RESOURCE ALLOCATION FOR ROAD MAINTENANCE FUNDS IN THE MINISTRY OF PUBLIC WORKS AND HOUSING: THE APPLICATION OF "HARD" AND SOFT OPERATIONS RESEARCH

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DEDICATION

Dedicated to my parents Stanley N. Muranga and Anne, for the devotion and loving care they have demonstrated to their children and family. They have acted as a constant re-assuring force in the midst of change and challenge, to keep us all sane.

DECLARATION

This project is my own original work and has not been subject for a degree in any other university.

Signed.....

NJIHIA J. M.

Date.....12/6/96

This project has been submitted for examination with my approval as the University supervisor.

Signed .....

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Abstract

We discuss the application of Peter Checkland's Soft Systems Methodology (SSM) to Road Maintenance Management in Kenya. This is in view of funds generated by the taxes, Fuel Levy and Transit tolls specifically for road maintenance.

We look at whether the Roads Department has the capacity to absorb these funds effectively and if not what needs and can be done about it. In the same vein, funds allocation methods used are analyzed and a Goal Programming model is suggested.

We find that the Roads Department needs to increase its commitment to planning and control functions as an integral part of all its activities. This is possible because certain donor funded units have such systems manned by ministry personnel. The suggested changes were obtained co-operatively and are not solely the researchers findings. Chances of implementation are enhanced if followed up. It is appreciated that termination of the study was arbitrary as all SSM studies are hence participants could follow up on the suggested course of action.

The GP model could not be tested due to lack of reasonable and sensible up to date data. Time and money did not allow us to obtain grassroots information for the model.

The approach used has specific benefits for a developing country especially the learning

achieved by participation, innovative solutions and creates momentum for change in institutions with high inertia.

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LIST OF ABBREVIATIONS

GP	Goal Programming
HMMS	Highway Maintenance and Management System
JICA	Japan International Co-operation Agency
MOPW&H	Ministry of Public Works and Housing
MRP	Minor Roads Programme
PMS	Pavement Maintenance System
RARP	Rural Access Roads Programme

CHAPTER 1 INTRODUCTION

1.1 BACKGROUND

The Ministry of Public Works and Housing is the institution charged with the responsibility of managing the road network in Kenya, for the government. This involves the construction of new roads for expansion of the network and maintenance of existing roads.

There are two general classifications for roads:-

(1) Paved Roads and **(2) Unpaved Roads.** Paved roads are all weather roads, unpaved roads are gravel and earth roads. In 1992, respective lengths totalled to 8700 Km and 54,500 Km respectively. Roads are also classified according to service levels, classes from **A** to **E,** and unclassified roads. They form a comprehensive national network with class **A** roads forming the national trunk roads, and the lowest class is of access roads.

In the period after independence, efforts were concentrated on construction of new roads so the Ministry of Public Works and Housing has well developed capacity in construction management. Maintenance was not emphasised as roads were new so this function is not as well developed in terms of formalised techniques and methods. Maintenance also lacks the political clout and glamour associated with new roads, so politicians lobby for new roads while neglecting

existing ones.

The importance of road maintenance has been highlighted in many reports and studies. Poor roads have adverse effects on agricultural development, affect other sectors of the economy such as tourism, manufacture, trade and commerce, indeed almost everything since transport is a fundamental activity. Within the context of current efforts in liberalization and structural adjustment programmes, the problem of road maintenance was critically examined in a World Bank sponsored proposed study on establishing an appropriate institutional framework for effective management of the entire Kenyan road network- **Road Maintenance Initiative Policy Reform.**

One of the impairing factors was low funding levels. Maintenance was seriously underfunded and it was not possible to do any serious remedial work. This problem has been effectively solved with establishment of a Road Maintenance Fuel Levy and Transit Tolls. The Ministry of Public Works and Housing should receive about 1.8 billion and 0.5 billion will go to the Ministry of Local Government, for the fiscal year 1994/95. Additional funding is expected from donors and the exchequer. With time the Levy is expected to be raised to a level that makes road maintenance self sufficient, at about Kshs. 9 billion.

1.2 ROAD MAINTENANCE - REVIEW OF CURRENT PRACTICE AND MANAGEMENT

This review will concentrate on funds allocation aspects of maintenance. Management systems at the Ministry of Public Works and Housing reflect problems associated with developing countries that take on responsibilities without matching capacity in terms of financial rsources, personal and sufficient authority to carry out decisions.

In general funding levels have been very low, allocation of these funds is done using rule of thumb approach based on experience and previous figures, for example a global factor for inflation is applied to them to obtain the next years estimates.

Under the donor funded Minor Roads Programme, work plans are prepared by District Minor Roads engineers and are used to justify funding requests. The national programme for classified roads lacks such a system. Information flows to and from headquarters are very inadequate. In making allocations to various districts, old estimates are usually revised taking into account politicians complaints in particular districts. Personal lobbying by District Works Officers may also result in their receiving extra funds.

On monitoring and control, there is no system to evaluate expenditure and productivity. In the Minor Roads Programme this is done by donor appointed external auditors.

There is a Canadian developed information system - **HMMS** - (Highway Maintenance and Management System) a pavement maintenance system (PMS) that could potentially cover much of the work. But it was installed by external consultants at high cost without giving consideration to top management and other issues. The result is that when the expatriate and other introductory personnel left, nobody knew how to use it fully. Poor documentation is one problem cited. It is used only for minor allocation works. Further to this, its design requires a very good system for information gathering and dispersion. Given the laid back culture of many civil servants and lack of top management support for the system it is getting reduced to an anachronism.

The planning section of the roads department serves the whole Ministry as a result of unco-ordinated re-organizations in the past. Frequent changes in the Kenyan ministerial structures is largely responsible for this. So it hardly does any planning for road maintenance in particular. It is more of a reactionary unit that prepares feasibility study reports upon request, usually to avail donor funds, or in response to politicians outcries.

Factors like external pressure on senior management, rigidity of civil service labour relations, external control of funding levels and use of non-technical evaluation criteria generally invalidate planning and other efforts to deploy resources efficiently and effectively.

One of the needs identified in the study by Grabowsky and Poort Consulting Engineers on Staff Organisation for Unpaved Roads Maintenance was rationalisation of maintenance polices. One aspect of this is an objective criteria for funds allocation. This study focuses on this aspect

but also takes into account other pertinent organizational issues.

1.3 STATEMENT OF THE PROBLEM

The urgent problem facing the management of the Roads Department is whether they have the capacity to absorb the envisioned funds in a manner that would be acceptable to all stakeholders, especially Kenyan tax payers.

Urgency is necessary because the department has to justify continued funding. Other government agencies are competing for state funds and it would be illogical to most Kenyans to hear that such substantial funds are allocated using ad hoc rules of thumb. Donor agencies and the World Bank are also putting pressure on the Ministry to rationalise its activities. Misuse of such funds would be scandalous to a high degree, and may make it difficult for the department to receive such backing again.

1.4 STUDY OBJECTIVES

1) To identify systems changes that are necessary in the Roads Department of the Ministry of Public Works and Housing to enable it to absorb funds from the Road Maintenance Fund Levy more effectively.

2) To come up with a system model that would allocate the funds in a manner commensurate with goals of various stake holders. This objective should be viewed as a tentative

proposal because the proposed method of study does not presuppose particular solutions.

1.5 SIGNIFICANCE OF THE STUDY

The study will serve to sensitize the top management of the roads department on what operations research/management science has to offer for the effective management of large scale resource deployment. Systems changes recommended by the study team should lead to better overall performance.

It will serve as a pilot study and if, as it is hoped the model will do, it should serve as a better allocation criteria. The department can use it to justify its methods to outside stake-holders.

Other important benefits are learning effects achieved when soft systems methods of study are used. Even if recommendations are not implemented, the exercise should still be worthwhile through such learning and insights gained from the process.

CHAPTER 2 LITERATURE REVIEW

2.1 OPERATIONS RESEARCH METHODOLOGY

2.1.1 Two Paradigms

Two general approaches can be discerned from current literature in Operations Research and Management Science. These are the 'Hard' and 'Soft' Systems approaches.

The term 'hard' has only come to be used recently to differentiate this approach from the 'soft' methodologies developed by recent researchers. (Checkland,1986, Ackoff 1975, Eden, Friend and others). It came to be used following serious criticisms of traditional OR methodology (scientific) by some OR researchers especially Ackoff (1979 a, b) and Checkland (1983). These criticisms focused on the inability of traditional OR/MS approach to make its mark at strategic levels of decision making. Strategic decisions and plans outline broadly the organizations directions, goals and means to achieve them. All other plans i.e. tactical and operational have to conform to the overall plan. The success of traditional OR/MS at these lower levels necessarily goes unnoticed since the really important decisions are already made anyway.

Traditional OR/MS approach is termed "hard systems thinking". Rosenhead (1989) describes it as,

"systematically ordered thinking concerned with means - definitions in well structured problems in which desirable ends can be stated" (pg.5)

But in many situations, the objective is usually not well defined. Multiple objectives of stakeholders conflict and resulting in frustrations at implementation. The approach also fails to account for important human behavioural and political factors. For example, the HMMS system is good operationally, but is not used because the implementors assumed they knew what the problem was and failed to get the support of top management.

The soft approach on the other hand does not assume a specific problem exists. It is a method of enquiry into problematic situations, that identifies possible changes that may improve the situation. The users and stakeholders are principal study personnel, with the outside expert/consultant to guide only. So proposed changes are from those concerned and hence chances of implementation are greater. The approach has been found useful for problems with a large behavioural and political dimension. The aim is to arrive at consensus and commitment from those concerned, not necessarily at the theoretically best solution (Eden,1989).

The alternative paradigm reflects the soft systems approach. 'Soft' refers to intangible variables such as political processes, compromise and other similar 'soft' variables the antithesis of hard variables such as numerical or quentitative facts and logic. Various methodologies came to prominence during the 1970's and 80's as realistic ways to make decisions based on the alternative paradigm.

Characteristics of alternative Paradigm	
1	Non optimizing seeks alternative solutions which are acceptable on separate dimensions without trade-offs.
2	Reduced data demands, achieved by greater integration of hard and soft data with social judgments.
3	Simplicity and transparency, aimed at clarifying the terms of conflict.
4	Conceptualises people as active subjects.
5	Facilitates planning from bottom up.
6	Accepts uncertainty, and aims to keep options open for later resolution.

Table 2.1 Adapted from Rosenhead (1989)

Some of these methodologies are Strategic Options Development and Analysis (SODA), Soft Systems Methodology (SSM), and Strategic Choice. These have origins in traditional systems thinking and social psychology but are more concerned about the decision making

process, not the final decision. Metagame and Hypergame analysis are game theoretic in nature and are concerned with the decision. Many of these were in fact conceived much earlier but were refined to practicality in the 1970s and 80s.

2.1.2 The Middle Approach

Of the two paradigms discussed above,there is as yet no proven superiority of either (Mbeche 1993). The formal SSMs have not yet entered the mainstream of management practice and teaching though they are starting to get integrated (Daellenbach a). It is therefore not easy to make conclusive judgements as yet (Rosenhead 1989). Since each has distinctive but complementary advantages and disadvantages it would be logical to use them together so that they complement one another. The soft systems approach can be used at first to bring out pertinent political, behavioral and other broad organisational factors that may invalidate or otherwise severely limit the potential benefits from any model made.

Sagasti (1982 a) and Mbeche (1993) have given such a proposal. Greater active participation by all stakeholders is sought coupled with a less quantitative and more qualitative prior analysis. This should set the stage for a more relevant quantitative application once the picture is clear.

It may be argued that the term Middle Approach is superfluous in the sense that the soft approaches do not shy away from churning out hard solutions when necessary. These are the

special case of soft systems whereby there is only one unique and desirable solution (Checkland 1989). Therefore the need for a given model should emerge within the context of the broader systems enquiry into the problematic situation. Indeed 'hard' and 'soft' approaches need not be opposed to each other. In large complex issues, amixture of methods often produces better results.

2.2 TRANSPORTATION AND RESOURCES MANAGEMENT USING OR/MS

OR models have been used successfully in many countries. In the US, **FORPLAN is a linear programming system** used for national Forest and land management. (Kent et al,1991). Combined linear programming and game theory have been used to raise agricultural production in China (Qingzhen, 1991). Systems concepts were successfully used in a masterplan transport study for Sudan (Saaty, 1982), and very effectively to improve transportation logistics in New Delhi, India (Tinker, in Luck et al 1982). Their employment can also be used to resolve resource allocation disputes since models are politically neutral as was the case in an Indian study (Patel, 1982).

Road maintenance is a major public expenditure item in all countries and also tends to be politically sensitive. OR/MS has been employed very successfully in many western countries. Road Maintenance Management Systems are a good example where OR/MS has been applied. They may be manual, computer based or a combination of these. Of course computer based

systems can do more, but as will be seen, it is only if their design and implementation is very well executed. RMMS employ a systems approach to road systems and serve as both planning and control tools. They incorporate a combination of OR/MS models, road engineering based ones for physical characteristics, financial cost models and optimization models. All these are designed to work from a common database.

