Impact of map literacy on development planning in South Africa

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CERTIFICATE

I, the undersigned, hereby declare that the work contained in this dissertation is my own original work and that I have not previously in its entirety or in part submitted it at any university for a degree.

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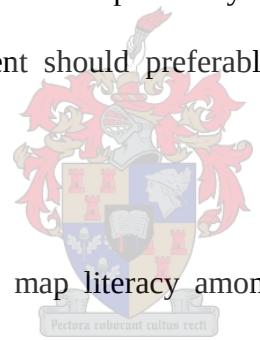
ABSTRACT

Most of the less developed countries are engaging in development projects to address the development needs of their citizens. Yet the record of success of these projects is not high. The ‘crisis in development planning’ has been under scrutiny for some time so that ways may be found of improving the development planning process. Development planning requires reliable quantities of information of an acceptable quality. In particular geo-spatial information should be used in development planning. However, there is evidence of poor usage of geo-spatial information in development planning. There is a need to review the development planning process, in particular the decision-making process, particularly where information and knowledge are used. A proposed new development planning process is presented, emphasizing the role of information and knowledge, as well as capacity and capacity-building in a community participative process.

From evidence presented in this research it is concluded that there is a significant relationship between geo-spatial information and development planning. A Geo-spatial Information Decision-making Model is developed, emphasizing the relationship between geo-spatial information, spatial knowledge and the decision-making process within the environment of the development planning process. This is an information / knowledge-centric model, with the objective of optimizing rationality in the decision-making process.

As geo-spatial information is best represented visually on a map, it requires those involved in development planning to be competent in using maps – that is, to be map literate. Through establishing the similarities between the natural language and the cartographic (map) language, the constructs and definition of functional map literacy are derived from the constructs and definition of functional literacy. Functional literacy is better described than literacy, and likewise for map literacy. A means to measure and test for functional map literacy, using a three skill level measure, is given here. For this purpose 18 map use tasks have been developed, and validated for applicability. A person is functionally map literate if the person is competent at Level 1 (achieves 80% at the second skill level) of the functional map literacy skill. Professionals working in a development planning environment should preferably be functionally map literate at Level 2 (third skill level).



Low levels or lack of functional map literacy among those involved in development planning has implications for development planning. The alternative (decision) selected could be defective, if the geo-spatial information is used incorrectly or not used at all. Some scenarios of these implications are given.

It is concluded that the functional map literacy levels in South Africa are inadequate for effective development planning. Thoughts on improving development planning, based on improving the use of geo-spatial information, are given. This includes map literacy training. It is shown that map literacy can be taught. In particular, the map awareness / map literacy project of the Chief Directorate of Surveys and Mapping has been effective

in raising the levels of functional map literacy among participants of the workshop intervention. The performance of participants in these workshops, using a pre-test and post-test, has been analysed. New representations of geo-spatial information should be considered to improve the understanding of the cartographic (map) language.

OPSOMMING

Meeste van die minder ontwikkelde lande is betrokke met ontwikkelings projekte om die ontwikkelings behoeftes van hul mense aan te spreek. Die sukses koers van hierdie projekte is ongelukkig nie hoog nie. Hierdie ‘krisis in ontwikkelings beplanning’ is vir ‘n geruime tyd ondersoek om ‘n manier te vind om die ontwikkelings beplanning proses to verbeter. Ontwikkelings beplanning het ‘n behoefte vir voldoende hoeveelhede betroubare informasie van aanneemlike gehalte. In besonder moet ruimtelike informasie in ontwikkelings beplanning gebruik word. Daar is egter bewyse van swak gebruik van ruimtelike informasie in ontwikkelings beplanning. Dit is nodig om die ontwikkelings beplanning proses in oënskou te neem, spesifiek die besluitnemings proses, waar informasie en kennis gebruik word. ‘n Voorgestelde nuwe ontwikkelings beplannings proses word aangebied, wat die rol van informasie en kennis, asook die kapasiteit en kapasiteitbou in ‘n deelnemende gemeenskaps proses, beklemtoon.

Van bewyse wat in hierdie navorsing aangebied word kan daar afgelei word dat daar ‘n betekenisvolle verhouding tussen ruimtelike informasie en ontwikkelings beplanning is.

‘n Ruimtelike Informasie Besluitnemings Model is ontwikkel, wat die verwantskap tussen ruimtelike informasie, ruimtelike kennis en die besluitnemings proses in die ontwikkelings beplanning proses beklemtoon. Dit is ‘n informasie / kennis-sentriese model, met die doel om die redelikheid van die besluitnemings proses te optimiseer.

Omdat ruimtelike informasie die beste op ‘n kaart voorgestel word, vereis dit dat almal wat in ontwikkelings beplanning betrokke is, met die gebruik van kaarte vaardig moet wees – dat hulle kaartgeletterd moet wees. Deur ‘n vergelyk tussen die natuurlike taal en die kartografiese (kaart) taal te traf, kan ‘n definisie van funksionele kaartgeletterdheid geformuleer word. Die omskrywing van funksionele geletterdheid is meer duidelik as die omskrywing van geletterdheid en die selfde geld vir kaartgeletterdheid. ‘n Manier om funksionele kaartgeletterdheid te meet en te toets, deur gebruik van ‘n drie vlak bekwaamheids maat, word hier aangebied. Vir hierdie doeleinde is agtien kaart gebruikstake ontwikkel en vir bruikbaarheid getoets. ‘n Persoon is funksioneel kaartgeletterd as hulle op Vlak 1 bevoeg is (behaal 80% by die tweede bekwaamheidsvlak). Professionele werkers wat in die ontwikkelings beplanning omgewing werksaam is, moet liefs op Vlak 2 (derde bekwaamheids vlak) funksioneel kaartgeletterd wees.

Lae vlakke of gebrekkige funksionele kaartgeletterdheid onder persone wat in ontwikkelings beplanning betrokke is het implikasies vir effektiewe ontwikkelings beplanning. Die geselekteerde keuse (besluit) kan, as die ruimtelike informasie verkeerd

of nooit gebruik is nie, gebrekkig wees. Enkele scenarios van hierdie implikasies word geskets.

Dit is bevind dat die funksionele kaartgeletterdheidsvlakke in Suid Afrika onvoldoende vir effektiewe ontwikkelings beplanning is. Voorstelle om ontwikkelings beplanning te verbeter, gebaseer op die verbeterde gebruik van ruimtelike informasie, word angebied. Dit sluit in opleiding in kaartgebruik. Dit is bewys dat kaartgeletterdheid aan geleer kan word. In die besonder is bevind dat die kaartbewustheid / kaartgeletterdheid projek van die Hoofdirektoraat van Opmetings en Kartering effektief om die vlakke van funksionele kaartgeletterdheid onder die deelnemers by werkswinkels te verhoog. Die kaartgeletterdheidsvlakke van deelnemers by hierdie werkswinkels is deur die gebruik van ‘n voor- en ‘n na-toets ontleed. Nuwe voorstellings van ruimtelike informasie moet oorweeg word om begrip van die kartografiese (kaart) taal te verbeter.

The capacity of the human mind for formulating and solving complex problems is very small compared with the size of the problems whose solution is required for objectively rational behaviour in the real world – or even for a reasonable approximation to such objective rationality.
Simon, 1957. Models of Man : Social and Rational

Show me a geographer who does not need them [map] *constantly and want them about him, and I shall have my doubts as to whether he has made the right choice of life …. Maps break down our inhibitions, stimulate our glands, stir our imagination, loosen our tongues. The map speaks across the barriers of language; it is sometimes claimed as the language of geography.*
Sauer, 1956

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CONTENTS

(Last page 281)

List of Tables, Figures and Graphs

CHAPTER 1

INTRODUCTION

1.1 Introduction

Humans face many challenges to survive into the future. Among these challenges is the inequality among the various peoples of the world in contributing to the survival of the human species and its environment. The efforts of one group can easily be undone by the actions or lack thereof by another group. It is therefore in the interests of all that there is a commitment to the common goal of survival. All peoples must share the responsibility for the sustained good health of our mother Earth. Every person must heed the words of Ismail Serageldin, Vice-President for Special Programs of the World Bank, in his keynote address to the Congress of the International Society for Photogrammetry and Remote Sensing held in Amsterdam in July 2000: "This world is not the world that we have inherited from our forefathers, rather, this world is the world we have borrowed from our children" (ISPRS, 2000).

Equality does not prevail in the world, with large disparities being found in different fields and different regions. There are disparities on the level of basic human needs, such as food, shelter and clothing. There are disparities in human life expectancy, dignity and security. There are also disparities in the state of the

environment on which human survival is dependent – this includes environmental degradation and pollution, potable water and productive soil.

The need to address the challenges facing human survival has been recognized, and numerous agreements, programmes and projects exist at the international, regional, national and local levels. Many of these initiatives have been implemented and driven by those countries generally regarded as developed countries, with the less developed countries comprising the main recipients of such initiatives. The terms 'developed' and 'less developed' countries are generally taken from the categorization made by the World Bank (2004). The donor-recipient relationship of developed/less developed countries could be explained in terms of the difference in availability of resources and the current state of development. This relationship could also be explained in terms of the fears of the developed countries that the less developed countries will negatively affect their attempts at survival, or it could be the guilt of the developed countries over their colonial exploitation of the less developed countries, which supported their own development in the past.

The less developed countries tend to struggle to develop themselves, generally because of a lack of human capacity and financial resources. In South Africa the government has placed development, particularly of its peoples, very high on the agenda and has a developmental approach to all its government programmes. After 1994 the South African government formulated a Reconstruction and

Development Programme, supplemented by the Growth, Employment and Redistribution (GEAR) Strategy in June 1996. This programme is an integrated growth and development policy that aims not only to address poverty, basic needs and sustainable economic growth, but also to transform South Africa into a democratic, non-racial and equal society. The need for development is repeatedly mentioned in the State President's State of the Nation address to the Parliament of South Africa each year.

Besides its own expressed development priorities and objectives, South Africa is also a stakeholder in a number of international and regional development initiatives. Most of these initiatives are not exclusive, but they either contribute directly to the others or are complementary to them. These include the New Partnership for Africa's Development (NEPAD) of the African Union, the Millennium Declaration Goals (UNDP, 2001:21-25) and the World Summit on Sustainable Development (WSSD, 2002). There are also initiatives for the South African Development Community (SADC) sub-region, such as food security and disaster mitigation (SADC, 2004).

Most development takes place in a spatial context, that is, it is located somewhere or there is a relationship between phenomena at a place or in adjoining regions. Typically, the following questions could be asked when discussing development issues:

- Where do the poorest of the poor live?

- Where is the nearest drinking water for that community?
- What exists at that place?
- What is the relationship between the occurrence of a settlement and a particular economic activity at a place?
- What is the demographic profile of a community in relation to its neighbours?
- Where is the best place to site a new industrial development?
- What is the environmental sensitivity of a given area to a particular type of development?
- How far is it from the nearest main centre?
- What is the geographical distribution of persons infected with HIV/AIDS or malaria?
- What is the spatial (geographical) equity of public policy implementation?

Information is required to answer such questions. This type of information is generally referred to as geo-spatial information. Geo-spatial information is best depicted visually on a map. The map simplifies the complex realm of the real world, providing a usable interpretation for the map user – the map lives up to the saying that "a picture paints a thousand words". The map, either in hard-copy or digital format, then becomes an essential tool for aiding decisions in the planning and monitoring of development programmes and projects. All planners and decision-makers inevitably at some stage of their work have to resort to using a map (geo-spatial information). They must have the ability to access or extract

relevant information from the map. Technology now available provides new ways of accessing, visualising and using geo-spatial information for more efficient planning and monitoring of development projects. This includes geographic information systems, spatial decision-support systems, virtual reality and internet mapping, even mobile maps on personal digital assistants (PDAs) and car navigation systems.

What is the relationship between development planning and geo-spatial information? If such a relationship does exist, then it goes without saying that geo-spatial information should be used by development planners. If maps are the primary source and visualisation product of geo-spatial information, and geo-spatial information is a major type of information in the development planning process, then there is certainly a need to consider map literacy in development planning. This research will consider these questions by looking at map literacy and its implications for development planning in a developing country such as South Africa.

1.2 Development Planning Problems

Although large quantities of resources, both human and financial, have been expended since the Second World War on the development of the so-called less developed countries (LDCs), mainly by the developed Western countries, there has been limited success.

The state of development of the LDCs is of concern to many governments and many groups of people involved in the plight of the communities in these LDCs, yet for many years there has been limited success in improving the level of development in these countries. Improving the success rate of development projects is of paramount importance. The objective here is to devise a specific visual map-related strategy that is both acceptable to all parties concerned and effective in attaining the goals of development planning.

It is necessary to review the historical position to determine the possible reasons for the failures of the past, and the reason for the 'crisis in development planning'. Consideration must be given to the context of planning and various models of planning to arrive at a development planning process. Based on this planning process, it must be asked what the relevance and future role of the 'new' approach is.

It is necessary first to summarise the linkages between development planning, information needs and map literacy before a concrete research problem statement can be formulated. These concepts are then assessed in more detail in Chapter 2.

1.3 The Origins of Development Planning in Less Developed Countries

Development efforts in less developed countries (LDCs) started to receive more emphasis in the post-Second World War era (Conyers & Hills, 1990:42). In this period the LDCs were attaining their independence from the colonial powers that had controlled them for many decades. Development planning was based on economic grounds and "planning was seen as a means of accelerating the process of economic development and preparing a sound economic basis from which the colonial territories could launch out as independent nations" (Conyers & Hills, 1990:43).

The emphasis on economic development planning in the LDCs was the result of the apparent success of the Soviet Union's five-year plans, Europe's wartime planning experience and the structuralist orientation of development economics (Argawala, 1983:3; Conyers & Hills, 1990:44). The centrally-planned economy of the Soviet Union was seen by some African countries as a way of bringing about the radical social and economic changes that the new governments saw as necessary to rid their countries of the repressive colonial policies and establish their own power bases. The experiences gained during the Second World War convinced economists and others involved in the national economy of those countries "that it was possible for a government to influence the rate and direction of growth of a mixed economy, rather than rely entirely on market forces, should it wish to do so" (Conyers & Hills, 1990:44).

1.4 Shifts in Schools of Thought on Development

The development schools have changed over time in response to finding a successful approach to development in the LDCs. The post-Second World War era has evidenced the most changes. The evolution of these schools of thought is summarised by Jeppe (1987) and Pieterse (2001).

The emphasis on economic development, the so-called growth approach, emerged in the 1940s and was dominant in the 1950s (Pieterse, 2001:7). This school of thought was dominated by the ideas of the more developed (First and Second World) countries. Development was seen as economic growth through industrialisation, specialisation, maximisation of income and production, urbanisation of workers and centralisation of authority and planning. In the 1960s the economic growth approach was being questioned and the modernisation theories emerged. Here the emphasis was on a sociological and political modernisation approach, where individuals and communities go through psychological change and become modernised – in terms of Western ideals. In the modernisation theories development is state-led growth (Pieterse, 2001:155). Economic growth remained at the core of the meaning of development, giving rise to the dependency theory of national accumulation. This led to the 'development of underdevelopment' (Pieterse, 2001:6). Dependency theory accounts for the limited capacities of less developed countries with the concept of the dependent

state, where the role of the government is to facilitate world market access into society.

By the end of the 1960s it was realised that, although the LDCs were achieving the objectives of economic growth, the quality of life of the majority of the people remained unchanged, and in the 1970s new understandings of development came to the fore, referred to as 'alternative development'. In the alternative development theories development should be society-led, equitable, participatory and sustainable (Pieterse, 2001:6, 155). These focused more on social and community development, including poverty alleviation. More attention was paid to satisfying the basic human needs of food, shelter, health and protection. Alternative development brought with it new thinking on the agency of development. No longer was development the preserve of national and international governments, but also the non-governmental organisations, giving rise to a strengthening civil society. An endogenous outlook (social, cultural and symbolic space) is fundamental to alternative development, refuting the idea that development is synonymous with (Western) modernisation (Pieterse, 2002:86). It was also in the early 1970s that some Western development theorists started taking more of an interest in the Marxist development theories, providing an alternative view on hegemonic power relations, the accumulation of capital and the role of the state (Harvey, 2001:7-11). An aspect of the poverty-alleviation approach is social transformation as well as social learning to mobilise the people to take responsibility for their own development. For this to take place there must

be capacity building, empowerment, equity and sustainability. Friedman (1992:6) refers to this as the "search for alternative development", emphasising empowerment, "which is centred on people and their environment rather than production and profits" (Friedman, 1992:31). People-centred empowerment requires social power, that is power associated with civil society (Friedman, 1992:67). Among the bases of social power are knowledge and skills (human resource development), and continuing access to appropriate information, together working to enhance social power (Friedman, 1992:68). "The keynote of alternative development is local knowledge" (Pieterse, 2001:88).

This thinking evolved, in the 1980s, to the human development understanding, emphasising capacitation of people and communities and enlarging peoples' choices. The unit of development has also changed from a singular unit, the state, to a pluralistic understanding that development is about local, national, regional and international needs.

Another proponent of the people-centred, human development approach is the Nobel Laureate in Economics, Amartya Sen. Sen's view of development is centred on the unleashing of peoples' capabilities as a means of improving their quality of life (Sen, 1989:43). To expand peoples' capabilities requires the removal of restrictions – the attainment of "real freedoms" (Sen, 1999:3). These freedoms go beyond the economic and basic needs of people and include freedom from tyranny, neglect of public facilities, intolerance or over-activity of repressive

states and other social deprivation (Sen, 1999:3). The Human Development Reports, published annually by the UN Development Programme (UNDP), are based on Sen's capability approach and have established a distinct development paradigm – the human development approach (Fukuda-Parr, 2002:1). The human development approach is particularly relevant for my research.

The Human Development Reports of the UNDP report on a Human Development Index (HDI) for each country and various regions. The HDI has become a very influential standard, giving people-centred development a mainstream position in development (Pieterse, 2001:94) The HDI measures the overall achievements in a country in three basic dimensions of human development, namely, longevity, knowledge and a decent standard of living (UNDP, 2001:14). Each of the dimensions is determined from a number of measures. Knowledge is measured by the ratio of school enrolment at the different school levels and by adult literacy. Empowerment is therefore a key issue in human development.

The need for sustainability in development was stimulated by the 1987 report (often referred to as the Brundtland Report) of the World Commission on Environment and Development, appointed by the United Nations "to propose long-term environmental strategies for achieving sustainable development" (World Commission, 1987:ix).

In the late 1980s to early 1990s two radically different perspectives on development were being propagated, namely, neo-liberalism and post-development (Pieterse, 2001:6). The neo-liberalism thinking calls for the reduction of government intervention and calls for economic growth through structural reform, deregulation, liberalisation and privatisation. This calls for anti-development means to achieve development goals. Post-development thinking is still more radical in that it calls for an anti-development approach, not only to the means of development but also to the goals and results of development. It is a radical reaction to the dilemmas of development, notably anti-westernisation of development, anti-modernism, anti-structuralism, anti-globalisation, anti-state intervention and anti-managerialism, and is influenced by factors such as the ecological movements (Pieterse, 2001:99-106).

Oldfield *et al.* (2004:285 – 287) provide an alternative thinking from theorists in a developing country in considering the 'moral geographies' of North – South relations. They criticise the Northern theorists for not fully understanding the power dynamics of the South (developing countries) and ignoring the complex patterns of injustice, which exist globally. In translating 'moral geographies' into action Oldfield *et al.* (2004:289) discuss a "framework of rights-based development" to "promote a moral not guilt-based intervention on behalf of the poor of the South". A rights-based approach shifts from addressing poverty in isolation to highlighting inequality. "Socially relevant and moral geography thus becomes infused with relational concerns of social exclusion, differentiation and

geopolitics of power" (Oldfield *et al.*, 2004:289). Oldfield *et al.* (2004:290) point out that this calls for an "emphasis on the relations between those who wield power and those who are oppressed" and that there is an "understanding that there should be direct action to effect a change in the relations of power." This does not support the approach of the post-development theorists.

1.5 Shifts in the Approach to Development Planning

With the changes in the schools of thought on development there has also come a new understanding of development (see Chapter 3). The changes in the various schools of thought on development led to changes in approaches to development planning.

The earlier approaches were based on national plans, or on the blue-print concept with 'trickle-down' of policies and benefits from the top to the bottom (community level) (Barnard, 1991:6; Black, 1991:20; Todaro, 1989:87). Reinforcing the national planning approach were development aid donor countries and organisations, such as the USA and the World Bank, who made the requirements of a national plan a prerequisite for financial aid (Conyers & Hills, 1990:45; Gillis *et al.*, 1983:97). National development planning generally consisted of the following tasks (Bryant & White, 1982:238):

- "Collecting and assessing aggregate indicators of the nation's economic and social conditions;
- Collecting and assessing data on major sectors within the nation's economy;
- Identifying the relationships between sectors in order to specify areas of essential activity for key problems;
- Specifying alternative approaches for the amelioration of problems affecting the whole economy and those affecting particular sectors;
- Identifying the allocative implications of alternative approaches;
- Identifying and specifying alternatives to top decision-makers, usually at cabinet level. Laying out their implications in light of sectoral linkages;
- Following up on decisions taken in earlier planning discussions;
- Continual monitoring of the indicators of national economic and social well-being and of the sectoral linkages;
- Carrying out evaluations and insuring that results are included in successive plans and policy discussions."

Development planning in the LDCs started with the transfer of the Marshall Plan from post-war Europe to the newly independent countries (Barnard, 1991:6). The Marshall Plan approach failed because the circumstances were different in post-war Europe than in the LDCs. The war had destroyed many industries and broken the economy but the basic infrastructure still existed, the people still had the skills required for development, and they had discipline and a high work ethic. The

plans were at a national level and dealt mainly with structural economic (macro) issues. They were acceptable to the people and the plans worked because there was little social development required. These factors did not exist in the LDCs.

The blue-print approach had two main aspects. Firstly, there was the emphasis on economic development, in particular the growth and structure of the national economy (Conyers & Hills, 1990:45). The focus on economic growth meant that the social, political and cultural aspects of development were ignored, and the modernisation theory was based primarily on the LDCs 'catching up' with the Western world (Coetzee & Lightelm, 1989:351).

Secondly, there was the methodological approach of development planning at the time. The major problems associated with the traditional approach to development planning were:

- "too much emphasis on the plan and not enough on its implementation" and monitoring,
- "overemphasis on the medium term,
- excessive rigidity in the plan" – blue-print approach,
- "differences in perspective and inadequate communication between politicians, planners and administrators" (Conyers & Hills, 1990:46-47), and
- lack of political will (Barnard, 1991:7).

Black (1991:2) discussed some fallacies surrounding development planning, arising from two aspects. Firstly, "there has been a serious disjuncture among field practitioners, theoreticians and policy-makers. In the design of theories and policies, information vacuums tend to be filled by prejudice", and secondly, "policy makers routinely invoke widely shared moral ideas to justify the pursuit of cruder interests". Black (1991:2-8) is of the opinion that circumstances of ignorance, self-interest and psychological need have nurtured some useful fallacies:

- the assumption that progress has been made. While this may be true in one or more aspects, there is evidence of a worsening situation in other aspects;
- patenting modernism as a Western-centric phenomenon, but from whose view point;
- blaming the victims for the dire situation they find themselves in, and then imposing foreign models on them 'for their own good', instead of putting the people first and planning with the people; and,
- limiting the options available to LDCs by making them pawns in the Cold War.

