENCE AND TECHNOLOGY POLICY RESEARCH INSTITUTE.

Analysis of the activity assessment based on the observational results as well as those obtained from the structured interview and "Future Workshop" for the Science and Technology Policy Research Institute (STEPRI) are highlighted below.

5.3.1. STEPRI's Activity Analysis.

The *Subject Dimension* for the analysis is represented by the whole institute (i.e. STEPRI). Results from the study of the institute's activity, based on observations and structured interview *(see Appendix G),* indicated that STEPRI is a well organized entity with well-focused staff. The institute's activities are mainly policy development which involved the collation of available policies on science and technology (S & T) as well as analysing and formulating them scientifically into appropriate policies which could help the Ghanaian Government in its policy development. Thus the institute's current output status is non-profit making, and depends wholly on government subventions. It emerged from the *interview* that activities of the institute could be viable for income generation *(Goals and Objectives)*, but the low level of the country's development was cited as a major constraining factor inhibiting this potential (*Social Context).* It was observed that an appreciable level of work coordination and

cooperation existed among the different categories of staff, despite the junior staff showing signs of displeasure regarding their prevailing service conditions *(Division of Labour* and *Institutional Rules)* . Judging from this perspective, it was realized that the attitude of the staff could significantly impact both positively and negatively on the institute's activities and output *(Resulting Outcome)*. The positive impact appeared to dominate the institute's operational sphere, and this could be by virtue of the manageable staff strength of 30 *(Environmental Context)*. Despite resource constraints, as well as minimal staff complaints, the staff tended to derive self-motivation from the significant improvements in the institute's operations *(Instruments and Materials)*. Activities of the institute also involved significant networking with other institutes and/or organizations. Despite this, the institute finds it difficult to coordinate the activities of the other remaining institutes under the CSIR, due to their current mandates to commercialise.

The design of the institute's management structure follows that of the standardized organizational structure for all the institutes under the CSIR *(Institutional Rules)*. It comprises of an External Management Board, comprising a maximum membership of eleven (11) with 40 % coming from the private sector, and which is supposed to be an advisory body to the Director of the institute. Appointment to the board is made by the CSIR Governing Council, which is the ultimate authority of the CSIR. The institute also has a Director, a Deputy Director, and Divisions (each consisting of a minimum of 4 staff with a Head), as well as an internal management committee, which handles issues relating to staff welfare. The internal management board of the institute is currently chaired by a Deputy Director-General of the CSIR who is appointed by the Director-General to whom he is directly responsible *(Institutional Rules)*. The rationale behind this was for the Deputy Director-General to be reporting directly to the Director-General on activities of the institute on regular basis. This

appeared to be having a rather negative impact on the effectiveness of the institute by virtue of the Deputy Director-General's divided attention as a result of chairing the boards of the other institutes as well *(Division of Labour* and *Environmental Context)*. It came out during the *interview* that the previous experience of appointing an external person as chairman of the institute's management board proved to be very effective *(Historical Context)*. It was also established that the country's industrial sector is very weak, and most of the activities, which are mercantile oriented (i.e. buying and selling, with about 80 percent representing imported items) are happening in the services sectors *(Social* and *Environmental Contexts)*. The resulting consequence being that the prevailing environment was unfavourable to the institute's activities and operations, in relation to its mandate to generate about 30 % of its annual operational budget *(Goals and Objectives)*. The sourced explanation for this unfavourable operational environment is that, currently the country's economy is growing as a result of mercantile activities by 5.2 %, whilst the industry sector is growing at 2.9 % (which is almost half the growth rate of the mercantile activity). At this growth rate, the institute perceived that the demand for S & T services is too weak for the institute to be really in business *(Social Context)*. A major demotivation factor relating to the institute's activities and outputs arose from the premise that S & T helps production, but because the production base of the country is weak, it is not benefiting from the institute's S & T efforts *(Historical Context)*. Even though there is abundant information on S & T available in the country, the capacity and resource for them to be utilized productively as well as effectively does not exist since the country's economy does not encourage production *(Instruments and Materials)*.

5.3.2. Identified Contradictions within STEPRI's Activity System

The analysis of contradiction within the existing activity dimensions of STEPRI was conducted with reference to the modified "dimensions of activity" model *(see section 2.9.4, page 31)* and based on Ruth (1993 and 2002). The rationale was to help establish possible

indicators of malfunctions within the institute's activity, with respect to each of its activity dimensions, and/or between the different dimensions, and/or between the different interacting activities of the entire STEPRI and other institutes forming the CSIR network. The dimensions analysed included the following:- Goals and Objectives, Resulting Outcome, Instruments and Materials, Institutional Rules, Division of Labour, Division of Labour, Social Context, Environmental Context, and Historical Context.

As noted in section 5.3.1 above, the institute has the potential for making profit, but the level of the country's development was classified as being a hindrance *(social, market and environmental dimensions)*. Coupled with the assertion that the institute is to coordinate S&T research efforts in the country gives an indication of contradiction in the institute's mission statement as well as its goals and objectives dimension *(Goals and Objectives)*. The prevailing operational mandate also tended to with the institute's mission statement *(see Appendix G),* thus giving an indication of contradiction in the institute's historical perspective (*Historical Context)*. The prevalence of resource constraints (especially non-human factors) also provides contradictions within the institute's division of labour dimension *(Division of Labour)*, on one hand, and its instruments and materials dimension *(Instruments and materials)*, on the other. The organizational structure and system linking the institute to the supervisory body (i.e. CSIR) also portrayed the existence of contradiction from the perspectives of its institutional rules dimension *(Institutional Rules)*. The country's inability to utilize productively as well as effectively the abundant information on S&T also portrays elements of contradictions in the institute's mandate *(Goals and Objectives)*, judging from its environmental and social dimensions *(Social Context)*, as well as in its resulting outcome dimension. The view of the institute to the fact that it finds it a bit difficult to go by the WAITRO "Best Practices", as a result of the institute's operations having to be customized to meet the different advises given

to it, portrays the existence of contradictions in its institutional arrangements *(Institutional Rules),* and also in its social and environmental dimensions *(Environmental Context).*

5.3.3. Outcome of Future Workshop at STEPRI.

Based on the outcome of the workshop *(see Appendix I)*, it was apparent that the contradictions within the social, environmental and historical contexts of the institute's activity were not deep rooted. These seem to form the underlying, but manageable influencing factors for the contradictions identified in section 5.3.2 above, with respect to the institute's goals and objectives, division of labour, instruments and materials, as well as its institutional rules. It was obvious that these contradictions existed not only inside single dimensions of the institute's activity system, but also between different interacting activity systems of the activity network within the entire CSIR. Using the stated contradictions as tools for solution identification, the total of thirty-five (35) problems *(see Appendix I, page 161-163)* catalogued by the 12 staff members through the medium of participative planning in the "Future Workshop" clearly outlined the specific constraints within the institute's activities that might have resulted in the identified contradictions. The following highlights key features in the workshop results.

a) Critical Problems.

The participants identified the following problems and/or constraints as critical.

i. Role of the Deputy Director-General of the CSIR on the institute's management.
ii. Service being rendered by individual members of the management board.
iii. Functions performed by the CSIR administration (Head Office) as opposed to the functions performed by the institute's management.
iv. Over-centralization within the CSIR administrative system.
v. Question of staff representation on the management board.

b) Workshop Sub-theme.

Based on the six (6) critical problems and/or constraints listed above, the participants chose the following topic "*Governance and capacity-building*" as the sub-theme for the workshop. Figure 15 below shows the participants engaged in a round-table discussion during the workshop.

Figure 15: Participants engaged in round-table discussion at the "Future Workshop" held at STEPRI, Accra, Ghana.

c) Phantasizing Best Solutions.

The participants phantasized the best solutions to help overcome the problems and/or constraints identified with the sub-theme using the same strategy as discussed previously in section 5.2.3(c). Consequently, the following solutions, which are supposed to help remove the contradictions identified from the institute's activity analysis, were generated.

i. Director to be allowed to run divisions.
ii. Heads of Divisions should be given increased authority to operate, as well as propose their own budgets.
iii. Drawing of effective plan for use of the institutes vehicles.

iv. Need for more vehicles.

v. Enhance regular information flow.

vi. New staff should be given both divisional and general administrative orientation of the institute.

vii. Provision of direct access to the internet to each staff.

viii. Members of internal management committee to serve on the Board.

ix. Staff to approve people appointed to the management Boards.

x. Appoint management board members who can serve as income identification avenues for the institute.

xi. Give same remuneration to the institute's staff as is given to those in the universities.

xii. Improve staff accommodation.

xiii. Management should be holding regular meetings.

xiv. Improve staff knowledge on the operations of different divisions within the institute.

xv. Ensure regular down flow of information.

xvi. Utilizing of internet cafés to accelerate information sourcing.

xvii. Institute should set its own website.

xviii. Institute should network with other institutions.

xix. Provide more facilities such as computers.

xx. Institute must run courses to generate more income.

d) Developed Strategies for Realization of Solutions

The participants discussed the twenty (20) proposed solutions listed above and collectively agreed on the following solutions whose realization were strategized, as outlined below.

i. *Solution.*

- Decentralize operations within the CSIR in order to make the institute viable.

ii. *Existing Barriers*.

- High staff turnover.
- Poor salary for staff.
- Mounting staff frustration.
- Poor information flow.
- Incapacitation of institute's Director's efforts by the role of the Deputy Director- General.
- Lack of access to the internet.
- Over-centralization of institute's administration.
- Lots of bureaucracy.
- Communication gap.

iii. *Proposed Action (short Term).*

The Director proposed to set in place a mechanism to immediately address issues relating to the following constraints which are within his capacity towards the realization of the proposed solutions.

- Poor information flow.
- Lack of access to the internet.
- Communication gap.

Thus the six (6) problems from the problem catalogue, which were deemed to be critical, served as the starting point for overcoming the contradictions associated with the institute's

historical, social and environmental contexts, as well as its goals and objectives. Further indication of the linkage between these critical problems and the various contradictions identified in analysis of the institute's activity was highlighted by the workshop's sole sub-theme, "*Governance and capacity building"*. Hence the derivation of the various solutions to serve as the base for future remediation efforts to overcome the contradictions associated with the institute's activity.

5.4. ANALYSIS OF ACTIVITIES AND CONTRADICTIONS FOR INSTITUTE FOR INDUSTRIAL RESEARCH.

Analysis of the activity assessment, based on the observational results as well as those obtained from the structured interview for the Institute for Industrial Research (IIR) is highlighted below.