The Model Structure generally consists of :

1. Pavement Condition Inventories.

   The structural, functional and traffic conditions of the pavement.

2. Pavement Condition models.

   They are used to predict the condition of the pavement with time and usage. They may be based on materials behavior theories, from empirical studies or based on surveys. The latter two are more common.

3. Maintenance Cost models.

   Give such relationships as pavement age vis-a-vis maintenance cost, they also give forecasts of future expected costs.

4. User Cost and Social Cost models.

   These are costs of a higher order of magnitude like time costs, vehicle operation costs,

accident costs. These relationships are not easy to determine so these models are not much used.

5. Optimization models.

For allocation of resources under budgetary, manpower, time or other constraints. The criteria is usually an economic measure of return on capital employed.

6. Road Data Bank.

Comprising a referencing system, database files, systems for retrieving, processing and presenting information, updating files and administration of the Road Data Bank.

(Adapted from Lars Bolet, Municipality of Herlev, Denmark)

The system addresses the road network from both national and project levels. Hence there is a direct link with the political and administrative system of the country.

In both Canada and Denmark, these systems were introduced gradually. The implementors never lost sight of the fact that it is roads being maintained, not the obtaining of an automated reporting and planning tool. Hence this process was combined with a mandatory management training course for all users that gave them a certificate. Sckeptism had to be overcome, and a high level course for senior managers was given.

In the Kenyan case, introduction was managed by external consultants and literally hammered down the throats of the ministry personnel. Understandably it was donor funded so the Kenyans had no objections, only that when these expatriates left, the system promptly fell into disuse. They failed to obtain support of top personnel in the ministry, or to look at the computer based system in the context of a ministry with many organizational weakness like lack of enough funds for data gathering and an unwieldily organizational structure. For example, according to one engineer some foreign donor representatives are exasperated trying to find out just who is responsible for what in the ministry, not withstanding job titles.

2.3. THE CHALLENGE FOR DEVELOPING COUNTRIES

The challenge of developing an economy from one economic level to another is great. One of the major aspects is technology transfer from the developed countries. Gass(1990) notes that OR technology transfer to non-western countries has been a difficult task. It's application there shows the need to be more cautious and creative when applying it.

In New Delhi India, a creative OR solution to urban transport was a shift to direction oriented rather than destination oriented movement. Fortunately quick and effective support of the government was obtained. (Tinker,1982) Luck et al (1982) in the commentary describe it as systems thinking at its best. Luck (1982) tells of the need to redirect ORSA in developed countries following experiences in Indonesian health services as follows.

Western Paradigm	*Needed in Developing Countries*
Competitive	Co-operative
Differentiating	Integrating
Sophisticating	Simplifying
Publishing	Implementing

(p. 53)

Obtaining broad support for OR projects usually proves elusive because the relationship between the political system and the functional arms of government is clouded by cronyism, tribalism, lack of accountability and political intrigue. (Ackoft, 1976)

Western society has a culture of openness and political maturity so that some of the ethical issues raised above are less common. Our social and economic structures confound rationality as it is understood in the west. The rational scientific model is bound for fail in LDCs if used indiscriminately. (Sagasti, 1982)

After considerable experience in rational planning for LDC's, Ackoff (1976) concluded that it is not solutions that lack but rather:

"The central problem of development is rather this: How to bring about the acceptance and effective implementation of any solution to any development problem .....not to

determine what changes to make but how to bring about any changes whatever".

(in Luck et al, 1982 p.166).

A cozy relationship between those in power and a rich exploitative business class use a combination of corruption, legislation, coercion and patronage to maintain the status quo. Efforts that can bring about real change especially in income distribution are always blocked. For example to reduce time wasting, Ackoff suggested to Mexican planers such things as reducing the lunch break to 1 hour from the current 2-3 hours [1]. It was rejected on the grounds that it is politically infeasible!

Some changes therefore require a political and cultural evolution. Ackoff (1976) suggests idealized planning, to be led by the president of the country himself. This is not easy in many third world countries where president's power bases often have little to do with good government. More likely, results will be obtained by the carrot and stick approach adopted by donor countries. Structural Adjustment Programmes, including Political reform, sponsored by the IMF and the World Bank are being painfully adopted by LDCs, on the pain of not receiving more money. Whatever changes they advocate will be a copy of the west, and their appropriateness is questionable.

The World Bank Vice President for Africa Edward 'Kim' Jaycox quoted off the record lamented ,the imposition of Northern technical assistance as,

[1] Comparable to "African time" in Kenya - an excuse for unnecessary lateness

"a systematical destructive force that is undermining the development of capacity in Africa".[2]

He suggested that plans should be written by the recipient, not the World Bank.

Asian countries like Japan, South Korea, and also understandably Western nations were unhappy about this independence especially in trade and agriculture policies, but cannot now ignore the fact that they got results.

Asian countries to some extent, have pursued their own courses making successful use of Western Technology extensively while maintaining their unique cultures (Kasekende,1982). Africa and South American LDC's may first have to learn and have self reliance, before they can reap full benefits of any external technologies.

[2]Ross Hammond," Structural Adjustment Policies in Africa have failed says World Bank," Third World Resurgence, issue No. 42/43 pg. 32

HAPTER 3 RESEARCH DESIGN

1 THE STUDY AREA

is the Roads Department of Kenya's Ministry of Public Works and Housing. There are other partments - Housing and Architectural, Mechanical and Transport.

Within the Roads Department there are the branches - Design, maintenance, Planning and onstruction. Maintenance branch is divided into two sections, for paved and for unpaved roads. ach branch is headed by a Chief Superintending Engineer (C.S.E.), the Chief Engineer (Roads) eads the department. The CEO for the Ministry is the Permanent Secretary, who is appointed the President.

Routine road maintenance activities are carried out by ministry personnel located in each istrict and Provincial headquarters. Periodic maintenance, i.e. resealing, recarpeting or construction is usually contracted out to private firms and is controlled from headquarters. It ually involves donor funding as it is expensive.

Unclassified roads (Minor roads) receive much donor support in terms of funding. Several ogramme are on-going. Minor Roads Programme (MRP), Roads 2000, Kenya Market evelopment Programme, Gravelling, Bridging and Culverting (GBC), all with various donors.

But as of now there is a move to unite these efforts and centrally co-ordinate them. It should be mentioned that while the Ministry as a whole lacks sufficient funding, these programmes are not lacking cash.

3.2 STUDY FORMAT

The proposed research methodology was a combination of both **"hard"** and **"soft"** approaches. The problem context was complex and full of uncertainty. Soft methodologies were employed in order to bring out behavioural, cultural, political and other systems aspects of the problem situation. It was important that these be given serious consideration so that any proposed changes were not over-ambitious as to forestall implementation. The approach facilitates a structured debate by concerned parties that brings out these issues very clearly.

The need for hard operations research model should come out in the context of the structured debate. Tentatively this will take the form of an allocation model. A goal programming (GP) model was envisioned. The GP model incorporates various priorities and was expected to prove most suitable. Priorities and weights ranking were expected to be brought out in the debate, discussions and are the major input into the model from the 'soft' systems enquiry.

Peter Checkland's Soft Systems Methodology was used because it is easy to learn and is the most widely used of the soft approaches. It requires few tools, just pencils and paper. At the

ame time it is not too decision focused like for example Strategic Choice. [See appendix]

General GP Model

oal programming is the most popular of all mathematical methods for multiple criteria decision naking (White 1990). It has been found to work satisfactorily in practice.

Form:

$$minimize|z=P_i\sum w_i(d_i^+ + d_i^-)|$$

Subject to the constraints:

$$f_i(x) + d_i^+ - d_i^- = f_i^\circ$$

$$x \in X,\ d_i^+ > 0,\ d_i^- > 0,\ 1 < i < n$$

Where,

P_i = Priority levels from 1 to n for a target objective f_i.

d_i^+ and d_i^- are deviations from the specified target.

$f_i(x)$ is the functional relationship between x and f_i° and w_i is the weighting factor.

In this study, it was expected that priorities would be based on such factors as class of road, traffic volumes, directives from authorities for particular roads and other development objectives. Certain constraints like money available do not allow for positive deviations. Similarly minimum maintenance requirements have to be met in line with maintenance policy guidelines.

3.2.1 Data and Information Collection

Principally senior engineers, planners and economists involved in road maintenance activities from the sections in the department - design, bridges, maintenance, planning were involved. The Chief Engineer (Roads) gave full backing to the study, and so did the heads of the sections.

Workshop format sessions were organised to enable structured enquiry into the problem of using soft systems methodology. Technical details and data for formulation of models were provided by the engineers. It should be noted here that a substantial workload of these people is administrative and managerial rather than technical.

3.2.2 Model Validation and Testing

The model developed was to be tested and validated using Micro-Manager package at the University of Nairobi. This has a limit of 50 variables and 50 constraints. Data were obtained from past records and allocations were compared with those done using current methods.

3.2.3 Other Recommendations

Recommendations for change arising from the structured workshop sessions were given to senior ministry personnel for their comments and possible implementation.

3.3 THE CONTEXT OF THE STUDY

In a wholly participative study of this nature it is vital to clarify it's context in terms of behavioural, power relationships, and expectations. It is also acknowledged that the author being an active participant had his own 'weltanschauung'[3] that may colour the final report. But an attempt will be made to report in as detached a manner as possible.

The author (researcher) was approached by one of the MOPW Engineers, to assist him and engineer in the HMMS section to come up with a proposal that would address the question of the MOPW's readiness to absorb and effectively utilize the expected Road Fuel Levy funds. The author had worked as an engineer for the MOPW & Housing for three years prior to going for further studies and was well acquainted with most of the personnel involved. The proposing engineer was crucial to the study since he could mobilize fellow engineers even senior ones into activity, calling for considerable personal initiative. It should be noted that in Ministries', including MOPW, most workers are content to sit back and only act when a crisis arises. This

[3] 'Weltanschuug', German word for World View, that captures the meaning intended in this context.

proposal had been requested by the Senior Superintending Engineer in charge of the funds collection. Further preliminary interview's with the Chief Engineer and other Senior Engineers brought out a general feeling of uneasiness concerning the role of Ministry's computer information system, the performance of field staff, the productivity of office (HQ) staff, and an air of the MOPW's activities being disorganized and some how out of control.

At the same time it was sensed that some Senior Engineers felt that the World Bank's ongoing studies were sufficient so there was no need for further studies. Given that this study was also for academic purposes, their sentiments were understandable, though their faith in consultants was without basis going by their many unread reports lying around in many offices.

It was the younger engineers who most keenly felt the urgency for the needed change. Its exact nature was unclear as yet. In general they were idle, under utilized and shut out from the action. They were familiar with computers, unlike their bosses, so they knew it's potential. There was a serious communication barrier between them and the working relationship was poor so that each stuck their position blaming the other for the impasse. Senior Engineers felt that lower cadre engineers were lazy, while the the latter say the their seniors did not bother about what they did.

Being a government ministry, the more senior the position the more politicized it is. Hence whatever change is suggested must also be politically acceptable to have a chance of implementation. This is in addition to overcoming inbuilt inertia from long serving civil servants. These two factors make procrastination on decision making the order of the day, each wants to

protect his own hide.

With these points in mind, we now proceed with a discussion of the study itself.

CHAPTER 4 FINDINGS

4.1 SYSTEMS STUDY REPORT

This discussion will proceed according to the 7 stages of Checkland's SSM. Effort was made to follow these systematically because it was a pioneering study. Whatever is written here should be taken as the sketch summarized by the author from his own point of view since the real situations that caused us to arrive at given outputs were rich animated deliveries of divergent views. This is as opposed to calculated attack on a problem using a certain "method". The flexibility of all soft systems approaches has been widely noted (Checkland 1989, Rosenhead, 1989). Inevitably the seven stages of SSM are not strictly steps, one moves to and from stages, choices made a one stage are made with foresight regarding expectation at other stages.

The first two days were devoted to introducing the participants to the methodology, its rationale and content. Happily the team members were enthusiastic and quickly grasped the essentials. The real learning experience came when we started applying it. Practical examples of applications were used to explain the expected benefits especially for implementation. Team members were all of the younger group, senior engineers could not spare the needed time.

4.1.1 Finding Out: Stages 1 and 2

A glance at the problem context shows that we started off with the ideal "messy" problem

situation. Hence the finding out stages 1 and 2 were very broad based. Over two days, the situation was expressed in form of rich pictures. These showed how work flowed, power and administrative arrangements, and reporting lines.

Team Members

Ndeda M.O.	Engineer, Design Branch
Njuguna J.G.	Engineer, HMMS
Oloo E.O.	Engineer, HMMS
Methu P.G.	Planning, Evaluation & Monitoring (PEM) Engineer, Minor Roads Programme
Kimani J.	Economist, Planning
Mbugua J.	Engineer, Design, formerly HMMS, attteded Pavement Evaluation Model course in the Netherlands.