It became increasingly evident that planning was having very little effect on what was actually happening, and there was increasing disillusionment with this approach (Conyers & Hills, 1990:47). The awareness of the problems of the

traditional approach led to what was termed, by Dudley Seers in 1969, as the 'crisis in planning'. Seers (1972:19) was of the opinion that "the experience of the past decade suggests that we now need to think out again the purpose of planning and its procedures."

The so-called crisis in planning and the fallacies of the theories on which development was founded at the time led to significant changes in development planning. Mehmet (1978:27) felt that the crisis in planning was not a crisis in relevance – economic planning was still required, but it was rather a crisis in approach, related to the objectives and strategies of planning.

Theron (1993) summarised the crisis in development as six-fold:

1. Participation – lack of participation by the people;
2. Distribution – of choice being limited;
3. Legitimacy – lack of legitimacy of the government;
4. Identification – lack of identification of the real development needs;
5. Integration – lack of integration of the various dimensions of development, and disciplines involved;
6. Penetration – poor horizontal and vertical penetration.

Todaro (2000:637) concludes that the gap between planned benefits and the practical results in most LDCs has been quite large, even to the extent that

planning policies may have unwittingly contributed negatively, perpetuating the situation. He is of the opinion that "some of the major explanations for this have to do with failures of the planning process itself" (Todaro, 2000:637). Certain specific problems are attributed to these failures:

- "Deficiencies in Plans and their Implications

  Plans are over ambitious … vague on specific policies for achieving stated objectives … (and) the gap between plan formulation and implementation is often enormous;

- Insufficient and Unreliable Data

  The value of a development plan depends to a great extent on the quality and reliability of the data on which it is based. When these data are weak, unreliable, or simply nonexistent, as in many poor countries, the accuracy and internal consistency of quantitative plans are greatly diminished ... In such situations, it can be both foolish and wasteful of scarce high-level human resources to engage in an extensive planning exercise;

- Unanticipated Economic Disturbances, External and Internal;

- Institutional Weaknesses

  … there has been much concern about incompetent and unqualified civil servants; cumbersome bureaucratic procedures; excessive caution and resistance to innovation and change; inter-ministerial personal and departmental rivalries;

- Lack of Political Will

  Poor plan performance … also attributable to a lack of commitment and political will on the part of many Third World leaders and high-level decision makers" (Todaro, 2000:637-638).

Conyers & Hills (1990:48-52) point to two significant changes that took place in development planning, namely the scope and the approach of development planning. There was a realisation that the scope had to be broadened beyond economic planning to include political, social and physical environmental aspects. This broadening of the scope has led to changes in the techniques of planning, as well as development planning as a discipline, with the incorporation of the social and environmental together with the economic components. Not only have these non-economic factors been incorporated, but attention has been given to the interrelationship between these political, social, environmental and economic factors. Pragmatism, as a normative planning theory, based on the premise that knowledge-based experience should guide planning action, came to the fore to address the limitations of rationalism (Lawrence, 2000:611). The new community participation approach to development places the emphasis on participation at the grass-roots level, or "learning through participation", and requires substantial departures from traditional planning practices (usually top-down) to include social mobilisation and social learning models (Friedman, 1992:170). The participatory approach to development has given rise to the current collaborative planning approach, which is based on the Habermasian communicative rationality and the

Foucaultian power relations. Collaborative planning is understood to revolve around practical concerns relating to understanding and action (Harris, 2002:22, 30). Collaborative planning, with its multi-disciplinary, participatory approach, is most relevant to my research.

The "emergence of the concept of 'integrated' development has resulted in a corresponding concern with 'integrated' development planning" (Conyers & Hills, 1990:49). The broadening of the scope has also led to greater concern about the distribution and equity of development benefits. The changes in approach to development planning were designed primarily to improve the implementation of plans.

The realisation of the new approach was, firstly, that planning was not just the preparation of plans (blue-print approach) but rather an "integral part of a much more complex and continuous process" (process approach) (Conyers & Hills, 1990:51) resulting not in plans on paper but an actual change in conditions for the target community, and secondly, that plans had to be realistic and take into account the social, political, economic and physical environments in which they have to be implemented.

1.6 The Need for Development Planning

Bryant & White (1982:229) state that "planning is a paradox: the more you need it, the less able you are to do it." This statement sets the scene as to why development planning is required. Development planners, according to Barnard (1991:3), face a unique problem, namely, as resources become scarcer, there is a greater need to utilize these resources strategically, and this requires good planning. On the other side, the more scarce these resources become in situations where they are most needed, the harder it is to plan. Barnard (1991:4) argues further that there is also a planning paradox in cases where planning is not future-oriented, with the eventual result that the country is faced with a development crisis.

Planning is needed to continuously monitor the state of development and to identify areas for attention. Planning develops alternatives for addressing development needs, evaluating these various alternatives and assisting in making a choice between these alternatives, taking into account the quantity and quality of the resources available for the allocation of these for the development project (Conyers & Hills, 1990:3-5).

Todaro (1989:466-467) gives a number of arguments for the need for planning:

- Planning is necessary from an economic market standpoint, because of the immature and distorted markets of LDCs. Markets are badly organised and distorted prices often send out false signals to producers. The absence of government interference leads to a misallocation of present and future resources, which is detrimental to social development. This is probably the main reason for government expanding its role in LDCs;
- Planning is necessary from an attitudinal or psychological standpoint, because a detailed statement of development objectives in the form of national development plans has national economic and social goals which unite a divided nation. This is particularly the case in countries that are divided. The government is able to rally the people behind it in its development campaign; and,
- Planning is necessary from a foreign affairs standpoint, because plans are usually a prerequisite set by donor countries and organisations for foreign aid.

1.7 Lack of Use of Geo-spatial Information (Maps)

Planning cannot be undertaken effectively without reliable quantities of information of an acceptable quality. The lack of information or the misuse of information is given as a major reason for the failure of development projects (Todaro, 2000:637). Conyers and Hills (1990:88) confirm this by stressing the important role that information plays in development planning, because "planning

is a process of decision-making and decisions cannot be made without at least a certain amount of information." In supporting the important role that information plays in orderly planning, Clarke (1998:14-15) states that "no country can expect to see rapid and sustainable development without relevant (geo-)spatial information." The United Nations Division for Sustainable Development in its Agenda 21 (paragraph 40.1) states that "in sustainable development, everyone is a user and provider of information considered in the broad sense. That includes data, information, appropriately packaged experience and knowledge. The need for information arises at all levels, from that of senior decision-maker at the national and international levels to the grass-roots and individual levels." (UN Division for Sustainable Development, 2003: Ch 40). EIS-AFRICA (2002:4) reinforces Agenda 21 in stating the need for geo-spatial information because of its vital role in development planning in Africa, because when such information is "readily accessible, creative problem solving can lead to sound decisions with a lasting, positive impact on people's lives." It is claimed by some authors that as much as 80% of decisions are based on some spatial aspects (Malczewski, 1999:3; Ostensen, 2001:16).

If information is so important in the development planning process then why is it not utilized to the extent that it should be? More specifically, why is geo-spatial information, the main type of information required for development planning, not utilized? There could be various reasons, including:

- Lack of access to geo-spatial information – in some developing countries this information is held by the military and access to the information is restricted, while in most countries the geo-spatial information is available only at the government offices in the capital city and not elsewhere, particularly in rural areas. The cost of purchasing the geo-spatial information can be prohibitive and this places it out of the reach of many. Although the new information and communication technologies (ICT) have the objective of reaching out to all parts of the country to bring them information, they have to rely on the availability of electricity – which, for many countries, does not exist much beyond the city boundaries;
- Lack of availability of geo-spatial information – in many developing countries there is a dearth of geo-spatial information, and what does exist is usually rather out-dated. Africa in particular is poorly mapped, with governments not adequately funding national mapping programmes. In the past the process of collecting the data and producing maps was slow and required skilled labour, but the new technologies have changed map-making significantly, making it easier to make a map – there are still further problems though, and that is the problem of lack of interoperability between systems and lack of standards, which still compound the problem of availability of geo-spatial information; and
- Lack of competency to use this information – even if the geo-spatial information was available and accessible, it can only be usable if the

development planner and others are competent to use the information – that is, if they are map literate.

Ottosson (1988:28) reports that the use of maps is frequently considered to be something relatively difficult. He is of the opinion that this view is due to basic difficulties in map understanding – map literacy.

In South Africa this difficulty in map understanding is evident in the poor results of the Geography examination written in the final year of schooling (Grade 12), and has been lamented by most examining bodies (Innes, 1998:1). These reports are based on the results of those learners who took Geography, but this must been seen in the context of the low numbers of learners who take Geography – in 2000 only 50% of Grade 12 learners took Geography (Innes and Engel, 2001:4). The low numbers of learners taking Geography and the poor results attained by those who do Geography could be attributable to the skewed education system of the past in South Africa, which favoured certain racial groups over others (Clarke, 1997:60). The low number of learners leaving school with an adequate competence in map literacy does not bode well for the use of maps (geo-spatial information) in the future workplace.

Low levels of map literacy have been found among public and development sector planners and implementers, as evidenced in the Map Literacy / Map Awareness (MapAware) workshops conducted by the Chief Directorate of Surveys and

Mapping, South Africa's national mapping organization. The results of a test performed on workshop participants showed an average score of only 59% based on elementary-level tasks (Innes and Engel, 2001:14 – 15). Low competence in map use, or low map literacy levels, will be a big factor in the low levels of map usage.

The low use of maps in South Africa is also evidenced by the very low per capita number of maps distributed by the national mapping organization in comparison to other, more developed countries (Clarke, 1997:60). It is possible that the low use of maps is not only attributable to low levels of map literacy, but may also be attributed to the lack of easy access to maps. However, the great need that has been expressed by development planners in South Africa for map literacy training and their perception that many people who do planning are not map literate support the statement that there are low levels of map literacy in South Africa (CDSM, 2002:4.24).

1.8 Problem Statement

If information is a main resource in development planning then it is necessary to ensure that relevant, reliable information is available in an optimal format and is used in the development planning process. The fact that development usually takes place in a spatial context implies that geo-spatial information is a key resource in development planning. Geo-spatial information is best portrayed on a

map and therefore relevant, reliable maps must be available and be used in the development planning process. To use a map and to extract the information from a map requires a certain level of competence in map use and understanding. Competence in map use is also referred to as map literacy.

Public and development sector managers and implementers, at all levels, must then be map literate to be able to contribute to the success of development planning. If this is not the case, then the question to ask is what the implications of low map literacy are in development planning.

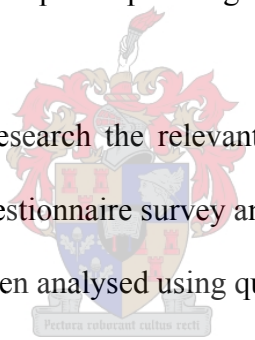
If a development planner is not sufficiently map literate, then can such a person make the best, adequately informed decisions on development policy and plans? As part of the answer to this question, the role of geo-spatial information in the development planning process, and more specifically the decision-making phase, must be established.

The research questions for this study can therefore be formulated as:

1) **Does geo-spatial information play a role in development planning, particularly in the decision-making process?**
2) **What is functional map literacy and how can it be measured?**
3) **What are the implications of map literacy for development planning?**

1.9 Research Methodology

To answer the research questions will firstly require the determination of whether or not there is a relationship between geo-spatial information and the decision-making process in development planning. If so, then what is this relationship, and how do we define the competencies required to undertake rational decision making using geo-spatial information? This will require an understanding of map literacy and how to measure competence in map literacy. Once this has been established, the implications of map literacy for development planning and what can be done to improve development planning can then be considered.

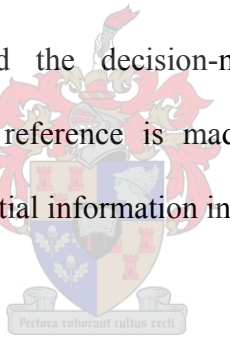


For the purposes of this research the relevant data have been gathered from a study of the literature, a questionnaire survey and quantitative testing (pre-test and post-test). The data have been analysed using qualitative and quantitative analysis, and the results interpreted following deductive reasoning and model-building.

The concepts of development, planning, and development planning are first discussed by way of the literature studies. It must be noted that this research is positioned at the implementation (process) level of development planning and therefore discussion does not go into the political economy framework or macro-level of development theory and development planning. The model for the development planning process, which emphasizes the capacity-building and knowledge-creation components, is of importance for this research. As decision

making is central to this research, the focus is on this phase of the development planning process. Literature studies are used to understand decision making and the decision-making process. This understanding is used to bring out the relationship between knowledge and the decision-making process. Through the relationship between knowledge and information, the role and nature of information in decision-making are determined.

Drawing on this assessment of information and knowledge in decision-making, the research focus is narrowed to geo-spatial information and spatial knowledge. This sets the scene to determine whether or not there is a relationship between geo-spatial information and the decision-making process in development planning. To achieve this, reference is made to the literature for evidence supporting the use of geo-spatial information in development planning.

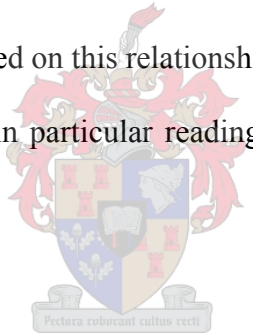


To independently test and validate the findings in the literature a questionnaire survey (see Annexure A) was conducted. The sample of this survey was a purposive sample of organisations in the South African public sector, which is a developmental sector. The sample size was 106 public sector organisations or components of such organisations in all three tiers of government that are considered by the researcher to be using geo-spatial information in development planning and implementation. These organisations were selected based on their past participation in the National Imagery and Mapping Advisory Committee, an interdepartmental advisory committee to the Chief Directorate of Surveys and

Mapping, in South Africa. On the basis of the personal knowledge of this researcher and the experiences of the Chief Directorate of Surveys and Mapping, these organisations represent the majority of the public sector organisations actively using geo-spatial information in their work programmes at the time of the survey. The questionnaire was posted out using the address list of the Chief Directorate of Surveys and Mapping. 78 responses (74% of the total sample) were received. The unit of analysis was the component of the public sector organisation engaged in development planning and implementation.. The responding organisation delegated a senior official of their choice to complete the questionnaire on their behalf (see Annexure B).A qualitative analysis of the findings of the survey was performed to determine whether or not geo-spatial information (and spatial knowledge) has an essential role in rational decision-making in the development planning process. It was not possible to establish quantitatively what the exact extent of this role is due to other causal factors found in decision-making.

A Geo-spatial Information Decision-making Model was then developed to describe the relationship between geo-spatial information, spatial knowledge and the development planning process. This model was built based on a synthesis and expansion of different theoretical models taken from the literature on the basic concepts already assessed.

The Geo-spatial Information Decision-making Model and underlying literature studies are used to demonstrate whether or not competence in the cartographic language, or map literacy, is required to effectively undertake development planning. Map literacy is not well defined in the literature and therefore the definition required refining. Definitions of the natural language were used to assist in defining map literacy. On the basis of the literature studies, an understanding of the constructs of the natural language and the cartographic language was developed to determine if a relationship between the natural language and the cartographic language exists. For the purposes of this research sufficient equivalence could be found between the natural language and the cartographic language. Based on this relationship, the understanding of literacy, or rather functional literacy (in particular reading), was used to derive a definition for functional map literacy.



A procedural model was also developed from the literature to assess competence in functional map literacy at three skill levels, based on the components of knowledge, comprehension, application, analysis, synthesis and evaluation. This model is a high-level generic model, and so for the purpose of measuring functional map literacy a test was developed, consisting of eighteen map-use tasks. This test can be adapted to any particular situation through reference to such situation in each of the map-use tasks. The test for functional map literacy was validated for application through the questionnaire survey (same survey as above). The sample for this survey was a purposive sample – this was the same

sample and unit of analysis as used above to validate the use of geo-spatial information in development planning.

South Africa is used as a case study in this research and therefore it is relevant to know how bad the map literacy situation is in South Africa. Conclusions about the level of functional map literacy in South Africa are drawn from the literature and from the MapAware Project of the Chief Directorate of Surveys and Mapping. The results of the map literacy pre-test and post-test assessments of the two-day adult learning workshop of the MapAware Project, as conducted by the Chief Directorate of Surveys and Mapping, was used in this research. The MapAware Workshop is further described in Chapter 5 (section 5.4). The pre-test assessment was used to determine the level of functional map literacy before the intervention. The difference in results between the pre-test and post-test assessments was used to determine the improvement, if any, in the functional map literacy levels following the intervention, indicating the effectiveness of the intervention in teaching functional map literacy. Participants had no prior knowledge of the material that would be used in the intervention and therefore the pre-test was not influenced by the intervention. The post-test assessment was only provided to participants after the completion of the intervention and therefore participants did not have prior knowledge of the post-test assessment. The Chief Directorate of Surveys and Mapping markets the MapAware Workshop as widely as possible but conducts the workshop only in response to requests from organisations for a

workshop. To-date these workshops have only been done for a limited number of organisations.

A quantitative analysis was done on the pre-test and post-test assessments conducted on 400 participants of the MapAware Project Workshop.. These 400 participants were all the participants of sixteen MapAware workshops (adult learners) conducted over the period May 2002 to July 2005 (see Annexure D for the list of participants). This sample is semi-random in that the participants are selected by the organisation requesting the workshop and include persons with different educational and cultural backgrounds and of various ages. The selection criteria used by the organisations are unknown. All of the organizations requesting such workshops have been South African public sector organisations and the participants are their respective employees. The participants are either development planners or implementers or secondary school educators teaching Geography. They. include managers as well as supervisors of field workers, in the case of the Working for Water participants. This sample has limitations in that the number of participants is low and is insufficiently representative of the population of South Africa. It does however represent data gathered over three years and is considered a sufficient indicator for the purposes of this research.

Together with my personal experience and work performed at the South African national mapping organisation, this research also provides the basis for map literacy training in the South African public service.

1.10 Structure of Report

The structure of this report is as follows:

Chapter 1: Sets the background, relevance and rationale for this research and the problem being addressed by the research. The research methodology is provided.

Chapter 2: The concepts of development planning and decision making are reviewed. Emphasis is placed on the nature of decision-making, in particular rational decision making. Linked to rationality is an understanding of knowledge and information. From this follows the role of information in the decision-making process. As decision making is part of the development planning process, it is possible to establish the role of information and knowledge in development planning. A revised development planning process model is proposed to better reflect this role.

Chapter 3: The concepts of geo-spatial information and spatial knowledge are reviewed. As geo-spatial information and spatial knowledge are a particular type of information and knowledge respectively, it is shown that geo-spatial information and spatial knowledge play a key role in development planning. This is supported by examples from the literature. A new Geo-spatial Information Decision-making Model is

proposed that shows the linkages between the decision-making process in development planning, geo-spatial information and spatial knowledge.

Chapter 4: Establishes a meaning for the term ‘map literacy’, or rather ‘functional map literacy’, from studies in functional literacy. A definition for functional map literacy is developed, together with a means to measure functional map literacy. Various map-use tasks are given with which to test functional map literacy.

Chapter 5: Brings together the findings from the previous chapters. It is deduced that there is a relationship between functional map literacy and development planning. Some implications of map illiteracy on development planning are given to illustrate the relationship. It is concluded that the functional map literacy levels in South Africa are inadequate for effective development planning. Some thoughts on improving development planning are given, including map literacy training and education. It is shown that map literacy can be taught. To further improve the understanding and use of geo-spatial information new representations of geo-spatial information are considered.

Chapter 6: Provides the conclusions for this report and recommends possible further research and makes other recommendations for implementation to improve the effectiveness of development planning.

CHAPTER 2

DEVELOPMENT PLANNING AND DECISION MAKING

2.1 Introduction

Decision making is a critical phase of the development planning process. It is in this phase that information plays a key role and therefore it is of more interest in the context of this research. To understand what is meant by development planning requires an understanding of what is meant by development and what is meant by planning. Likewise, it is necessary to understand what is meant by decision making.

2.2 The Meaning of Development

Black (1991:1) is of the opinion that development is a term which means different things to different people – "it has no precise meaning, no generally accepted definition". Over time development has carried different meanings and is in a state of flux, with no one clear theory of development (Pieterse, 2001:1, 5). Nonetheless, Bryant and White (1982:3) feel that "development is one of the most compelling concepts of our time. It provokes painful questions about values, techniques, and choices." The earlier views of development saw it as an economic problem and expressed development as a need for growth (Bryant & White,

1982:5-6; Todaro, 1989:86-87; Jeppe, 1987:9-11). Contemporary views are that development must be 'people-centred' (Coetzee, 1989:1,5; Haq & Kirdar, 1989:13; Esman, 1991:8) and development must include a normative approach – "it implies choices about goals for achieving what Gandhi calls the 'realisation of the human potential'" (Bryant & White, 1982:3). Sen (1999:3) confirms that "development can be seen as a process of expanding the real freedoms that people enjoy" or the removal of major sources of "unfreedom". The people-centred, social approach, or human development approach, recognises that different people or communities have different needs.

Todaro (2000:16) concludes that development must "be conceived of as a multidimensional process involving major changes in social structures, popular attitudes, and national institutions, as well as the acceleration of economic growth, the reduction of inequality, and the eradication of absolute poverty". Development is also multi-scalar, ranging from the local to the international level, and involves a number of agencies (Pieterse, 2001:156-157). Development is also a contested field, involving political and intercultural power relations. The power-laden environment of development is emphasised by Oldfield *et al.* (2004:286, 289), calling for a rights-based approach to development to address the injustices and inequalities that exist. Development can best be described as complex, lying somewhere between underdevelopment and post-development (Pieterse, 2001:158). Pieterse (2001:155) indicates that while various development theories

have prevailed since the 1940s, there are remnants of each of these in today's mainstream views on development.

Todaro (2000:16 - 18) believes that the conceptual understanding of development is based on three core values, namely life-sustenance, self-esteem, and freedom from servitude. Life-sustenance means the ability to provide the basic human needs, which include food, shelter, health, and protection. Self-esteem means having a sense of worth and self-respect, or having the dignity, respect, honour, or recognition of being human. Freedom from servitude is about being able to have choices.

The UN Development Programme, in its 2001 annual Human Development Report, supports these views on development as the enlargement of people's choice. Fundamental to enlarging these choices is building human capabilities "to lead long and healthy lives, to be knowledgeable, to have access to the resources needed for a decent standard of living and to be able to participate in the life of the community" (UNDP, 2001:9).

To satisfy the three core values of development it is necessary, firstly, to increase the availability of basic human needs, such as food, shelter, health and protection; secondly, to raise standards of living by increasing income levels, lowering the unemployment level, providing better education, and paying greater attention to cultural and humanistic values - these factors not only enhance material well-

being but also foster individual and national self-esteem; and thirdly, to provide individuals and nations with the means to have economic and social choices which free them from servitude and dependence, not only in relation to other people and countries but also to the forces of ignorance and human misery (Todaro, 2000:18). Along similar lines, Bryant and White (1982:15) see certain implications if development is to influence the future – "First, it means paying attention to *capacity*, to make change. Second, it involves *equity*; uneven attention to different groups will divide peoples and undermine their capacity. Third, it means *empowerment*, in the sense that only if people have some power will they receive the benefits of development. And finally, it means taking seriously the interdependence in the world and the need to ensure that the future is sustainable." Schuuurman (2000:14) contextualises development as "a preoccupation with the poor, marginalized and exploited people in the South. In this sense, *inequality* rather than *diversity* or *difference* should be the main focus of development … inequality of emancipation".