5.4.1. IIR's Activity Analysis.

The *Subject Dimension* for the analysis is represented by the whole institute (i.e. IIR). Results from the study of the institute's activity (see Appendix F) showed that it shared similar organizational constraints as highlighted for the FRI in section 5.2.1 *(page 71).* It appeared that the constraints in the institute are deep rooted with increasing staff turnover as a result of low motivation resulting from poor remuneration *(Division of Labour)*. It was established that the existence of a rigid promotion criterion for the senior researchers continues to be a source of discourse, which has consequently affected staff morale and commitment to the institute's activities *(Institutional Rules)*. Though the existing institutional rule does not impose restrictions on the institute's activities, the division of labour between the human and non-human actors is not balanced *(Division of Labour)*. The lack of adequate resources has resulted to staff not showing much commitment in their interactions with the Institute's activities, leading to increasing staff turnover Transportation for carrying out

operations is a major constraint whilst facilities for internal communication are very poor. *(Instruments and Materials)*. The continued use of old-fashioned, obsolete and inadequate instruments and materials tended to impact negatively on the institute's outputs, mostly resulting in activities not running according to plan of action *(Resulting Outcome)*. In this respect, resulting outcomes of most activities undertaken by the institute normally tend to differ from the desired outcomes *(Goals and Objectives)*. The heads of the divisions normally meet to consider issues relating to the institute's output, but not those related to its commercialisation *(Institutional Rules)*. The institute promotes its output and services to the prevailing market and community through its commercial department, but there seemed to be lack of appreciation from the surrounding society as well as the prevailing market to the institute's performance and service delivery *(Social Context)*. Though the institute sees itself as operating within a good physical environment, it does not receive collaboration from others, whilst intra-institute interaction with the other institutes of the CSIR is very poor *(Environmental Context),* and hence resulting in the duplication of activities.

5.4.2. Identified Contradictions within IIR's Activity System

The analysis of contradiction within the existing activity dimensions of the IIR was conducted with reference to the modified "dimensions of activity" model *(see section 2.9.4, page 31)* and based on Ruth (1993 and 2002). The rationale was to help establish possible indicators of malfunctions within the institute's activities with respect to each of its dimensions, and/or between the different dimensions and/or between the different interacting activities of the entire IIR and other institutes forming the CSIR network. The dimensions analysed included the following:- Goals and Objectives, Resulting Outcome, Instruments and materials, Institutional Rules, Division of Labour, Division of Labour, Social Context, Environmental Context, and Historical Context.

The activity system of the institute established that the non-flexibility of promotion criteria coupled with poor remuneration *(Institutional Rules)* shows the existence of contradiction in its desire to improve its operational efficiency *(Resulting Outcome)* in order to become profit-oriented *(Goals and Objectives)*. The consequence being the show of discourse by staff and the negative effect on morale and commitment *(Environmental Context)*. The imbalance between the human and non-human actors *(Division of Labour)* showed the prevalence of contradictions among the institute's dimensions relating to instruments and materials, division of labour, and within the context of its resulting outcome. This stands to explain the rationale behind the staff not showing much commitment in their interaction with the institute's activities, and possibly the increasing turnover *(Environmental Context)*. This absence of collaboration and/or intra-interaction shows the existence of contradiction in the institute's environmental context. The tendency of the heads of divisions not to discuss issues relating to the institute's commercialisation efforts *(Institutional Rules)* implies the existence of another level of contradiction from the dimensions of its institutional rules. The institute being projected as operating in a good physical environment *(Environmental Context)*, but yet experiencing the show of lack of appreciation from the surrounding society and the market *(Social Context)* clearly establishes the presence of contradictions from the perspectives of the institute's social and environmental contexts, as well as in its goals and objectives. The institute's expectation of clients to come to it *(Social Context)*, coupled with its transportation constraint *(Instruments and Materials)*, and the tendency by senior research staff to limit their interests in areas of their specialization only *(Institutional Rules)*, rather than show interest in the institute's commercialisation and marketing activities *(Resulting Outcome)* portrays the existence of a multi-dimensional contradiction among the different activities in its activity system. This multi-facet contradiction resulted from prevailing contradictions in the institute's

goals and objectives, its social and environmental contexts, instruments and materials, as well as the resulting outcome of its activities.

Figure 16: The “Future Workshop” facilitator (author) scanning through his notes.

6. DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

6.1. DISCUSSION

The results obtained from the mails survey compared favourably with those gathered through the activity study. Actually, results from the activity study provided an in-depth explanation to the prevalence as well as the derivative sources of the external constraints that affected the internalisation of the benchmarks by the RTOs. The results from the "future workshop" reinforced those obtained from the interviews and observations. These helped in the clear identification of the prevailing contradictions in the activity systems of the RTOs, and thus the level of micro-ergonomics stability within the RTOs.

The analysis of the survey responses (section 5.1) clearly indicated that the most dominant external environmental factors common to almost all the respondents are "consumer and market forces" (CMF) and "climate and culture" (CC). These are followed by the prevailing "political" (P) environment, "communication interfaces" (CI), and the "educational background" (EB) of the staff, as well as "decision-making" (DM) with regards to the activities of the organizations. The combined strength and influences of these dominant environmental factors might have resulted in some of the organizations facing additional constraints emanating from their prevailing "socio-economic and legal" (SEL) frameworks, thus affecting their "sub-system stability" (SS). The continued prevalence of CMF, CC, P, and CC, which tended to be inter-related in some respect, appear to create unfavourable atmospheres within the operational environments of the organizations. This atmosphere, seems to have a relatively strong ability to impact negatively on the operations of these

organizations. This effect might explain the reason as to why some of the respondent RTOs could not improve upon their overall operational performances despite undergoing three (3) or more organizational and/or system transformations over the past ten (10) or more years. The rationale behind the inability of these organizations to overcome the influences of these dominant environmental factors despite their numerous attempts, in one way or the other, could be related to such factors as the influence of the key actors in the decision-making process for the change implementation as well as the methodology to be followed (adoption, adapting or using other procedures altogether). An additionally related influencing factor could be the level of understanding of the change process and the rationale behind it by the different categories of the organization's staff as well as its clients, government technical staff, other stakeholders, and even its competitors. These observations are clearly established in table 3 *(pages 55-56)* where the influences of the various external environmental factors on each of the ten (10) listed "Best Practices" for the respective RTOs are indicated. From the table, it is noted that within individual RTOs, some specific practices are affected by almost all the external environmental factors, some are affected by only few. A typical example is that portrayed by CARIRI, which has almost all the external environmental factors, with the exception of *culture and climate,* affecting its implementation of the best practice on "Personnel Management", as compared to only two environmental factors *(political, and socio-economic and legal)*, which affected its implementation of the practice on "Governance". Another observation from table 3 is the case of CSIR (SA), which has almost all the external environmental factors, with the exception of *educational background,* serving as constraints to its implementation of the best practices on "Policy and Programming" as well as "Organization Management". Yet, its implementation of the best practice on "Capacity Building" was affected by only the external environmental constraints related to its *subsystem stability.* Similar variations could also be observed in the case of TAIWAN, and to a less

extent, SIRDC. In the case of TIRDO and STEPRI, the effects of the environmental factors on the best practices implementation appeared minimal. Yet, there exist similar variations with respect to specific best practices.

The analysis established that strong variations existed with respect to transmitted knowledge and the level of understanding of the change processes by the various categories of staff as well as other interested groups so far as the organization's activities as concerned. This observation was further corroborated by the outcomes of the two "future workshops" held at the FRI and STEPRI in Ghana. It was established from the analysis that whilst the board members and senior management staff tend to be highly knowledgeable about the change process within the organizations, the corresponding knowledge of the junior staff as well as clients, government technical staff, and other stakeholders tended to be very low. This disparity might be related to the prevailing low, and to some extent average ratings for the organization's management information systems (MIS). This situation implied the inability to override the environmental constraints imposed by the prevailing communication interfaces (CI) on the change process. This was clearly portrayed by the low levels of cooperation received from those actors with corresponding low knowledge of the change process, both within and outside the organizations. The impact levels of these situations on the organization's subsystems stabilities (SS), which appeared to depend on their prevailing different operating environments, tend to explain the relative variations in the levels of progress ratings for the different best practices which were either adopted, adapted or implemented using other procedure in the change processes. As observed in the analysis, whilst some of the RTOs indicated good results for specific practices based on either adoption, or adaption or using other procedures, others reported achieving poor results for similar practices and implementation processes. These observations corresponded to the

findings by Negandhi (1977) as reviewed in chapter two and appraised in chapter three. The implementation approach, as observed above, appeared to rely mostly on management decisions, without allowance being made for the identification and continuous interaction with the "real" sources of the best practice being implemented, irrespective of the implementation approach, as pointed out in the technology transfer model (Shahnavaz, 2002) and also appraised in chapter three.

The observations made in the analysis of activities *(see section 5.2)* and the prevailing contradictions found to be inherent in the various activity dimensions of the three institutes studied, clearly explained the rationale behind the inability of an organization to override the identified environmental factors and hence achieve success in its activity. The interwoven relationship that seems to pertain between these environmental constraints and the realization of an organization's missions, goals, and objectives was traced to the levels of contradictions within the various dimensions and contexts of the organizations activities. As was identified in the assessment of activities, as outlined by Ruth (1993 and 2002), at the FRI and STEPRI, the prevalence of contradictions in the organization's historical context, social dimension, division of labour, institutional rules, as well as its goal and objectives dimensions tended to combine effectively to establish a contradiction within the resulting outcome dimensions of the organizations' activities. The levels of these contradictions with respect to the different organizations, even when operating under the influence of the same external environmental constraints as identified, were found in the analysis of the outcomes of the "future workshop" to be dependent on the extent of its subsystem stability. This stand to explain the significant variations in the types and levels of constraints experienced by the individual RTOs with respect to their efforts at introducing changes within their organizations through the use of benchmarked practices, and under this context, the "WAITRO Best Management Practice".

It also explained the reason as to why most of the RTOs tended to observe some levels of progress being made with respect to almost all the best practices being adapted, and also why some RTOs were successful in their adoption of the practices whilst others were not. Similar explanation also holds for the success of those RTOs who neither adopted nor adapted the benchmarks, but were successful by using other process.

The above discussions has established the effectiveness of the combined use of *subjective opinions* (Helali and Shahnavaz, 1998), and *systems, subjects and environment interactions* (Ruth, 1993 and 2002), as indicators for the identification of the organizational problems associated with the RTOs internalisation of the WAITRO "Best Practices". This is gives an indication of the significance of "joint design" using humanized task approach by considering the organizations socio-technical characteristics (Hendricks and Kleiner, 2001). Therefore, the adaption of the humanised task approach (Ruth, 1993 and 2002) has helped to clearly identify those elements in the RTOs work organization and system design, which is key to finding solutions to the existing problems, associated with the RTO's "Best Management Practices" implementation efforts.