Three diagrams were prepared. First for the whole ministry, then for activities under donor funded road programmes (MRP), the GOK funded routine maintenance for classified roads, (uses HMMS) and for periodic maintenance. (Diagrams 4.1,4.2,4.3)

It was immediately apparent that the MRP system was quite good with internal checks, and not surprisingly it worked well. The Road Departments GOK funded routine maintenance and periodic maintenance activities were full of anomalies and laxity. Money is literally thrown at

Day 3

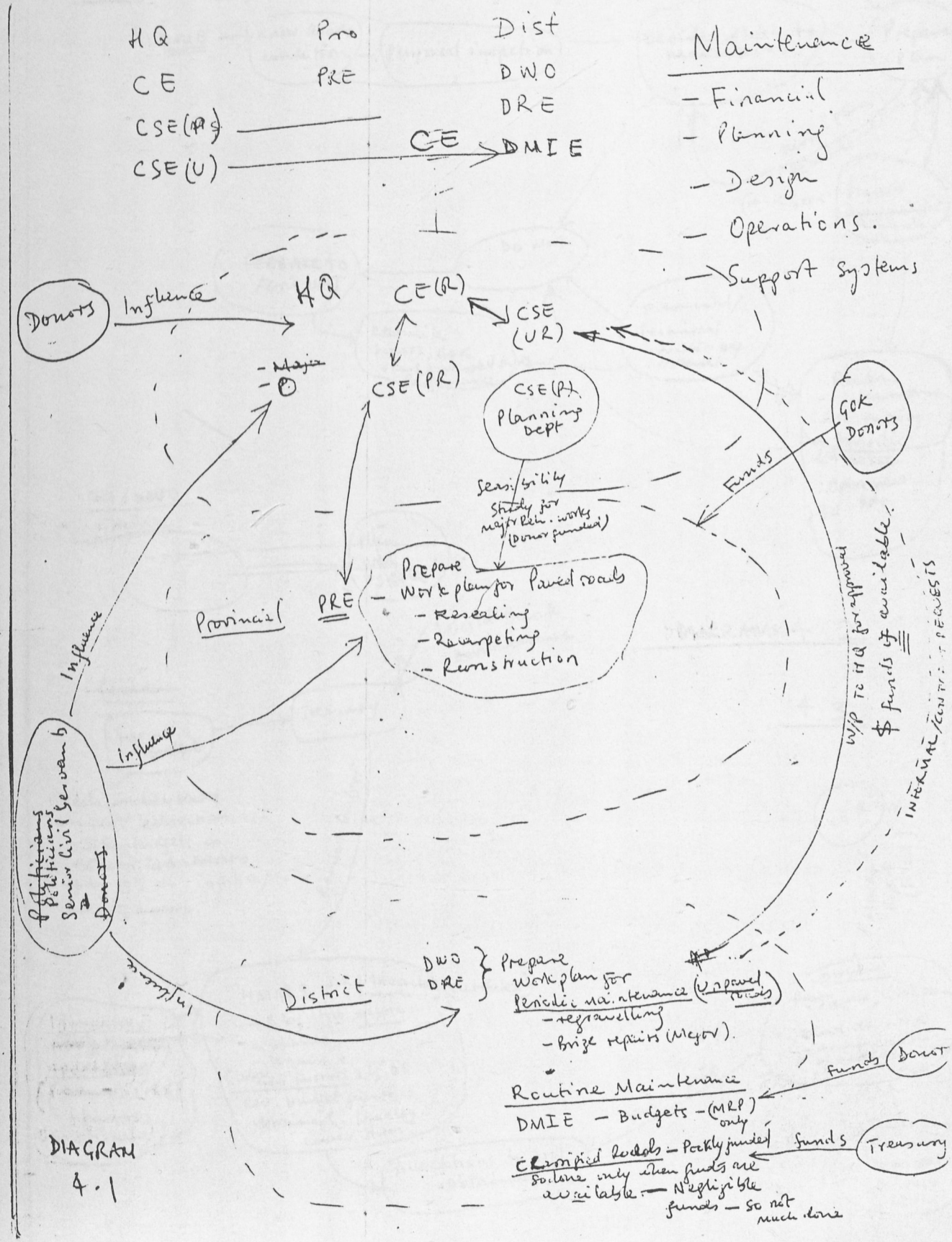
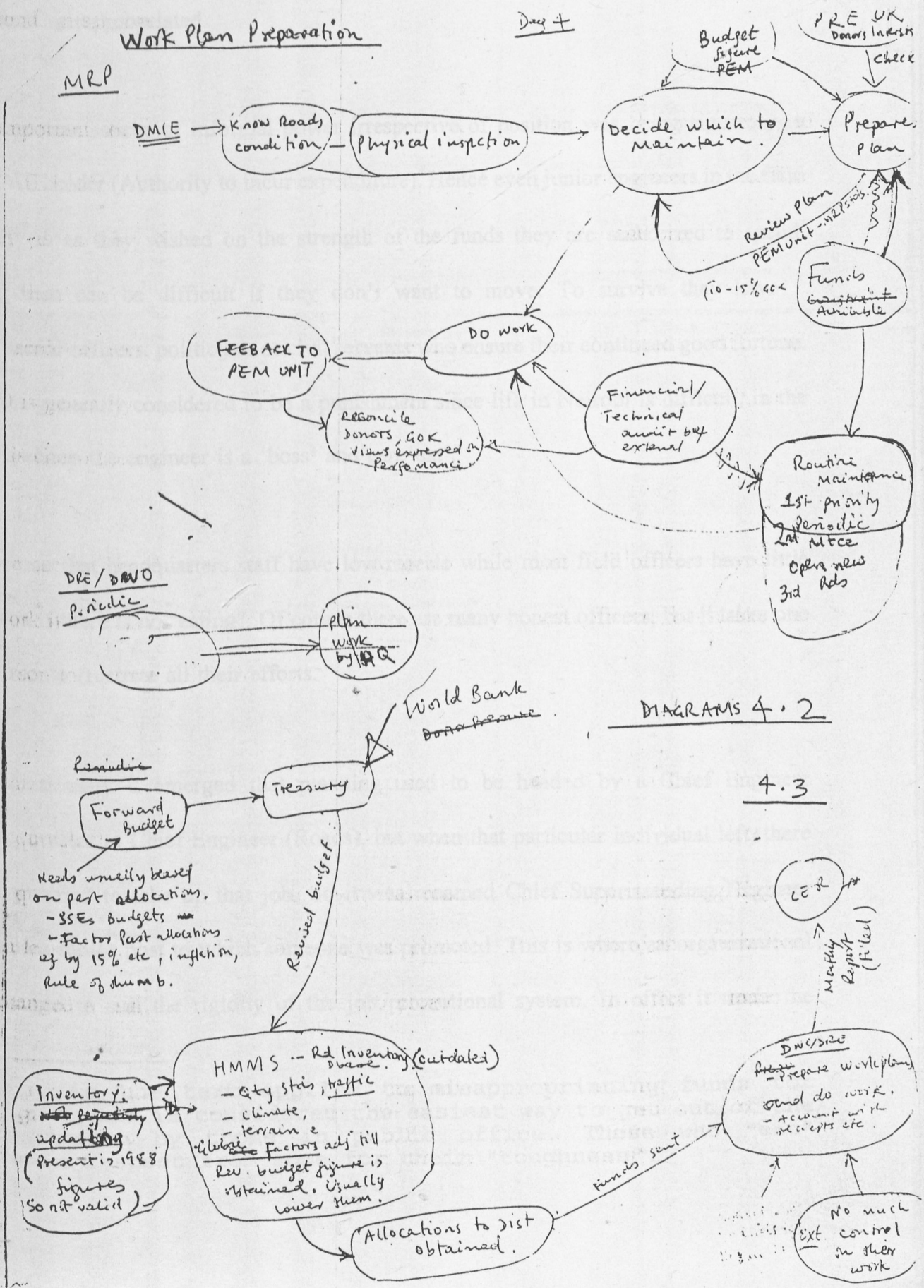


DIAGRAM 4.1


Work Plan Preparation
MRP
Dept
DMIE
Know Roads condition
Physical inspection
Budget figure PEM
PRE UK Donors Inputs
Check
Decide which to Maintain.
Prepare plan
Review Plan
PEM Unit - M&E
10-15% GOK
Funds
DO work
FEEBACK TO PEM UNIT
Reconcile Donors, GOK views expressed in Performance
Financial/ Technical audit by external
Routine Maintance
1st priority
Periodic
2nd Mtce
Open new
3rd Rds
DRE/DWO
Periodic
plan work by DRQ
World Bank
DIAGRAMS 4.2
4.3
Periodic
Forward Budget
Treasury
Needs usually based on past allocations.
- SSEs Budgets
- Factor Past allocations eg by 15% etc, inflation, Rule of thumb.
Revised budget
HMMS -- Rd Inventory (outdated)
- Qty stds, traffic
- climate,
- terrain e
Global Factors adj till Rev. budget figure is obtained. Usually lower them.
Inventory: updating (Present is 1988 figures so not valid)
Allocations to dist obtained.
funds sent
DWC/SRE
- Prepare workplans
Send do work.
- Account with receipts etc.
No much Ext control on their work
CER
Monthly Report (Filed)

projects or districts with little follow up. The system is easily short circuited by some officer, untamable funds misappropriated.

An important source of informal power irrespective of position was being signatory to funds, or an AIE holder (Authority to incur expenditure). Hence even junior engineers in the field could literally do as they wished on the strength of the funds they are authorized to spend. Transferring them can be difficult if they don't want to move. To survive they have "godfathers" senior officers, politicians or civil servants who ensure their continued good fortune. Being at HQ is generally considered to be a punishment since life in Nairobi is difficult, in the district, life is cheap the engineer is a 'boss' and can 'eat'.[4]

So we see that headquarters staff have low morale while most field officers have little interest in work if there is no "eating". Of course there are many honest officers, but it takes one dishonest person to frustrate all their efforts.

Organizationally it emerged that planning used to be headed by a Chief Engineer (Planning), equivalent to Chief Engineer (Roads), but when that particular individual left, there was no one qualified to take up that job. So it was renamed Chief Superintending Engineer (Planning), a less senior post to which someone was promoted. This is where an organizational need was changed to suit the rigidity of the job promotional system. In effect it made the

[4]Eating is the term applied to misappropriating funds for personal gain, and is considered the easiest way to get out of the cycle of poverty by those in public office. Those who "eat" actually gain respect from some for their "toughness".

ning branch come completely under roads department though it used to plan for the whole stry.

By laying out the activities diagrammatically, team members found themselves discovering some activities are still done though their purpose was no longer useful. They also eciated that the current structure of activities simply could not work. The organization had bility to effectively spend additional funds. Each maintenance programme revolved about its f Superintending Engineer as a personal fiefdom ensuring failure of any overall strategy.

2 First Methodological Cycle: Stages 3,4,5

n stages 1 and 2, the nature of the problem begun to take specific shapes in the minds of icipants. The following were suggestions for relevant activity systems.

- System to spend Fuel Levy Funds effectively
- A funds allocation system.
- Information, communication system.
- Production of well maintained roads.
- Respond to needs of road users
- Respond to the political system of Kenya
- a resource planning system.

At this time, uppermost in the teams mind was the role of information in the roads department. Although it had much of it, it was scattered in different computer systems and stores. hence the first root definition considered focused on information management to aid decision making.

Root Definition 1

'A system to manage an information resources involving the creation and manipulation of a road database from relevant date, covering the MOPW road maintenance needs now and in the future as an aid to decision making, within manpower and financial constraints.

CATWOE ANALYSIS

C MOPW (implied)

A IT professionals in Roads Department

T Need for well managed information - need met

W well managed information is vital for proper execution of maintenance activities while the resources are readily available to do it.

O MOPW

E Manpower, finances, equipment resistance to change by some staff or grassroots policy makers like DDCs.

The conceptual model for Root Definition 1 on next page.

This model was compared with existing systems as at stage 5. Without going into highly detailed comparisons, it became obvious that activities in modules 1 - appreciate MOPW definition of present and future needs, 2 - translation of these needs into definitions of decisions concerning road maintenance, and also 3 were practically non-existent.

Very likely the reason for this start was that most of the participants were involved directly in computer information processing at the MOPW and so tended to view the problem with IT as a reference point.