Achieving the objectives of development involves both a physical reality and state of mind for the underdeveloped people. It requires an effort on the part of both the underdeveloped people and the development agency. Development involves both a process and an intervention (Bryant & White, 1982:14; Pieterse, 2001:145)

2.3 The Meaning of Planning

In an elementary sense planning is "deciding in advance what to do, how to do it, when to do it, and who is to do it. Planning bridges the gap from where we are to where we want to go" (Koontz *et al.*, 1984:156). More specifically "planning has to follow policy-making where policy constitutes a statement of an intention to satisfy a societal need. As such planning is a set of processes which must be carried out to find the best course of action which has been identified and described with the policy statement" (Fox *et al.*, 1991:47). Argawala (1983:1) takes this further by saying that "planning involves anticipating the future and formulating systematic programs of action to attain desired goals".

Planning is therefore future-oriented, multidisciplinary and involves the expertise to co-ordinate and focus on societal problems, with the purpose of effectively attaining long-term objectives (Kotze, 1986:18-19). This is supported by Conyers and Hills (1990:3-8, 67) who say that planning is about the ability to make choices, making decisions about the best utilisation of available resources and making decisions about alternative means of achieving goals. They describe planning as continuous, cyclical and future-oriented. A plan should be regarded as a living instrument, flexible and evolving in response to changes in the numerous assumptions on which its direction, policies and programs are based.

Planning is not free from politics and must provide for the power relations that exist at the various levels. It is, after all, about the distribution of scarce resources, which is a contested terrain. The collaborative planning approach provides for power relations. However, oppressive forms of planning must be guarded against (Harris, 2002:30-31). Flyvbjerg and Richardson (2002:50) are of the opinion that rationality is penetrated by power and that it is not possible to "operate with a concept of rationality in which power is absent". Rationality then is shaped by power relations, rather than being context-free and objective. Foucault (in Flyvbjerg and Richardson, 2002:51) believes that knowledge and power can rarely be separated and is quoted as saying that "there is no power relation without the correlative constitution of a field of knowledge". Collaborative planning is based in the ideology of democracy, with the concept of stakeholding as a central element (Harris, 2002:35), and a strong democracy guarantees the existence of conflict. Flyvbjerg and Richardson (2002:62) suggest then that collaborative planning must be practical, committed and ready for conflict. According to Healy (1997:87) collaborative planning, as a process, must "work in ways which interrelate technical and experiential knowledge and reasoning, which can cope with a rich array of values, penetrating all aspects of the activity, and which involve active collaboration between experts and officials in governance agencies and all those with a claim for attention arising from the experience of co-existence in shared places". Lawrence (2000:617) summarises the assumptions associated with collaborative planning as:

- "communications and interactions are central to planning;

- the public interest is jointly discovered and willed;
- information is embedded in understandings, practices, and institutions;
- theory and practices and personal and processed knowledge are merged; and
- planners require skills in process organisation, communicative action, creative problem solving, interpersonal relations, consensus building and conflict resolution."

Harris (2002:34) points out that planning theory has been criticised for its deficiency with reference to issues of 'place' and that one of the defining characteristics of collaborative planning is to inject an element of spatial awareness and understanding into planning theory. This spatial context of planning is central for this research.

2.4 The Meaning of Development Planning

Development planning can then be regarded as a combination of the two concepts of development and of planning. Conyers and Hills (1990:62) describe development planning as "a particular type of planning activity, in which the goal is the attainment of a developed society and which involves trying to control or influence the process of development designed to achieve this goal." Development planning can then be regarded as a multidimensional, multiscalar, interdisciplinary, future-oriented process (Barnard, 1991:3), with the objective of

purposively stimulating the capacity, equity, empowerment, sustainability and interdependence of underdeveloped communities.

2.5 The Context of Development Planning

Development planning can be better understood by looking at the context in which it takes place. There is an interrelationship between policy-making, planning and implementation. According to Conyers and Hills (1990:17) there is no clear division in responsibility between the politicians, planners and administrators, and a significant implication of this "is the fact that planning cannot be considered in isolation from the social, administrative, and, in particular, political environment in which it has to operate. It is especially important to take into consideration the political system of the country concerned …, the political ideology of the government in power and the social structure of the society" (Conyers & Hills, 1990:17).

Bryant and White (1982:233) draw attention to the serious tensions between the development planner and the politicians. Killick (1976:168) is of the opinion that the training of development planners leads them to make unrealistic assumptions about political behaviour. This increases the tensions due to a widening gap between planning in theory and the actual implementation. "Often these tensions grow out of the different mandates that each has and the different information

with which each deals. Sometimes they grow out of differences between short-term and long-term consequences.

"Political leaders have to be elected or stay in power in the short run; planners by definition are considering long-run questions and draw up recommendations in the light of long-term consequences. Political leaders, in marshalling support, may share a concern for the long run, but they must respond to public opinion about the short run" (Bryant & White, 1982-233). Conyers and Hills (1990:18) describe the situation as one in which frustrations are frequently experienced by planners as a result of the political interference by politicians. This can lead to a crisis of conscience for the planner.

From an administrative point of view the environment in which organisations function influences development planning, The environment is important for two main reasons: firstly, the influence it has on the allocation of resources, and secondly, the limitations and constraints that it imposes on the organisation (Bryant & White, 1982:47-48).

2.6 Sustainable Development

A lot of effort and funding has gone into development projects over many years, yet there is little evidence of much return on this investment. What difference has it really made? It is also important that any development that takes place must be

done for the sake of long-term benefits and not to win votes at the next election. Development must be done in a sustainable way.

The United Nations (Commission on Environment and Development) defines sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (National Research Council, 2002:2). Principle 1 of the Rio Declaration also established that "human beings are at the centre of concerns for sustainable development. They are entitled to a healthy and productive life in harmony with nature" (UN Div for Sustainable Development, 2003).

In supporting the UN's definition of sustainable development, Todaro (2000:411) is of the opinion that, from an economist's point of view, a "development path is sustainable if and only if the stock of overall capital assets remains constant or rises over time." He says that "future growth and overall quality of life are critically dependent on the quality of the environment" (Todaro, 2000:411).

The United Nations, in its Millennium Declaration, contextualises sustainable development well in its statement that "we must spare no effort to free all of humanity, and above all our children and grandchildren, from the threat of living on a planet irredeemably spoilt by human activities, and whose resources would no longer be sufficient for their needs" (GISD, 2002:3). Pieterse (2001:156)

points out that sustainable development is "now part of any approach to development".

2.7 The Meaning of Decision Making

Decision making is generally defined as the act of choosing between alternative possibilities (Craythorne, 1990:457; Easton, 1976:5; Griffin, 2000:96; Koontz *et al.*, 1984:184; Pritsker & Sigal, 1983:3; Robbins, 1984:57). It is important to note that the alternative selected could be not to take any action.

Pritsker and Sigal (1983:3) point out that the making of a decision is just one step in the whole process that occurs immediately prior to implementation. This is confirmed by Heirs (1986:8), who refers to this step as the "tip of the iceberg" with the rest of the iceberg (decision process) submerged, and also by Mintzberg (1979:58) who refers to this step as "the icing on the cake". Once a choice has been made between the alternatives, the result is a choice and not a decision itself.

Heirs (1986:8-12) is of the opinion that the making of the decision is preceded by "well-managed, imaginative and rigorous thinking" and prefers to use the term 'decision-thinking' to describe the whole process. Furthermore, he feels that to become a professional manager or planner requires professional 'decision-thinking'. Decision making is the term commonly used for the decision process and will be used further in this discussion.

2.8 The Nature of Decision Making

Decision making can be referred to in terms of different theories and classifications, some of which will be discussed below.

Decision making can take place either formally, semi-formally or informally. In the latter case the decision is usually taken by the decision maker on the spur of the moment. These decisions are referred to as intuitive or hunch decisions and are difficult to analyse (Feldberg, 1975:12). Although intuitive decisions do not appear to follow the usual stages in decision making, 'good' decisions can nonetheless be taken by experienced decision makers, often because the rational reasoning process is followed, albeit at speed. Unfortunately, in practice there are some decision makers who take snap decisions without any basis for the decision. These decision makers have not learnt from past experiences and are more dangerous than a decision maker who is afraid to take a decision. Intuitive decision making is not discussed further here.

Rational decision making can be categorised as programmed and non-programmed decisions (Fox *et al.*, 1991:136; Griffin, 2000:97; Mintzberg, 1979:59). Programmed decisions are standing decisions to guide decision makers in highly repetitive, routine decisions. Included in this category are standards, procedures, methods and policies. Standards provide criteria against which work

performance, quality of operations and behaviour can be measured. A procedure is a sequence of steps established for the accomplishment of some task. A method is the manner in which to complete a step in a procedure. A rule is an explicit statement setting out what a person ought or ought not to do. Policies are vague guidelines for decision making allowing the person to use his or her own judgment.

Programmed decision making restricts the discretion given to decision makers. The major advantage of programmed decision making is that decision makers of lower qualifications or limited experience can be employed for numerous tasks. These tasks, however, must be repetitive in nature, requiring few decisions about exceptions. Programmed decision-making permits decisions on operational tasks to be taken at lower levels thereby freeing senior decision-makers to concentrate on strategic decisions. The major problem with programmed decision-making is that it is largely inflexible and unable to cater for exceptions to the rule. Situations are encountered when an exception arises or when new ground must be covered and programmed decision-making is unable to cope. Such situations require creativity and a greater degree of judgment on the part of the manager.

Non-programmed decision making is not routine but rather *ad hoc* and does not exist for continual use. It is a response to novel, ill-structured and uncertain circumstances.

Decision making can also be categorised along functional lines, such as operating, tactical and strategic decisions (Mintzberg, 1979:59-60). Operating decisions are routine processes that are programmed and executed by operational personnel. They use programmed decision making. Such decisions are typical of decisions taken in predetermined ways. Tactical, or administrative, decisions can be regarded as those that are co-ordinative or exceptional. A co-ordinative decision guides and co-ordinates the operating decisions. It is largely routine but is less programmed than operating decisions. Exception decisions are *ad hoc* and non-routine, dealing with a particular case on hand, and as such are largely non-programmed. Strategic decisions are also exception decisions, but differ from tactical decisions in that they have greater significance for the organisation. These decisions are non-routine and non-programmed, and are usually the domain of senior decision makers only.

Decision making is complicated by the fact that every decision involves two elements, namely factual and value elements. Facts are statements about the observable world and can be measured and tested empirically. However, decisions are mostly a choice of alternative future states, where facts are not the sole component. The decision of a future state involves an imperative quality, selecting one alternative and directing behaviour towards it. It is this second element that provides for judgment in decision making. Decision makers can make "decisions on the basis of feeling, emotion, and mental sets, as well as on rationality" (Fox *et al.*, 1991:147) and, as such, the values and ethics of the decision-maker play an

important role. For public/development managers the fact that their values and ethics play a role in his or her judgment makes public ethics important, particularly where decisions have to be considered to be in the public interest (Fox *et al*., 1991:147).

A further complicating factor is the political pressure under which the public and development manager operates (Craythorne, 1990:459); this pressure is exerted by the influences of the political environment of the public management system (Fox *et al*., 1991:19). The public and development manager must be fair in his or her decisions and be guided by the principles of justice (Fox *et al.*, 1991:147).

Decision making is based on the premise of rationality, where the 'economic man' is capable of a rational reasoning process to arrive at a decision (Conyers & Hill, 1990:67; Craythorne, 1990:457; Fox *et al.*, 1991:134; Griffin, 2000:98). However, three factors have emerged that render traditional decision-making incomplete, namely, 1) "the rising number of possible social, political, commercial, environmental, and legal consequences associated with any important decision; 2) the growing complexity of the information and assumptions that need to be considered before a decision can be taken; and 3) the ever-increasing rate of change which obliges us to make more and more decisions" (Heirs, 1986:16). The decision maker is faced with choosing between alternatives, i.e. those of which he or she is aware, but limited by his or her values and unconscious reflexes, skills and habits, about which he or she has imperfect knowledge (Golledge & Stimson,

1987:46; Griffin, 2000:105). Griffin (2000:98) suggests that the decision-maker faces conditions of either 1) certainty - or reasonable certainty; or 2) risk – the more common decision-making condition, where probabilities of occurrence are used; or 3) uncertainty – where not all the alternatives or their likely consequences are known. The latter condition results in higher ambiguity and the chance of making a bad decision – not the desired state (Griffin, 2000:98).

Herbert Simon (in 1957) recognised these limitations of rationality and postulated that the administrative man who satisfices rather than optimises (rational economic man) is taking the correct approach in understanding public decision-making (Choo, 1998:164; Fox *et al.*, 1991:134). Simon referred to the limitations of rationality as 'bounded rationality' (Choo, 1998:164; Golledge & Stimson, 1987:3; Griffin, 2000:105). Golledge and Stimson (1987:3) point out that "behaviour thus generated may appear to be irrational. but merely reflects the outcomes of man's individually variable ability to cope with and store information which is fragmented and incomplete under severe time constraints." Choo (1998:164) is of the opinion that "the rationality of the organisational decision maker is bounded in at least three ways:

1. Rationality requires a complete knowledge and anticipation of the consequences that will follow on each choice …

2. Since these consequences lie in the future, imagination must supply the lack of experienced feeling in attaching value to them. But values can only be imperfectly anticipated.

3. Rationality requires choice among all possible alternative behaviours. In actual behaviour, only a very few of all these possible alternatives ever come to mind."

The knowledge that the decision-maker has of the problem environment will contribute to the level of rationality that can be achieved. The desired knowledge is that which can be formalised or codified in some way as it diffuses more quickly and more extensively than knowledge that cannot (Choo, 1998:110). Codified knowledge is knowledge which can be "stored or put down in writing without incurring undue losses of information" and "diffused knowledge is shared with others" (Boisot, 1995:145). Knowledge can then be classified according to the degree of codification and diffusion:

Table 2.1 Classification of knowledge (Boisot, 1995:146)

Codified	Proprietary knowledge	Public knowledge
Uncodified	Personal knowledge	Commonsense knowledge
	Undiffused	Diffused

Public knowledge is the knowledge in open society and is well structured, generally through printed, visible or audible media. The codes must be well

organised and applicable to the public audience. On the opposite side is personal knowledge, which is knowledge that the individual has acquired through his or her own experience that is not accessible to others and is difficult to share with others. Commonsense knowledge is acquired over time through experiences that are shared with others, but is not necessarily well structured. Proprietary knowledge is knowledge that is developed by an individual or group and is well structured and documented, but is not available to others for various reasons (Boisot, 1995:147).

Choo (1998:111) offers an adaptation of Boisot's classification by differentiating the knowledge of an organisation into tacit knowledge, explicit knowledge, and cultural knowledge. Tacit knowledge "is the implicit knowledge used by organisational members to perform their work and to make sense of their worlds. … Tacit knowledge is hard to verbalise … It is learned through extended periods of experiencing and doing a task, during which the individual develops a feel for and a capacity to make intuitive judgments about the successful execution of the activity" (Choo, 1998:111). Tacit knowledge is similar to Boisot's personal knowledge. Tacit knowledge is used by the individual to build new knowledge. Explicit knowledge "is knowledge that can be expressed formally using a system of symbols, and can therefore be easily communicated or diffused" (Choo, 1998:112). Explicit knowledge can be divided into object-based or rule-based. Object-based knowledge can be found in icons, drawings, computer databases and photographs, while rule-based knowledge is expressed in procedures, routines and

rules (Choo, 1998:112). Cultural knowledge "consists of the cognitive and affective structures that are habitually used by organisational members to perceive, explain, evaluate and construct reality. … These shared beliefs, norms and values form the framework in which organisational members construct reality, recognise the saliency of new information, and evaluate alternative interpretations and actions" (Choo, 1998:112).

Knowledge may also be expressed in an ordered sequence of development and complexity and categorised as declarative knowledge, procedural knowledge and configurational knowledge – with configurational knowledge being the most complex (Golledge & Stimson, 1987:71; MacEachren; 1991:153). Declarative knowledge is knowledge about symbols or objects and their meanings and significance. Procedural knowledge is knowledge of process or navigation. Configurational knowledge is knowledge of relationships between symbols or objects. (Golledge & Stimson, 1987:94).

Spatial knowledge constructs will be discussed further in Chapter 3.

Various models of decision making have been put forward, such as those discussed below.

The Optimising (Rational) Model

The optimising model is based on the rational process where decision-making attempts to maximise or optimise a specific outcome, that is, the best alternative is chosen (Easton, 1976:4-6; Fox *et al*, 1991:136). The rational decision process requires clarity and implies that the decision-maker is fully objective and logical (Fox *et al*, 1991:137, Heirs, 1986:9). There are a number of assumptions in rationality and therefore in the optimising model (Fox *et al.*, 1991:138):

1) objective-orientation – the assumption that there is no conflict over the objective;
2) all the options are known - requiring an exhaustive search for alternatives;
3) all preferences are evident – the assumption that alternatives and decision criteria can be assigned numerical values and ranked;
4) the preferences are invariable – the assumption that the criteria will be consistent and stable over time; and
5) the final choice will maximise the result.

Rationality in decision making is more desirable than non-rationality because it is based on facts, the reasoning process is systematic and the decisions can easily be explained (Easton, 1976:33). Critics of the rational approach hold that there are a number of shortcomings in this approach, such as, 1) "the difficulty in identifying and isolating a given problem and its cause; 2) decision-makers seldom have the

time, the capacity, and the information required to make the in-depth studies that the optimising model calls for …" in searching for and evaluating all options; 3) "the problem of values" that form part of most decisions; and 4) "the relationship between alternatives and consequences may be ambiguous" (Fox *et al.*, 1991:137). The rational approach therefore is an ideal approach and not necessarily practical. The alternative is to limit the rational process (Conyers & Hills, 1990:68).

The Satisficing Model

The satisficing model seeks to address the shortcomings of the optimising model and is characterised by bounded (limited) rationality and incrementalism (Conyers & Hills, 1990:68-69; Fox *et al*, 1991:139; Koontz *et al.*, 1984:185). In the satisficing model the same decision process is followed, except that no attempt is made to understand the full complexity of the problem, nor to obtain all the information, nor to determine all of the alternatives available (Fox *et al.*, 1991:139; Griffin, 2000:105). The decision maker uses reductionist strategies to simplify his or her understanding of the problem (Choo, 1998:165).

The decision-maker uses his or her knowledge and experience to select a limited number of alternatives. These alternatives are then evaluated in turn to determine whether the alternative will satisfy the decision criteria – that is, the alternative is satisfactory and sufficient or good enough, rather than the best possible (Choo,

1998:165; Fox *et al.*, 1991:141; Koontz, 1984:185). Choo (1998:165) likens the difference between optimising and satisficing, by quoting Simon, as "the difference between searching a haystack to find the sharpest needle in it and searching the haystack to find a needle sharp enough to sew with."

It is assumed that the cost of further search for a 'better' alternative will be greater than the marginal gain (Easton, 1976:4-6). "An alternative satisfices if: there exists a set of criteria that describes minimally satisfactory alternatives; and, the alternative in question meets or exceeds all of these criteria" (Fox *et al.*, 1991:140). Choo (1998:167) regards satisficing as more than just a rule about how decisions are taken but also as a rule about how information is searched for. He is of the opinion that the search for information only takes place when performance falls below an acceptable target level. What, how much and when information is used is dependent on the problem situation and can vary from one situation to another (Choo, 1998:167). The use of new information in satisficing is therefore less than in optimising.

The decision maker applies incrementalism when an option previously chosen proved to be satisfactory, and "instead of thoroughly examining a wide and cumbersome range of alternatives, as is required for optimising, the satisficer will be inclined to consider only those alternatives that differ in a relatively small degree from the choice currently in effect" (Fox *et al.*, 1991:139). Choice is simplified in incrementalism by considering changes at the margin, reducing the

number of alternatives to be considered (Choo, 1998:168). While incrementalism "reinforces democratic pluralism and the multiplication, decentralisation, and deconcentration of decision points", it "destroys the public accountability of those who make policy" and "it is protective of the status quo and justifies bureaucratic apathy" (Fox *et al.*, 1991:139-140). Choo (1998:167-168) warns that incrementalism makes changes "to move away from current ills rather than to move toward defined goals". Incrementalism is sometimes referred to as "muddling through" (Choo, 1998:168; Craythorne, 1990:457 Easton, 1976:25).

The Mixed-scanning Model

The mixed-scanning model is a compromise between the costliness and time-consuming nature of the optimising (rational) model and the bias towards the status quo of the satisficing model (Fox *et al.*, 1991:141). In this model the decision-maker does not limit himself or herself to one approach, but scans the situation in a general way without processing large quantities of data to first establish its outline, and then 'homes in' with a detailed study of the most promising alternatives (Craythorne, 1990:457; Fox *et al.*, 1991:141). If it is "evident that no in-depth investigation is necessary, decisions are taken on an incremental basis" (Fox *et al.*, 1991:141). The advantage of this model is its flexibility during decision making (Craythorne, 1990:457; Fox *et al.* , 1991:141).

The Knowing Organisation Model

Choo (1998:3) takes the approach of information use to discuss the interconnected processes of what he refers to as sense making, knowledge creation, and decision making. "During *sense making*, the principal information process is the interpretation of news and messages about the environment. Members must choose what information is significant and should be attended to. They form possible explanations from past experience, and they exchange and negotiate their views in order to arrive at a common interpretation. During *knowledge creation,* the main information process is the conversion of knowledge. Members share their personal knowledge through dialogue and discourse, and articulate what they intuitively know through analogies, metaphors, as well as more formal channels. During *decision making,* the key information activity is the processing and analysis of information about available alternatives in order to weigh their relative merits and demerits." Choo (1998:3) refers to an organisation that is able to successfully integrate sense making, knowledge creation and decision-making as a 'knowing organisation'. He represents the knowing organisation as shown in Figure 2.1.