6.2. CONCLUSIONS

Based on the observations made from the analysis of the results, as discussed above, the facts outlined by Negandhi (1977) related to external environmental factors affecting organizations as well as those established by Hendrick and Kleiner (2001), among others, as reviewed in chapter two and appraised in chapter three, held true in this study, from the perspectives of systems as well as organizational design and management. The study was able to establish that the non-success of the macroergonomic changes in the RTOs was due to the weakness in their micro-ergonomics elements. The study has also established the positive effect of combining

the “activity study” (Ruth, 1993 and 2002) and “future workshop” (Helali and Shahnavaz, 1998) techniques in the organizational assessments. Hence the hypothesis upon which this study was carried out has proved to be true. Based on these deductions, the following two (2) definite conclusions could be drawn on the subject matter of the study.

a) The external environmental factors which seem to prevent the RTOs from successfully internalising the WAITRO Best Management Practice are derivatives of constraints associated with some or all of the following:

   i. Prevailing socio-economic and legal frameworks;
   ii. Influence of consumer and market forces;
   iii. the Pervading Political Atmosphere;
   iv. The RTOs operating climate;
   v. The subsystem stability (RTO’s operating system);
   vi. The existing communication interfaces within the RTO’s organizational structure, on one hand, and between the RTO and the surrounding environment.
   vii. The educational background (qualification) of its staff;
   viii. The decision-making approach.

b) The extent to which these external environmental factors inhibit the efforts of each RTO in its “Best Practice” implementation effort, irrespective of the approach being used, depends on the level of contradictions existing in the respective RTO’s activity systems from the perspectives of some or all of the following activity dimensions:

   i. Historical Context;
   ii. Social Dimensions;

iii. Goals and objectives;

iv. Institutional rules;

v. Labour divisions;

vi. Instruments and materials; and

vii. Environmental context.

6.3. RECOMMENDATION

Based on the conclusions drawn above, the following recommendations are being proposed.

a) Further and extensive investigation involving "activity studies" and "future workshops" should be conducted to relate each of the ten (10) "WAITRO Best Management Practices" to the prevailing activity systems of a representative sample of RTOs.

b) Development and testing of specific remediation plans, based on the studies in (a), which could remove any contradictions that may exist within the activity systems of the RTOs, and thus help overcome the influences of external environmental factors in the RTOs' benchmarks implementation efforts.

REFERENCES

1. Bailey, R. W. (1989). Human performance engineering (2nd Ed). Englewood Cliffs, NJ: Prentice Hall.
2. Burns, T., & Stalker, G. M. (1961). The management of innovation. London: Tavistock.
3. Cherns, A. (1976). Principles of socio-technical design. Human Relations, 29, 783-792.
3. Cherns, A. (1987). Principles of socio-technical design revisited. Human Relations, 40, 153-162.
4. De Lisi, P. S. (1990). Lesson from the steel axe: Culture, technology and organizational change. Sloan Management Review, 132 (1), 83-93.
5. DeGreene, K. (1973). Socio-technical systems. Englewood Cliffs, NJ: Prentice-Hall.
6. Duncan, R. B. (1972). Characteristics of organizational environments and perceived environmental uncertainty. Administrative Science Quarterly, 17, 313-327.
7. Emery, F. E., & Trist, E. L. (1965). The causal texture of organizational environments. Human Relations, 18, 21-32.
8. Engeström, Y. (1987). Learning by expanding. Doctoral Thesis, Orienta Konsultit, Helsinki.
9. Glendon, A. I. (2001). Safety Culture. In: Karwoski, W. (Ed.). International encyclopaedia of ergonomics and human factors, vol. II, London: Taylor and Francis. 1337-1340.
10. Helali, F. & Shahnavaz, H. (1996). Ergonomic intervention in industries of the industrially developing countries. Case study: Glucosan - Iran: In Brown, O. Jr, & Hendrik, H. W. (Eds), Human Factors in Organizational Design and Management V, Amsterdam: North Holland, 141-146.

11. Helali, F. & Shahnavaz, H. (1998). Adapting macroergonomic approach for identification of workplace problems and development of low-cost/no- cost solutions in industrially developing countries. Case study: Glucosan - Iran: In P. Vink., E. A. P. Koningsveld & S. Dhondt (Eds.), Human Factors in Organizational Design and Management - VI, 585-590.
12. Helander, M. G. (1997). The human factors profession. In Salvendy, G. (Ed.), Handbook of Human Factors and Ergonomics: Wiley, New York. 3-16.
13. Hendrick, H. W. (1994). Future directions in macroergonomics. In Proceedings of the 12th Triennial Congress of the International Ergonomics Association (vol. 1). Toronto: Human Factors Association of Canada/ACE. 41- 43.
14. Hendrick, H. W. (1995). Humanizing re-engineering for true organizational effectiveness: A macroergonomic approach. In Proceedings of the Human Factors and Ergonomics Society 39th Annual Meeting. Santa Monica, CA: Human Factors and Ergonomics Society. 761-765.
15. Hendrick, H. W. (1996). Human factors in ODAM: an historical perspective. In Brown, O. J., & Hendrick, H. W. (Eds.), Human factors in organizational Design and Management: Elsevier. 429-434.
16. Hendrick, H. W., & Kleiner, B. M. (2001). Macroergonomics – an introduction to work system design. HFES issues in Human Factors and Ergonomics Book Series, Vol. 2. Santa Monica. HFES.
17. Ketchum, L. (1984). Socio-technical design in a third world country: The railway maintenance depot at Senar in Sudan. Human Relations, 37, 135-154
18. Katz, D., & Kahn, R. L. (1996). The social psychology of organizations. New York: Wiley.

19. Kleiner, B. M. (1996). Macroergonomics lessons learned from large-scale efforts in industry, government and academia: in O. Brown, Jr. & H. W. Hendrick (Eds.), Human factors in organizational design and management - V, Amsterdam: North-Holland. 483-487.
20. Kleiner, B. M. (2002a). Macroergonomics in large-scale organizational change: In Hendrick, H. W. & Kleiner, B. M. (Eds.), Macroergonomics. - Theory, Methods and Applications. Lawrence Erlbaum Associates, Publishers: Mahwah, New Jersey.
21. Kleiner, B. M. (2002b). Laboratory and field research in macroergonomics: In Hendrick, H. W. & Kleiner, B. M. (Eds.), Macroergonomics - Theory, Methods and Applications. Lawrence Erlbaum Associates, Publishers: Mahwah, New Jersey.
22. Lawrence, P. R., & Lorsch, J. W. (1969). Organization and environment. Homewood, IL: Irwin.
23. Leino, A., & Matilla, M. K. (2001). Safety, ergonomics and total quality management. In: Karwoski, W. (Ed.). International encyclopaedia of ergonomics and human factors, vol. II, London: Taylor and Francis. 1341-1343.
24. Majchrzak, A. (2001). Rapid macroergonomic redesign. In: Karwoski, W. (Ed.). International encyclopaedia of ergonomics and human factors, vol. II, London: Taylor and Francis. 1322-1326.
25. Mengu, M., & Grier, D. (Eds.) (1999). Best practices for the management of research and technology organizations - Special report. World Association of Industrial and Technological Research Organizations (WAITRO), DTI: Denmark.
26. Neghandhi, A. R. (1977). A model for analysing organization in cross-cultural settings: A conceptual scheme and some research findings. In A. R. Neghandhi, G. W. England, & B. Wilpert (Eds.), Modern organizational theory, Kent State, OH: University Press. 285-312.

27. Noro, K., & Imada, A. (1991). Participatory ergonomics. London: Taylor & Francis.
28. Robbins, S. R. (1983). Organizational theory: The structure and design of organizations. Englewood Cliffs, NJ: Prentice-Hall.
29. Robson, C. (1993). Real world research: A resource for social scientists and practitioners-researchers. Blackwell Publishers Ltd. oxford: UK.
30. Ruth, W. (1991). New technology in old culture. An action theory for working environment planning in the introduction of new technology in production systems of tomorrow: In Karwowski & Yates (Eds.), Advances in Industrial Ergonomics and Safety, Vol. 3. Taylor & Francis: London. 753-760.
31. Ruth, W. (1993). From "coolies" to skilled technicians! - The human actor as slave or master of the system?: In Marras et al (Eds.), The Ergonomics of Manual Work. Taylor & Francis: London. 461-464.
32. Ruth, W. (2002). Consequences of sub-arctic mining activities: The human working environment - Assessment and remediation methods. In Rasmussen, O. (Ed), Consequences of mining and energy production in the arctic and sub-arctic. Kluiwer International Publishers, (in Press).
33. Ruth, W., & Ruth-Balaganskaya, E. (2000). Human attitudes and industrial work activity as causes of industrial impact on nature: A methodological approach to integrate ecology into economic and social development: In Mander, U., & Jongmann, R. G. H. (Eds.), Consequences of land use change. Advances in Ecological Sciences 5. WIT Press, Southampton: Boston. 75-118.
34. Shahnavaz, H. (1989). Ergonomics: An emerging concept in industrially developing countries. International Journal of Industrial Ergonomics, 4, 91-100.
35. Shahnavaz, H. (1998). Cultural differences: In Encyclopaedia of Occupational Health and Safety (4th ed.). Geneva: International Labour office. 29, 79.

36. Shahnavaz, H. (2002). Macroergonomic Considerations in Technology Transfer: In Hendrick, H. W. & Kleiner, B. M. (Eds.), Macroergonomics - Theory, Methods and Applications. Lawrence Erlbaum Associates, Publishers: Mahwah, New Jersey.
37. Taylor, J. C., & Felten, D. F. (1993). Performance by design. Englewood Cliffs: Prentice Hall.
38. Thompson, J. D. (1967). Organizations in action. New York: McGraw-Hill.
39. Trist, E. L., & Bamforth, K. W. (1951). Some social and psychological consequences of the long-wall method of coal-getting. Human Relations, 4, 3-38.
40. Trist, E., & Murray, H. (1993). The social engagement of social science: A Tavistock anthology. Philadelphia PA: University of Pennsylvania Press.
41. Warring, A. E, & Glendon, A. I. (1998). Managing risk: Critical issues for survival and success into the 21st century. London:

APPENDIX A

RTO PROCESSES AND SUB-PROCESSES

The following processes and sub-processes were benchmarked by the WAITRO project team (Mengu and Grier, 1999):

A.1. RTO GOVERNANCE

A.1.1. Ownership.

Who legally owns and is ultimately responsible for the RTO?

A.1.2. Legal Structure.

From whom does the RTO get its overall direction?

A.1.3. Constitution of Board.

How is the board constituted?

A.1.4. Size of the Board.

Establishing a board that functions well.

A.1.5. Choice of Board.

Who chooses members of the board and how?

A.1.6. Mission and Vision.

RTO's "raison d'etre" and its direction for the future.

A.1.7. Level of Autonomy.

Affording the RTO autonomy in a way that maximizes its effectiveness (key issues include choice of service mix, target market, staffing decisions, choice of agencies to collaborate with, development of international work, development of resources).

A.1.8. Mandate.

RTO's boundaries in terms of geography and/or technology.

APPENDIX A (continued)

A.1.9. Internal Decision-Making.

Managing the non-project-related day-to-day affairs of the RTO.

A.1.10. Change Management.

Ability to change with changing situations.

A.2. FINANCIAL MANAGEMENT

A.2.1. RTO Funding Methods

Acquiring the funds necessary to operate the RTO.

A.2.2. Government Funding.

Providing the level of support needed to make an RTO viable.

A.2.3. Establishing Funding Level.

Establishing the amount of the RTO's grant.

A.2.4. Grant Decision-Making.

Who decides on amount of grant and how much?

A.2.5. Flexibility in Use of Funds.

Using funds in most effective manner.

A.2.6. Retention of Surplus/Loss.

Using funds in most effective manner.

A.2.7. Financial Management System.

Providing the necessary information and controls.

APPENDIX A (continued)

A.3. RTO SERVICES

A.3.1. Service Type.