4.1.3 Second Methodological Cycle: Gaining Insight into the Situation

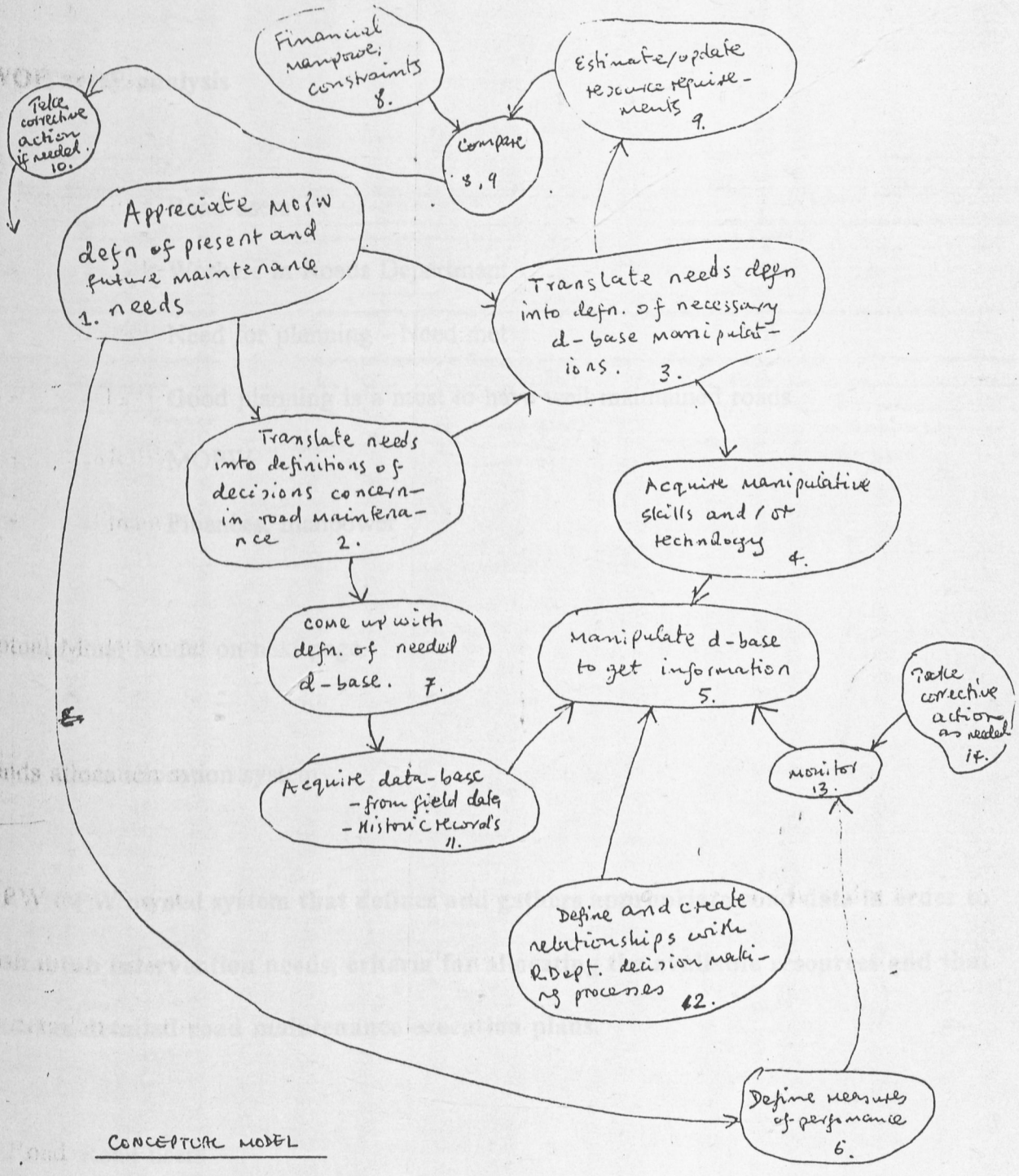
A root definition encompassing broader activities was needed. It must be higher in the hierarchy of systems.

Suggested Root Definitions

These were based on the relevant systems;

2) a resources planning system,

A MOPW owned system utilizing resources in form of money, physical resources and people to plan and execute road maintenance activities in the best way possible



CONCEPTUAL MODEL

RD 1.

within the resources constraints.

CATWOE analysis

C - Road users

A - Workers in Roads Department

T - Need for planning - Need met

W - Good planning is a must to have well maintained roads.

O - MOPW

E - Finances, manpower

Conceptual Model on next page.

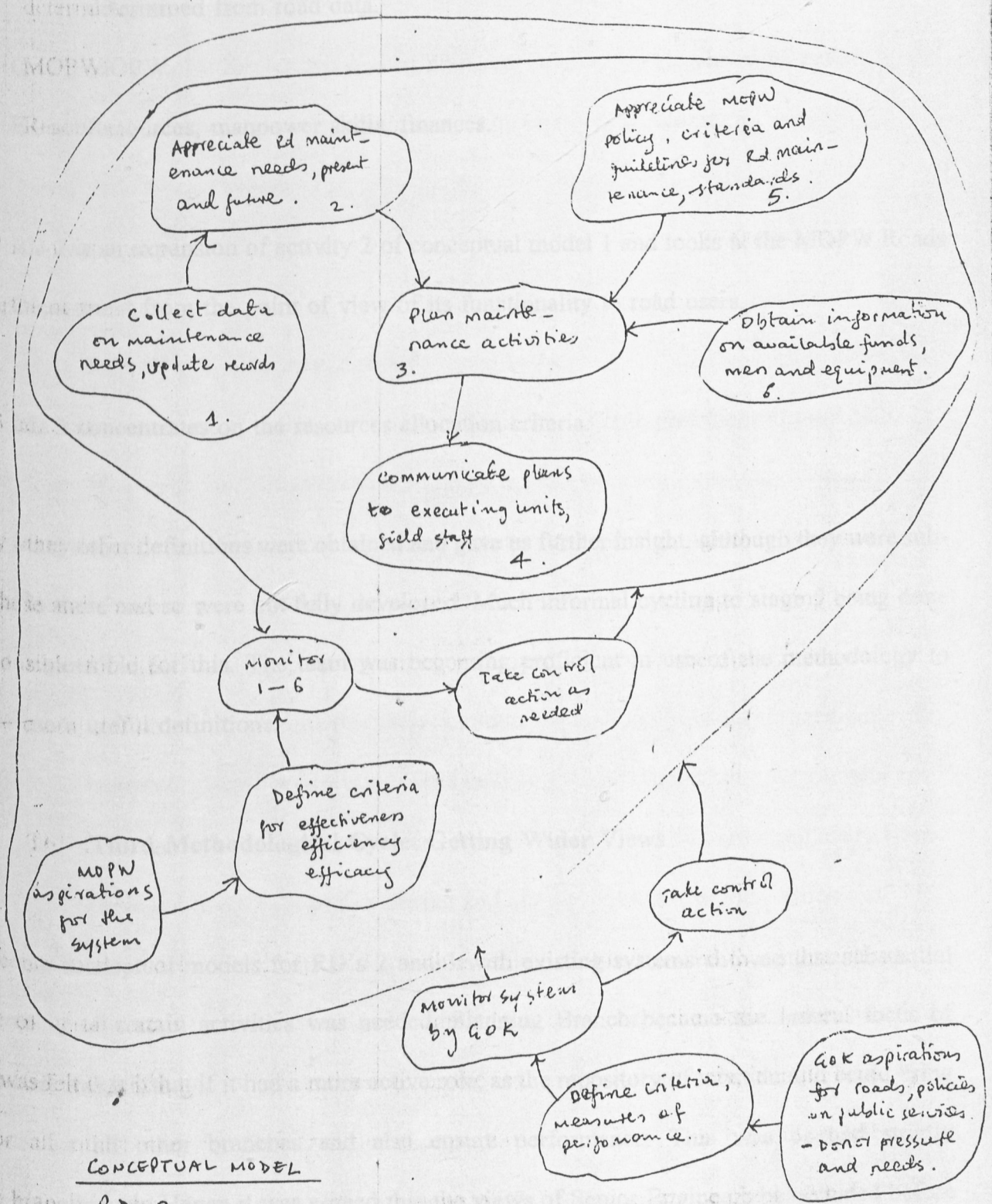
3) a funds allocation system

A MOPW owned system that defines and gathers appropriate road data in order to establish intervention needs, criteria for allocating the available resources and that makes detailed road maintenance execution plans.

C - Road users

A - IT staff, Engineers

T - Road data - intervention needs execution plans



CONCEPTUAL MODEL

RD 2

W - Available resources need to be allocated with a justifiable criteria which can be determined from road data.

O - MOPW

E - Resources, manpower skills, finances.

RD 2 is an expansion of activity 2 of conceptual model 1 and looks at the MOPW Roads Department from the point of view of its functionality to road users.

RD 3 concentrates on the resources allocation criteria.

Many other definitions were obtained and gave us further insight, although they were sub-ordinate to these and so were not fully developed. Much informal cycling to stage 5 being done by was responsible for this. The team was becoming proficient in use of the methodology to identify more useful definitions.

4.1.4. Third Methodological Cycle: Getting Wider Views

Comparing conceptual models for RD's 2 and 3 with existing systems showed that substantial restructuring of certain activities was needed. Planning Branch became the natural focus of attention. It was felt that if it had a more active role, as the repository of most data, it could bring guidance for all other branches and also ensure performance. This was beyond strictly maintenance branch. Hence it was agreed that the views of Senior Engineers be obtained before

further progress.

An outline for informal interviews was prepared jointly, the interviews were done by the author and one of the participants. It included other factors that had come up.

Outline & General views expressed

1) **Role of planning department.**

Government policies for Roads - Formulate and interpret them to user units.

2) **How to improve HMMS and marry it with other planning activities.** Sell to top management, educate them, make it more user friendly.

3) **Monitoring and control of all activities.**

A few felt it was unnecessary, that field engineers could be trusted. Most said that it must be done more effectively, but noted that if data was not utilized collecting teams could not be motivated. Data collection used to exist but died out with time. Reluctance of some to revive it is that they view it as an internal policing system. Undeniably the lack of monitoring and control has led to some officers enriching themselves greatly at public expense. This is public knowledge as many have even been interdicted. These cases usually don't go far due to informal networks of corruption that protect their own.

In one of the World Bank sponsored studies one of the recommendations is the

setting up of an inspectorate. In fact one of the doors is labelled as such but that unit is not active as yet.

4) **Personnel - Commitment, Motivation and Management Skills.**

This was generally very low and is a major stumbling block to any initiative.

5) **Communication between field and headquarters, and between senior and junior engineers.**

The former is rather erratic because field staff have little motivation to respond, unless it has to do with money. The latter is poor, senior engineers had little understanding of the work of their juniors. Some termed them idlers who only want to go the field to make money; junior engineers felt that their bosses were too engrossed in power play to pay much attention to them or their work. So there exists a palpable tension between these two groups. A suggestion by one engineer was for a common canteen, or cocktail parties to break down this barrier.

6) **Money - How it is handled, power and problems associated with it.**

This was a sensitive topic, one senior engineer said he wanted nothing to do with it at all. Illustrative is the experience in MPR. When the PEM engineer was an expatriate, he used to issue money to field officers, and they complied with his requirements. Being an expatriate no one interfered with his work. But upon leaving, the local replacement had no clout. Hence field officers can short circuit

the system and obtain funds before his approval.

This tells us that for any control system to be effective it must tie up with availability of funds.

7) **Roles of individual officers.**

Job and task definitions were especially vague at headquarters, a lazy person could literally do nothing, yet nothing would halt.

It was suggested that there be greater specialization and a reduction of high rate of transfers between stations.[5] Individual officers should also be more proactive in advising the C.E. (R) on needs. Of course if nothing happens then they will not do it.

These interviews took about a week. Interviewees were:

Chief Superintending Engineer (Planning)

Senior Superintending Engineer (Planning)

Senior Superintending Engineer (Paved Roads Maintenance)

Was part of HMMS implementation team.

Economist (Planning)

[5] Saaty (1982) note that high personnel turnover creates discontinuity between planning and implementation thus slowing down development.

Senior Superintending Engineer (Contracts)

Involved in HMMS implementation.

Engineer (Design)

Other important points mentioned included poverty of our Government so that plans are made to suit financiers. The established fund should counter this.

After obtaining these views, the team reconvened to analyze them and come up with more concrete, desirable proposals.

The most important factor was the lack of a basic planning function for the Roads Department. Engineers assigned there felt that they were being dumped. Its' activities were limited evaluation of projects either for upgrading to bitumen standard or gravel, and reconstruction. Feasibility study reports were used principally to obtain money from donors - the poverty aspect. For example, JICA is doing a Road Masterplan study with Japanese Consultants on a Grant from their Government. It cannot be refused, most likely it will also leave no impact.

At this point it was not clear whether the Information Technology function should be an independent service unit serving all branches. A new Root Definition was proposed for the Planning Branch. It is a revision of RD 2 but with more detail and specificity. Planning Branch could take charge of the MIS because it already possessed data gathering units - funds collection, traffic data, road safety. It had experience in handling data in general. Presence of many dispersed

rsonal computers in offices meant that there was no need to have a large independent computer partment.

Root Definition 2b

A system to support and guide the road maintenance activities for all branches by providing a link between Government policy on roads and the other branches that implement these policies by breaking them down to tactical and operational plans, suitable for execution by the branches including monitoring and control programs.