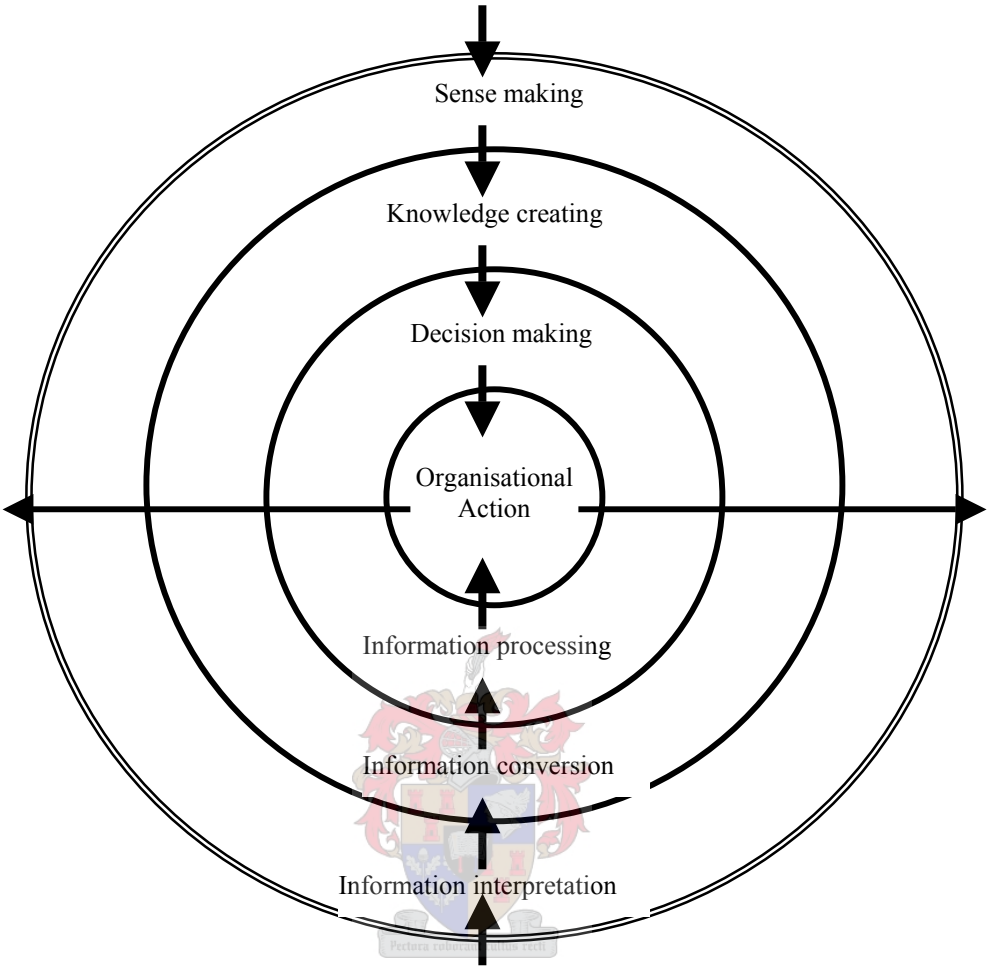


Figure 2.1 The Knowing Organisation (Choo, 1998:4)

A model put forward by Choo (1998:18-19) links the processes of sense making, knowledge creation and decision making into a continuous cycle of learning and adaptation called the 'knowing cycle'. Signals from the environment combine with streams of experience to form shared meanings or mental models. The formation of shared meaning and mental models draws on the knowledge base. Should these meanings or models be of a familiar nature, then decision making

can be engaged, resulting in goal-directed, adaptive behaviour - action to influence/change the environment. Should the meaning or model created not be familiar, then it will be necessary to fill the knowledge gaps and missing capabilities. Knowledge may also be sought from the external environment. The knowledge created increases the knowledge base and then interacts again with sense making to form new or revised meanings and mental models. Decision making can then occur.

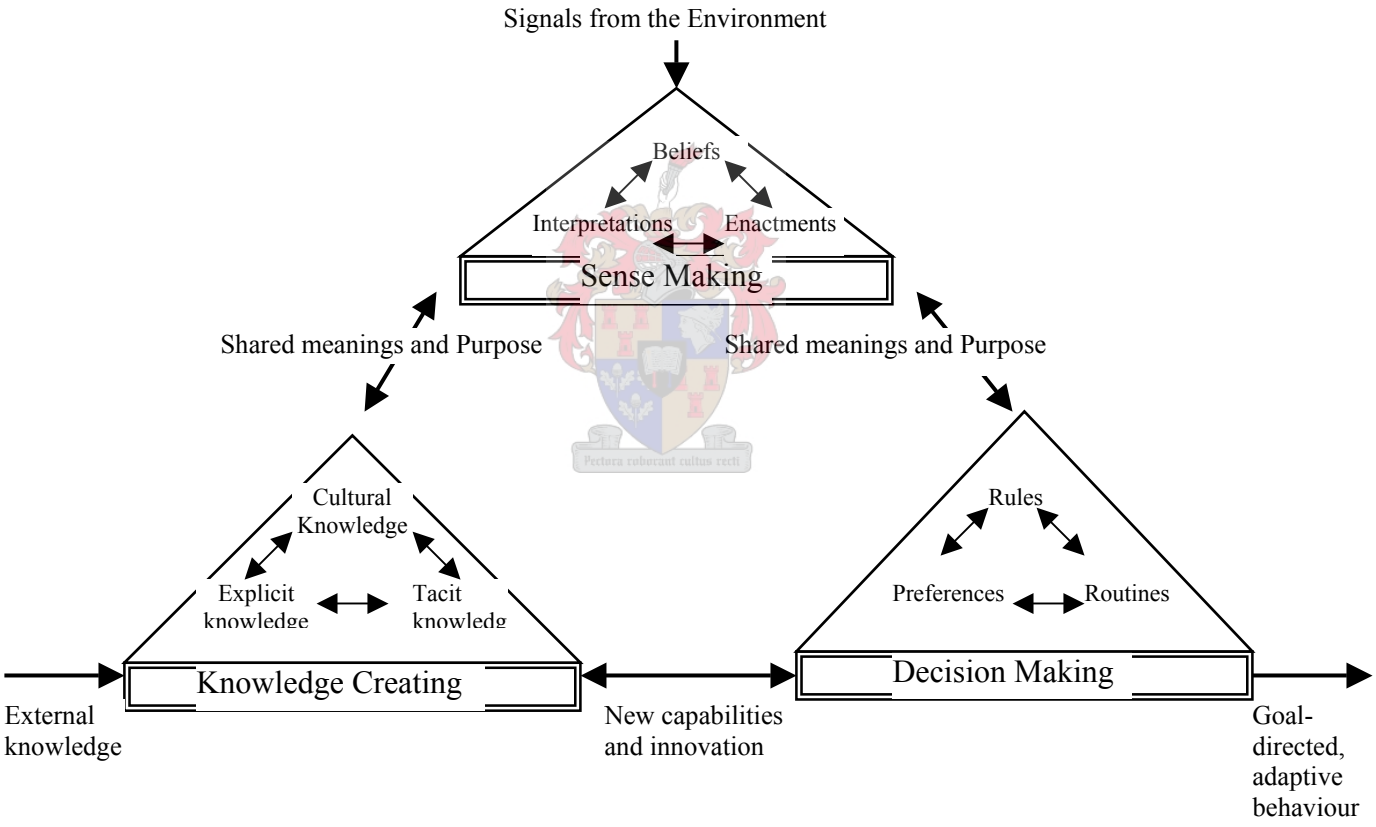


Figure 2.2 The knowing cycle (Choo, 1998:241)

2.9 The Decision-making Process

It is generally accepted that the decision-making process consists of four major stages (Bryant & White, 1989:3-5; Feldberg, 1975:12; Heirs, 1986:28-29). Although certain authors provide for six (Fox *et al.*, 1991:136-137) or seven stages (Easton, 1976:7; Mintzberg, 1979:58), these are just a breakdown of the major stages. The optimising model and the satisficing model differ only in those stages where the information gathering is done and the alternatives are developed. Choo's (1998) knowing organisation model indicates three main processes (stages), but again these do not contradict the four main stages discussed below. Feeney *et al.* (2002:22) also use a three-phase process (drawing on the work of Herbert Simon, 1960), consisting of; 1) Intelligence – or problem formulation; 2) Design – developing/adopting methodologies to solve the problem, including information processing and knowledge creation; and 3) Choice – comparing alternatives and selecting the alternative that best meets the decision criteria. This can be directly related to Choo's knowing cycle. The latter two authors have combined the last two stages of the four stage process, and therefore also do not contradict the four-stage process.

The four major stages of the decision-making process are: 1) analysis of the problem (or problem formulation); 2) development of alternative options; 3) analytical evaluation of the various alternatives; and 4) selection of the best alternative.

Analysis of the Problem

The first thing to do is recognise the need for change or that a decision is required. This may be because a problem has been perceived, or there is an inconsistency between the desired and the actual state of affairs, or it may even be an opportunity to improve an existing state. Generally, signals from the environment will be the main source alerting decision makers to the problem. The next step is to diagnose the real problem. Reliable information must be gathered to fully understand the problem. For complex problems this could be a difficult and time-consuming task, often skimmed over by the satisficing model. This is followed by the identification of the criteria on which the decision will be based and the allocation of weights and priorities to the criteria. Complex problems may be broken down into more understandable and manageable component problems. The first stage requires good judgmental abilities and reliance on prior experience and knowledge.

Development of Alternative Options

This stage requires the development of viable alternatives for solving the problem. This stage requires the decision maker to engage in lateral thinking and to have creative skills as well as experience. There are a number of techniques that can be

employed to improve the development of alternatives. In the satisficing model the number of alternatives will be restricted.

In most organisations this stage is not successfully dealt with, mainly because of limitations of time, group pressure to conform and retain the status quo, and the lack of creativity - probably why the satisficing model is more popular than the optimising model.

Evaluation of the Various Alternatives

This stage requires each alternative to be critically evaluated and brought to a level for comparison with the other alternatives. The strengths and weaknesses of the alternative are considered against the decision criteria. Difficulties are encountered when determining the costs of the alternative, also because of the social costs that are usually involved. The opportunity costs for the alternative must also be taken into consideration. There are a number of techniques that can be used to aid the decision maker in evaluating the alternatives. These techniques are largely of a quantitative nature. Decision making involves values and the judgment of the decision maker and it is important to realise that these techniques can only assist the decision maker and are unable to make the decision for him or her. In the satisficing model the alternative is evaluated to determine if it meets the minimum criteria of the decision.

Selection of the Best Alternative

A final choice must be made on the best alternative based on the outcome of the previous stage. This stage requires the knowledge and judgment of the decision maker in selecting the best alternative. Once the decision on the alternative has been made, it must be implemented through specific actions to achieve the desired result. The decision-making process can then be represented diagrammatically as in Figure 2.3.

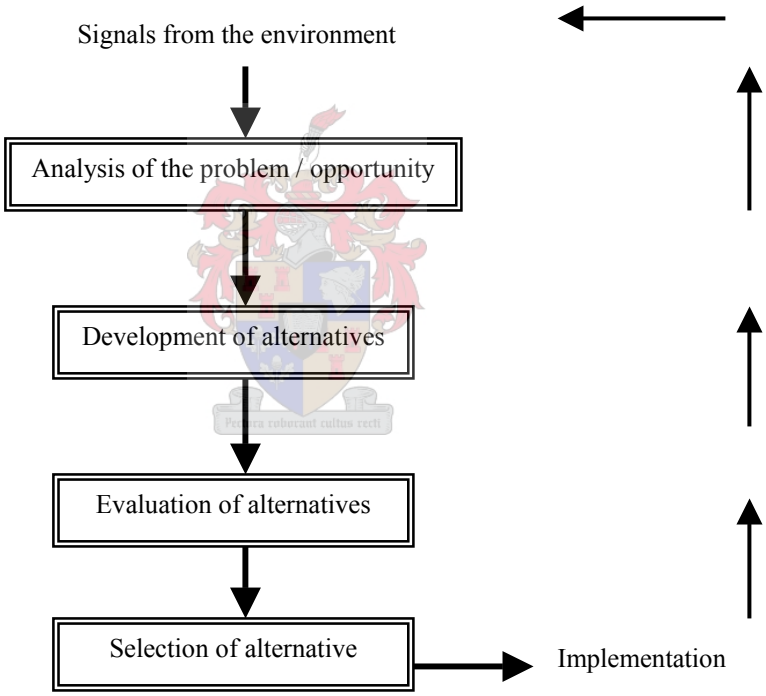


Figure 2.3 The Decision-making Process

This process is linear in nature, with an input-process-output system. This is likened to an information-processing approach (Choo, 1998:16). By adding the implementation and 'feedback', it provides for an open system.

2.10 Information in Decision Making

Information is used extensively in the decision-making process (Conyers & Hills, 1990:88), particularly in the first three stages given above, namely problem formulation or analysis, development of alternatives and the evaluation of alternatives. The decision-maker is faced with the challenge of identifying what information is needed, that is, what is relevant to the problem situation, then where and how to source that information, and then how to process and use the information. The danger of information overload is very real nowadays, particularly with the World Wide Web. A meeting of an international expert group on information for decision-making and participation (UNEP, 2000:6) reported that "reliable access to information is essential for knowledge-based decision-making." This is in agreement with the adage 'information is knowledge'. In the context of this research it is appropriate to take the adage to the next step, that is, 'information is knowledge; knowledge is power'. It can therefore be transitively reasoned that information is power. It can furthermore be deduced that to *empower* a person, community or society requires them to have knowledge, which requires them to have information.

There is a tendency to use the terms data and information interchangeably. This is understandable as it can be seen from the definition of these two terms that what is regarded as information by one person (the provider of the information) is regarded as data by the next person (the user), who usually must further process the information supplied to create new meanings, and therefore new information. 'Information' is defined as "data that have been shaped into a form that is meaningful and useful to human beings", while 'data' is defined as "streams of raw facts representing events occurring in organisations or the physical environment before they have been organised and arranged into a form that people can understand and use" (Laudon & Laudon, 2000:7).

To formulate or analyse the problem situation in decision-making requires signals (or data) from the environment, such as observations, statistical and other reports, community participation feedback, recorded or remembered experience, media and other literature (Feeney *et al.*, 2002:22; Griffin, 2000:101). These signals may originate either internally or externally, and may be reactive or proactive in nature, depending on the problem situation. The signals are collected, filtered and coded according to the needs of the problem situation, and are influenced by the data collector's frame of reference and biases (Choo, 1998:89-90, 201; Feeney *et al.*, 2002:22).

Information is required to invent, design or develop alternative courses of action for the problem situation (Choo, 1998:189-191 Feeney *et al.*, 2002:22). Any

limitation in available or usable information will impede the development of alternatives. These limitations will influence the degree of rationality achieved, with the highest level of rationality being the goal. In this stage the information must be processed to form new knowledge about the possible solutions.

To evaluate the alternatives prepared in the previous stage requires knowledge of the possible outcomes or consequences of each alternative, based on the criteria established for the problem situation (Feeney *et al.*, 2002:22). The techniques used in this stage feed information into the process to derive the outcome. The evaluation of alternatives provides the decision maker with the merits and demerits of each alternative, establishing the choices available to the decision maker (Feeney *et al.*, 2002:22).

Choo (1998:40-63) puts forward a multi-perspective general model of information use. The framework for this model is the information environment and the information-user behaviours. The environment can be divided into two parts, namely, the information-processing environment, which consists of the cognitive needs and affective responses, and the information-use environment, which contains the situational dimensions, such as the organisational structure and culture. The specific behaviours are information needs, information seeking and information use. "The person first becomes aware of or recognises a problematic situation, and clarifies or defines *information needs* in terms of important entities or concepts, their attributes and relationships, available options, desirable

outcomes … *Information seeking* then is the process in which the individual searches for information in order to change his or her state of knowledge. … *Information use* is the selection of the relevant messages from the larger space of information encountered during the search, and the processing of the information so that it leads to a change in the state of the individual's knowledge or capacity to act" (Choo, 1998:40-41).

Information needs are often considered in terms of the individual's cognitive needs – the gaps in knowledge and understanding – but also include affective or emotional needs (Choo, 1998:51). The individual often cannot identify the information needs upfront, being unable to clearly express the information need or having only a vague idea of this need, and an uneasy sense of the lack of knowledge. A better understanding of the need evolves with involvement and experience. Choo (1998:52) refers to R S Taylor's (1968) conceptualisation of four levels of information need experienced by individuals, namely:

- visceral level – a vague or inexpressible sense of a shortcoming in the knowledge base;
- conscious level – follows the visceral response, where a mental description is likely to be formed but ambiguity exists;
- formalised level – follows the conscious response, where ambiguity is sufficiently reduced to form rational thought; and

- compromised level – follows the formalised response, where the need may be modified or rephrased so as to represent the information need.

The information needs reaching the formalised or compromised levels may be inadequate for the individual. Choo (1998:52) is of the opinion that "the better that the information found is able to connect with these conscious or visceral needs, the more the individual will feel that the information is pertinent, meaningful, or useful".

The way information is sought can vary from individual to individual, based on past experiences, personal preferences, knowledge of sources and the perceived accessibility of the information, which is a strong predictor of source use (Choo, 1998:53). Information which is perceived to be less accessible or of uncertain quality could be overlooked in favour of information which is perceived to be accessible.

Information use is influenced by the individual's knowledge, experience and frame of reference. The information must be perceived to be relevant to the question at hand or problem situation for it to be used (Choo, 1998:56). Choo (1998:56) regards information relevance from a human judgment perspective to be:

- "Subjective, depending on human judgment and thus not an inherent characteristic of information or a document;
- Cognitive, depending ultimately on human knowledge and perceptions;
- Situational, relating to individual users' information problems;
- Multi-dimensional, influenced by many factors;
- Dynamic, constantly changing over time;
- Measurable, observable at a single location in time."

This general information model is given in Figure 2.4.

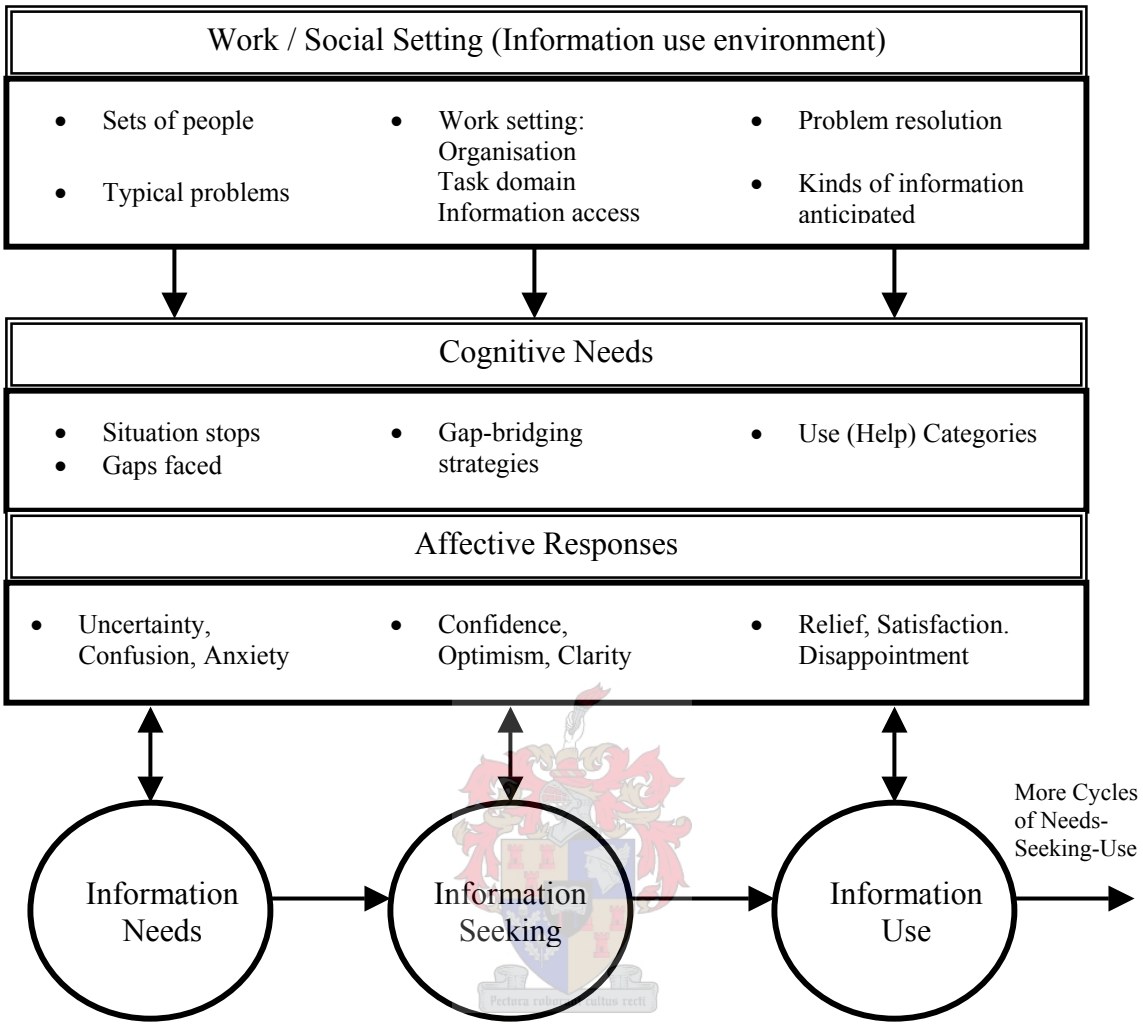


Figure 2.4 General model of information use (Choo, 1998:61)

Geo-spatial information and the use of geo-spatial information will be discussed further in Chapter 3.

2.11 The Development Planning Process

Following on the discussion of decision making and the decision-making process, which is also part of development planning, it is appropriate to discuss the development planning process.

There are a number of models of planning and assumptions taken about development planning that provide the basis for the specific process followed. Development projects vary in nature, scope and spatial extent. There are two main models used for development projects, namely, the blue-print model and the process model (Barnard, 1991:14). The blue-print model is used when the designer has certainty about the requirements and applicability of the techniques to be used (Sweet & Weisel, 1979:129-130). The project is designed 'behind closed doors' and implemented with the knowledge that, with good management, it will be successful. It is therefore accepted with this model that the problem is well defined and there are solutions to the problem. In cases where projects fail, the reasons given for the failure are usually that there was poor management or poor co-operation rather than a poor design.

The process model is the method used in the more recent approach to development planning. This model is based on participation by the target community in the planning process, commonly referred to as 'planning with the people' (McGowan, 1993:4; Sweet & Weisel, 1979:130). The process model

reinforces the concept of 'learning through participation'. Often the development problems are not well defined and as such need to be incremental with a great degree of flexibility. Collaborative planning (discussed in section 2.3 above) is a recent approach in the process model.

It has already been said that development planning is a continuous process and that the rigid blue-print approach has generally been replaced by the process approach. However, both models are applicable. Sweet and Weisel (1979:130) sum this up by saying that "this dichotomy between the exploratory process and more conventional blue-print approach is perhaps overstated. In fact, it is probably more useful to think of these approaches as a continuum, with the pure blue-print model at one extreme and the pure process model at the other end, and with numerous combinations in between." For example, the construction of a building would be closer to the blue-print approach, while a project affecting human values would be closer to the process approach. Harrison (2002:2, 3, 9) calls for an element of Deweyan pragmatism, allowing for creative experimentalism in planning. This will require less rigidity and more innovation in the planning process, through sharing experiences and information.

Conyers and Hills (1990:67) interpret the "activity of planning as a continuous, cyclical process of decision-making", striving to achieve better and more rational decisions. According to them, the concept of rationality is "central to the notion of

a cyclical planning process" (Conyers & Hill, 1990:67). Limitations on rationality, or bounded rationality, have been discussed above.

In the less developed countries (LDCs) there are limitations to the rational approach. The limits to rationality include limitations in the abilities of planners and decision-makers to identify all of the alternatives and assimilate all of the information; the lack of information; the cost of collecting and processing the information; the fact that development is value-laden and there is political interference; and the uncertainties in the environment of development planning. The alternative chosen is not necessarily the best but it is satisfying. (Conyers & Hills, 1990:68-70; Fox, 1991:136-141; Rondinelli, 1983-74).

Conyers and Hills (1990:70) are of the opinion that no type of planning activity can be discussed without giving consideration to the problem of uncertainty. "In practical terms planning is itself an attempt to reduce uncertainty about what will happen in the future by managing and controlling change to achieve desired objectives" (Conyers & Hills, 1990:70). Planners are unable to accurately forecast the future or to control the future due to uncertainties. This has a direct effect on the viability of future plans. There are three major areas of uncertainty that affect the planning process (Conyers & Hills, 1990:71):

1. Many uncertainties about the general environment within which planning takes place;

2. ‘Knock-on’ effects from related fields which are outside the scope of the project being undertaken; and
3. Uncertainties about the appropriate value judgments to be applied.