Providing the types of services that the target market needs, such as basic research, applied research, experimental development, consulting, testing, training and information dissemination.

A.3.2. Service Mix.

Providing the mix of services that the target market needs.

A.3.3. Determination of Services.

Deciding which services should be offered to the target market.

A.3.4. Ensuring Service Quality.

Ensuring that clients are offered quality service.

A.3.5. Funding and Service Provided.

The role of grant funding in the services provided.

A.4. BUSINESS DEVELOPMENT

A.4.1. Managing Business Development.

Coordinating and conducting business development activities as effectively (bringing in enough business) and efficiently (lowest cost) as possible.

A.4.2. Rewards for Success.

Encouraging growth in client revenue.

A.4.3. Financing Business Development.

Managing the cost of business development while ensuring the appropriate activities are done.

A.4.4. Awareness Creation Strategy.

Informing clients and funders of RTO's capabilities and services (and successes).

A.4.5. Identification of Group Needs.

Identifying needs of client groups in order to decide what services to offer.

A.4.6. Identification of Individual Needs.

Identifying individual client needs.

A.4.7. Project Pricing Methods.

Setting the price of work done for clients in a way that enables the RTO to best meet its financial targets.

A.4.8. Methods for Reducing Cost of Projects to Clients (Leveraging).

Enabling clients to acquire RTO services at a price they can afford while providing the RTO with adequate revenue.

A.5. ORGANIZATIONAL MANAGEMENT.

A.5.1. Organizational Management Style.

Providing the support, supervision, direction setting, and communication to employees so RTO meets its goals.

A.5.2. Grouping of RTO Capabilities.

Organizing staff into groups that allow the RTO to most effectively meet its goals.

A.5.3. Unit Responsibility Level.

Level of responsibility that results in the best RTO performance.

A.6. PROJECT MANAGEMENT

A.6.1. Project Management Structure.

Creating a team that most effectively and efficiently does the RTO's projects.

A.6.2. Authority for Project Management.

Directing the project activities in a manner that results in a successful project.

A.6.3. Grant Funded Project Selection.

Deciding on projects, which meet the goals of grant funding.

A.6.4. Project Assignment.

Selecting person(s) to conduct projects so that the RTO's goals are met.

A.6.5. Contract Signing Authority.

Committing the RTO to performing work according to an agreed price, schedule and deliverable.

A.6.6. Project Management.

Keeping projects on time and within budget.

A.6.7. Project Follow-up.

Ensuring that the client is satisfied with completed work and exploring opportunities for future work.

A.7. CAPABILITY BUILDING

A.7.1. Decision on Capability Building.

Who identifies the need for developing new skills or acquiring new staff, equipment or technology to address client needs and opportunities.

A.7.2. Capability Building Opportunities?

How are opportunities for capability building identified?

A.7.3. Funding Staff Improvement.

Undertaking and funding activities that build staff capability.

A.7.4. Funding Capital Investments.

Acquiring equipment needed to deliver client services.

A.8. PERSONNEL MANAGEMENT

A.8.1. Recruiting/Hiring.

Acquiring staff with the required expertise.

A.8.2. Promotion to Managerial Positions.

Having the most appropriate persons in supervisory and managerial positions.

A.8.3. Advancement of Technical Staff.

Promoting technical staff within their technical or professional stream.

A.8.4. Compensation.

Compensating employees for their contribution to the RTO, to encourage high performance, and to attract appropriate talent.

A.8.5. Decision on Compensation Package.

How are decisions made regarding compensation?

A.8.6. Non-Pay Based Rewards.

Encouraging and rewarding high performance in ways other than salary and bonuses.

A.8.7. Staff Evaluation.

Identifying the need for staff improvement.

A.8.8. Discharging Staff.

Ability to remove staffs that are not needed.

A.8.9. Internal Communications.

Instilling an understanding of common purpose in the employees.

A.9 NETWORKING

A.9.1. Relations with Technology Providers.

Developing mutually beneficial relationship with other technology providers.

A.9.2. Relations with Industry.

Developing mutually beneficial relationship with industry in order to better understand its needs.

A.10. POLICY AND PROGRAMMES

A.10.1. Role of RTO in Science and Technology Policy.

RTO's role in helping the country (or other political unit) form its science and

technology and industrial policies.

A.10.2. Use of Government Programmes.

Taking advantage of government programmes that help RTO meet its goals.

APPENDIX B

OVERVIEW OF RTOs BEST PRACTICES

The following is a list of best practices as identified in the WAITRO study, arranged by major process areas (Mengu and Grier, 1999):

B.1. RTO Governance

i. The RTO should be controlled by an industry association if serving an industrial sector or by a regional government if serving a region.

ii. Its legal structure should be such that it has financial and decision making autonomy (agency, foundation).

iii. The majority of representatives on an RTO board must be industry clients.

iv. The RTO's mandate should be defined according to the role its client serves in the innovation chain.

v. The RTO chief should nominate people to sit on the board with the owner approving (or rejecting) his/her nominations.

vi. RTO management must identify the needs for change and have the power to address those needs.

B.2. Financial Management

i. RTOs need an accounting system that provides total, unit, and project financial information as soon as possible (on-line is best, then weekly, biweekly).

ii. The RTO should be accountable for deliverables rather than to controls that govern how money is spent.

iii. The RTO should be able to retain surpluses and losses.

iv. Industry cess funds and RTO membership fees are effective methods of funding RTOs, providing industry has significant input into the use of the funds.

v. A government-owned or regional RTO should have not less than 25 % and not more than 50% unrestricted grant.

B.3. RTO Services

i. Offering a few primary service types gives better results than many service types.

ii. Market pull (industry committees, consultations) is the best way to determine the service types to offer.

iii. Feedback processes from clients (meetings, surveys) are necessary to ensure service quality.

iv. Grant funding should be provided in proportion to client revenue and be used to fund service development rather than administration.

v. Identifying and applying appropriate technology is often better solution than developing new technology.

vi. RTOs serving SMEs generally need to provide testing, information dissemination, and consulting, more than research.

vii. RTOs serving larger, more technologically developed clients are more successful if they concentrate on applied research and experimental development.

B.4. Business Development

i. A corporate business development group should handle awareness and market strategic planning, while project managers conduct the bulk of selling activities.

ii. Rewards for business development (financial and recognition) are effective.

APPENDIX B (continued)

iii. RTOs need to monitor business development costs at corporate and unit levels.

iv. Awareness activities focusing on major client groups need to be conducted.

v. Client needs should be identified based on input from staff, board and regular meetings with industry groups.

vi. Market-based rather than cost-based pricing should be used (although it is necessary to know costs).

B.5. Organizational Management

i. "Guided Missile" (project-oriented, management by objectives) style is best for RTOs.

ii. "Eiffel Tower" (hierarchical, management by job description) style is bad.

iii. An RTO's business units must have full responsibility for financial performance (revenue and costs).

B.6. Project Management

i. RTOs need to form project teams that have the appropriate expertise for each project, regardless of where individuals report in the organization.

ii. Project managers should be given authority and responsibility to manage projects with out interference once they have been thoroughly checked by management with contact expertise.

iii. A committee of industry and RTO experts should decide on grant-funded projects.

iv. Individuals at all levels should interact with clients and formulate projects.

v. Project managers need a financial management system that monitors expenses against the project budget, and progress against the project plan.

vi. Project follow-up with the client is an essential component of project management.

APPENDIX B (continued)

B.7. Capability Building

i. Input from the market (industry), client majority boards, those following the technology, and an effective performance management system, are all necessary for identifying capability-building opportunities.

ii. A concerted effort by the management team to make capability-building plans is much more effective than decisions by individual managers.

iii. Successful RTOs have at least two professionals for each non-professional staff.

B.8. Personnel Management

i. A flexible recruitment system is needed, which uses input from managers, co-workers and human resources department to select appropriate new staff and promote existing ones.

ii. RTOs should set market-competitive salary scales with market salary data, and reward high performance.

iii. Non-pay based awards (formal and informal recognition events are effective motivators.

iv. Compensation package decisions should be made by the management team for each staff person using the results of individual performance evaluations.

v. Employees should be evaluated against common objectives by the supervisor and the RTO's senior management team and the results should be communicated verbally and in writing.

vi. RTOs should have the authority to dismiss staff that no longer meets the RTO's needs.

vii. Internal communication systems are essential to successful RTO operation, especially if interviewing (with the possible use of a questionnaire) of CSIR's staff and management, as well as collaborating SME managers. Similar approach will be applied to the RTO in either Sweden or Finland. there are more than 40 staff members

APPENDIX B (continued)

B.9. Networking

i. RTOs need to support some low-cost and some high-quality networking methods with technology providers.

ii. RTOs should use at least four methods of interacting with industry to understand client needs.

B.10. Policy and Programmes

i. RTOs should concentrate on providing appropriate technology.

ii. RTOs need access to government programmes for which they compete with othe technology providers.

APPENDIX C

SURVEY OF ORGANIZATIONAL AND WORK SYSTEMS TRANSFORMATION IN RESEARCH AND TECHNOLOGY ORGANIZATIONS (RTOs)

INTRODUCTION

Benchmarking has been proved to be a very effective method for improving work practices, but the inhibiting factors that prevent the successful implementation of benchmarking, especially in work organization and systems, has not been fully established (Mengu and Grier, 1999). Research and Technology organizations (RTOs) have been encouraged to use the benchmarking methods (sampled from other successful RTOs and compiled by WAITRO) using the WAITRO implementation model as guide. Yet, most RTOs have been unable to adopt and internalize these best management practices. Failure to adopt such best management practice may be due to lack of adequate resources to effect change, or a result of old-fashioned organizational cultural practices.

The aim of this survey is **TO UNDERSTAND ORGANIZATIONAL AND WORK SYSTEMS TRANSFORMATION IN RTOs FROM THE PERSPECTIVES OF THE "BEST PRACTICE" MODEL DEVELOPED BY WAITRO.**

1. Name of RTO location (State/Region & Country)

.....

2. Client specification

- [ ] Small-scale industries only
- [ ] Medium-scale industries only
- [ ] Large-scale industries only
- [ ] Small- and Medium-scale industries
- [ ] Medium- and Large-scale industries
- [ ] All categories of industries

3. According to a WAITRO report, there is no significant difference in the type of organizational and management problems faced by RTOs, whether in the industrially developed or developing countries. What is your organization's impression on this observation? *(Figures in parenthesis are codes for official use only)*

- [ ] Strongly Agree (4)
- [ ] Agree (3)
- [ ] Agree (but with reservation) (2)
- [ ] Disagree (1)
- [ ] Strongly Disagree (0)

4. How many organizational and work system transformations, including the on-going one, has your organization undergone over the past 10 years (since 1992).

- [x] 1
- [x] 2
- [x] 3
- [x] 4
- [x] 5 or More

5. Which of the following approaches did your organization follow in the implementation of the WAITRO Best Practices (benchmarks).