C - Implementing Branches

A - People in supporting system

T - Need for link - Need met.

O - MOPW's Road Department

W - Such a link between policy and execution is vital for maintenance activities to be rationalized.

E - Government policy, financiers professional skills available.

Conceptual Model on next page.

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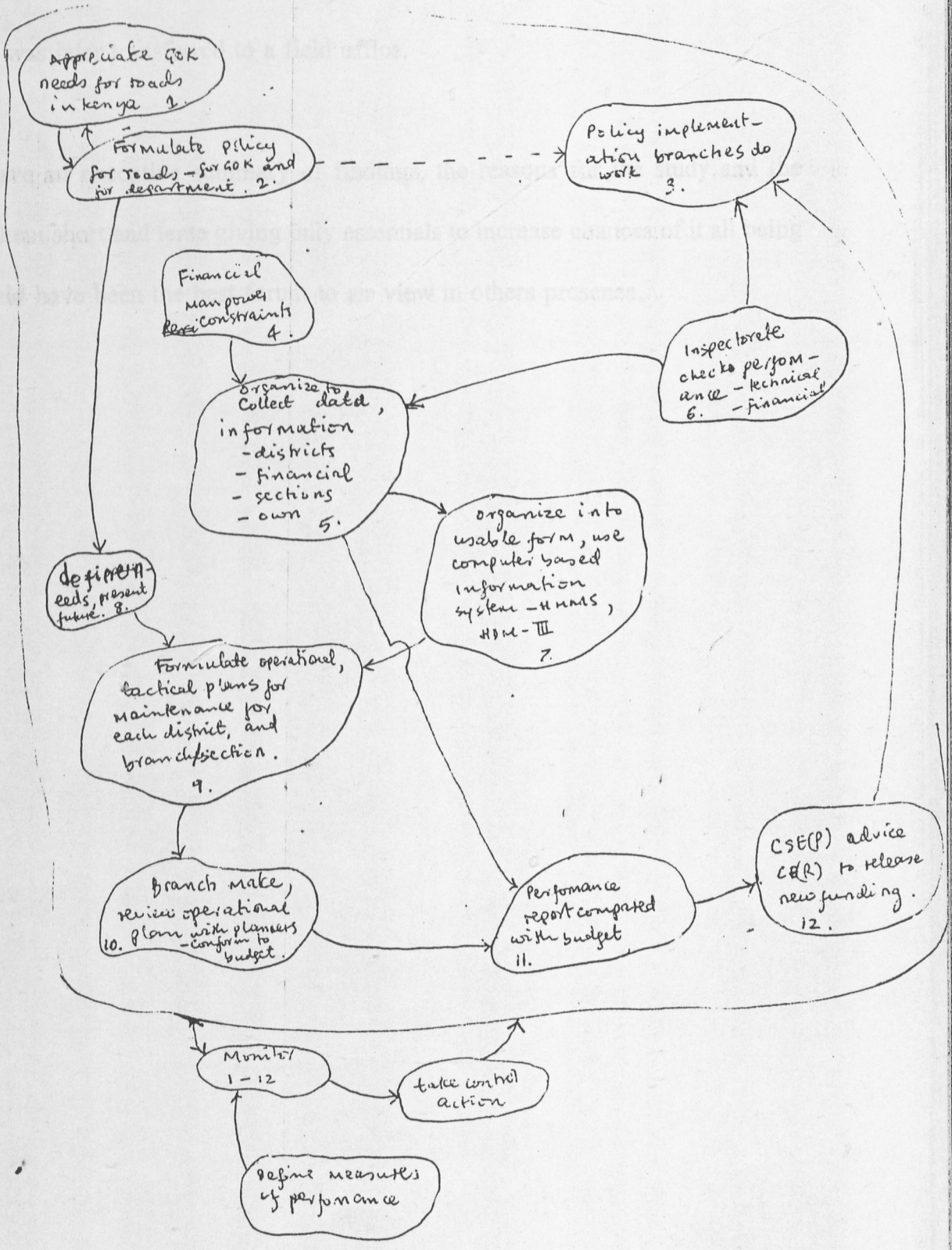


CONCEPTUAL MODEL

RD. 2b

fast so that the outcome could be included in this report. Unfortunately the person to do this was slow to respond and was later transferred to a field office.

The report gave an executive summary of findings, the reasons for the study and the method used. It was kept short and terse giving only essentials to increase chances of it all being read. A seminar would have been the best forum to air view in others presence.

4.2 EXTRACT FROM DRAFT REPORT SUBMITTED FOR DISCUSSION

4.0 PRELIMINARY FINDINGS FOR DISCUSSION

4.1 Planning

One useful definition for this activity was :

A system to support and guide road maintenance activities for all branches by providing a link between government policies and implementing branches , by breaking them down into tactical and operational plans, suitable for execution by the branches including monitoring and control programs.

This definition is close enough to a possible reality as it was later realized that the PEM unit of the MRP does nearly that. Hence useful changes can be suggested by comparing a conceptual model of the definition with existing systems.

This is how it looks .....(Diagram to be presented, See conceptual model 2b)

This comparison together with others suggest the following four as the main desirable and feasible changes:

Planning branch be given the central duty of co-ordinating activities of all branches, including setting targets and budgeting. It should monitor performance to ensure the overall goal is achieved. Hence it really serves as the brain for the Chief Executive Officer, the Chief Engineer (Roads).

The C.E.(R) will be advised by Planning Branch to release funding once the field offices gives satisfactory returns.

The information resource be centralized under Planning branch. This is necessary to enable (a) above. Fortunately personnel, hardware, software and considerable data are available. It is only a matter of bringing them together as one unit. A program to ensure constant review of software suitability and information needs be set up. This will guide the progressive transition to fully integrated planning, using such tools as pavement condition evaluation models, together with financial planning models. Some engineers have already received this training locally and overseas.

Retaining personnel who get good experience in information systems may prove difficult given private sector competition. Innovative arrangements like contracting may be considered since it is much more expensive to re-train new people.

A monitoring unit be set up as a vital link in the planning-control cycle. The team will check works done at random to ensure they are up to standard. It will also support the database by ensuring it's validity.

It need not be very large, for example under MRP, one engineer from donor appointed technical auditor, Carl Bro Int., is able to cover districts in 3 months.

Road maintenance be standardized to the extent possible with immediate issuance of a standard manual to all field staff. These specifications will facilitate uniformity of all works. It is against these that performance will be evaluated. RARP and MRP have standards, paved roads under DWO have no standards.

Secondary needs of no less importance.

Personnel :

Avoid frequent transfers to get full benefits of learning and enable specialization in tasks. This is especially critical in the field where high staff turnover and poor handing over makes long term planning difficult.

Job definitions be made very clear to engineers especially at headquarters. They should be task specific to avoid ambiguity of roles. Much time is wasted in learning how to get

things moving and what it is they are expected to do.

(c) Mandatory training in basic management be provided to all staff - engineers, supervisors and field team leaders. Modern management is to a large extent a technical activity as the Chief Engineer noted in one observation. It can therefore be learnt and improved upon. Similar courses are offered to MRP/RARP engineers and their productivity is markedly better.

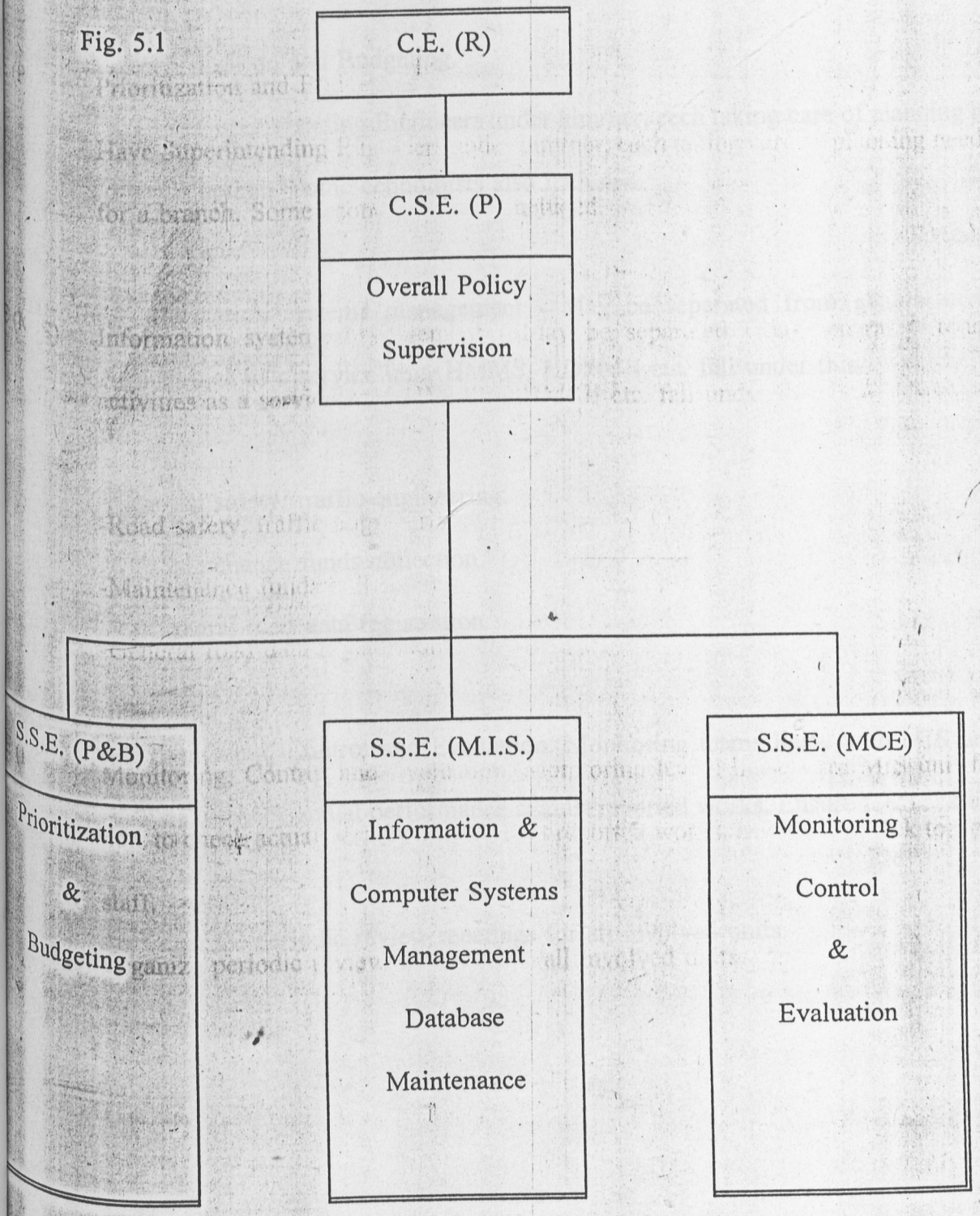
(d) Reduce confusion and duplication at district level brought by presence of DMIE, DRE(UR), DRE(PR) or DWO, PRE(UR), PRE(PR) etc. Presence many field engineers each with a vehicle and staff is a waste. These may be better deployed at headquarters which will require more staff with time.

(e) Individual officers be more proactive in informing their seniors and the C.E.(R) on needs. This communication can be enhanced through informal gatherings e.g. Cocktail parties or a lunch canteen.

(f) Financial incentives may not be easy to adjust, but alternative motivators like personal recognition for a well done job, valuing ideas from each one (participative management), training,trips on merit. In addition a job well done is itself a great source of self esteem,job satisfaction and hence motivation.

TENTATIVE ORGANIZATION OF PLANNING BRANCH

Fig. 5.1



CSE (P) Overall policy formulation, communication and supervision of it's implementation.

SSE (P) Prioritization and Budgeting.

Have Superintending Engineers under him/her, each taking care of planning needs for a branch. Some economists also included.

SSE (MIS) Information systems management - May be separated from general roads activities as a service unit. HMMS, HDM-III etc. fall under this.

-Road safety, traffic engineering.

-Maintenance funds collection.

-General road data registration.

SSE (P) Monitoring, Control and Evaluation. Monitoring teams liaise with MIS unit for data to check actual performance against reported works. Ensure feedback to field staff.

Organize periodic review meetings for all involved units.

HOW TO PROCEED FROM NOW

It is recognized that sudden conversion is impossible without extensive training. A good way to progress is:

Appoint officers/committee to guide and oversee change.

All senior engineers from SSE to the CE(R)should receive broad based but practical knowledge on the concept of a Network approach to road maintenance management and on pavement management systems. This can be organized through internal seminars given by our own engineers. It should be viewed as a serious step in career development for those who grasp the consequences. The CE(R) could or rather must take personal responsibility for this training.

Re-organize Planning Branch as above or along similar lines. It costs nothing other than staff re-assignment. Not all people have to be appointed to begin with, more can be taken on as work grows, but all units should be in place. Experience gained from PEM unit in MRP could assist.