Conyers and Hills (1990:70) offer two basic ways of dealing with the problem of uncertainty: “firstly, by looking at the resources of uncertainty and trying to get a better understanding and control over them; and secondly, by adopting a flexible approach so that planning can adapt and respond to uncertainties as and when these become apparent.”

Various approaches to the process model for the development planning process have been put forward. In the striving for rationality, the planning process should mesh with the model for rational decision making, namely (Carley, 1980:11):

1. Problem identification and definition;
2. Classification and organisation of goals, values and objectives relating to the problem;
3. Identification of alternative courses of action;
4. Prediction of the consequences of each alternative;
5. Comparison of the predicted consequences in relation to specified goals and objectives;
6. Selection of a course of action.

The models for the planning process must also consider the factors deemed necessary for planning to be successful. Swanepoel (1992, 80-87) recommends that these factors include the following:

1. planning must be incremental;
2. planning must be short-term;
3. objectives must be attainable in a fairly short period;
4. long-term planning must always accompany short-term planning;
5. planning must be simple and singular;
6. planning must state what action should be taken, when to take that action, who will be responsible for the action, and how the action should take place;
7. planning must be written down;
8. planning must involve the whole action group.

A number of models for the development planning process have been put forward by different authors. Beenhakker (in Conyers & Hills, 1990:72) describes a comprehensive system "which involves a continuous, cyclical process based on the following ten stages:

1. appraisal of the current state of affairs;
2. assessment of future directions for progress and preliminary priorities among directions;

3. preliminary formulation of objectives and estimation of available funds;
4. consideration of alternative courses of action;
5. specification of objectives and sub-objectives;
6. identification of alternative programmes, projects, policies and strategies;
7. search for the best solution;
8. derivation of evaluation criteria;
9. application of evaluation criteria;
10. determination of action plans and budget."

Killick (in Conyers & Hills, 1990:72-73) does not propose a step-by-step model, but rather submits criteria for a 'well-prepared' plan. "A well prepared plan will:

1. be comprehensive (and include the private sector, semi-government organisations and central government);
2. include a review of past economic performances and identify the most serious current problems;
3. specify economic objectives and priorities between them;
4. translate objectives into targets and then present a strategy to achieve them;
5. translate the strategy into specific policies;
6. set out programmes of government capital spending for the planning period and break these down to the project level;

7. provide a range of forecasts about economic performance over the plan period, usually by means of macroeconomic models, to supplement specific policy targets;
8. focus on the medium-term policies in the 'perspective plan' setting medium-term policies in the context of long-term goals and objectives, and annual plans."

Conyers and Hills (1990:73-75) have considered these previous models and propose a model (Figure 2.6) of a cyclical process involving a sequence of stages linking the formulation of basic policy goals with the design of specific projects, with an emphasis on the 'learning process' from one cycle to the next, and on the fact that the stages are interrelated.

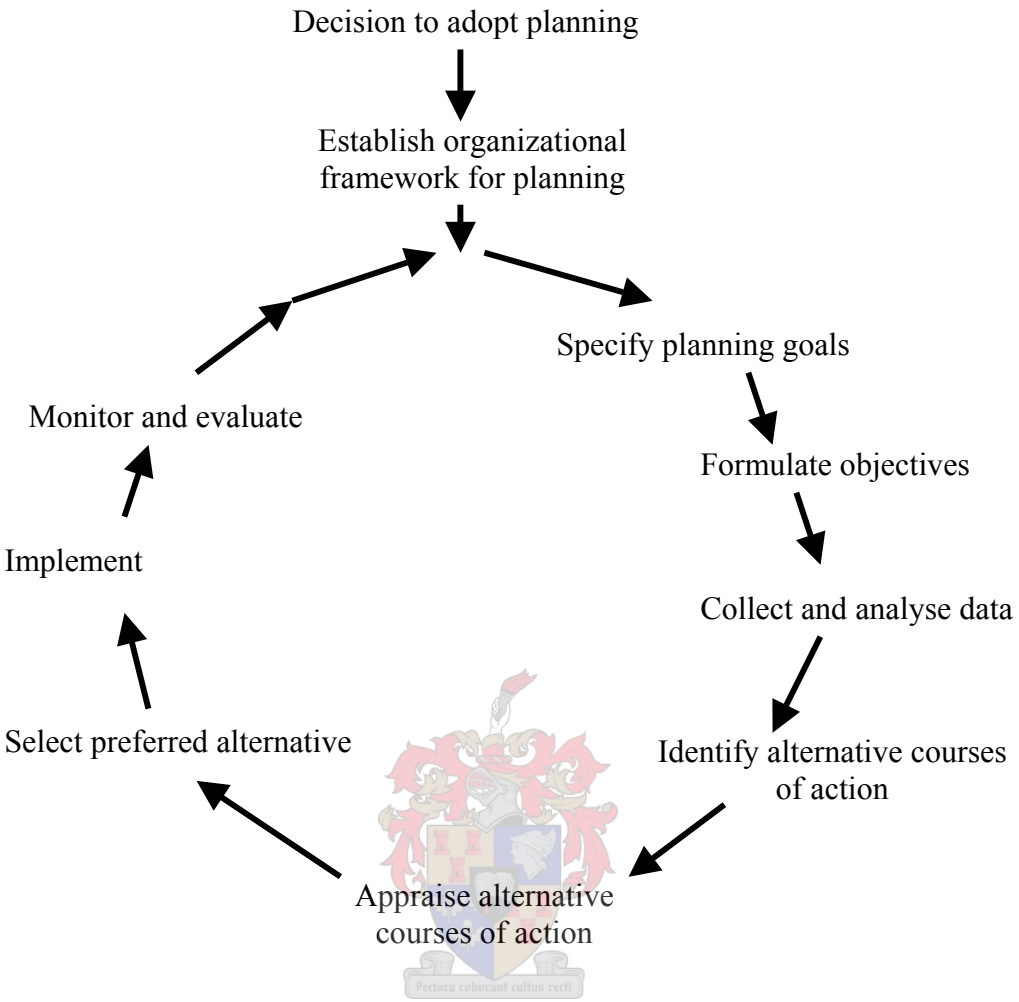
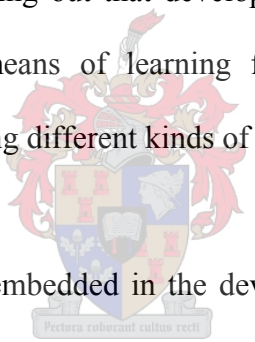


Figure 2.6. The Planning Process (Conyers & Hills, 1990:74)

Byrant & White (1982:119, 121) strongly recommend that, as part of the learning process, a feasibility study be undertaken prior to proceeding with the project. Rondinelli (1983:91, 92, 99-104) supports this with the idea of a pilot project or, for cases where there are many unknowns, an experimental project. Naturally the size, duration and scope of projects will influence such an approach. Pilot projects can test the applicability of innovations, and may also serve as prototypes for large-scale projects, proceeding through all the stages to an evaluation stage. The

major advantage is that the feasibility of the larger project can be tested without incurring any major costs or impacting adversely on the community and the environment. A further consideration is a demonstration project that can be used to show the applicability of new technologies, methods or programmes compared to the traditional ones (Rondinelli, 1983:104-105).

Swanepoel (1992, 34-35, 39-40) discusses a process for community development planning, which emphasises the needs, resources and opportunities which arise out of a profile analysis of the target community. Bryant and White (1982:109) support this view by pointing out that development planning "is a process, one that has as its core a means of learning from the environment, exploring opportunities, and evaluating different kinds of intervention."



Development planning is embedded in the development theory being applied at the time, and therefore the development planning process will be influenced by the development theory. For example, this is evident in the human approach to development calling for participation by the community; or by the neoliberal theorists changing the stakeholders involved in the process. However, development planning and the development planning process are still evident irrespective of the development theory. The development planning process contains the decision-making process, which makes extensive use of information and knowledge. The role of the various stakeholders, whoever they may be, and of the relevant information and knowledge used by these stakeholders in the

decision-making process is of relevance to this research. This research then can be focused on the development planning process, at the process or implementation level, and not be overly concerned by the development theory at the macro level. The human development approach, emphasising capacitation of people and communities and enlarging peoples' choices, together with the collaborative planning approach based on communication and participation by all stakeholders, provides the most appropriate framework for this research. Oldfield *et al.* (2004:290), in sharing their South African experience, in promoting a direct action strategy to address injustice and inequality that prevail provides further support to the framework for this research.

Following the framework for this research given above, a revised development planning process is proposed in Figure 2.7:

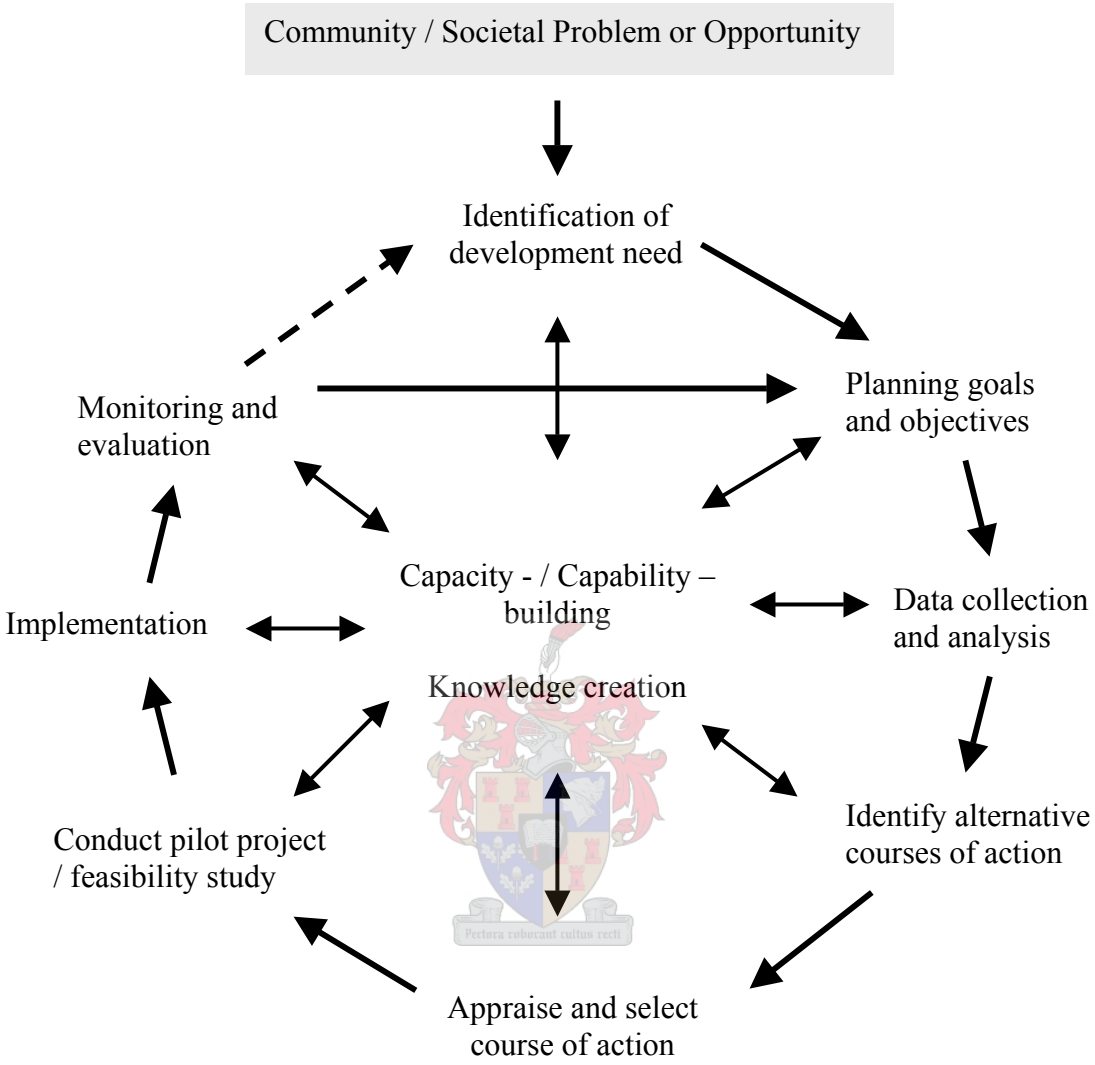


Figure 2.7 Revised Development Planning Process

The main stages of this process are briefly discussed below:

a) *Community /Societal Problem or Opportunity*

A development need will not exist unless there is a problem or an opportunity to change a current state in the community or society. This problem may be a perceived problem, provided it is perceived by the community or society itself, and is not imposed upon them by an external entity. From an external perspective, such as the government or international bodies, the development problem will most likely arise when the community profile falls below defined development measures or indices, such as the Human Development Index. In the rights-based approach, referred to by Oldfield *et al.* (2004:289-290), the expression of injustice or inequality prevailing would indicate a development problem. It is important, however, that the target community recognises and acknowledges that there is a problem or an opportunity to change. It must be relevant to that community. What is a problem in one community may not be regarded as a problem in another community.

b) *Identification of Development Need*

A project is undertaken to address a problem (Bryant & White, 1982:110). The first step then is to make a profile analysis to determine what the need or problem is (Bryant & White, 1982:110; Swanepoel, 1992:39). This requires the participation of the society or community and other role players – a bottom-up approach and not a top-down approach. It is important that real needs are

identified, and that consensus among the community is reached on the identified needs (Swanepoel, 1992:51-54). For this a comprehensive approach must be taken and the development manager must not impose his or her values on the society or community. It may be necessary to break the needs into sub-projects of manageable size.

This stage is the same as the problem-formulation stage of the decision-making process.

c) *Planning Goals and Objectives*

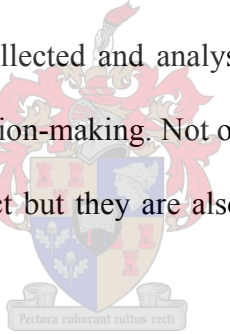
The goals give direction and express the priorities of planning. They express the development needs and societal aspirations (Conyers & Hills, 1990:76). Goals are usually general in nature and the details are expressed in the objectives. Objectives should include targets to be reached and the criteria against which success can be measured.

Conyers and Hills (1990:76) argue that politicians should be involved in the setting of goals and objectives because they will ultimately be responsible for establishing priorities and making the necessary resources available. However, they could also build a political agenda into these goals and objectives. Conyers and Hills (1990:77) also point out that "we are dealing with a dynamic process in a dynamic setting: goals and objectives will change, almost certainly in the

medium to long term and often in the short term. The continuous cyclical approach to planning should encourage the development of a 'learning process' on the part of both politicians and planners. As lessons are learned it is almost inevitable that the direction of planning, as expressed through goals, objectives and targets, will change. This is both desirable and necessary."

d) *Data Collection and Analysis*

It is necessary to have a good 'picture' of the existing situation "to determine the nature and extent of particular planning problems" (Conyers & Hills, 1990:77). Appropriate data must be collected and analysed. Adequate, relevant data are a prerequisite for rational decision-making. Not only will the data be used as a base-line for evaluating the project but they are also used by planners for forecasting and scenario sketching.



There are various ways of collecting data, such as using existing records, surveys, interviewing, direct observation and combinations of these (Bryant & White, 1982:139-141). Data collection requires special skills and must deal with the question of what is to be collected or measured, and how it is to be sampled (Bryant & White, 1982:141-145). Similarly there are various techniques for analysing the data. These are based largely on the type and structure of the data collected and the objectives of the projects. The data-collection and -analysis stage may reveal information that could make it necessary, even at this early stage

in the process, to reconsider some of the objectives and reformulate priorities (Conyers & Hills, 1990:78).

However, considerable specialised human resources, financial resources and time are required for data collection and analysis (Conyers & Hills, 1990:77). This is probably the reason for the statement by Conyers & Hills (1990:77) that "availability of data is one of the serious problems facing planners in Third World countries".

Although the data-collection and -analysis stage is positioned here in the process, this stage only reflects the largest effort of data collection and analysis, and is not the only point where data (or information) is used. Information is already required at the first stage to identify the development needs and problems, which form the basis for formulating the development policies, goals and objectives. Information is used extensively in the development and evaluation of alternative courses of action – as discussed above with decision making, and again in the monitoring and evaluation stage. "Information is thus needed at various stages in the planning process" (Conyers & Hills, 1990:88).

e) *Identify Alternative Courses of Action*

Planning is about making choices and there are usually more ways than one to solve a problem. This stage requires viable alternatives to be developed, and this

requires the planner to engage in lateral thinking and to have creative skills as well as experience. Various techniques can be employed to improve the development of alternatives (Fox *et al.*, 1991:279; Koontz *et al.*, 1984:472).

This stage is the same as that for the decision-making process.

f) *Appraise and Select Course of Action*

"Appraisal basically means identifying the advantages and disadvantages of different courses of action" (Conyers & Hills, 1990:79). This stage requires each alternative to be critically evaluated and brought to a level for comparison with the other alternatives. The strengths and weaknesses of the alternatives will be determined by evaluating the alternative against the decision criteria of the goals and objectives. There are a number of techniques that can be used to aid the planning in the evaluation process. (Conyers & Hills, 1990: 134-147; Koontz *et al.*, 1984:188-192, 199-205; Fox *et al.*, 1991:284-290). These techniques are largely of a quantitative nature, but in development planning values and other non-quantifiable social issues must also be considered.

A final choice must be made on the best alternative based on the outcome of the previous stage. This stage requires the judgment of the decision-maker in selecting the best alternative. However, because of the limitations of rationality and because consensus must be reached on the selected alternative, it may not be

the ‘best’ but rather a satisficing option. Consideration must also be taken of the resources that each will require and the organisational loading.

This stage is the same as the evaluation of alternatives and the selection of the alternative (choice) stages in the decision-making process.

g) *Conduct Pilot Project / Feasibility Study*

Depending on the nature of the project, its size, duration, scope and impact, it could be advisable to conduct a pilot project or feasibility study. This is in essence a miniature version of the project, its purpose being to test the likelihood of the project’s success (Rondinelli, 1983:99). If the pilot project fails, then it can be assumed that the project will fail. However, not great cost or other resources have been expended so far. Should the pilot project fail, the project will either be terminated or referred ‘back to the drawing board’. Should the pilot project succeed, it may show up certain shortcomings, which can now be rectified prior to implementation. This could entail a possible reformulation of the goals and objectives. The extent of the changes made, however, may imply that another alternative should be followed.

h) *Implementation*

Implementation entails the operationalisation of the plans – the 'doing' (Conyers & Hills, 1990:80). "This involves, among other things, identifying the various activities associated with a plan or project, preparing a time schedule and mobilising the resources (finance, staff, materials, and equipment) required for implementation" (Conyers & Hills, 1990:80-81). It must be remembered that development is not *for* the people but *with* the people. The target society or community must be enabled, or empowered, to do the work for themselves, as much as possible. Implementation will require capacity building.

Conyers and Hills (1990:80) are of the opinion that "implementation problems are widely recognised as one of the major weaknesses of planning in many parts of the Third World." These plan-implementation problems can be categorised as four main types of factors (Conyers & Hills, 1990:156):

1. "nature of the planning process;
2. organisation of planning and implementation;
3. content of plans;
4. management of the implementation process."

i) *Monitoring and Evaluation*

Bryant and White (1983:146) say "evaluation is an effort both to document *what* happened and to determine *why* it happened". Conyers and Hills (1990:81) expand slightly on this by adding "evaluation is designed to reveal the extent to which plan objectives have been achieved, any unanticipated effects it may have had and, so that lessons can be learned for future planning, the reasons for its successes and failures." The project as a whole needs to be evaluated at the end and the results used in the learning process for the next cycle.

There should be on-going, continuous monitoring and evaluation of each stage. This will assist in the early detection of any deviations, which will make corrections easy to apply, or necessitate a change in direction – flexibility is crucial for this to take place (Conyers & Hills, 1990:81).

j) *Capacity -/Capability – building and Knowledge creation*

The old adage 'If you give a man a fish, you feed him for a day. If you teach a man to fish, you feed him for life' should be a primary basis of the development planning process. Firstly, communities must be totally involved in the development planning process. They must have the capability and knowledge to participate in the whole process, from identifying the need for development, to the decision on the development alternative, to the implementation of the project. Secondly, communities must become self-reliant and not remain dependent on the

government or other development agencies. Having the capability to develop further will accelerate the development of the community.

As stated above, information is used in all the stages. Information is transformed into knowledge, to better enable or empower the planning and decision making. The whole process is a 'learning' process, through which new knowledge is created to build on the existing knowledge base. There is continuous learning as the process takes place, learning from the experiences gained to improve on the process, particularly for the next project.

2.12 Summary of Chapter

The basis of the research is development planning, with an emphasis on the decision-making phase, and this chapter starts with outlining the theoretical concepts of development and planning and therefore of development planning. Of particular interest for this research is the human development approach, supported by the rights-based approach, to development and collaborative planning. Contributing to understanding development planning is the organisational context within which it happens, in particular the different role players, from politicians, professionals, to the community involved. Within the modern context it is also appropriate to include sustainable development in the discussion – the link between human development and a sustained environment is of particular note.

Detailed attention was devoted to developing an understanding of decision making and the nature of decision making. Different types of decision making are therefore included in the discussion. An objective of this research is to contribute to maximising rationality, or bounded rationality, in decision making. The knowledge that the decision-maker has of the problem is paramount in achieving a rational decision. It is therefore appropriate to discuss knowledge and the different types of knowledge and knowledge structures. In particular tacit knowledge, explicit knowledge and cultural knowledge are singled out to help understand knowledge in the context of the individual or group. Also appropriate to this research is the need to categorise knowledge in the ordered sequence of declarative knowledge, procedural knowledge and configurational knowledge. Spatial knowledge constructs are based on these knowledge constructs, but are discussed further in the next chapter.

The common decision-making models are discussed, including Choo's Knowing Organisation Model, which highlights the information-processing approach – what he calls the 'knowing cycle' of sense making, knowledge creation and decision making, in a continuous cycle. Choo's model brings to the fore the relationship between information, knowledge and decision making.

No discussion on decision making will be complete without including the decision-making process (here a four stage process is used), and more importantly, the role of information in decision making – looking at information in each of the

decision-making stages. The information process is discussed in terms of information needs, information seeking and information use. It is important to note that humans do not always know what their information needs are for a particular decision, and therefore may have to go through an iterative process – 'the more you know, the more you know what you don't know'.

Following the theoretical concepts of development planning and decision making and the discussion on the decision-making process, the chapter reviews the development planning process. Based on the human development approach, the rights-based approach, the collaborative planning approach, what various authors have put forward for a development planning process and the objective of maximising rationality while recognising that development is value-laden and requires community involvement – participatory development planning – a revised development planning process is proposed (Figure 2.7). This revised process emphasises community/societal participation in identifying the development need, and the cyclical nature of the process – using monitoring and evaluation to assess the achievement of the development needs, and the subsequent re-planning, if required. The main differences from other processes put forward are the central components of capacity and capacity-building and of knowledge creation. These interact with each phase of the process. All the role players, and in particular the community, must have the capability and knowledge to participate in the whole development process. They must also become self-reliant and not remain dependent on the government or other development agencies, so that they can

accelerate their own development. The old adage ‘If you give a man a fish, you feed him for a day. If you teach a man to fish, you feed him for life’ should be a primary basis of the development planning process. This is of great relevance to this research.