- [x] Adoption (exact procedure as recommended by WAITRO)
- [x] Adaption (WAITRO procedure with relevant modifications)
- [x] Other (different from WAITRO recommended procedure)

6. The following is a list of "Best Practices" documented by WAITRO *(see Appendix for the summary).* Put "X" below the process used by your organization to implement each one of them (i.e. Adopted or Adapted, or Other Process), and rate the level of progress recorded which scales from "Very Poor" (VP) to "Excellent" (E).
(Figures in the 5th column are codes for official use only).

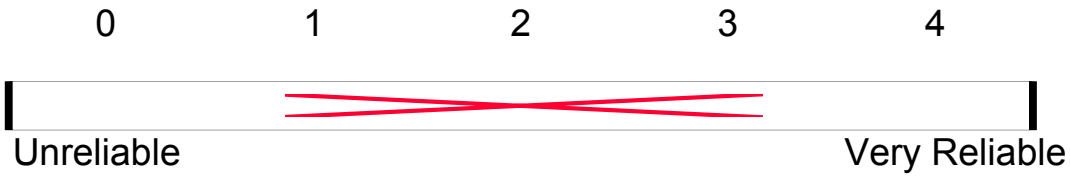
	ADOPTED	ADAPTED	OTHER PROCESS	RATING FOR PROGRESS (mark along the line) VP E 0 1 2 4 5 6
RTO Governance				
Financial Management				
RTO Services				
Business Development				
Organizational Management				
Project Management				
Capability Building				
Personnel Management				
Networking				
Policy and Programming				

7. From your organization's viewpoint, which of the following factors tended to serve as inhibiting constraints to your WAITRO "Best Practice" implementation efforts. Tick as many as applicable to each specific "Best Practice".

CONSTRAINT FACTORS / BEST PRACTICES	Political	Socio-Economic & Legal	Consumer & Marketing Forces	Communication Interfaces	Decision Making	Education Background	Culture & Climate * *see the note below*	Subsystem Stability ** *see the note below*
RTO Governance								
Financial Management								
RTO Services								
Business Development								
Organizational Management								
Project Management								
Capability Building								
Personnel Management								
Networking								
Policy & Programming								

Note: * (e.g. autonomy, cohesion, trust, pressure, support, recognition, fairness, innovation).
** (e.g. production, level of formalization, participation).

8. Rate the reliability of your organizations Management Information System (MIS) before applying the WAITRO "Best Practices" to your work and organizational systems. *(Figures are codes for official use only)*



9. The following is a set of statements about the significance of "Best Practices". For each statement, please say whether you strongly agree, agree, are neutral, disagree, or strongly disagree with it. Tick the appropriate box. *(Figures in parenthesis are codes for official use only)*

	Strongly Agree (4)	**Agree (3)**	**Neutral (2)**	**Disagree (1)**	**Strongly Disagree (0)**
Best practices can be transferred across national and organizational boundaries.					
Best management practices are not the preserve of RTOs in rich countries.					
Focusing on clients needs is the number one best practice.					
RTOs that receive more than half of their funds directly from industry, or in a manner that its use is controlled by industry, become industry-focused.					

10. Which of the following mechanisms did your organization use to select a WAITRO "Best Practice" for application.

- [x] Decision of Organization's Board.
- [x] Decision of Management.
- [x] Personal discretion of Managing Director.
- [x] Recommendation by an external consultant.
- [x] General review involving senior management staff and junior staff representatives, as well as representative of government, clients and other stakeholders.

11. Give an indication of your organization's staff informed knowledge and understanding about the changes (WAITRO's Best Practices) they were putting into practice.
(Figures in parenthesis are codes for official use only)

- [x] Very little. (1)
- [x] Little (2)
- [x] None (0)
- [x] Much (3)
- [x] Very much (4)

12. Give an indication of clients knowledge and understanding about the changes (WAITRO's Best Practices) your organization chose to pursue. *(Figures in parenthesis are codes for official use only).*

- [x] Very little. (1)
- [x] Little (2)
- [x] None (0)
- [x] Much (3)
- [x] Very much (4)

13. Give an indication of stakeholders' knowledge and understanding about the changes (WAITRO's Best Practices) your organization chose to pursue. *(Figures in parenthesis are codes for official use only).*

- [x] Very little. (1)
- [x] Little (2)
- [x] None (0)
- [x] Much (3)
- [x] Very much (4)

14. Kindly give an indication of the level of cooperation received during WAITRO "Best Practices" implementation efforts by your organization from the following. Tick the appropriate box.
(Figures in parenthesis are codes for official use only).

	Very High (4)	High (3)	Low (2)	Very Low (1)	None (0)
Board					
Senior Management Staff					
Junior Staff					
Clients					
Government					
Other Stakeholders					
Internal Organizations (competitors)					
External Organizations (donors/funding agencies)					

15. Any other information, which in your opinion, would be of great value to this research and which was not covered by this survey would be very much welcomed. Kindly provide such information on a separate sheet.

****

THANK YOU VERY MUCH FOR YOUR COOPERATION

****

NOTE:

THIS IS PART OF AN MSc RESEARCH PROJECT IN MACROERGONOMICS AT THE DIVISION OF INDUSTRIAL ERGONOMICS, DEPARTMENT OF HUMAN WORK SCIENCE, LULEÅ UNIVERSITY OF TECHNOLOGY, SWEDEN

APPENDIX D

STRUCTURED INTERVIEW QUESTIONS ON THE COMBINED MICRO- AND MACROERGONOMIC STUDY OF THE APPLICATION AND INTERNALISATION OF WAITRO "BEST PRACTICES" BY RESEARCH AND TECHNOLOGY ORGANIZATIONS

****

1. How will you classify your Institute's workers, in terms of the activity that they perform, either as individuals or a group?

2. From your observation, do you think that your Institute's workforce, whether as individuals or as a group function in a way which tends to affect the organization's desired objectives of achieving a desired outcome regarding your main productive purposes?

3. Do resulting outcomes of activities undertaken by your Institute normally differ from your desired outcomes?

4. What is your impression about the instruments and materials used by your Institute to perform activities (i.e. anything that is needed or useful for your workers when performing their activities)?

NOTE

This can be raw materials, tools, components, equipment, technologic artefacts like machines, transport system, computers, safety protective devices etc. Consider the instruments to include money, theoretical models, other human actors, information, communication, etc.

5. What is your opinion on existing institutions (like formal and informal rules) in relation to their influence on your Institute's activities? This can be legislation, agreements, and internal rules at the Institute and workplace level, as well as shared values, attitudes and "hidden agenda".

6. How do you view the current state of your Institute's division of labour, especially between the human and non-human actors involved in or interacting with activities?

APPENDIX D (cont'd)

7. Can describe the decision-making system and power relations in your Institute's activity system?

8. How do you view the reactions of the surrounding society as well as the prevailing market, among others, to your Institute's performance and service delivery?

9. How will you classify the physical environment in which your Institute's activity takes place?

10. How will you classify the natural environment with which your Institute's activity interacts?

11. Lastly, could you tell me a brief history about your Institute?

****

THANK YOU VERY MUCH FOR YOUR COOPERATION

****

APPENDIX E

ACTIVITY STUDY RESULTS

FOOD RESEARCH INSTITUTE (FRI), CSIR

ACCRA, GHANA

E.1 : VISION

The Food Research Institute's vision is to be recognized nationally and internationally as an S & T institution that is playing a key role in the transformation of the food processing industry to be internationally competitive with particular reference to product safety, quality and presentation.

E.2 : MISSION

The Institute's mission focuses on providing scientific and technological support to the growth of the food and agricultural sectors of the national economy in line with corporate prioritisation and national objectives. Primarily, the FRI's mission is to conduct market oriented applied research and provides technical services and products profitably to the private sector and other stakeholders. To do this the FRI will conduct business in a conducive and transparent working environment with a cadre of highly qualified and motivated staff for timely delivery of quality services and products to clients.

E.3 : GOAL

The overall goal of the Institute is to assist in poverty alleviation through creation of opportunities for generating and increasing income within the micro, small, medium and large scale food industry; contribute to food security, foreign exchange earnings and the application of cost-effective food processing technologies that are environmentally friendly.

E.4 : OBJECTIVES

i. To develop and provide technical information, training and services to the private sector and other stake holders in the food industry.

APPENDIX E (cont'd)

ii. To provide appropriate technology packages for processing and storage of raw agricultural produce to facilitate curtailment of post harvest losses and promote value addition for local and export markets.

iii. To strengthen the Institute's capability and linkages with industry through human resource and infrastructure development, restructuring and re-organization for effective commercialisation of operations.

E.5 : PERSONAL OBSERVATIONS.

1. Problem of effective communication within the system.
2. Lack of adequate incentive to the staff.
3. Absence of effective tools, such as computers to facilitate administrative work.
4. Apparent lack of good and quality operational transportation.
5. Existence of vertical and hierarchical management structure.
6. Apparent non delegation of duty.
7. Lack of trust of the working environment by the staff.
8. Apparent lack of commitment to the institutional objectives by the staff.
9. Sidelining of junior staff in the implementation of change programmes.
10. lack of interest shown by senior research staff on issues not bringing direct benefit to individuals
11. Research staff show of disinterest in participation of workshop due to non receipt of feedback from previous workshops. Felt time was wasted.
12. Bureaucratic management approach.

APPENDIX E (cont'd)

E.6 : EXTRACTS FROM STRUCTURED INTERVIEW.

1. Staff can be said to be motivated as individuals, but collectively, they are not because they depend on the government for their remunerations which are not adequate.
2. Staff classified into three main groups. These are the Research Scientist (senior staff), Technical staff (middle level personnel), and the junior staff (both skilled and unskilled).
3. Institute's workforce does not fully function in a way which tends to affect the Institute's desired objectives of achieving a desired outcome regarding its main productive purposes.
4. Activities involve mainly donor funded projects with specific outcome requirements. Thus resulting outcomes do not really differ from desired outcomes.
5. Instruments and materials used to perform activities are can be viewed as adequate, since most of them come with the donor funded projects.
6. Such instruments and materials favour scientific research work.
7. Instruments and materials for administrative work is highly inadequate, and this tend to have a great negative impact on the overall output efficiency of the institute's activities.
8. Poor facilities for junior staff to carry out their functions result in output delays which extend to affect the desired outputs of the research staff.
9. Inability to provide adequate facility to the junior staff as part of the change process can be seen as a drawback for the institute.
10. Possible flaws in the act of parliament establishing the Institute,
11. Commercialisation forced on the Institute without really understanding the fundamentals of the change process as highlighted in the WAITRO report.

APPENDIX E (cont'd)

12. Consultants hired to effect the change process were highly incompetent. This is because; they were using the opportunity to offer employment to their own staff without really understanding the issue before them.
13. Consultants were finally disengaged.
14. Institutional rules are O.K. No negative observations regarding shared values and staff attitudes in relation to the Institutes internal rules.
15. Current state of the Institute's division of labour, especially between the human and non-human actors involved in or interacting with activities is good, especially after the restructuring exercise which took place.
16. The Internal Management Committee is the main decision-making body with representation from all the classified staff categories. They approve every decision that is taken.
17. Surrounding society has not come to terms with the concept of commercialisation.
18. Society still views the Institute as a government entity and thus research findings should be taken for free.
19. Government has not come out with favourable terms to enhance commercialisation.
20. Institute's drive to get to the society is not being effective.
21. Develop technologies continue to gather dust on the shelves.
22. Institute was given up to the year 2000 to generate 30 % of income, but have up till now (2002) been able to generate only 6 %.
23. Commercialisation effort can thus be classified as not successful.