Begin systematic data registration with only a few convenient districts. This will to some extent bring out unforeseen problems that will be solved progressively and realistically before embarking on the national programme.

5. Standard road maintenance manuals that tally with the standards in the computer based pavement management systems in use should start being used countrywide NOW, or as soon as they are availed.

The steps above are designed as the beginning of a step by step process of change. Haste should be avoided without loosing our long term aim of achieving systematic pavement management.

The only real drawback to taking SOME decisive action is the lack of will or of self-confidence which cannot be solved by anyone's 'solution' other than WE ourselves.

PRIORITIZATION MODEL

Prioritization of Projects

ne of the great shortcomings of the HMMS model was lack of a prioritization module, it is only eant for budgeting and control. This problem had been identified by nearly all studies carried by various bodies and researchers.

The World Bank developed Highway Design and Maintenance Model (HDM - III) was oduced into planning to provide a sound economic rationale for project selection. Its main rk is to evaluate road projects either for upgrading to bitumen or gravel standard or onstruction. The basic criteria used is IRR, with a 12% cut off. NPV and the C/B ratio are o assessed as Donors are very strict on these criteria, while the Kenyan Government is more ible.

But according to economists in the branch, HDM-III is unlikely to be fully utilized. Its rmation needs are too great while funds to collect data are limited. The main input into sibility studies is traffic data. Other economic benefits -farming and industrial development not easy to quantify. Insistence on IRR therefore does not always lead to the best allocation ause of the vast data gaps and unreliability of available data.

Currently roads from class B to E needing periodic maintenance are prioritized by District

pment Committees (DDCs) according to their own needs. Planning Branch then decides are viable. That with highest IRR is chosen and funds sought from Donors through the Bank. Donors pick the ones to fund according to their own preferences and aims of their grammes.

Due to the erratic nature of periodic maintenance funding, for purposes of this research, decided that the best place to begin would be a prioritization module for HMMS. This y used for routine maintenance budgeting as of now. Currently some allocations are ously low because the funds are spread too thinly to be effective (about Ksh. 1 billion need for Ksh. 9 billion annually). After discussions,it was decided that the HMMS mme could be run only for selected roads instead of all, so that realistic budgets can be ed which can then be followed up.

The total budget (B) is to be initially allocated to Districts in proportion to the lengths of and unpaved roads, a weight of 2.5 is attached to paved roads. (weight given by HMMS ers based on costs comparisson from experience)

Basic Steps

1. DDC suggests and ranks roads for routine maintenance subjectively.

2. DWO assess required maintenance levels in accordance with HMMS standards, for

each of these roads. This information could also be obtained directly from the computer if data is up to date.

3. Marry national network priorities by reviewing suggested roads to ensure continuous maintenance of important roads traversing districts. This can be eased by encouraging adjoining districts to collaborate in the exercise.

4. HMMS team at Headquarters allocates the district's budget (B_i) to these projects in accordance with priorities of maintenance department.

   1. Routine maintenance
   2. Periodic maintenance
   3. Other projects.

5. Release funds and work programmes to field officers

6. Monitor, control and evaluate performance by receiving regular feed back - HMMS can do this well for now if supported by data collection function.

Assumptions

1. Total Budget figure is known in advance and can be planned for. This is easy especially for the fuel levy fund which by law should go to road maintenance.

2. Class A and B roads are high priority roads, and should be funded always if possible. These are roads of national importance and hence are given relatively high weights.

Goal Programming Model

General GP Model

These are the priorities for maintenance works at national level.

P_1 - Routine maintenance work

P_2 - Periodic maintenance works

P_3 - Other projects.

Let,

B = Total Budget

B_i = Budget for district i

C_{ij} = Cost of maintenance on road j in district i

S_{ij} = weight for class of road j in dist. i

	Class A	B	C	D	E
Equivalent S	10	5	1	1	1

D_{ip}, D_{iu} = Total length of paved/unpaved roads Nationally

d_{ip}, d_{iu} = Total length of paved/unpaved roads in district i

m_{iu}, m_{ip} = Cost of maintaining the minimum lengths of paved and unpaved roads that must be maintained in district i every year.

W_{ij} (d_i^+ = weight (rank) of project j in district i.

$$= P_1 \quad w_{ij} (d_i^+ + d_i^-) S_{ij} + P_2 \quad W_{ij}(d_i^+ + d_i^-)s_{ij} + P_3 \quad W_{ij} (d_2^+ + d_i^-) s_{ij}$$

S.t.

$C_{ij} X_{ij} + d_i^- = B_i$

$m_{ip} + m_{iu} + d_i^+ = B_i$

$$Bi = B \frac{2.5\, d_{ip} + d_{iu}}{2.5\, D_p + D_u}$$

X_{ij} = { 0,1}, 1 if project j is chosen, 0 otherwise

For Routine maintenance only:

Let the class of roads be priority, the model is run separately for each district.

Therefore $P_1 = A$, $P_2 = B$ .....$P_3 = C,D,E$ U(classified)

$w_{ij}(d_i^+ + d_i^-)_A + P_2 w_{ij}(d_2^+ + d_i^-)_B + P_3 \; w_{ij}(d_i^+ + d_i)_C$

$w_{ij}(d_{i1}^- + d_i^+)_D + P_3 w_{ij}(d_i^- + d_i^+)_E + P_3 w_{ij}(d_{in}^- + d_i^+)_U$

del could not be tested or validated due to lack of reasonable and updated data. Serious

were made to make some sense of what was available but it proved a worthless exercise.

model can only be used once the overall data management system is overhauled along the

elt out in this study.

Findings

gs suggest that the Roads Department should begin a systematic restructuring centering

nning/control function. Without such or similar change it will be unable to effectively

ources at hand. This is a finding that seems obvious at first since planning and

e basic functions of management. But is it convincing enough to initiate action? To

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dy, as part of Structural Adjustment Programmes - A proposal to administer Kenyan

APTER 5 DISCUSSION AND CONCLUSIONS

DISCUSSIONS

s research involved applying a fairly new approach to a 'wicked' 'messy' ill defined problem. question of greatest relevance is how well it fared in comparison with the traditional OR roach. Secondly we would also like to know whether the results have any implications for eloping countries dilemma of technology transfer clashing with cultural, political, and avioral norms. (Ackoff 1976, Sagasti 1982, Gass 1990)

1 Findings

e findings suggest that the Roads Department should begin a systematic restructuring centering the planning/control function. Without such or similar change it will be unable to effectively ply resources at hand. This is a finding that seems obvious at first after all, planning and ntrol are basic functions of management. But is it convincing enough to initiate action? To se that participated it became so, unfortunately they were not of sufficient rank to effect mediate implementation. A seminar to present the findings was not possible in the available e, but it is hoped that these will proceed on the suggested course of action. This particular dy, being also academic, was viewed by some of the MOPW personnel with the customary achment. There was also a high profile involvement of the World Bank in a similarly very oad study, as part of Structural Adjustment Programmes - A proposal to adminster Kenyan

s under a Parastatal Authority other than directly by the Ministry. This would presumably it greater autonomy from Government control and hopefully effectiveness. Senior MOPW ers may wait to be forced to act by it, it has the money. So this study was not expected to olutionize things. But interestingly one of the World Bank supported reports recommended lar restructuring but without going into such detail. The cost of coming up with that mmendation must obviously be higher than what it cost this study team, considering the heads of a full external consultancy firm.

A participative approach can therefore save money by tapping internally available llectual capital.

2. Method

efits

oved very easy to teach Checkland's methodology, SSM to the participants and they were applying it effectively. One key benefit that was observed was the gradual change in the eption of the problem. We started off with an information processing focus gradually, this ly broadened to view the whole department as a resources planning system. A system higher ierarchy to the information processing function. This is a clear example of changing reciative settings"(Vickers in Checkland 1981). Addressing the problem of computer systems ld be futile before addressing the weakness in the system containing that computer system - resource planning system. To illustrate, one reason that HMMS failed was because field staff no action resulting from their data gathering efforts, the planning/control cycle was mplete.

The approach brought out relevant issues very fast by focusing on activities. It resulted e serious debates and learning by the participants as they perceived their own organization ically.

Some issues brought out as being vital were unexpected. First was the power associated uthority to release funds. In the suggestion, this would only be effected only when the (P) was satisfied to ensure compliance with budgets. It will also be clear who is to blame oblems arising, including corrupt practices.

Secondly the personnel issues cited are crucial to the success of any venture in the Roads rtment. Attempting to change systems without doing something about them is a waste of Finally it was appreciated that to effect change, younger engineers with the knowledge of ment Management Systems could sell the idea to their superiors. Hopefully they will nue with the process begun by this study.

These findings were obtained at relatively low cost in comparison to large external ltancies as pointed out earlier (5.1.1). By relying on internal intellectual resources neers, economists e.t.c.) creatively, we save on costs.

It is clear that without an open approach such as SSM, such vital findings could be missed Most likely buried in mountains of technical data and information, which misses the whole lem.

comings and Problems Encountered

tudy of this nature top management support is a must. This was secured. But it is doubtful er they realized the real meaning of support. One gets the feeling that too many studies are yet nothing changes, and the apathy of the management becomes understandable ,1982). This meant that trying to convene a Seminar to present findings was a formidable though no one was against it. Even getting a 5 page draft report read by some proved sible.

Some of the participants lacked the morale and patience demanded by the approach. This e countered by provision of refreshments and monetary allowances for them. Renumeration in the civil service do not encourage any extra effort (or even any at all for some). ing and applying SSM is mentally taxing, though it gets exciting as it narrows down to fic issues. For example, the session on the structure of Planning Branch was visibly charged an air of purposeful activity and was personally gratifying to all. So if participants can be through initial stages they catch on later.

We cannot rule out the influence of the "consultant" on the final report. Were the findings ed" by the MOPW or just he consultants ideas pushed on to them ? (Huxham, Cropper & et in Rosenhead, 1989) This point has bearing on the team's enthusiasm to defend them for ple before a meeting or seminar. Care was taken to keep the consultants role to guidance, rodding by intermittent questions to keep the discussions from becoming too general as to out on the benefits of the methodology. However a working rapport was easy to establish

is researcher's familiarity with the problem area and participants. Eden and Simpson nade a conscious choice of the client role occupier while SSM enables us to try many ve root definitions. Dynamism of actual discussions coupled with many unexpected reduce the degree of consultant induced bias greatly. He or She necessarily becomes a

Practical Value For Developing Countries

g is one great benefit of using SSM in DCs. Participants gain insight into the real s of organizations without blinding themselves with OR "tools". This leads to increased ess within, thus creating internal momentum for change. Ackoff's (1976) idealized g relies on the leader, this approach aims at consensus for all, facilitating bottom-up g. Causing any change in DCs is not easy (Ackoff 1976, Gass 1990). The political force by awareness can even overcome key personnel opposed to change for their own ends.[6]

Important also is the possibility of small progressive changes. Culture shock is avoided rching for agreeable changes only, small changes are better than no change at all. These have to be the best. Merely seeing the piles of unread reports by consultants, with long revolutionary changes is proof enough that such an approach will not work. Small changes stage for the larger more painful ones by giving time for organizational re-adjustment and t to build up.

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[6]See the case of Cordia Engineering, in Checkland, 1981, p. 168, 264.

CONCLUSION

land developed SSM as part of ongoing "Action Research" (Checkland and Jenkins 1974 ckland 1981). Clark (1972) in the same text states that the subject and researcher cannot arated just as in applied Social Research, hence situation specific. In view of these facts ot possible to give general conclusions. However SSM relies on what Checkland (1981) lly argues is an epistemology- systems thinking. Useful conclusions may therefore be if we restrict ourselves to systemic interactions.

A traditional OR approach could not have brought out all the findings above. With SSM re able to learn subtle relationships and to re-orient our focus of attention progressively. to redefining the role of Planning Branch. It is this dynamism that leads to learning, very and development of our concepts that makes the soft approach a good way to begin R study. The results obtained are more practical, defensible, and hopefully superior.

The problem of introducing a full scale Pavement Management System was appreciated fully. Integration of a system such as HMMS requires greater commitment to all planning d activities or it will remain inconsequential.

Participants and many senior officers interviewed agreed with these suggestions, hence the ining bit is communication (selling) to those in authority and whether they have the will to

hat they desire.

As a final comment evidence here shows that the limit of any study aimed at entation is simply the desires and will of those in authority not the intellectual appeal of Good findings properly communicated can serve to influence those desires and build us to effect that will. In any case the purpose of leadership is to set those limits and give n. The desirerability of it is for those affected to judge and make a choice whether to act ngly or not, depending on their capabilities. This is the source of political activism and e.

LIMITATIONS OF THE STUDY

systems approach study demands much time and commitment, it was not available as ary. Participants could not take enough time off their normal duties to see the study etely through. This study for example took a month of almost continous interraction with dy team, and in addition, furhther interviews with other officers.