The phenomenon of geo-spatial information will be assessed in the next chapter.

CHAPTER 3

GEO-SPATIAL INFORMATION

3.1 Introduction

Following the general discussion on development planning and decision making and having established the role of information in the development planning and decision-making processes, it is appropriate to discuss a specific type of information, namely geo-spatial information and spatial knowledge. It is necessary to determine whether geo-spatial information and spatial knowledge play a role in the development planning and decision-making processes.

3.2 The Meaning of Geo-spatial Information

Geo-spatial information is also referred to by other terms, such as spatial information and geographical information. These terms all mean the same thing, and are often used interchangeably.

There are probably as many definitions of geo-spatial information as there are textbooks on this topic. The differences are mostly related to the discipline and country from which the author originates. Geo-spatial information is applied in numerous disciplines, and hence the different viewpoints. Fundamentally, spatial

information is information about location (space or place) and is possibly also localised at a particular time (Chorley, 1987:7; Longley *et al.*, 2001:5). The prefix 'geo-' relates to the Earth, rather than space in general, and therefore geo-spatial information is information that occurs on, above or below the Earth's surface. Geo-spatial information represents phenomena that are either natural or human-made, and can be physical or abstract in nature. As with information and data, the terms geo-spatial information and geo-spatial data are occasionally used interchangeably.

3.3 The Nature of Geo-spatial Information

Physical phenomena include phenomena that can be directly observed, such as a river, a mountain or a building, while abstract phenomena, such as population migration or annual rainfall, cannot be directly observed and are usually associated with or derived from other phenomena. Human-made phenomena include roads and buildings, while natural phenomena include rivers and topography.

The Earth is infinitely complex and the phenomena, whether physical or abstract, must be reduced to a representation that makes geo-spatial information manageable by humans. To achieve this representation the phenomena are subjected to a system of classification (semantic), which simplifies the complex Earth into geo-spatial features. This process does involve filtering, which in most

cases is destructive – there is loss of information, preventing full reconstruction to the original state.

Geo-spatial features have a spatial and a non-spatial descriptive component. The non-spatial component includes the feature class, such as road, river, savannah grassland, and its descriptive attributes, such as name, route number, owner. The spatial component describes the geometry, location and topology of the feature. The feature may be either point (zero-dimensional), linear (one-dimensional), areal (two-dimensional) or volumetric (three-dimensional) in nature. Each of these instances must be located within a geo-referencing system, an Earth co-ordinate system defining its location or position (Longley *et al.*, 2001:60-74).

Geo-spatial information is best represented on a map (Antle and Klinkenberg, 1999:150; GISD, 2002:6). Robinson and Petchenik (1976:4) are of the opinion that maps are "considered to be the most fundamental way of converting personal knowledge to transmittable knowledge. … maps are surrogates of space." The map then is a representation of the geo-spatial features occurring on, above or below the Earth's surface. The map may be either in digital or 'hardcopy' format. In the digital map (also referred to as geographic information system) the features are represented by their co-ordinates and descriptive information, stored in the database, and viewed as points, lines, areas and solids, using symbology (with the various graphic/visual variables). In the 'hardcopy' map space is represented at a set scale (e.g. 1 mm on the map represents 50 000 mm or 50 m on the ground,

otherwise expressed as a ratio of 1: 50 000) and the features are represented by map symbology (with the various graphic/visual variables) and annotated text.

3.4 Spatial Knowledge

Spatial knowledge is a type of knowledge and therefore the knowledge concepts discussed in Chapter 2 apply. In this discussion the term 'spatial knowledge' rather than 'geo-spatial knowledge' is used as it is more generic and is the more commonly used term.

The categorisation of knowledge in developmental knowledge acquisition stages given by Golledge and Stimson ((1987:71-94) as declarative knowledge, procedural knowledge and configurational knowledge (see Chapter 2), is most appropriate in the context of this research (map literacy). Procedural knowledge is considered to be at a higher cognitive development level than declarative knowledge, and configurational knowledge to be at the highest level. MacEachren (1991:153-154) relates this developmental approach to the Piagetian development in children and the gradual developmental process of knowledge acquisition in adults. This links with Choo's "knowing cycle" of sense making, knowledge creation and decision making (see Chapter 2).

This developmental approach to knowledge acquisition is a cognitive process called 'cognitive mapping' (MacEachren, 1991:154). From a behavioural

approach Golledge and Stimson (1987:38) explain cognition as "the way information, once received, is stored and organised in the brain so that it fits with already accumulated knowledge that a person has, and with his/her values." This explanation is incomplete as it does not provide for the recall and decoding of information. It does, however, highlight the role of a person's values, making the knowledge process value-laden. Peterson (1987:35) describes cognition as including "such mental activities as perception, thought, mediation, reasoning, problem solving, and mental imagery." This explanation overcomes the problem with the explanation by Golledge and Stimson as it includes the recall and use of information.

A number of authors (Kuipers, 1978:130; Lloyd, 1989:101; MacEachren, 1991:154; MacEachren, 1992:245, 250; Peterson, 1987:35) have established that there is a relationship between spatial knowledge and cognitive mapping. The cognitive map is a metaphor for the understanding of the environment that humans construct (Crampton, 1992:47). The cognitive map involves the processing of the spatial product (mental image or the map), spatial storage and spatial thought. Spatial thought uses explicit knowledge, but also draws extensively on the tacit knowledge of the user (Lloyd, 1989:104). Spatial knowledge has been shown to be stored in a hierarchical structure (region-based rather than network-based hierarchies) (Stevens and Coupe, 1978:434-437). It has also been shown to be stored in 'chunks'. This chunking lends itself to the manner in which a user perceives a map – in regions or chunks and not linearly. This

structure provides for efficiency in the storage-computation trade-off. This structure, based on an understanding of the spatial features mapped, particularly the location properties, makes possible the process of geographical inferences (inferential processes) to be drawn from the spatial relationships between these features (MacEachren, 1995:182; Robinson and Petchenik, 1976:112) – using configurational knowledge.

The amount of spatial knowledge stored and the ease with which it is extracted is dependent on many factors, including the construction of the cognitive map. MacEachren (1995:172) indicates that map reading is reliant on knowledge structures based on both declarative and configurational knowledge and that the process of map reading can generate or alter the representations of the cognitive map. The ability to interpret a map has been shown to be dependent on the development of the cognitive map, or the mental model (Crampton, 1992:60). Map users are "able to make quicker and more accurate judgments of spatial relations when an appropriate mental image has been formed" (Antle and Klinkenberg, 1999:154). This is supported by MacEachren's (1995:198-199) general map schema, which is founded on the general graph schema. It can be concluded that effective map use involves spatial thought.

It has also been shown that the cognitive map can consist of data, processes, propositions and images (Crampton, 1992:48; MacEachren, 1995:47). Peterson (1987:39-40) has developed the 'human geographic information system' (Figure

3.1) to depict these processes. In his model geographic (geo-spatial) information is sent into a register (sensory register), from which patterns and relationships are formed and extracted (pattern recognition). These are then stored in the short-term memory for further processing, as well as in long-term memory for later recall to the short-term memory, as propositions and images. The query system uses the propositions and images in memory appropriate to the problem at hand to provide knowledge.

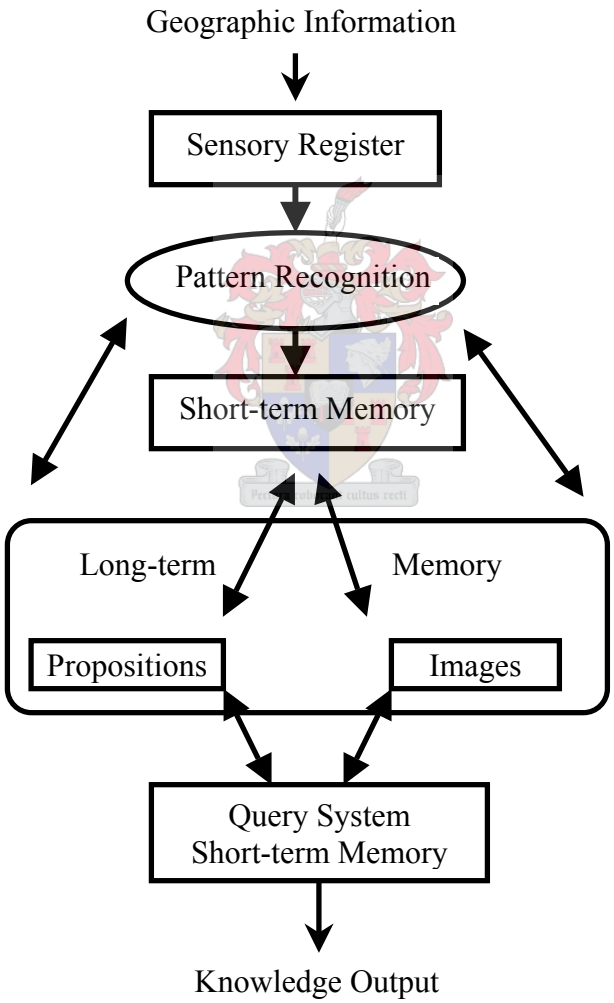


Figure 3.1 Human Geographic Information System (Peterson, 1987:40)

Dobson (1979) developed a similar model, which he called the visual information-processing model. The main difference with Dobson's model is that he describes the perception processes in more detail before moving onto cognitive processing and storage. The key features in both models are the use of images, the differentiation between short-term and long-term memory, and the reliance on stored knowledge (tacit and explicit) in the processing of new information, which adds to the already stored knowledge. An understanding of these models forms the basis for the discussion on cartographic communication and cartographic language – in Chapter 4.

MacEachren (1992:250) indicates that a "cognitive representation obtained from a map may differ substantially from a representation for the same area derived from direct environmental experience." Crampton (1992:49) is of the view that in way-finding (navigation), where mainly procedural knowledge is used, it is easier to describe a route in the direction experienced than in the reverse direction. It has also been shown that users learn more quickly from a map than from following a route on the ground. This is most probably because a map, as a representation, orders and simplifies the complex milieu of phenomena in the real world (Robinson and Petchenik, 1976:74).

An experienced map user, with greater tacit knowledge, an expectation of what to find and a better-developed cognitive map, performs better than a novice user

(Board, 1984:91; Eastman, 1985:95; Eastman and Castner, 1983:126, 137; Kulhavy *et al.*, 1992:8; Rieger, 1999:136; Robinson and Petchenik, 1976:77). This is particularly apparent at the higher task levels using procedural and configurational knowledge. Based on the Paigetian development theories, age is also a factor in spatial (cognitive) performance, with children performing worse than older users (Robinson and Petchenik, 1976:88-103). Various authors have also found spatial performance differences based on gender and cultural background, with females and persons native to less developed countries displaying lower performance (Board, 1973:232; Golledge and Stimson, 1987:43; Liebenberg, 1998:112, 116). However, it has been shown that these differences are not necessarily due to the inability to construct a cognitive map or other cognitive processing, but rather to the circumstances under which the user has developed. The differences are also task specific, with better performance in some tasks than in others (Balchin, 1976:36; Kitchin, 1996:285; Louw and Edwards, 1993:367-372; Rieger, 1999:128, 135). Whether on grounds of gender or culture or both, a user would have had a different exposure to spatial (cognitive) experiences and therefore had a different cognitive development. It is indicated that such users, once they have had adequate training and experience in spatial skills and the construction of cognitive maps, have comparable spatial performance to other users. These differences are largely experience and age-related factors. It can then be concluded that spatial performance (storage and recall of spatial knowledge) is dependent mainly upon experience and age (Piagetian development stages).

3.5 Use of Geo-spatial Information in Development Planning

The relationship of information and knowledge to the decision-making and development planning process has been shown – see Chapter 2. Geo-spatial information and spatial knowledge have been shown to be distinct types of information and knowledge respectively. It can therefore be deduced that geo-spatial information and spatial knowledge play a key role in decision making and development planning.

This relationship is confirmed by Lance (2003), who states that "to implement NEPAD (New Partnership for Africa's Development), geographic information, across all sectors is an obvious tool for planning and monitoring – this transcends 'environmental information' or 'disaster information' or 'health information' or 'economic information' or 'demographic information'." Further evidence of this relationship can be found in the United Nations' Agenda 21's various action items requiring geo-spatial information (National Research Council, 2002:14-17, 24-26). The Johannesburg Plan of Implementation that resulted from the World Summit on Sustainable Development (WSSD) in 2002 reaffirmed the essential role of geo-spatial information in development planning and decision making (WSSD, 2002):

"119.septies Promote the development and wider use of earth observation technologies, including satellite remote sensing, global mapping and geographic information systems, to collect quality data on environmental impacts, land use and land-use changes, including through urgent actions at all levels to:

(a) Strengthen cooperation and coordination among global observing systems and research programmes for integrated global observations, taking into account the need for building capacity and sharing of data from ground-based observations, satellite remote sensing and other sources among all countries;

(b) Develop information systems that make the sharing of valuable data possible, including the active exchange of Earth observation data;

(c) Encourage initiatives and partnerships for global mapping.

119.octies Support countries, particularly developing countries, in their national efforts to:

(a) Collect data that are accurate, long-term, consistent and reliable;

(b) Use satellite and remote-sensing technologies for data collection and further improvement of ground-based observations;

(c) Access, explore and use geographic information by utilizing the technologies of satellite remote sensing, satellite global positioning, mapping and geographic information systems."

The GISD (2002:17) found that "reliable geographic information is critical to the development of adaptive and responsive natural resource management", and that this information can be used to track the impact of development programmes.

To empirically test the role of geo-spatial information use in the development planning process in South Africa, a questionnaire survey was undertaken – see Annexures A and B. The sample group was a purposive sample, being organisations in the South African public service (national, provincial and local government), which are deemed to be users or potential users of spatial information. This sample was chosen to give a more informed response on the main purpose of the survey, namely to validate the applicability of the map-use tasks for measuring functional map literacy and the skill level of each map-use task deemed necessary (see Chapter 4, section 4.7). The bias in the sample is therefore immaterial. The sample size was 106 organisations or components of an organisation.

The questionnaire survey received 78 responses - 74% of the total sample – see Annexure B. The questionnaire was completed by an appointed senior employee in the organisation. Of the 78 responses, 6 indicated that they did not use spatial information and did not complete the questionnaire further. This left 72 useable responses – 68% of the total sample. Of these users, 64% indicated that they used geo-spatial information extensively and 63% indicated that geo-spatial

information was used on a daily basis in their work, while 34% are moderate users of geo-spatial information and 22% use it on a weekly basis.

It can be concluded from this survey that, in the South African public sector, which is a development sector, geo-spatial information is essential.

The situation in South Africa is no different to the situation in other developing countries and one can generalise that geo-spatial information is essential in the development of any country. In Africa this has been emphasised at the meetings of the inter-governmental Committee on Development Information (CODI), which operates under the auspices of the UN Economic Commission for Africa (UNECA). The discussions at these meetings are encapsulated in the resolutions of the meeting. Examples of these include calling on all African governments to establish a national spatial data infrastructure, include spatial data infrastructure in their national information and communication infrastructure plans, to collect and maintain relevant fundamental geo-spatial datasets (UNECA, 2005).

The key role of geo-spatial information in development planning is further supported by way of numerous examples of real world applications. To illustrate this point a few such examples in a development environment are briefly discussed. They are land reform, food security, crime prevention, primary health care and mortality, environmental conservation, disaster management and mitigation, and tourism.

Land Reform

The land reform programme in South Africa consists of land restitution (restoration of land rights affected by apartheid legislation), land redistribution (provision of land to those previously impeded in participating in the land market) and land tenure reform (improving security of tenure for vulnerable groups) (DLA, 2005). The land restitution and tenure reform programmes require knowledge of the location of human habitation and land use in the past, prior to such persons or communities being removed from the land, and of land ownership over time. This is required in order to verify claims being made to that land. Geo-spatial information contained in maps and aerial photographs, for the time period immediately prior to the removal of these people, and associated deeds records of ownership linked to the cadastral land parcel, have proven to be a key component in the decision-making process. A property valuation tool, reliant on geo-spatial information, has been developed to assist in the land restitution process in South Africa, particularly to mitigate against the risk of artificially raised land values (De Kock, 2005:623-625).

In all of the land reform programmes, be it for housing purposes or agrarian reform, the land development project must be planned in a sustainable manner. Not only must the land be evaluated for its suitability for particular land use, but also the development must be planned in detail. Any land development like this

requires a range of geo-spatial information, starting with the location of the land, the natural resources available on the land (if for agriculture) such as water and soil type, topography (particularly slope), geology, roads, telecommunications, electricity and other public service infrastructure, and location to markets or places of work.

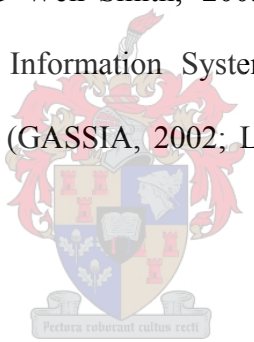
It has been accepted by the South African Department of Land Affairs that in South Africa there would be no effective land reform without geo-spatial information (DLA, 2005; Engel, 2003:591, 598).

In Namibia land-cover and land-use mapping is being used to assist the land reform programme through improving the quantification of land productivity information. This information aids the optimal re-settlement of farmers and for the land taxation system being introduced (Espach and Coetzee, 2005:1154-1158).

Food Security

Sustainable agricultural production is necessary to feed the people in developing countries, particularly in those areas where poor agricultural methods are evident. Many of these areas are prone to drought or flooding, which affects agricultural output. Various national and regional systems (such as the Regional Remote Sensing Unit of SADC, UN Food and Agriculture Organisation, Famine Early Warning Systems NET) have been or are being set up to predict drought

conditions and crop yield (FAO, 2005; SADC, 2004). If such systems can predict crop failure, then relief measures can be provided timeously. On the more positive side, where crop failure is not the issue, systems are being used to improve agricultural production, such as by assisting farmers with the best location for planting particular crops and selective soil preparation and fertilisation to minimise costs (also referred to as precision farming). All of these systems make extensive use of geo-spatial information, such as distribution of soil types, slope, location of water resources, rainfall distribution, monitoring of crop growth using aerial photography or satellite imagery, and land cover (Bydekerke *et al*., 2005:985; Lindemann and Weir-Smith, 2005:381). One such system is the Agricultural Geographical Information System (AGIS) of the South African Department of Agriculture (GASSIA, 2002; Lindemann and Weir-Smith, 2005: 379-382).



Crime Prevention

South African society is plagued by high crime rates and the security services are stretched too thinly to combat crime effectively. The poor and most vulnerable communities are particularly at risk. The South African Police Service has developed a geographic information system which uses fundamental geo-spatial information as a framework upon which the incidence of crimes is correlated. This allows them to identify crime 'hotspots' or to determine crime patterns by particular criminals and then to effectively plan their crime prevention strategies

or ultimately to arrest criminals (Cooper and Schmitz, 2003:269-279; Richards, 2005:828,833). Accessibility analysis techniques, based on geo-spatial information, have been used for the optimal location of police stations (Maritz and de Jong, 2005:169-171).

Similarly, the Ghana Police CID are now using geo-spatial information for analysing crime data to identify spatial patterns and temporal trends, otherwise not apparent in tabular data. They are also using this for community policing to deploy resources (Ampofo, 2005:241-246). Richards (2005:828) reports on the use of spatial location as a factor in modelling crime as a risk for economic investment.

Primary Health Care and Mortality

Knowledge of the location of communities, prevailing health conditions of these communities and the location of health-care facilities is necessary to plan and effectively provide a primary health care service.

The prevalence of malaria and HIV/AIDS in many of the rural areas, where most of the vulnerable communities live, is increasing the mortality rate in these communities. Primary health care should therefore to be targeted at such areas. The Medical Research Council (MRC) and the Human Sciences Research Council (HSRC) in South Africa have been recording the occurrence of these two

diseases. The location of households (with information on the infection status), the location of health-care facilities, access routes between such households and the health-care facility, location of surface water, and the movement of people, are being used to plan preventative actions and the provision of health care to such households (Sharp *et al.*, 2003:56-63). Pillay (2003:47) reported on the use of maps to depict the spread of HIV/AIDS spatially over a three-year period, at district level, in four African countries. Similar programmes are being conducted in countries such as Uganda, Ethiopia, Rwanda, Burundi, Kenya and Tanzania (GISD, 2002:23).

Geo-spatial information on the location of households, sanitation, safe water supplies and illiteracy rates was used in South Africa to contain and effectively deal with a cholera outbreak, resulting in the world's lowest ever recorded fatality rate for such outbreaks (EIS-AFRICA, 2002:6).

Environmental Conservation

The sensitivity of environments to development and the protection of biodiversity are concerns for sustainable development.

The South African Department of Environmental Affairs and Tourism has developed an Environmental Potential Atlas (ENPAT) to aid decision making on environmental impacts of development projects (DEAT, 2005). This system

brings together various geo-spatial information such as land-cover/land-use, topography, soil types, rivers and wetlands, rainfall distribution, location of settlements and communication networks, to determine the environmental sensitivity and potential of particular sites for particular developments.

An environmental conservation plan for the Gauteng Province of South Africa has been developed that maps spatial surrogates for supporting ecological processes to identify and maintain biodiversity in sensitive areas (Compaan *et al.*, 2005: 355-366). This conservation plan was dependent on the geo-spatial information of the spatial occurrence of dolomite, ridges, rivers and wetlands.

As part of its coastal, marine and island biodiversity conservation project, Eritrea has collected geo-spatial information on the underwater habitats, mangrove swamps, turtle nesting beaches, coastal villages, fishing sites and coastal infrastructure. This information, together with digital elevation and bathymetric data, land-cover and land-use data, is being used to establish a geographic information system as a management tool (Ghebremeskel, 2005:1160-1163).

The Congo Basin Forest Partnership has been established to manage natural resources, including monitoring illegal logging and wildlife poaching, and natural resource conservation. The objective is to promote economic development, poverty alleviation and improved local governance. Geo-spatial information on deforestation, ecologically sensitive areas, forest landscapes, wildlife corridors,

and human settlement and movement is key to this work (Sustainable Development Partnerships, 2005).

Disaster Management and Mitigation

Disasters usually result in great loss of life (human and animal), damage to infrastructure and environmental damage. When a disaster strikes it is necessary to mobilise rescue services and attempt to restore essential services as quickly as possible. Disaster reaction requires knowledge of the location of people and their essential resources and the assessment of damage to infrastructure and the supporting environment. A good example of the use of geo-spatial information in disaster management was the Limpopo valley flooding in 2000 (GISD, 2002:19; World Bank, 2000). Information on the location of settlements, road and rail infrastructure, health-care facilities, other public facilities and crops prior to the flooding, and the topography of the region was overlaid with the flood extent obtained from satellite imagery. Rescue operations and flood relief could be efficiently executed using this information. This information was also used to assess the flood damage, in order to determine the restoration work required.

Minimizing the effects of disasters through disaster mitigation interventions is a better option. This requires an assessment of possible risks and the effects of various types of disasters and then managing such risks. For example, in the case of flooding, information on the topography of the river catchment will enable

flood lines to be determined. Overlaying this information onto the location of settlements and infrastructure will identify those at risk. Flood-control measures can then be established. Following the Limpopo floods the South African government established a National Disaster Management Centre. This Centre is making extensive use of geo-spatial information in its risk assessments and mitigation programmes and in relief work (GISD, 2002:19; Strydom and Braune, 2005:152, 154, 156-157). Similarly, Tchindjang *et al.* (2005:142-150) report on the use of satellite radar imagery for the management of flooding in the Congo Basin.