APPENDIX E (cont'd)

24. Locally, the market for developed technology is not there, because the local entrepreneurs cannot afford the cost of technology developed by the Institute. The other option is for the Institute to explore the competitive external market, which it has not been able to do yet.

25. The Institute collaborates with some organizations, both in the field of research and industry, whose production inputs are the outputs from the Institute, as a way exploring marketing avenues.

26. Institute currently engaged in multiplicity of functions due to the weakness of the collaboration efforts.

27. New mandate requires that the Institute generates two-third of its revenue, in the same way as the organizations. This has resulted in some kind of competition and rivalry hence the need to adopt the multidisciplinary approach (i.e. delving into extended areas instead of collaborating with others who have superior expertise and facility).

28. Lack of effective collaboration also due to the lack of intellectual and property right laws which might prevent collaborating partners from unduly exploiting the Institutes products by taking credit to what is due to the Institute.

29. The natural environment, such as the market forces and politics, is not favourable, because the central government does not see science and technology as a priority as compared to other issues.

30. Budget allocation for science and technology is 0.4 % of the Gross Domestic Product.

31. Instability in the sub-regional also affects RTO development.

32. Institute faces competition from other organizations, such as the Universities, the Ghana Standard Board (whose action is a deviation), international organizations, as well as other organizations in the sub-region.

APPENDIX E (cont'd)

33. There is lack of operational synergy among the various Institutes of the CSIR. This is because of the multiplicity of functions, some of which are a repetition of other Institute's functions and hence a deviation from mandate.

34. CSIR has become a huge bureaucratic entity. There is the need for the CSIR to be restructured to meet the Institute's current expectation.

35. Senior Research staff has seen the need for restructuring and has made recommendation to government to restructure the NIRP to involve people within the CSIR in the restructuring effort.

APPENDIX F

ACTIVITY STUDY RESULTS

INSTITUTE OF INDUSTRIAL RESEARCH (IIR), CSIR, ACCRA, GHANA

F.1 : MANDATE AND OBJECTIVES

The mandate of the Institute of Industrial Research (a merger of the former Industrial Research Institute and the Scientific Instrumentation Centre) is to undertake research in process and product implementation of appropriate technologies for design and development and to promote adaptive technology, scientific instrumentation and calibration and repair of precision equipment.

F.2 : OBJECTIVES

i. To improve upon and/or adapt existing technologies which will suit the local environment.

   To develop cost-effective intermediate technologies which meet the needs of Ghanaian industries.

ii. To promote technology transfer to enhance the efficiency and competitiveness of Ghanaian industries.

iii. To provide facilities for scientific instrumentation and the repair, maintenance and calibration of scientific, educational and medical equipment.

F.3 : PERSONAL OBSERVATIONS.

1. Increasing staff turnover
2. Low motivation among staff.
3. Poor communication within the Institute's (example, security at the Institute's mains entrance does not know the name of the Institute's Director).

APPENDIX F (cont'd)

4. Inadequate operational transportation.
5. Relaxed attitude among staff.
6. Open management style.

F.4 : EXTRACTS FROM STRUCTURED INTERVIEW .

1. Distinct classification of the Institute's staff –Researcher Scientist, Technical Staff, and Junior Staff.
2. Existence of a rigid promotion criterion for the senior researchers has been a source of discourse and consequently affects morale and commitment.
3. Staff not highly motivated as a result of prevailing poor remuneration.
4. The Researchers, who are mostly engineers and scientists, tend to be more interested in activities related to their field of specialization, rather than the commercialisation and marketing activities of the Institute.
5. Output of staff can be classified as satisfactory in relation to the way they function as individuals or as a group with respect to the Institute's desired objectives of achieving a desired outcome regarding its main productive purposes.
6. Resulting outcomes of activities undertaken by the Institute normally differs from the desired outcomes when the activity does not run according to prepared plan of action.
7. Instruments and materials used by the Institute's workers when performing their activities are considered to be old-fashioned, obsolete and inadequate. The laboratories are ill-equipped.
8. Inadequate Transportation for carrying out operations.
9. Very poor internal communication facilities.
10. Inadequate funds.
11. Increasing staff turnover.

APPENDIX F (cont'd)

12. Existing institutions does not impose restrictions on the Institutes activities.

13. The division of labour between human and non-human actors is not balanced. Lack of adequate non-human actors has resulted to staff not showing much commitment in their interactions with the Institute's activities.

14. The decision-making system and power relations in the Institute are as follows:

    i. Management Board,

    ii. Director (reports to Management Board),

    iii. Divisional Heads,

    iv. Internal Management committee (with representation from Senior Research Staff, Technical Staff as well as Skilled and Unskilled Junior Staff – involve in issues relating to staff discipline, health and welfare).

15. Lack of appreciation from the surrounding society as well as the prevailing market to the Institute's performance and service delivery.

16. Commercial Department responsible for the promotion of the Institute's output and services to the prevailing market and community.

17. Heads of Division meetings only consider issues relating to the Institutes output and not issues relating to its commercialisation.

18. Institute expects interested clients to come to it. It has not been chasing clients.

19. Institute operates in a good physical environment.

20. Lack of collaboration from others.

21. Intra-Institute interaction (reference to CSIR Institutes) is very poor, resulting in the duplication of activities.

APPENDIX G

ACTIVITY STUDY RESULTS

SCIENCE AND TECHNOLOGY POLICY RESEARCH INSTITUTE (STEPRI), CSIR, ACCRA, GHANA

G.1 : VISION

The vision of STEPRI is to be the foremost national institution that facilitates the development of local innovation, enhanced through mastery of proven technologies, and sustainably utilized in accordance with national needs, resources and priorities.

G.2 : MISSION AND MANDATE

The primary mission of the STEPRI is to provide the research support necessary for the formulation and implementation of a comprehensive science and technology policy that seeks to promote innovation and create the enabling conditions for the effective use of science and technology (S&T) for national socio-economic development.

This mission is addressed with the following five-point mandate:

i. S&T policy studies, monitoring and assessment in all sectors of the economy;

ii. Technology evaluation, transfer and diffusion;

iii. Facilitation of commercialisation of technological innovation;

iv. S&T acculturation and popularisation;

v. Survey on S&T human resource development and management

G.3 : PERSONAL OBSERVATIONS.

1. Well-focused staff.
2. Apparent work coordination among the different category of staff.
3. Some elements of internal displeasure emanating from the junior staff.
4. Apparent staff displeasure over prevailing service conditions

APPENDIX G (cont'd)

G.4 : EXTRACTS FROM STRUCTURED INTERVIEW.

1. This is a policy development institute and is not in production.
2. Institute has neither pilot plants nor laboratories.
3. Collate available policies, analyse them and help formulate them scientifically into appropriate policies which could help the government in its policy development.
4. Institute is non-profit.
5. Potentially, the Institute can be viable for making profit, but the level of the country's development will not make it possible for the Institute to be profit-making.
6. Manageable level of staff strength (30).
7. A little bit difficult to go by all the WAITRO recommendation since it has to be customized to meet the different advisory services given to the various research institutes of the CSIR.
8. Institute coordinate science and technology research efforts in the country.
9. Attitude of staff affects the institute's output, both positively and negatively. The staff is small and well knitted together and behaves like a family.
10. Positive collaboration, teamwork and commitment among the staff. Existence of synergy among the different divisions.
11. Non-human factors are a very big constraining factor.
12. The Institute is the least resourced among the 14 Research Institutes, receiving, on the average one (1) percent of the CSIR budget. The Institute is hugely under funded.
13. Minimal complaints from staff despite the resource constraints.
14. Staff is motivated as a result of significant improvement within the institute.

APPENDIX G (cont'd)

15. Management structure is standardized for all institutes under the CSIR. The structure is as follows:

    i. The External Management Board (advisory body to the Director). It has a maximum membership of 11 with 40 percent coming from the private sector. Appointment is made by the CSIR Governing Council (which is the ultimate authority of the CSIR),

    ii. A Director,

    iii. A Deputy Director,

    iv. Divisions (each consists of a minimum of 4 staff with a head),

    v. An Internal Management Committee, which handles issues relating to staff welfare (used by the Director to administer the work environment). Representation includes the following:

        - Heads of Divisions.
        - Labour groups (i.e. Research Scientists, Technical Staff and Junior Staff).

16. For the past four (4) years, the Deputy Director-General is appointed by the Director-General to chair the External Management Boards of all the Institutes so that the Deputy Director-General will report to him directly. There is prevailing argument from the various Institutes to have this changed. Previous experience has shown that using an external chairman is very effective.

17. Similarities in the operations of some of the Institutes, though not the same.

18. Pairing of the Institutes to facilitate idea sharing and avoid duplication of functions due to their having similar mandates.

APPENDIX G (cont'd)

19. Environment in the country is not conducive for the use of science and technology information. The possible exception is in the area of agriculture.

20. Industrial sector is very weak.

21. Most of the activities are happening in the services sectors. Most of the activities are mercantile (buying and selling, with about 80 percent representing imported items).

22. The environment is not favourable to the operations of the Institutes, in relation to their mandate to generate about 30 percent of their budget. This is because; the country's economy is growing as a result of mercantile activities by 5.2 percent, whilst the industry sector is growing at 2.9 percent (which is almost half the growth rate of the mercantile activity). At this growth rate, the demand for S & T services is too weak for the other institutes to be really in business, except perhaps for the agricultural sector.

23. Science and technology helps production, but because production is weak in the country, it is not benefiting from the country's S & T efforts.

24. Even though there is abundant information on S & T available in the country, the capacity and resource for them to be utilized productively as well as effectively does not exist.

25. The economy does not encourage production.

APPENDIX H

REPORT ON FUTURE WORKSHOP CONDUCTED AT THE FOOD RESEARCH INSTITUTE (FRI), CSIR, ACCRA

(Part of MSc. Research Project, 2002/2003)

By

Mohammed-Aminu Sanda

(Division of Industrial Ergonomics, Lulea University of Technology, Sweden)

1. INTRODUCTION

According to the World Association of Industrial and Technology Organization (WAITRO) it has become obvious over the years that key impediment to successful RTO performance is often not technology, but management. The situation has escalated in recent years as governments have, for a variety of reasons, reduced funding to RTOs. Against this background, WAITRO identified a tremendous opportunity to assist its members to improve their capabilities to serve industry by assembling a body of knowledge that would provide the information that the RTOs need to re-structure their management systems. An international collaborative research project was thus launched with the objective of identifying, benchmarking, and documenting successful RTO practices (best practices and underlying principles) and assisting RTOs in the implementation of these principles and practices, so that they can serve their clients better. But from WAITRO's observations, most RTO's have not been able to successfully internalise the WAITRO documented best practices. It thus became necessary to conduct a combined micro- and macroergonomic as well as system study of the application and internalisation of WAITRO-developed best management practices by RTO's. Conduction of the Future Workshop forms part of the study strategy, and the derived outcome is to help in performing activity analysis of the RTO.