Additionally, a better funded study and time would have enabled us to travel to various f the country to obtain views from people other than headquarters staff, or invite those able e time off and travel to a central place where their views and feelings can be brought er.

The GP model could not be tested due to lack of updated data for comparison. Obtaining jective rankings from DDCs could not be done in the time available. Introducing the idea and ting it accepted needs time. The GP model if incorporated as an initial module for HMMs tem would assist in allocating funds whre they were most needed and could be best used. ese would be in sufficient quantity to do real work other than spreading out funds too thinly be effective anywhere.

RECOMMENDATIONS FOR FURTHER RESEARCH

chnically an SSM study has no end. Hence it would be possible to continue where we left off ng several lines;

1. Proceed with refinements of the exact structure of Planning Branch in terms of manpower, deployment, and resources. But it should be done after a go-ahead is obtained from the top management. The study could easily be extended to other units within the Ministry.

2. Get inside the PMS in use-HMMS- and develop modules that make it more user friendly to produce summary reports in pictorial/graphical form for top management, to enhance acceptability.

3. Use SSM as a means to greater understanding of the personnel and motivation issues raised here.

4. Develop the goal programming model and implement it appropriately.

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PPENDICES

STEPS OF SOFT SYSTEMS METHODOLOGY

STARTING QUESTIONNAIRE FILLED BY SENIOR SUPERITENDING ENGINEER

(HMMS)

HMMS OUTPUT SAMPLES AND INFORMATION

(i) Paved Roads

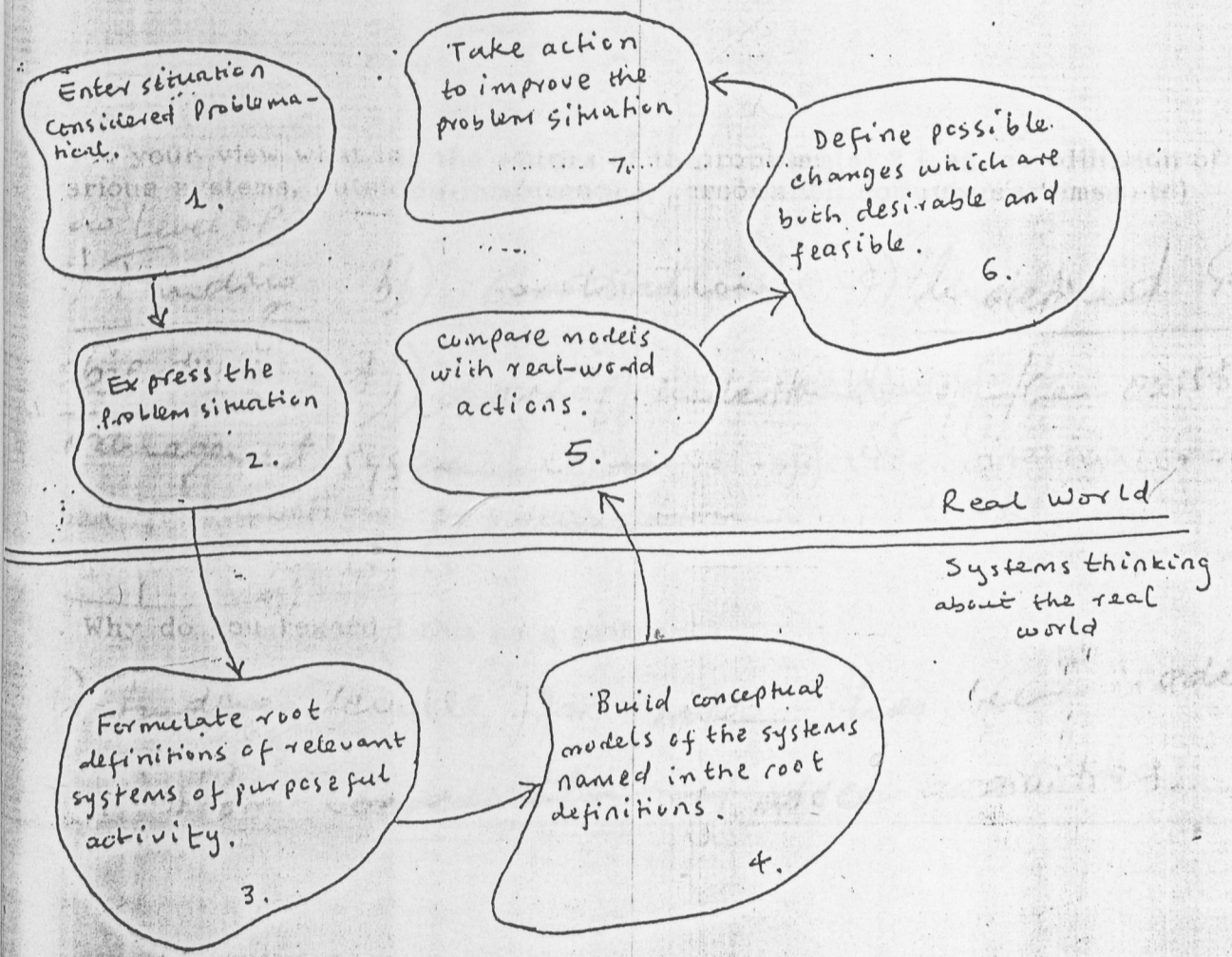
(ii) Unpaved Roads

(iii) Performance Budget Summary

(iv) Summary Information

SOFT SYSTEMS METHODOLOGY

Learning Cycle of S S M



ENGINEER (HMMS)

APP II

Please express your views with the aid of the following questions.

1. What are your aspirations for road maintenance in view of increased funding levels ?

a) Improved maintenance levels hence improved road conditions

b) Better management and organisation of road maintenance

2. In your view what is the nature of the problem(s) ? (eg. co-ordination of the various systems, outside interference, personnel, computer systems, etc)

a) Low Level of Funding & objectives b) Coordination c) Undefined Goals and objectives d) Lack of understanding of the existing mtce management systems e) ~~Use~~ No objective criteria (or not used) for allocation (f) Utilization - is it ok. Management by Crisis

3. Why do you regard this as a problem ?

a) Funding levels for mtce has been inadequate

b) Poor Coordination of mtce activities.

4. What do you expect of the study being carried out ?

a) Should assist in management and organization of road mtce.

App III (i)

Report criteria = org_code matches "741"

Report 6230-1
Performance Budget, Road Detail
District - Nakuru District

Ministry of Public Works
Highway Maintenance Management System

Nov 11, 199
page 1
Budget Year - 93/9

Activity	Inventory	Work Program	Total	BUDGET SHILLINGS BY PERIOD Per 1/7	Per 2/8	Per 3/9	Per 4/10	Per 5/11	Per 6/12
A104 -01 - Temporary Inventory									
10001 - Pothole Patch, Site	7000.0	1.7	682	68	136	102	34	0	34
	Sq. M.	Sq. M.		102	136	68	0	0	
10002 - Pothole Patch, Stock	7000.0	1.7	591	59	88	147	88	29	
	Sq. M.	Sq. M.		29	59	59	29	0	
10003 - Pothole Patch, Stab.	7000.0	1.7	216	21	43	54	10	0	
	Sq. M.	Sq. M.		21	43	21	0	0	
10101 - Spot Sealing	7000.0	1.2	37	7	7	3	0	0	
	Sq. M.	Sq. M.		3	3	0	0	0	
10201 - Crack Sealing	7000.0	201.7	1165	233	233	116	0	0	116
	Sq. M.	Metres		116	116	0	0	0	233
10301 - Sealing	7000.0	472.8	11139	0	0	0	0	0	1113
	Sq. M.	Sq. M.		3341	4455	2227	0	0	
14001 - Shoulder Grading	2.0	0.6	307	30	30	30	30	30	
	Kms.	Kms.		30	30	30	0	0	61
14101 - Shldr Grad, Pt. Grav	2.0	0.2	348	34	34	34	34	17	17
	Kms.	Kms.		17	34	34	34	34	17
14201 - Shldr Rebuild, Mech.	2.0	5.1	1860	149	148	167	148	148	167
	Kms.	Cubic M.		148	148	167	148	148	167
14301 - Shldr Rebuild,Manual	2.0	0.1	87	6	6	7	6	6	7
	Kms.	Cubic M.		6	6	7	6	6	7
20001 - Ditch Clean, Mech.	1.7	524.8	488	24	48	73	48	24	24
	Kms.	Metres		24	48	48	48	48	24
20102 - Caslab drainage	1.7	1419.0	3519	281	281	281	351	351	281
	Kms.	Metres		281	281	281	281	281	281
70001 - Minor Washout Repair	1.0	0.4	43	8	0	0	0	4	8
	Kms.	Man Hrs.		0	0	0	0	8	12
70101 - Flood Damage Repair	1.0	0.8	93	9	4	0	0	4	18
	Kms.	Man Hrs.		0	0	0	9	18	27
		Total for road	20575	928	1058	1014	749	613	1786
				4118	5359	2942	555	543	836
A104 -40 - PROV BOUND-C88(Naivasha)									
10001 - Pothole Patch, Site	202400.0	42.8	17191	1719	3438	2578	859	0	859
	Sq. M.	Sq. M.		2578	3438	1719	0	0	0
10002 - Pothole Patch, Stock	202400.0	42.8	14979	1487	2231	3719	2231	743	0
	Sq. M.	Sq. M.		743	1487	1487	743	0	0
10003 - Pothole Patch, Stab.	202400.0	42.8	5442	544	1088	1360	272	0	0
	Sq. M.	Sq. M.		544	1088	544	0	0	0
10101 - Spot Sealing	202400.0	28.6	900	180	180	90	0	0	90
	Sq. M.	Sq. M.		90	90	0	0	0	180
10201 - Crack Sealing	202400.0	4998.5	28891	5778	5778	2889	0	0	2889
	Sq. M.	Metres		2889	2889	0	0	0	5778
10301 - Sealing	202400.0	11717.8	276071	0	0	0	0	0	27607
	Sq. M.	Sq. M.		82821	110428	55214	0	0	0

(ii)

Report 6230-1
Performance Budget, Road Detail
District - Kiambu District

Ministry of Public Works
Highway Maintenance Management System

Nov 11, 1994
page 3
Budget Year - 93/94

Activity	Inventory	Work Program	Total	Per 1/7	Per 2/8	Per 3/9	Per 4/10	Per 5/11	Per 6/12
			BUDGET. SHILLINGS BY PERIOD						
D395 -01 - DIST-BOUNDARY-MANGU									
12001 - Heavy Road Grading	98.0	18.4	4401	396	396	396	396	396	220
	Pass Kms.	Pass Kms.		220	396	396	396	396	396
12101 - Light Road Grading	98.0	92.1	6852	616	616	616	616	616	342
	Pass Kms.	Pass Kms.		342	616	616	616	616	616
12201 - Spot Patching	122000.0	22.9	1337	120	120	120	120	120	66
	Sq. M.	Sq. M.		66	120	120	120	120	120
12301 - Gravel Patching	122000.0	22.9	2868	258	258	258	258	258	143
	Sq. M.	Cubic M.		143	258	258	258	258	258
20001 - Ditch Clean, Mech.	29.3	4128.2	3839	191	383	575	383	191	191
	Kms.	Metres		191	383	383	383	383	191
20102 - Caslab drainage	29.3	2151.8	5336	426	426	426	533	533	426
	Kms.	Metres		426	426	426	426	426	426
20201 - Culvert Clean, Light	2.0	0.2	16	3	0	0	0	1	1
	Number	Number		0	0	0	1	4	3
20301 - Culvert Clean, Heavy	2.0	0.0	0	0	0	0	0	0	0
	Number	Number		0	0	0	0	0	0
20401 - Culvert Repair/Replc	2.0	0.0	0	0	0	0	0	0	0
	Number	Metres		0	0	0	0	0	0
20501 - New Culvert Installn	2.0	0.0	0	0	0	0	0	0	0
	Number	Metres		0	0	0	0	0	0
70001 - Minor Washout Repair	24.4	4.6	497	99	0	0	0	49	99
	Kms.	Man Hrs.		0	0	0	0	99	149
70101 - Flood Damage Repair	24.4	9.2	1077	107	53	0	0	53	215
	Kms.	Man Hrs.		0	0	0	107	215	323
		Total for road	26223	2216	2252	2391	2306	2217	1703
				1388	2199	2199	2307	2517	2482
D398 -02 - A2-RUIRU-A104-KINARI									
12001 - Heavy Road Grading	54.0	12.2	2918	262	262	262	262	262	145
	Pass Kms.	Pass Kms.		145	262	262	262	262	262
12101 - Light Road Grading	54.0	60.9	4530	407	407	407	407	407	226
	Pass Kms.	Pass Kms.		226	407	407	407	407	407
12201 - Spot Patching	67000.0	15.1	881	79	79	79	79	79	44
	Sq. M.	Sq. M.		44	79	79	79	79	79
12301 - Gravel Patching	67000.0	15.1	1891	170	170	170	170	170	94
	Sq. M.	Cubic M.		94	170	170	170	170	170
20001 - Ditch Clean, Mech.	16.1	2722.1	2531	126	253	379	253	126	126
	Kms.	Metres		126	253	253	253	253	126
20102 - Caslab drainage	16.1	1418.9	3518	281	281	281	351	351	281
	Kms.	Metres		281	281	281	281	281	281
20201 - Culvert Clean, Light	21.0	2.4	193	38	0	0	0	19	19
	Number	Number		0	0	0	19	57	38
20301 - Culvert Clean, Heavy	21.0	0.5	404	121	121	161	0	0	0
	Number	Number		0	0	0	0	0	0
20401 - Culvert Repair/Replc	21.0	0.1	428	0	0	0	0	0	214
	Number	Metres		214	0	0	0	0	0
20501 - New Culvert Installn	21.0	0.5	690	138	0	0	0	172	172
	Number	Metres		0	0	0	69	138	0