Tourism

The economy of Mauritius is very dependent upon tourism and it is necessary to optimise the development of tourism facilities, particularly along its coastline. A multi-criteria spatial decision support system has been developed for this purpose. Key to this system is geo-spatial information on current land use, road access, coastal morphology, location of settlements and location of existing tourism facilities (Beedasy and Whyatt, 1999:163-174).

The Zimbabwean Tourism Authority has created an electronic media atlas (collection of maps, photographs, video and audio clips) as a means to disseminate accurate and well-presented information to prospective tourists in an

attempt to boost the faltering tourist industry in Zimbabwe (Dondofema and Gandawa, 2005:1097-1099).

Development planning should take place using a community participatory approach (see Chapter 2), which means that these communities, and not only the government or development agency, must have access to geo-spatial information. Access to such information by communities will allow development planning to meet the needs of those communities and ensure that this is needs-driven. Harris and Weiner (1998:68-69), however, warn that as much as geo-spatial information is empowering it can also be marginalizing. Communities are marginalised as a result of: 1) lack of data accessibility, including availability and affordability, 2) lack of skills to utilise the information, and 3) possible political reasons. Geo-spatial information can also have bias. Geo-spatial information and the technologies used are complex and can be very technical. This point is further expounded by Brooner (2002:203), who claims that "geographic information is an expensive resource. Appropriate information and the resources to fully utilize it may not always be available, particularly in the developing world".

The development planning process described in Chapter 2 indicates the strong utilisation of information at the various stages in the process. The above assessment indicates that most of the information used in development planning, is geo-spatial information. It can be concluded that there is a strong relationship

between geo-spatial information and development planning. That is, rational decisions about development planning must utilise visual geo-spatial information (maps). It is noted, however, that for geo-spatial information to be effective in the development planning process, it must be relevant to the particular development problem or opportunity (needs-driven) and, most importantly, it must be accessible and usable by the community, development planners and policy-makers. As geo-spatial information is best represented on a map, which is an image or visual presentation form, it goes without saying that users will require good visual interpretation and cognitive abilities to fully utilise geo-spatial information.

Failure to have access to, and the inability to use, the relevant geo-spatial information will diminish the rationality and effectiveness of decision making in the development planning process. The level of functional map literacy is therefore relevant for the effectiveness of development planning – see Chapter 4.

3.6 A Geo-spatial Information Decision-making Model

Having established that there is a relationship between geo-spatial information and development planning, it is now appropriate to explore this relationship in more detail. For this purpose a new model is proposed. The model combines the

development planning process, in particular decision making, information processing and knowledge creation – adopted from the discussion in Chapter 2.

This model, which will be named the Geo-spatial Information Decision-making Model, is developed from a synthesis and expansion of the following:

a) the Development Planning Process – the revised model proposed in Chapter 2 (Figure 2.7), based on the human development approach, emphasising capacitation of communities and other stakeholders and enlarging peoples' choices, supported by the rights-based approach to address injustice and inequality, together with the collaborative planning approach based on communication and participation by all stakeholders, with the emphasis on information use and knowledge creation and the decision-making process (Figure 2.3);
b) the nature of decision making;
c) the General Model of Information Use (Figure 2.4);
d) visual information processing;
e) the Knowing Cycle (knowing organisation) (Figure 2.2);
f) spatial knowledge constructs;
g) the principle of rationality in decision making, with the objective being to achieve the highest possible level of rationality, although it is recognised that development planning takes place in a value- and power-laden environment; and

h) an open systems approach.

The Geo-spatial Information Decision-making Model is an information/knowledge-centric model. The generalised model is given in Figure 3.2 below, with the inner part of the model given in more detail in Figure 3.3 below:

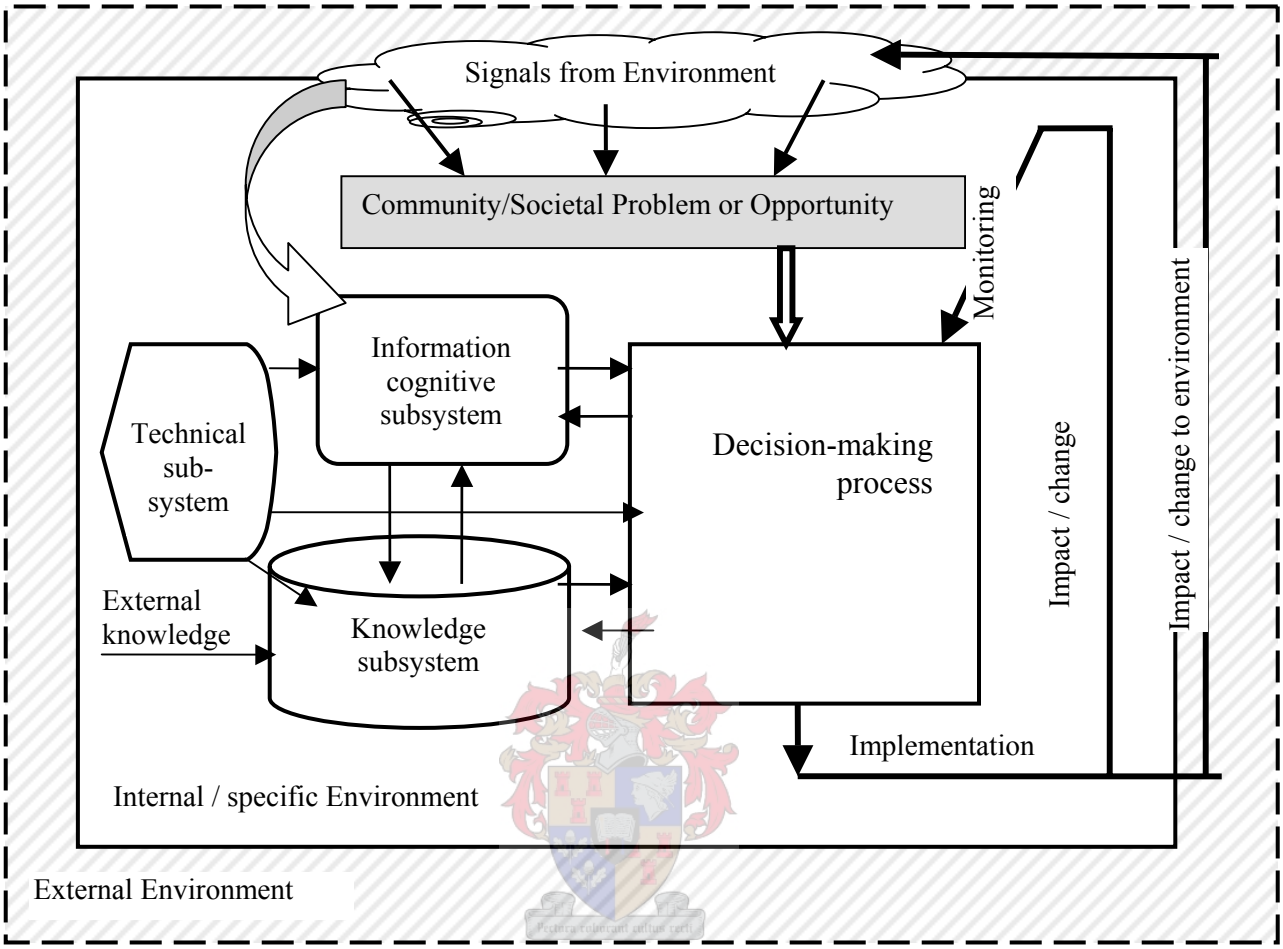


Figure 3.2 Generalised Geo-spatial Information Decision-making Model

The inner part of the model is given in more detail below:

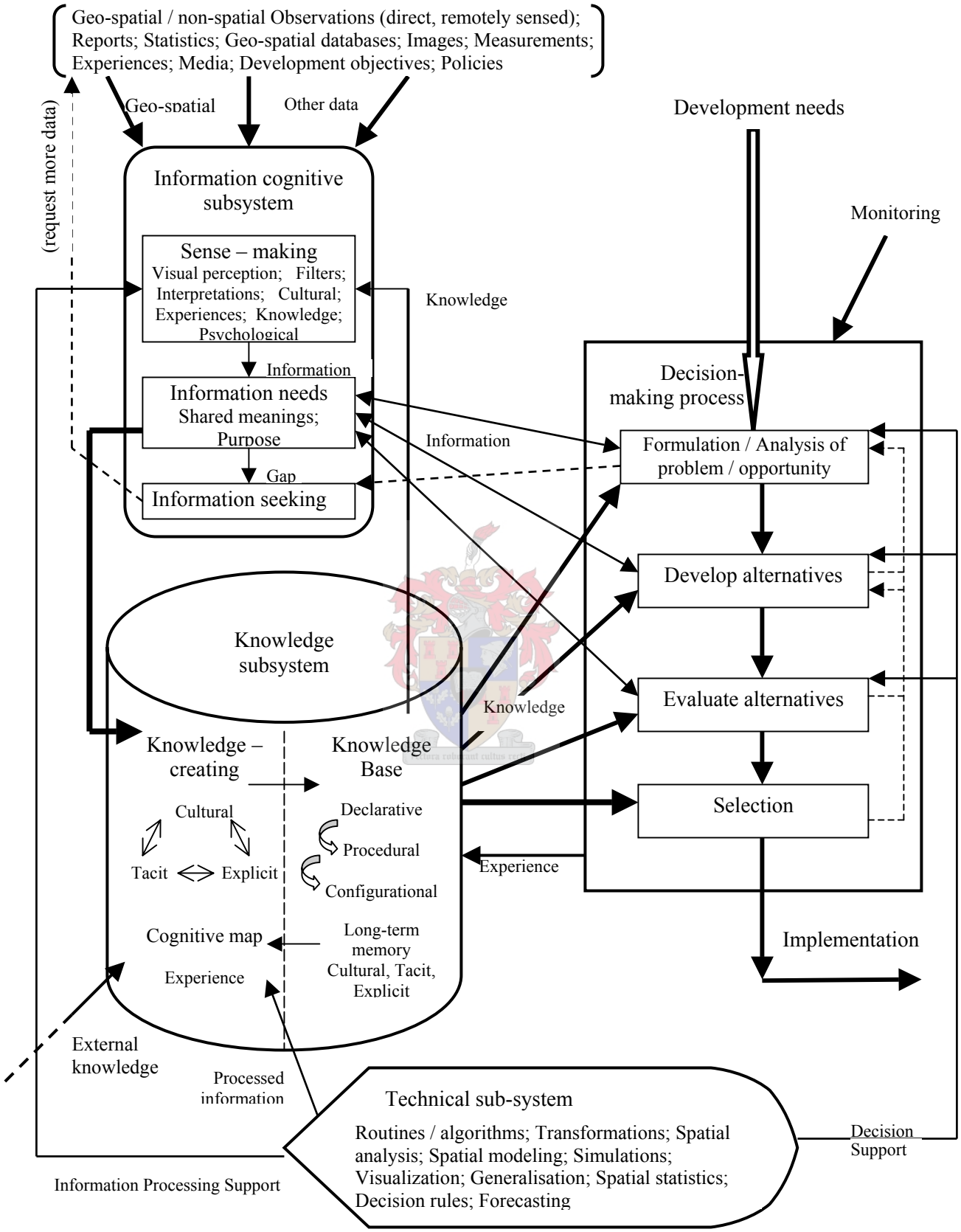


Figure 3.3 Geo-Spatial Information Decision-making Model (inner part of model)

The Geo-spatial Decision-making Model and its component parts can be summarised as follows:

a) Environment

The Geo-spatial Information Decision-making Model is an open system, appropriate to the particular developmental community or society to which it is being applied. As with other open systems, this model exists within an environment. The environment and the system interact with each other with mutually influencing forces. The purpose of implementing a decision is to impact on the environment to change the environment in the desired manner. The open system is completed with the feedback from this change to the environment into the community or society – has it achieved its development objective? The Geo-spatial Information Decision-making Model community or society it is being applied to must therefore be seen in the context of the environment in which it exists.

The environment can be viewed in two parts, namely, the external or general environment and the internal or specific environment. The internal environment would be the community or society in question and its immediate suppliers and physical environment. The external environment would be those influencing forces further removed, such as the national government and regional and international communities. The internal or specific environment

has the greatest influence, being more directly related to the system (Fox *et al.*, 1991:3-5).

b) Signals from the Environment

The interaction between the environment and the community or society is observable by signals received from the environment. The signals could be indicating different parameters of the current state of the community/society or indicating differentials between this community/society and other communities/societies, locally, nationally, regionally or globally. The signals could also be indicating the parameters of the natural environment, such as land cover, animal population or meteorology.

The signals could be in various forms, including:

- observations: geo-spatial and/or non-spatial, made directly (*in situ*), such as animal sightings, air temperature readings, or remotely sensed;
- reports and statistics, such as demographic and economic census, Human Development Report, State of the Environment Report;
- existing geo-spatial databases and other databases containing relevant information;
- images recorded of the applicable area and its surrounds, recently and also over a period of time to show changes, including close-up photographs, aerial photographs or satellite images;

- measurements made either directly or derived from other observations and images, such as distances, areas, slope, water chemical composition;
- personal experiences of the community or individuals, which are then relayed to the development planners, politicians or the media;
- the development objectives and policies of the community or the government, which may also be derived from regional or international protocols and agreements, such as the Millennium Development Goals.

As has already been shown, most development takes place in a spatial context and therefore most of the signals from the environment will be geo-spatially related. This will include data on location (position) in absolute position (single referencing) and/or spatially related to other phenomena (see section 3.3 above).

c) Community/Societal Problems or Opportunities

From the signals received from the environment (internal or external) a problem may be identified which will draw attention to a development need, or the signals may indicate an opportunity for development to a better state. In both cases there is an indicator of change, which can be achieved through identifying a development need. The development need must be recognised

and acknowledged by the particular community / society. It must also be tailored to the needs of that community / society. Refer also to Chapter 2 (section 2.11) for further discussion.

d) Decision-making Process Subsystem

The decision-making process - consisting of the various stages of 1) formulation/analysis of the problem or opportunity; 2) the development of alternatives; 3) the evaluation of the alternatives; and 4) the selection of the best or most appropriate alternative - has already been discussed in detail in Chapter 2 (section 2.9).

The development need, identified in the Community/Societal Problem or Opportunity stage, initiates the decision-making process.

The model makes provision for iterations to occur within the stages, if required (depicted by the broken line in figure 3.3). Such iterations could occur under the following circumstances:

- after developing alternatives it may be necessary to review or refine the formulation or the analysis of the problem/opportunity;
- in evaluating the alternatives it may be found that further alternatives must be developed;

- that new variables must be used, which could require the analysis to be repeated;
- it is also possible that at the final stage of selection there will be a need to return to an earlier stage in the process, perhaps when agreement cannot be reached on the alternative to select - either further alternatives must be developed, or the problem/opportunity must be reformulated with new variables and weightings.

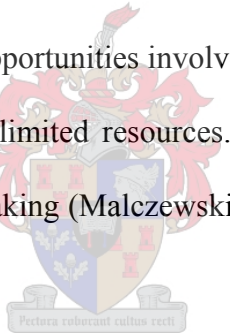
The Geo-spatial Information Decision-making Model, being an information/knowledge-centric model, highlights the role of information and knowledge in the decision-making process. The main purpose of this approach is to achieve the highest possible level of rationality. Rational decision-making requires all relevant information to be used in the various stages of the process. This will result in all possible alternatives being identified and evaluated. The best alternative is then selected. Decision making in a development planning process is value laden, with many competing needs from the various individuals and groups. This will detract from the ideal situation, but does not excuse a significant reduction in rationality. In such cases the full use of all relevant information is even more important in order to bring objectivity to the process.

The Decision-making Process Subsystem interacts with the Information Cognitive Subsystem, the Knowledge Subsystem and the Technical

Subsystem. Geo-spatial information is used directly in the decision-making process based on the information need identified, signifying information use. The information use may be trivial, which does not improve the knowledge base. In this case it is mainly fed into the Technical Subsystem to be used in decision support at the various decision-making stages (hence the two-way arrow connectors between the Information Cognitive Subsystem and the Decision-making Process Subsystem in Figure 3.3). Further information needs may also be identified during the different stages in the decision-making process, resulting in a request to the Information Cognitive Subsystem to seek further information (hence the dashed arrow connector returning to the Information Cognitive Subsystem in Figure 3.3).

The connection between the Knowledge Subsystem and the Decision-making Process Subsystem is strong, indicating the significant role of spatial knowledge in the decision-making process. At each stage spatial knowledge is being used, at times in conjunction with additional information, in particular from the results being returned as decision support information from the Technical Subsystem. The type of knowledge used may differ in each stage of the decision-making process. The type of knowledge used will also differ depending on the type of problem/opportunity under consideration. The knowledge may be declarative, procedural or configurational (refer to Chapter 2 for explanations). The knowledge and the experience of the decision-maker are used particularly in the final stage of selection, where judgment is often

required. The degree of knowledge and experience used will depend on the level of rationality achieved in the process and the degree of structure in the decision. The more unstructured the decision is, the more judgment is required. Many individual (private) spatial decisions are simple and do not require formal spatial processing. These decisions are often based on heuristics, supported by mental maps (Jankowski *et al.*, 2001:101) created from spatial knowledge stored in both long-term and short-term memory, and from experience. The decision equity at stake here is generally small and therefore making a wrong selection does not carry a high price compared to the cost of making the decision. On the other hand, most, if not all, development problems/opportunities involve conflicting criteria, possibly with multiple objectives, and limited resources. This is commonly referred to as multi-criteria decision-making (Malczewski, 1999:81-85). The decision equity in such cases is high.



There is also a reverse link between the Decision-making Process Subsystem and the Knowledge Subsystem. Each time there is a pass through the decision-making process, new experience is gained. This experience is returned to the Knowledge Subsystem to be used to create new knowledge. This illustrates the fact that experience contributes to knowledge creation and in general the more experience the decision maker has, the more knowledge he or she has. The amount that the experience contributes to the knowledge will depend on the extent of the experience and how appropriate it is to the situation.

The Technical Subsystem provides decision support to the first three stages of the decision-making process. The type and extent of the decision support will depend on the type and complexity of the problem/opportunity being considered. The Decision-making Process Subsystem passes to the Technical Subsystem the relevant information, decision variables and the type of analysis or decision support required. In return it receives from the Technical Subsystem the results of such processed information, analysis or decision support. The Technical Subsystem does not return a decision.

e) Implementation

The alternative selected (i.e. the decision) resulting from the Decision-making Process Subsystem must now be implemented. This may be the formulation of a new or revised policy, which in turn will lead to actions, or it may result in a direct action to be taken. It is possible that the decision is to take no action (the null alternative), but this is not common in the development planning process.

An implementation plan will be prepared and put in place. The objective is to achieve the goal originally identified in the Community/Societal Problem or Opportunity stage.

The impact of the implementation, if successful, will be a changed environment, in particular for the internal environment but possibly also the external environment.

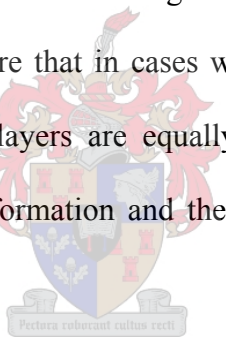
f) Monitoring

The development planning process (see Chapter 2) provides for monitoring and evaluation to determine the extent, if any, of the change in the environment due to the implementation of the selected alternative (decision). Also, continuous monitoring will detect any deviations from the implementation plan and allow for corrective action to take place timeously, which may include a change to the alternative selected should it be shown that the desired results will not be achieved. The evaluation of the state of the environment will determine whether or not the goal of the development intervention has been achieved or ascertain the amount of change that has occurred.

The findings from the monitoring and evaluation may require the decision-making process to be followed again, using the new information from the environment – as would be expected to be found in an open system.

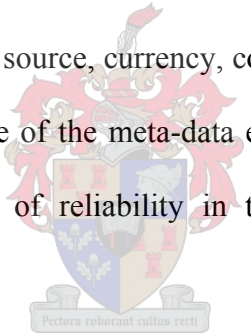
g) Information Cognitive Subsystem

With lack of information being given as a major reason for the failure of development projects (see Chapter 1), it can be deduced that there is a direct relationship between the use of information, or more specifically geo-spatial information, and the success of decision making in development planning – although this is not the only causal factor. Decision makers and development planners must ensure that they are using all relevant geo-spatial information to increase their knowledge base, which will empower them to achieve the highest possible level of success through making good, informed decisions. It is also important to ensure that in cases where there is conflict, all decision makers and other role-players are equally empowered, that is, have equal access to all relevant information and the ability to use this information to extend their knowledge.



Geo-spatial information will only be used in the decision-making process and for knowledge creation if it is relevant, reliable, accessible and useable. For the information to be relevant, it must fill any information gaps and add value to the decision-making process or knowledge creation, within the context of the development need (problem or opportunity). Any information being passed through that is not relevant will only cause 'information overload' and delay the process or detract from the development need.

The reliability of the information determines the confidence level that the decision-maker has in that information. The higher the confidence level, the easier it is for the decision maker to use the information. Information with low reliability will result in ambiguity, uncertainty and inaccuracy. This does not mean to say that information with low reliability cannot be used. In the human and physical environments there are many instances where information is not absolute, such as the exact boundary between clay soil and sandy soil, or between two vegetation biomes. Such boundaries are referred to as 'fuzzy' information. To use information correctly requires information about the information, or meta-data. Meta-data should include the accuracy (spatial, attribute and semantic), source, currency, completeness and consistency of the information. Knowledge of the meta-data enables the decision-maker to take into account any lack of reliability in the analysis or modelling of the information.



Information that is not accessible or useable by the decision maker will generally not be used in the decision-making process. Decision making often takes place in an environment of tight time constraints, requiring information to be readily accessible. The information must also be in a format that is usable to the decision-maker. Information that is not accessible and/or useable will disempower the decision maker. It is also possible that a particular group could be marginalised by not having access to relevant information. Systems must therefore be put in place to provide easy access to information, in

particular to assist the decision maker in determining what information could be used in addressing the decision problem under consideration. The systems should also ensure the usability of the information, through the use of standards and good end-user interfaces for the presentation of the information. Geo-spatial information is generally visual information, requiring the user to have the visual and cognitive skills and competencies to interpret this information. A user who does not have these skills and competencies, that is map literacy, will not be able to use geo-spatial information as required.

The Information Cognitive Subsystem consists of three main components, namely Sense-making, Information needs and information-seeking components. The signals and data, both geo-spatial and non-spatial, are received by the sense-making component from the signals from the environment stage. The signals and data are transformed into information – sense-making. Filters and interpretations are applied to the universe of signals and data to allow only relevant signals and data to pass through. This will define the information to be extracted, resulting in a particular representation of the universe. The information processor's/cartographer's (or decision maker's) visual perception plays a big role in this process, as does the frame of reference (prior knowledge – hence the link from the Knowledge Base, experience, cultural background) and psychological state of the information processor. In transforming signals and data into information, the Technical Subsystem is used for various information processes, such as transform, filter,

sort, aggregate, build spatial topologies, visualise, and calculate means, variances, distributions, areas, distances, etc. Refer to Chapter 4 for discussion on cartographic communication and cartographic language.