APPENDIX H (cont'd)

A Future Workshop is sometimes the direct and immediate tool to identify problems. However, most of the times, it prepares the foundation for;

- New perspectives;
- Future vision; and
- New ideas for solving problems.

The ultimate aim is to involve people in problem identification and problem-solving through a participative process.

The Food Research Institute (FRI) is a member of WAITRO, and by its current mandate, the FRI is supposed to commercialise its products and services. From this perspective, a Future Workshop was conducted on the 7th November, 2002, under the theme "FOOD RESEARCH INSTITUTE's COMMERCIALISATION EFFORTS". The rationale is to help identify problems and/or constraints which might be having negative effect on the commercialisation efforts. Seventeen (17) staff members, ranging from senior research staff to junior staff participated. The participants were taken through the Experience (critic), Phantasy, and Strategy phases of the workshop

2. EXPERIENCE (CRITIC) PHASE.

This is the problem identification phase. Participants were given the chance to voice out what they think are problems or constraints which are hindering the Institute's commercialising efforts. A catalogue comprising forty-one (41) problems/constraints as expressed by the participants was developed.

2.1. Problem catalogue

1. Staff attitude.
2. Demotivation of staff.

APPENDIX H (cont'd)

3. Commercialisation appears to be for some few people and not the whole staff.
4. Commercialisation concept not well understood.
5. Steps for acquiring materials for work.
6. Lack of funds.
7. Separation of commercial division is not total.
8. Failure of industrialists to call for research findings.
9. Staff commitment is negative.
10. Lack of training.
11. Adherence to time.
12. Linkage between FRI and industries not strong.
13. management commitment
14. Lack of refresher courses.
15. Government support.
16. Lack of publicity.
17. poor sanitation
18. Tackling too many things.
19. Cumbersome procedures.
20. Slow response to clients.
21. Inadequate equipment.
22. Marketing not aggressive.
23. Location of the commercial and information division (CID).
24. non-attachment of personnel to industries
25. scattered activities under commercialisation
26. Inadequate promotion of the institute to the public.

APPENDIX H (cont'd)

27. Lack of motivation for clients.
28. Frequent changes in policies.
29. Lack of logistics.
30. Staff's lack of knowledge about the institute's products being commercialised.
31. Most do not know how to give quality service.
32. Sources of raw materials.
33. Price of products and services.
34. Poor administrative services.
35. Quality of goods sometimes questionable.
36. Lack of capacity for potential clients.
37. Delay within the system.
38. strong competition
39. Poor storage facilities.
40. Locating new market.
41. Non-exploitation of full potential.
42. No maintenance schedule for equipment.
43. Electricity and water outages.
44. Inadequate monitoring and audit of purchases.
45. Lack accredited results to clients.

2.2. Critical Problems

Participants voted on the above-listed problems and the outcome showed that the following problems and/or constraints were deemed to be critical.

i. Staff attitude.

ii. Demotivation of staff.

iii. Commercialisation concept not well understood.

iv. Lack of funds.

v. Lack of training.

vi. Management commitment.

vii. Marketing not aggressive.

2.3. Workshop Sub-themes.

Based on the above-listed critical problems and/or constraints, participants developed three (3) sub-themes for the workshop. These are as follows:

iv. Reorientation of staff towards the commercialisation of activities and general attitude to work.

v. Lack of management commitment (with emphasis on training, funding, and staff demotivation).

vi. Marketing.

3. PHANTASY PHASE

The participants after selecting the sub-theme they prefer working on formed three (3) groups with each group handling one of the sub-themes. Participants in each group phantasized as to the best solutions to help overcome the problems and/or constraints identified with their respective sub-themes. Participants came out of the daily limitations which usually lead to restraints, traditional thinking, and acting. As a result, many new ideas that the participants have in their unconsciousness popped up by after thinking over their daily limitations. Everything was considered to be possible with in this phase (i.e. no cultural barriers, and also no economic, personal, technical, and organizational limitations). For each group, each

member's fantasy was discussed with regards to its ability to solve one or more of the problems associated with the group's specific theme. Disagreement within the group was allowed and accepted. The phantasies developed by each group for specific sub-theme are as listed below. These are "FUTURE VISIONS" that are supposed to have enough power to solve all the critical problems that the groups have decided to work with. Participants further conducted a "Desirability (D) and Possibility (P)" assessment of their various alternate solutions which allows for the practical choice of the most feasible.

b. Reorientation of staff towards the commercialisation of activities and general attitude to work.

i. Train staff on work ethics. *[D=100%; P=90%]*

ii. Develop flowchart to show the inter-dependence of grades of staff and units. *[D=90%; P=80%]*

iii. Indiscipline among the staff should not be tolerated, and offenders should be sanctioned. *[D=80%; P=70%]*

iv. Institute best worker and discipline awards. *[D=80%; P=80%]*

v. Motivate staff with long service awards (example, 10 years and above). *[D=100%; P=80%]*

vi. Senior members must set good examples, in terms of discipline and hard work. *[D=90%; P=90%]*

vii. Improve security and the environment (uniforms, record-keeping of visitors, landscaping of the environment). [*D=100%; P=60%]*

viii. Every staff to sign attendance book (both "in" and "out"). *[D=80%; P=80%]*

APPENDIX H (cont'd)

ix. Proper arrangement should be made before staff is recruited (such as office accommodation and job description). Such new staff should go through orientation and counselling from time to time. *[D=80%; P=70%]*

x. Supervision should be improved at all levels. *[D=100%; P=100%]*

c. Lack of commitment (with emphasis on training, funding, and staff demotivation).

i. Management should have a programme for training of staff and must implement it. *[D=100%; P=80%]*

ii. Training needs of staff should be identified on periodic basis (yearly). *[D=100%; P=100%]*

- Use of equipment.
- New methods.
- Upgrading of professional skills.
- Attachment/secondment to industries.
- Within 3 years, each member of staff should have opportunity to attend refresher courses, attachment etc.

iii. Funds should be sourced and prioritised. *[D=1000%; P=80%]*

- Expenditure to be managed to avoid wastage of limited resources.
- Monitoring and auditing of purchases to ensure maximum benefits for services.
- Goods and services should be properly priced.

- Quick release of funds for commercial activities, and timely delivery of inputs.

iv. Staff should be motivated by level of work done. *[D=70%; P=50%]*

- Certain staff in certain categories do not have stringent criteria for promotion (i.e. there should be different lines of progression for different categories of non-research staff. For example, a Chief Technical Officer in the mechanical workshop should not be equated to that in the laboratory where so many courses have to be taken before progression).
- Incentive should be given to staff that excel (e.g. long service awards – i.e. 5, 10, 15, 20 years etc.).
- Loans should be given to staff promptly, and easily accessible.
- Administrative support should be improved (e.g. delivery of services – maintenance work, requests, etc).
- Working environment should be improved (fans, air-conditions, common-room to relax during lunch).
- Electricity and water supply should be constant (e.g. generators should serve the purpose for which they are installed by the provision of fuel).

d. Marketing.

i. Serious conscientization of top management and staff in marketing. *[D=90%; P=90%]*

ii. Staff periodic orientation in marketing. [*D=90%; P=90%]*

iii. Research must address the marketing concept. *[D=90%; P=40%]*

iv. Institute must embark on aggressive promotional activity. *[D=90%; P=60%]*

v. Identifying products with competitive advantage. *[D=90%; P=50%]*

vi. Identifying potential clients *[D=90%; P=60%]*

vii. Developing strong linkages between FRI and industries. *[D=90%; P=80%]*

viii. Set achievable targets. *[D=90%; P=55%]*

ix. Establishing good customer relationship. *[D=90%; P=70%]*

x. Rewarding for exceptional performance or contribution. *[D=90%; P=50%]*

xi. Just-in-time delivery to clients. *[D=90%; P=70%]*

4. STRATEGY PHASE

The participants then discussed the two most feasible solutions proposed by each group and collectively agreed on one solution each to be realized by each group, based on the respective sub-themes. In the realization approach, each group sought to find all barriers that are existing for the realization of the fantasies, taking into consideration the following factors;

- Economic,
- Technical;
- Organizational; etc.
- Realities that are existing in the organization;
- Realities that are existing in the society

The Participants discussed in group basis as to whether any of the real barriers they identified could be removed. Afterwards, each group tried and prepared a plan and/or a programme for

change which could make it possible to realize the fantasies that the group has decided should be realized. The outcome of this phase is as summarized below under each specific sub-theme.

a) REORIENTATION OF STAFF TOWARDS THE COMMERCIALISATION OF ACTIVITIES AND GENERAL ATTITUDE TO WORK.

i. Selected solution.

Train staff on work ethics.

ii. Existing barriers.

The following were identified as barriers to supervision within the system.

- Indiscipline.
- Insubordination.
- Unfairness/favouritism.
- Setting of bad examples.
- Absence of mutual respect amongst staff.
- Irresponsibility.
- Absenteeism/lateness to work or meetings

iii. Plan and/or Programme of Action.

The following actions were proposed as the required steps necessary for achieving the solution.

- Divisional or Unit "open" forum for informal discussion (at least once a quarter).
- Making use of communication skills and interactions with subordinates.
- Institution of socialization activities at Unit/Division level.
- Staff should be made familiar with conditions of service at all levels.

- Institute channels for complaints (e.g. suggestion box).
- Supervision at all levels should be encouraged to set good examples.

b) LACK OF COMMITMENT

(with emphasis on training, funding, and staff demotivation).

i. Selected Solution.

Funds should be sourced and prioritised.

- Expenditure to be managed to avoid wastage of limited resources.
- Monitoring and auditing of purchases to ensure maximum benefits for services.
- Goods and services should be properly priced.
- Quick release of funds for commercial activities, and timely delivery of inputs.

ii. Existing Barriers.

The following were identified as the prevailing barriers.

i. Lack of funds
ii. Untimely delivery of goods and services.
iii. Inability of clients to pay for products and services.
iv. Inadequate monitoring and auditing of purchases.
v. Unavailability of inputs from suppliers.
vi. Transportation and financial problems.

APPENDIX H (cont'd)

iii. Actions to Remove Barriers.

The following actions were proposed for removing the existing barriers in the order in which they appear.

vii. Good business plan to convince funding agencies.

viii. Timely delivery as well as attitudinal change.

ix. Prices of goods and services must be affordable.

x. Proper auditing.

xi. Better planning for the provision of inputs (i.e. advance and timely preparation of estimates).

xii. Better remuneration.

iv. Programme of Action.

The following action programme was recommended.

xiii. Monthly review of commercial activities.

xiv. Constant monitoring of daily activities (for determination of bottlenecks.

xv. Penalizing staff for non-conformity.

c) Marketing.

i. Selected Solution.

Developing strong linkages between FRI and industries.

ii. Plan and/or Programme of Action.

Aim: - Sustaining Clients.

Objectives: - Sustain already existing clients.

- Win 10 new clients annually.

- Increase revenue by 70 %.

APPENDIX H (cont'd)

Action: - Visit to key clients twice every year by the Commercialisation and Information Division (CID) and experts to discuss FRI's services provision to them.