(iii)

Report 6230-2
Performance Budget Summary
District - Vihiga District

Ministry of Public Works
Highway Maintenance Management System

Nov 15, 1994
page 44
Budget Year - 93/94

Activity	Inventory	Maint Level	Work Program	Prodctn Per Day	Man Hours	Cost Distribution Labour	Equipt	Matl etc	Total
10001 Pothole Patch, Site	611500.0 Sq. M.	0.0001	100.9 Sq. M.	20.0	686	0	7385	33143	40529
10002 Pothole Patch, Stoc	611500.0 Sq. M.	0.0001	100.9 Sq. M.	20.0	403	0	4197	30880	35077
10003 Pothole Patch, Stab	611500.0 Sq. M.	0.0001	100.9 Sq. M.	20.0	565	0	4157	8672	12829
10101 Spot Sealing	611500.0 Sq. M.	0.0008	499.7 Sq. M.	400.0	99	0	5126	10603	15730
10201 Crack Sealing	611500.0 Sq. M.	0.0193	11803.7 Metres	2000.0	472	0	9679	58546	68225
10301 Sealing	611500.0 Sq. M.	0.0417	25542.1 Sq. M.	5000.0	1879	0	169088	432683	601771
14001 Shoulder Grading	173.8 Kms.	0.2065	35.9 Kms.	10.0	287	0	18380	7	18387
14101 Shldr Grad, Pt. Gra	173.8 Kms.	0.0684	11.9 Kms.	8.0	178	0	15365	5358	20723
14201 Shldr Rebuild, Mech	173.8 Kms.	1.7238	299.6 Cubic M.	120.0	379	0	55327	53966	109294
14301 Shldr Rebuild,Manua	173.8 Kms.	0.0345	6.0 Cubic M.	5.0	153	0	4128	1099	5227
20001 Ditch Clean, Mech.	104.6 Kms.	216.7045	22667.3 Metres	3000.0	664	0	21088	0	21088
20102 Caslab drainage	104.6 Kms.	585.2294	61215.0 Metres	20.0	0	0	0	151813	151813
20201 Culvert Clean, Ligh	153.0 Number	0.0503	7.7 Number	10.0	73	0	609	12	622
20301 Culvert Clean, Heav	153.0 Number	0.0261	4.0 Number	1.0	384	0	3168	64	3232
20401 Culvert Repair/Repl	153.0 Number	0.0045	0.7 Metres	5.0	13	0	200	2796	2997
30202 Caslab Bushclearing	36.6 Kms.	507.6092	18578.5 Metres	10.0	0	0	0	9289	9289
70001 Minor Washout Repai	88.5 Kms.	0.2745	24.3 Man Hrs.	56.0	24	0	2187	441	2628
70101 Flood Damage Repair	88.5 Kms.	0.5480	48.5 Man Hrs.	104.0	52	0	5204	473	5678
			Total for District		6318	0	325287	799851	1125138

********** End of Report **********

(iii)

Report 6230-2 — Ministry of Public Works — Nov 15, 1994
Performance Budget Summary — Highway Maintenance Management System — page 4
District - Murang'a District — Budget Year - 93/94

Activity	Inventory	Maint Level	Work Program	Prodcto Per Day	Man Hours	Cost Distribution Labour	Equipt	Matl etc	Total
12001 Heavy Road Grading	5588.0 Pass Kms.	0.2048	1144.5 Pass Kms.	30.0	3662	0	273157	606	273764
12101 Light Road Grading	5588.0 Pass Kms.	1.0238	5721.1 Pass Kms.	40.0	5721	0	425649	0	425649
12201 Spot Patching	6853300.0 Sq. M.	0.0002	1416.0 Sq. M.	20.0	6796	0	56073	26620	82694
12301 Gravel Patching	6853300.0 Sq. M.	0.0002	1416.0 Cubic M.	100.0	1472	0	149076	28320	177396
20001 Ditch Clean, Mech.	1831.2 Kms.	153.0087	280189.6 Metres	3000.0	8218	0	260576	0	260576
20102 Caslab drainage	1831.2 Kms.	79.7542	146046.0 Metres	20.0	0	0	0	362194	362194
20201 Culvert Clean, Ligh	1022.0 Number	0.1104	112.9 Number	10.0	1083	0	8941	180	9122
20301 Culvert Clean, Heav	1022.0 Number	0.0216	22.1 Number	1.0	2121	0	17503	353	17856
20401 Culvert Repair/Repl	1022.0 Number	0.0031	3.2 Metres	5.0	61	0	916	12784	13701
20501 New Culvert Install	1001.0 Number	0.0216	21.7 Metres	8.0	303	0	11501	18475	29976
70001 Minor Washout Repai	1294.3 Kms.	0.2051	265.5 Man Hrs.	56.0	265	0	23895	4818	28713
70101 Flood Damage Repair	1294.3 Kms.	0.4101	530.9 Man Hrs.	104.0	571	0	56971	5187	62158
			Total for District		30279	0	1284262	459541	1743804

HIGHWAYS MAINTENANCE MANAGEMENT SYSTEM

An Executive Summary

HMMS – Highways Maintenance Management System

A computer system developed for the Roads Department and used in budgeting and control. As well as budget itemising, it tracks down utilisation of resources deployed for maintenance of roads by recording and updating the road network inventory; road surface condition: equipment and personnel.

BUDGET production:

The budget sub-system shares out the fiscal allocation for road maintenance, assigning it to specific activities on specific roads as influenced by road inventory, priorities assigned each activity, resource prices, production standards and quantity standards. Consequently, a work program (detailing actual work and when it is to be done) is produced for all the budgeted activities in all parts of the republic. The ideal budget allocation is also computed and is in this case called the bench-mark budget. From this, the actual budget is proportionately scaled down.

Input

The relevant data collection forms are attached and most of the entries are to be entered in pre-coded form.

a. From the Maintenance Camps

1. Daily activity sheet – this records any work done in the field. The particulars of the camp(station), the road and the date are filled in. The particulars of workmen involved, equipment used and materials used are recorded together with the day's accomplishment in a standard unit of measure e.g. 'sq m' for pot-hole patching. The HMMS Procedures Manual, which is available at every camp is used for coding purposes.

2. Overhead sheet – this used to report back all the overheads incurred over a particular month. Records the particular activity and its associated overheads that could be in form of equipment, labour, materials. A batch control slip is used whenever the above two sheets are prepared in numbers more than 1. This is normally the case.

b. Periodic Data

3. Inventory – this involves updating the inventory of roads i.e. their classification, surface type, surface age, traffic class, location, road furniture and makings etc.
4. Production standards.
5. Quantity standards and Quantity standards factors.
6. Resource prices.
7. Equipment update.
8. Fiscal estimate – the allocation for all maintenance operations.

Output

1. The Performance budget and work program – The money allocated for all the activities listed. Work program for the listed activities spread as per the production standards over the fiscal year, and goes to the districts and their maintenance camps. ?Three samples of Performance budget and work programme are enclosed:

   a) Periodic distribution

   b) Summary

   c) Road detail

2. Reports – either on–screen inquiries or management reports and are produced as ordered by station, activity or road number as desired.

   – Maintenance Performance reports – a measure of actual performance as reported from the districts against the planned work program in monetary terms as well as in the relevant unit of measure for the specific activity. A sample of this report is enclosed.

   – Maintenance Expenditure – a measure of actual performance in monetary terms.

   – Maintenance cost – measure of actual cost per unit measure of specific activity against that in plan (which was used to budget calculation).

   – Grader history – records of all the work done by a specific motor grader. This listed road by road for each month in question.

LINK with Equipment Management System(EMS)

The EMS provides input data (No.7 above) for HMMS. This is because its CM&TE department that keeps an upto–date record of all machinery on behave of the ministry. This includes all those under the CE(Roads) that are involved in roads maintenance. EMS also gets the equipment usage data from HMMS. All data transfer is by magnetic tape and is done periodically, currently once a month.

The Highway Maintenance Management System

(A Roads Maintenance budgeting and monitoring Model)

The HMMS model is designed to budget and monitor both routine and periodic maintenance of roads. In order to accomplish this task, the model is equipped with the following:-

1. Road Inventory
2. Quantity Standards
3. Production Standards
4. Resource Prices

A brief description of these definition follows.

1. Road Inventory

The total length of the National road network and also a numerical count of all associated road features eg. road signs, shoulders, culverts, bridges, scour checks, road side bush etc.
The inventory is divided on a District basis i.e. a road that traverses several Districts is divided into sections, each section in a district is considered separately.
This inventory ought to be carried out annually just before the preparation of the budget, and each of the features are categorised on a scale of 1 to 9 to signify the level of deterioration (Level 1 being the worst). This will enable the model determine what level and type of maintenance is required for each road.

2. Quantity Standards

As explained above, the road inventory contains information of the length of road and a number from 1 to 9 signifying its level of deterioration. The quantity standards is a table containing the information of the level of maintenance to be carried out per unit length on each category of road.
An example of the quantity standards for pothole patching in the HMMS is listed below.

Road type	Service category	Work Quantity
Premix	1	0.033 m^2/Sq M.
"	2	0.030 "
"	3	0.024 "
"	4	0.021 "
"	5	0.018 "
"	6	0.012 "
"	7	0.009 "
"	8	0.003 "
"	9	0.003 "

From the above quantity standards it is clear that the model would calculate a pothole patching requirement of 3.3% of total road area for the most deteriorated road and 0.3% for the best category of road.

The Highway Maintenance Management System

(A Roads Maintenance budgeting and monitoring Model)

The HMMS model is designed to budget and monitor both routine and periodic maintenance of roads. In order to accomplish this task, the model is equipped with the following:-

1. Road Inventory
2. Quantity Standards
3. Production Standards
4. Resource Prices

A brief description of these definition follows.

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3. Production Standards

Production standards are simply the resources required for the performance of any activity specified in the Quantity Standards, and a measure of daily output. E.g, the HMMS production standard for regravelling is as follows:-

Labour	Equipment	Materials
Inspector 1 No.	Tippers 4 No.	Gravel 140 cu M.
Overseer 1 No.	Grader 1 No.	
Drivers 5 No.	Wheeled Loader 1 No.	
Plant Oper. 4 No.	Water Tanker 1 No.	
Labourers 5 No.	Pneumatic Roller 1 No.	

Accomplishment 1000 Sq M

The Production standards therefore enable the model to calculate the resource inputs required for any maintenance activity.

Resource Prices

This is a table containing the unit prices of he resource inputs (Labour, Equipment and Materials) required for maintenance activities.

HMMS Budgeting Procedure

The HMMS budgeting procedure comprises the following steps :-

1. Calculation of Work Quantity. This is Accomplished by multiplying the Road inventory with the Quantity standards for each relevant activity (and taking into account the road condition)

2. Calculation of Resource requirement. This is accomplished by dividing the quantity of work calculated above by the Production standard for each activity. The result is the Labour hours, Equipment hours and quantity of materials required.

3. Calculation of the financial budget. This is accomplished by multiplying the resource requirement calculated in (2) above by the Resource costs table.

The following reports can then be generated

1. Work Programme - the amount of each type of maintenance activity to be carried in each District.

2. Resource requirement in terms of:
   a) Labour type, hours required and cost
   b) Equipment type, hours required and cost
   c) Materials by type, quantity and cost

These reports can be obtained on request for National budget, District or section of a road.

HMMS field work reporting

After preparation of budgets and disbursement of funds to the implementing officers, HMMS provides a reporting system that enables progress towards achievement of the work programme can be monitored.

Daily activity sheets are issued to the supervisors of maintenance gangs. On these sheets, the supervisor records the resources used (Labour, Equipment & Materials) and work accomplishment.

These forms are forwarded to headquarters on a bi-weekly basis and the information entered in the computer.

Reports can then be produced to compare:

a) Actual Performance vs work programme
b) " Expenditure vs Budget

for the National road network, district or road.

Schematic representation of HMMS budgeting Model