- Invitation of key clients to FRI's "end of year" get-together.
- Visit to industries to prospect for clients.
- Participating at trade fairs and exhibition.
- Provision of updated brochures.

APPENDIX H (cont'd)

LIST OF PARTICIPANTS

1. DR. Amoa Awua	Dep. Director (Experience Phase only)
2. Mr. Ben Awortwi	Microbiology Laboratory
3. Mr. Charles Reynolds	Commercialisation & Information Div.
4. Mr. David K. Asiedu	Microbiology Laboratory
5. Mrs. Magaret Obodae	Microbiology Laboratory
6. Ms. Mary Halm	Processing Hall
7. Mr. William Amevor	Chemistry Laboratory
8. Madam Kate O. Acheampong	Processing Hall
9. Mr. Sam Tagoe	Chemistry Laboratory
10. Madam Gladys Neequaye-Tetteh	Fisheries Resource Centre
11. Mr. Kafui Kpodo	Chemistry Laboratory
12. Mr. Patrick Feglo	Microbiology Laboratory
13. Mr. Godwin Armah	Processing Hall
14. Madam Phoebe Lokko	Fisheries Resource Centre
15. Mr. J. K. Magbo	Engineering Workshop
16. Mr. Philip O. Baidoo	Commercialisation & Information Div.
17. Mr. Patrick O. Mintah	Engineering Workshop
Mr. Mohammed-Aminu Sanda	

APPENDIX I

REPORT ON FUTURE WORKSHOP CONDUCTED AT THE SCIENCE AND TECHNOLOGY POLICY RESEARCH INSTITUTE (STEPRI), CSIR, ACCRA

(Part of MSc. Research Project, 2002/2003)

By

Mohammed-Aminu Sanda

(Division of Industrial Ergonomics, Lulea University of Technology, Sweden)

1. INTRODUCTION

According to the World Association of Industrial and Technology Organization (WAITRO) it has become obvious over the years that key impediment to successful RTO performance is often not technology, but management. The situation has escalated in recent years as governments have, for a variety of reasons, reduced funding to RTOs. Against this background, WAITRO identified a tremendous opportunity to assist its members to improve their capabilities to serve industry by assembling a body of knowledge that would provide the information that the RTOs need to re-structure their management systems. An international collaborative research project was thus launched with the objective of identifying, benchmarking, and documenting successful RTO practices (best practices and underlying principles) and assisting RTOs in the implementation of these principles and practices, so that they can serve their clients better. But from WAITRO's observations, most RTO's have not been able to successfully internalise the WAITRO documented best practices. It thus became necessary to conduct a combined micro- and macroergonomic as well as system study of the application and internalisation of WAITRO-developed best management practices by RTO's.

APPENDIX I (cont'd)

Conduction of the Future Workshop forms part of the study strategy, and the derived outcome is to help in performing activity analysis of the RTO.

A Future Workshop is sometimes the direct and immediate tool to identify problems. However, most of the times, it prepares the foundation for;

- New perspectives;
- Future vision; and
- New ideas for solving problems.

The ultimate aim is to involve people in problem identification and problem-solving through a participative process.

The Science and Technology Policy Research Institute (STEPRI) of the Centre for Scientific and Industrial Research (CSIR) is a member of WAITRO, and by its current mandate, the STEPRI is supposed to put into proper perspectives, Ghana's strive towards achieving a better science and technology status through the formulation of effective science and technology policies for the country. From this perspective, a Future Workshop was conducted on the 6th November, 2002, under the theme "STEPRI's EFFORTS TOWARDS BEST MANAGEMENT PRACTICE". The rationale is to help identify problems and/or constraints which might be having negative effect on the institute's prevailing management capacity. Twelve (12) staff members, including the Institute's Director participated. The participants went through the Experience (critic), Phantasy, and Strategy phases of the workshop. Round-table discussion format was adopted in the proceedings.

APPENDIX I (cont'd)

2. EXPERIENCE (CRITIC) PHASE.

This is the problem identification phase. The participants initial sought clarification on the specific areas of the management practices to be considered. Based on this, highlights of the WAITRO documented ten (10) best management practices were given by Mr. Moses Mengu. The areas covered are as follows:

1. RTO Governance
2. Financial Management
3. RTO Services
4. Business Development
5. Organizational Management
6. Project Management
7. Capability Building
8. Personnel Management
9. Networking
10. Policy and Programmes

The prevailing management system and practice in the Institute, in particular, and the CSIR as a whole was also outlined to the participants by the Director of STEPRI. With these information base, participants were given the chance to voice out what they think are problems or constraints which are hindering the Institute's best management practice efforts. A problem catalogue as summarized below was thus developed.

2.1. Problem Catalogue

1. Composition of the CSIR Council.
2. Deputy Director-General of CSIR serving as the chairman of Management Boards of the Institutes.

APPENDIX I (cont'd)

3. Management Board not making any impact on policies.
4. Criteria for promotion of staff too ambiguous.
5. Information flow.
6. Inability of the Institute to compensate individual researchers.
7. Non-orientation of Board members after appointment.
8. Huge expenditure on Board meetings.
9. Lack of sufficient meeting of the boards.
10. Lack of interaction between the boards and the respective Institutes.
11. Non-representation of general staff on the Management Boards.
12. Standardization of administrative structures problematic.
13. Supervision role of the Deputy-Director Generals over the Directors.
14. Coordination function of CSIR institutes by the Deputy-Director Generals not being carry out.
15. Huge sitting allowances being paid to the board members.
16. Constraints due to Location and activities of Management Board members.
17. Non-consultation of staff before appointments is made to management board.
18. Board not assisting the institute to overcome inherent bureaucracy within the system,
19. Board not assisting the institute to source for funds.
20. Board not assisting the institute in dealing with the political environment.
21. Non-awareness of staff to staff representation on the CSIR Council.
22. Institute does not have the capacity to handle some viable projects.
23. Over-centralization of Institute management.
24. Limitation of the Director's authority by the Deputy Director-General.

APPENDIX I (cont'd)

25. Lack of adequate information to the institutes.
26. Delay in the release of subventions to the institutes.
27. One person, the Deputy Director-General, chairing the boards of 5 institutes.
28. Interaction between board and institute.
29. Effectiveness of the Deputy-Director Generals as supervisors of Institutes.
30. Strong influence of the political environment.
31. No benefit from external Board members.
32. High expenditure on Board meetings.
33. Level of Management Board's authority.
34. Communication problems.
35. Lot of bureaucracy from the CSIR administration.

2.2. Critical Problems.

Participants, by general consensus, agreed that the following problems and/or constraints could be deemed to be critical.

vi. Role of the Deputy Director General of the CSIR on the Institute's Management.
vii. Service being rendered by individual members of the Management Board.
viii. Functions performed by the CSIR administration (head office) as opposed to functions performed by the Institute's management.
ix. Over-centralization within the CSIR system.
x. Question of staff representation on the Management Board.

2.3. Workshop Sub-theme.

Based on the above-listed critical problems and/or constraints, participants settled on the topic *"Governance and capacity-building"* as the sub-theme for the workshop.

APPENDIX I (cont'd)

3. PHANTASY PHASE

By virtue of their number, and to ensure effective input, the participants elected to work as a unit instead of breaking into group. As such, the sub-themes were considered one after the other by all the participants. Participants phantasized as to the best solutions to help overcome the problems and/or constraints identified with the sub-theme. Participants came out of the daily limitations which usually lead to restraints, traditional thinking, and acting. As a result, many new ideas that the participants have in their unconsciousness popped up by after thinking over their daily limitations. Everything was considered to be possible in this phase (i.e. no cultural barriers, and also no economic, personal, technical, and organizational limitations). For the respective sub-theme, each member's fantasy was discussed with regards to its ability to solve one or more of the problems associated with the group's specific theme. Disagreement was allowed and accepted. The phantasies developed for the sub-theme are as listed below. These are "FUTURE VISIONS" that are supposed to have enough power to solve all the critical problems that the groups have decided to work with.

3.1. Phantasized Solutions.

e) Directors to be allowed to run divisions.

f) Heads of Divisions should be given increased authority to operate, as well as propose their own budgets.

g) Drawing of effective plan for use of the institutes vehicles.

h) Need for more vehicles.

i) Enhance regular information flow.

j) New staff should be given both divisional and general administrative orientation of the institute.

APPENDIX I (cont'd)

k) Provision of direct access to the internet to each staff.

l) Members of internal management committee to serve on the Board.

m) Staff to approve people appointed to the management Boards.

n) Appoint Management Board Members who can serve as income identification avenues for the Institute.

o) Give same remuneration to the Institute's staff as is given to those in the universities.

p) Improve staff accommodation.

q) Management should be holding regular meetings.

r) Improve staff knowledge on the operations of different divisions within the Institute.

s) Ensure regular down flow of information.

t) Utilizing of internet cafés to accelerate information sourcing.

u) Institute should set its own website.

v) Institute should Network with other Institutions.

w) Provide more facilities such as computers.

x) Institute must run courses to generate more income.

- **STRATEGY PHASE**

The participants collectively discussed the proposed solutions and collectively agreed on the solutions to be realized, based on the sub-theme. In the realization approach, the participants sought to find all barriers that exist for the realization of the fantasies, taking into consideration the following factors;

- Economic,
- Technical;
- Organizational;

APPENDIX I (cont'd)

- Realities that are existing in the organization;
- Realities that are existing in the society

The Participants then discussed as to whether any of the real barriers they identified could be removed. The outcome of this phase is as summarized below under the specific sub-theme.

a). Sub-Theme

Governance and Capacity building

b). Solution.

Decentralize operations within the CSIR in order to make the institute viable.

c). Existing barriers.

i. High staff turnover.
ii. Poor salary for staff.
iii. Mounting staff frustration.
iv. Poor information flow.
v. Incapacitation of Institute directors' efforts by the role of the Deputy Director General.
vi. Lack of access to the internet.
vii. Over-centralization of institute's administration.
viii. Lots of bureaucracy.
ix. Communication gap.

APPENDIX I (cont'd)

4.1. Proposed Action (short Term).

The Director proposed to set in place a mechanism to immediately address issues relating to the following constraints which are within his capacity towards the realization of the solution.

i. Poor information flow.

ii. Lack of access to the internet.

iii. Communication gap.

4.2. General Observation.

The interaction provided an additional platform for the staff and Director to come to a common understanding e on some basic issues which initially were considered as not problematic from the Director's viewpoint, but to the contrary on the part of the staff.

APPENDIX I (cont'd)

LIST OF PARTICIPANT

1. Dr. J. O. Gogo (Director)
2. George O. Esegbey
3. Gladys Kwadzo (Mrs.)
4. G. A. Sampson
5. Emmanuel Tetteh
6. Richard Ampadu-Ameyaw
7. Alex K. Aboagye
8. Johnny K. Aboagye
9. Joseph K. Noonoo
10. Nelson Obirih-Opareh
11. David Tsetse
12. Nana Arko
13. Moses Mengu (WAITRO, Denmark)
14. Mohammed-Aminu Sanda (Facilitator, LTU Sweden)