Information is passed from the sense-making component to the information-needs component. The information need is considered in terms of the cognitive needs based on the purpose for the information need, but it also includes the affective and emotional needs. In cases where groups are involved in the process, they must also have shared meanings as to the information need. As discussed in Chapter 2, the information needs are not always clearly articulated upfront, with the individual experiencing four levels of information need, namely the visceral level (a vague or inexpressible sense of a shortcoming in the knowledge base), conscious level (follows the visceral response, where a mental description is likely to be formed but ambiguity exists), formalised level (follows the conscious response, where ambiguity is sufficiently reduced to form rational thought), and compromised level (follows the formalised response, where the need may be modified or rephrased so as to represent the information need). The information is now passed to the Knowledge Subsystem and/or to the Decision-making Process Subsystem.

As indicated above in the Decision-making Process Subsystem, a need for further information could be identified. This request is returned to the

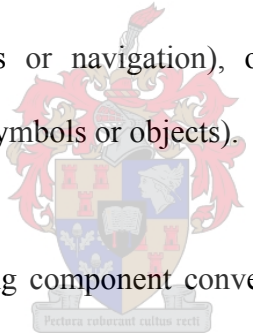
Information Cognitive Subsystem, which checks against the information need component for a gap in the information need. Should a gap exist, then the information-seeking component will address the gap. The gap will either be addressed from the sense-making component, where information may be present but not previously used, or the request will be to search the environment for further signals and/or data. These new signals/data will then be processed through the sense-making component to the Information needs component.

h) Knowledge Subsystem

The Knowledge Subsystem can be considered as the heart of the Geo-spatial Information Decision-making Model. As stated above, information is fed into the Knowledge Subsystem at the one end and spatial knowledge is passed into the Decision-making Process Subsystem at the other end. The Knowledge Subsystem interacts with each stage of the Decision-making Process.

Spatial thought draws particularly on explicit knowledge (see section 3.4). The level of rationality of the decision-making process is dependent upon the extent of appropriate knowledge used, which in turn depends on the information used.

The Knowledge Subsystem consists of two components, namely the Knowledge-creating component and the Knowledge Base component. The Knowledge Base component is the store of spatial knowledge (or database). For the individual, the store of knowledge is mainly in their long-term memory, but the short-term memory is also used. As discussed in Chapter 2 and in section 3.4 above, knowledge can be classified in different ways as cultural (cognitive and affective structures of shared beliefs, norms and values), tacit (implicit or personal) or explicit (public, documented). Knowledge may also be described progressively as declarative (knowledge about symbols or objects and their meanings and significance), procedural (knowledge of process or navigation), or configurational (knowledge of relationships between symbols or objects).



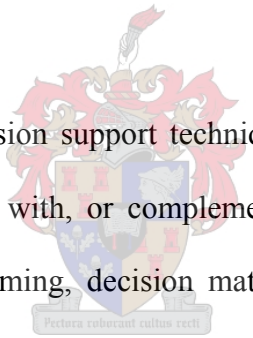
The Knowledge-creating component converts the information received from the Information Cognitive Subsystem into spatial knowledge. This process draws on the existing base of spatial knowledge (from the Knowledge Base component) and the individual's or group's experience. They may also use external knowledge, such as the knowledge of others, to aid their knowledge creation. The cognitive mapping process is critical for the creation of spatial knowledge (see section 3.4).

The Technical Subsystem provides support to the Knowledge Subsystem through the processing of information to extract new geo-spatial information,

such as spatial analysis using topological relationships, spatial modelling and spatial statistics.

i) Technical Subsystem

The Technical Subsystem, as shown above, supports the other subsystems in the model. It is important to note that the Technical Subsystem does not make decisions, but supports decision making by presenting processed information in different ways, and likewise it does not create knowledge but processes information to reveal new information.



There are various decision support techniques that are used, either on their own or in conjunction with, or complementary to, other techniques. These include linear programming, decision matrix, network analysis, simulation, gaming theory, 3-D visualisation, probability theory, cost-benefit analysis (or social cost-benefit analysis), Bayesian decision theory, discounting, queuing theory, forecasting, generalisation, classification, spatial statistics, neighbourhood analysis, spatial modelling and spatial analysis. These techniques are generally available in typical computerised decision support systems and geographical information systems – or what are alternatively called spatial decision support systems.

> In multi-criteria decisions the Technical Subsystem provides the tools for multi-criteria decision-making (MCDM). These MCDM tools provide for two classes, namely multi-attribute decision-making and multi-objective decision-making (Malczewski, 1999:81). They further cater for deterministic, probabilistic and fuzzy decision problems. In spatial multi-criteria decisions the Technical Subsystem uses spatial visualisations, primarily maps and cartograms, in a dynamic and interactive manner to represent criterion outcomes and spatial decision options (Jankowski *et al.*, 2001:104 – 105).

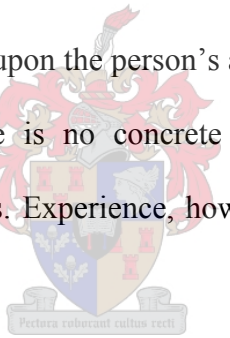
The Geo-spatial Information Decision-making Model is relevant for and can be applied in development planning in different ways, depending upon the complexity and extent of the development need or decision space, and the capacity and competencies of the development planner/decision maker. In trivial cases or where the decision space is small enough, the process can take place in a very short space of time, and be performed by a single person. That is, the same person will gather the signals/data from the environment, process the information, create the required knowledge and perform the decision-making process to arrive at the selected alternative. In cases where the development need is complex, and possibly involves multi-criteria and conflicting needs, and the decision space, including community values, is beyond the scope of a single person, then the process requires more than one person. In such cases the community, professionals from different disciplines and possibly politicians will be involved,

and the decision will take place over a period of time. The community members, supported by the development planners, will, in a participatory manner, identify the development need and undertake the decision-making process. This will require them to create new knowledge to build the required knowledge base to perform the task. Through group interaction they will transform personal or tacit knowledge into explicit knowledge for the benefit of the group. Cultural knowledge will be an influencing force. External knowledge, obtained from other professionals, can be drawn upon at any stage to enhance their own knowledge base. The cartographer would normally collect the signals and data from the environment based on the information need for the particular development need and process the signals and data into information and present this information for use by the development group in the form of a map – in hardcopy format or digital format (including geo-spatial information database). The cartographer then operates in the Information Cognitive Subsystem. The cartographer could also assist the development planners and community members to operate the Technical Subsystem – this will alleviate the problem of communities (and perhaps development planners) not being skilled in the use of the technical systems.

The Geo-spatial Information Decision-making Model presented here highlights the dependency of the development planning process on geo-spatial information and spatial knowledge.

3.7 Summary of Chapter

This chapter discussed the meaning and nature of geo-spatial information, a particular type of information. Geo-spatial information is best represented on a map. The constructs of spatial knowledge (or geo-spatial knowledge) are based on the constructs of knowledge (from Chapter 2), as it is after all a special type of knowledge – at times in the chapter the term 'knowledge' is used, which includes spatial knowledge. An important construct of spatial knowledge is the cognitive map (or mental map) – with the cognitive map being a metaphor for the understanding of the environment that humans construct. Spatial performance has been shown to be dependent upon the person's age, which links with the Piagetian development theories. There is no concrete evidence that gender or culture influence cognitive processes. Experience, however, has been shown to improve spatial performance.



It has been concluded that there is a significant relationship between geo-spatial information and development planning, particularly in the decision-making process. The main supporting evidence for this deduction are the numerous examples of geo-spatial information use in development planning, the relationship that has been established (in the literature) between information and development planning and the claims that as much as 80% of development and public decisions are spatially related. The relationship is both direct and transitive through spatial

knowledge. Without geo-spatial information there can be no effective development planning.

Drawing on the material covered in the previous chapter, such as the development planning process, the nature of decision making, the general model of information use, the knowing cycle, the principle of rationality and the open systems approach, together with the nature of geo-spatial information and the spatial knowledge constructs, a Geo-spatial Information Decision-making Model has been developed. This model is an information/knowledge-centric model, emphasising the relationship between geo-spatial information, spatial knowledge and the decision-making process within the environment of the development planning process. The five main components of the model are: 1) Signals from the Environment; 2) Decision-making Process Subsystem; 3) Information Cognitive Subsystem; 4) Knowledge Subsystem; and 5) Technical Subsystem. These main components are linked to four other components, namely, a) Environment (internal and external); b) Community/Societal Problems or Opportunities, resulting in development needs; c) Implementation; and d) Monitoring.

Having established the relationship between the development planning process and geo-spatial information, the next chapter turns to developing an understanding of map literacy.

CHAPTER 4

MAP LITERACY

4.1 Introduction

The role that geo-spatial information plays in the development planning process has been established in Chapter 3, where it is deduced that without geo-spatial information there can be no effective development planning. The process can, however, only be effective if the geo-spatial information is relevant to the purpose and is used by the decision maker or development planner. To use the geo-spatial information the user (decision maker, development planner or associated professional) must interpret, process, understand and comprehend the information received. To achieve this the user will require competence in these areas.

Geo-spatial information (particularly depicted on a map) is largely a visual form of information, that is, the information is portrayed using a particular system of codes and conventions. It could then be said that this is similar to the written natural language. Natural language literacy (commonly referred to just as literacy) is commonly regarded as competence in written natural language. Could it then be said that to be competent to use a map requires the user to be map literate? But what is map literacy?

First it is be necessary to define what is meant by literacy and then to establish whether there is a relationship between the written natural language and the map language (cartographic language).

4.2 The Meaning of Literacy

Literacy is generally understood to mean the ability to read and write, or more fully, “the capacity to recognise, reproduce and manipulate the conventions of text" (Anon., 2002). Literacy is generally taught in the home and at school, but it is difficult to measure literacy, or to clearly state who is literate and who is not (McArthur, 1992). It is assumed that a school learner, on the achievement of a particular grade in a language, will be literate. This is not always guaranteed, however, as it is shown that even in developed countries, a significant percentage of school-leaving learners do not meet modern standards of functional literacy (Leseman, 1994:164). A person deemed not to be literate, that is, lacking knowledge of written language, is said to be illiterate (Verhoeven, 1994: 3).

Because of the difficulties of understanding what is meant by literacy, a more practical approach has been adopted, and reference is rather made to functional literacy. In the 1960s UNESCO used the term ‘functional literacy’ to mean “the process and content of learning to read and write to the preparation for work and vocational training, as well as a means of increasing the productivity of the individual” (Verhoeven, 1994:6). The Organisation for Economic Cooperation

and Development defines functional literacy as a person being "able to understand and employ printed information in daily life, at home, at work and in the community" (National Literacy Trust, 2002).

Functional literacy is relevant to the development of communities and to national economic growth. "The inability to read and write not only prevents people from functioning fully within their communities, but also exerts an influence on national priorities and the use of human and material resources" (McArthur, 1992). According to UNESCO, the highest occurrence of illiterate people, up to 95%, live in developing countries (Verhoeven, 1994: 4). Taking this figure together with the observation that "there is a high correlation between illiteracy on the one hand, and poverty and infant mortality on the other" (Verhoeven, 1994: 4) shows that functional literacy must be a priority for the development of communities.

Functional literacy has been linked to communicative competence and we can use the latter to help us understand the former (Verhoeven, 1994:8; Levine, 1994:122). On the basis of the theoretical framework of communicative competence, Verhoeven (1994:9-11) proposes a construct of functional literacy consisting of grammatical competence, discourse competence, (de)coding competence, strategic competence and socio-linguistic competence, each consisting of various abilities, as shown in Figure 4.1 below. This construct begins to operationalise educational objectives in functional literacy.

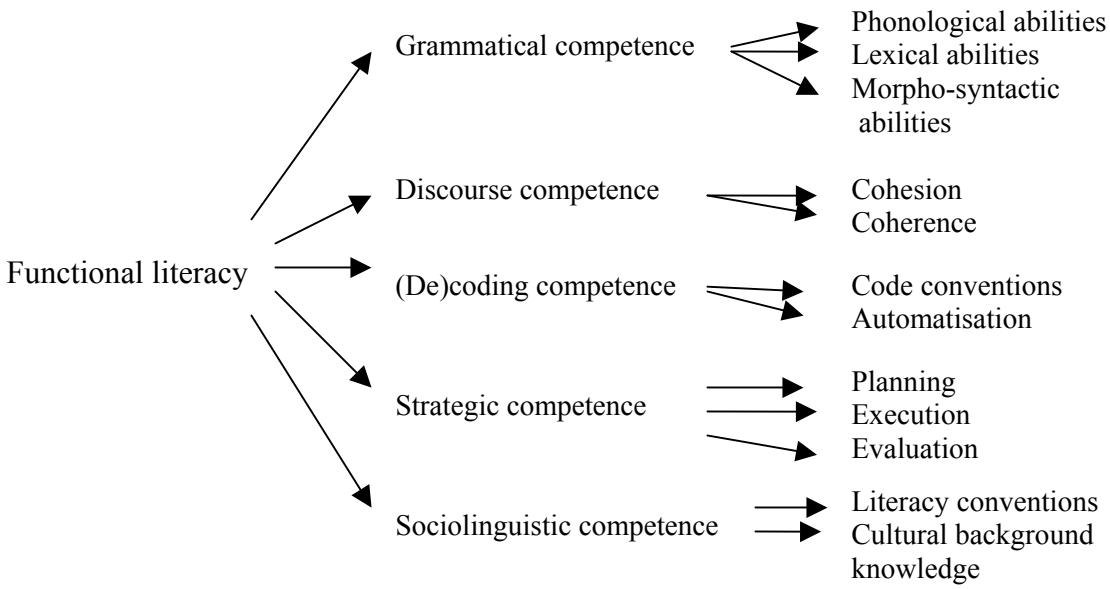


Figure 4.1 The construct of functional literacy (Verhoeven, 1994:9)

Grammatical and discourse competence covers the fundamental rules of word and sentence formation and organization – constituting the basic components of functional literacy. The phonological abilities refer to the link between the oral and written language. Lexical abilities indicate the vocabulary or the words and their meanings (semantics) of the language, while the syntax gives the grammatical rules. In order to learn to read and write successfully requires a minimum level of grammatical and discourse competence. According to Verhoeven (1994:10), people acquiring literacy in a second language are faced with the dual task of learning the code and the grammatical and discourse competence. This would be relevant to acquiring map literacy as it would not be a 'first language'.

Coding and decoding competence is more technical and refers to the abilities related to understanding the language code itself. Knowledge of the code conventions of the language is required. The complexity of the codes, the number of codes in the language and the degree of learnability of the code will have an impact on literacy abilities. Likewise, the degree of automation in the coding and decoding process will impact on the efficiency of literacy. The greater the complexity and the larger the number of codes, the more difficult the language will be to use. Automation will require a high level of consistency and a low level of ambiguity in the code.

Strategic competence refers to the meta-cognitive abilities "to perform planning, execution and evaluative functions to implement the communicative goal of the written text" (Verhoeven, 1994:9-10). A certain level of numeracy skills is required with respect to the strategic abilities involved in literacy tasks. These include the basic numeric operators of addition, subtraction and comparison.

Sociolinguistic competence is "related to the mastery of socio-cultural conventions within varying social contexts". It comprises "the literacy conventions which are appropriate in a given culture and in varying social situations, and a mass of cultural knowledge, including knowledge of the power structure in a given society" (Verhoeven, 1994:8-9). The literacy conventions refer to types of documents that are used in the social institutions of a society –

letters, forms, legal briefs, political tracts, novels, poems and religious texts. Cultural-specific knowledge is required to interpret and use such documents, as they may vary from one culture to another. In a multi-cultural democratic society, such as South Africa, it is usual that a dominant written language (and code) will be used in societal institutions, while the right to use other languages is still recognised. The 'official' language may not be a person's mother-tongue language, which will make literacy in that language difficult. The result will be different levels of literacy for the person's different languages.

Research since the 1970s has considered the "relationship between words and their meaning and towards the mental processes involved in reading …. Reading was now considered as a form of information processing" (Noordman and Vonk, 1994:77). The reading process, considered to be a complex skill, was broken down into a number of sub-processes, ultimately arriving at a cognitive representation of what the writer intended to communicate. A large amount of inferring is required for an adequate understanding of a text. It can be deduced that the ability to make inferences is an important component of reading. Inference tests may then be a better means of measuring reading abilities (Noordman and Vonk, 1994:82). The ability to make inferences from reading depends on a number of factors, one of which is prior knowledge. The ability to make inferences can vary from person to person and from situation to situation, making it difficult to know what information may be left implicit and which must be explicit.

In the context of this research the reading ability in literacy is of greater relevance than writing, as the first stage of map use is map reading. Writing is equivalent to the encoding of map information or the map-making task undertaken by the cartographer. Educational objectives for reading according to Bloom (in Pumfrey (1977:129)), can be categorised as successive stages, of increasing complexity, in the development of a person's understanding and competence in an area of knowledge (cognitive domain) and in the growth of emotional involvement in a given area (affective domain) as follows:

Cognitive domain:	Affective domain:
1. Knowledge	1. Receiving
2. Comprehension	2. Responding
3. Application	3. Valuing
4. Analysis	4. Organising
5. Synthesis	5. Characterisation by a value or a value complex
6. Evaluation	

Taking this to the next level for the effective use of reading tests, Pumfrey (1977:131-134) refers to the Barrett Taxonomy of the cognitive and affective dimensions of reading comprehension, namely:

- Literal comprehension: focuses on ideas and information which are explicitly stated. The following tasks may be relevant:
  - Recognition: locating and identifying ideas or information explicitly stated, and includes the following recognition tasks:
    - Recognition of details: locate or identify facts;
    - Recognition of main ideas: locate or identify an explicit statement which is the main idea;
    - Recognition of a sequence: locate or identify the order of incidents or actions explicitly stated;
    - Recognition of comparison: locate or identify likenesses and differences in characters, times, and places that are explicitly stated;
    - Recognition of cause and effect relationships: locate or identify the explicitly stated reasons for certain happenings or actions;
    - Recognition of character traits: locate or identify explicit statements about a character which helps to describe the type.
  - Recall: produce from memory ideas and information explicitly stated, including the following recall tasks:
    - Recall of details: producing facts from memory;
    - Recall of main ideas: state a main idea from memory, when the main idea is explicitly stated;
    - Recall of a sequence: provide from memory the order of incidents or actions explicitly stated;

- Recall of comparison: produce from memory the likenesses and differences in characters, times, and places that are explicitly stated;
- Recall of cause and effect relationships: produce from memory the explicitly stated reasons for certain happenings or actions;
- Recall of character traits: call up from memory explicit statements about characteristics which illustrates the type.

- Reorganisation: requires the analysis, synthesis and/or organization of ideas or information explicitly stated. Reorganisation tasks are:
  - Classifying: place people, things, places, events etc. into categories;
  - Outlining: organize into outline form using direct statements or paraphrased statements;
  - Summarising: condense using direct or paraphrased statements;
  - Synthesising: consolidate explicit ideas or information from more than one source.
- Inferential comprehension: the use of ideas and information explicitly stated, intuition, and personal experience as a basis for conjectures and hypotheses. Inferences may be convergent or divergent in nature. Inferential comprehension demands thinking and imagination that goes beyond the printed page. The following tasks may occur:
  - Inferring supporting details: extrapolate additional facts which might have been included and would have made it more informative, interesting or appealing;

- Inferring main ideas: provide the main idea, general significance, theme, or moral which is not explicitly stated;
- Inferring sequence: conjecture as to what action or incident might have taken place between two explicitly stated actions or incidents, or hypothesise about what would happen next if it continued and did not end as it did;
- Inferring comparisons: infer likenesses and differences in characters, times, or places;
- Inferring cause and effect relationships: hypothesise about the motivations of characters and their interactions with time and place, or conjecture about the reason for including certain ideas, words, characterisations or actions;
- Inferring character traits: hypothesise about the nature of characters on the basis of explicit clues presented;
- Predicting outcomes: conjecture about the outcomes based on an initial portion of a reading;
- Interpreting figurative language: infer literal meanings from the figurative use of language.

▪ Evaluation: deals with judgment and focuses on qualities of accuracy, acceptability, desirability, worth, or probability of occurrence. The ability to make an evaluative judgment by comparing ideas presented with external criteria from various sources, or with internal criteria provided by the

person's experience, knowledge or values. Evaluative thinking may be demonstrated by:

- Judgments of reality or fantasy: from experience answer the question 'could this really happen?';
- Judgments of fact or opinion: analyse and evaluate the writing on the basis of the knowledge the person has on the subject as well as analysing and evaluating the intent of the author. Does the author provide adequate support for his/her conclusions?;
- Judgments of adequacy and validity: comparing written sources of information, with the purpose of determining agreement or disagreement, and completeness or incompleteness. Is the current information in keeping with existing knowledge of the subject?;
- Judgment of appropriateness: make a judgment about the relative adequacy of different parts of the text for answering a question;
- Judgments of worth, desirability and acceptability: calls for judgments based on the reader's moral code or his/her value system – was the action right or wrong? Was the behaviour good or bad?;

▪ Appreciation: involves all the cognitive dimensions of reading referred to above, and deals with the psychological and aesthetic impact on the reader. Appreciation includes both the knowledge of and the emotional response to literary techniques, forms, styles and structures:

- Emotional response to the content: verbalise the reader's feelings about the text in terms of interest, excitement, boredom, fear, hate, amusement, etc. – the emotional impact;
- Identification with characters or incidents: demonstrate sensitivity to, sympathy for, and empathy with characters and happenings portrayed;
- Reactions to the author' use of language: response to the author's craftsmanship in terms of semantic dimensions of the selection of words (connotations and denotations);
- Imagery: verbalise feelings about the author's artistic ability to paint word pictures which cause the reader to visualise, smell, taste, hear or feel.

Leseman (1994:167) uses the information processing approach to reading and interpretation of text and gives the general component tasks as:

"a. Processes of perceiving, recognising and interpreting visual stimuli;

b. Processes of decoding the perceived visual patterns in mentally represented linguistic signs, corresponding with the phonemes of the language;

c. Processes of word recognition and lexical interpretation;

d. Processes of parsing a sentence into its meaning constituents, combining these constituents to form mental propositions that express the meaning of these sentences and connecting/integrating propositions expressed in several subsequent sentences to establish a local coherence of meaning;

e. Processes of forming a sort of macro-proposition or ….. generating a 'text-model', expressing the content, the 'message', of the text and the situation or 'possible world' in which this message makes sense."

Leseman's information processes make the assumption that reading comprehension starts with elementary, technical processes related, in part, to the language and its writing system, and progresses to complex cognitive processes of a more general nature. It also assumes that the lower level processes function in a highly automated manner to make the higher level comprehension processes possible.

A structure for objectively understanding functional literacy can be extracted from the above models. Leseman (1994:168) suggests that several levels of difficulty can be distinguished in reading and writing, using the written language processing theory as a guideline. The easiest level of literacy would involve the reading and writing of very short texts that are almost void of linguistic meaning, such as a person's name and address or a shopping list. At this level very few different lexical items are involved and are probably common knowledge. Also, the syntax applied is very simple, and the semantic and pragmatic meaning is given explicitly without requiring the generation of complex inferences or abstract mental models. This level refers to the first two (a. and b.) processes given by Leseman's information processing tasks above. The most difficult level of literacy would concern texts that require complex inferential reasoning processes and

technical and propositional processing to establish a logically coherent mental model. This level may also require specialized knowledge of specific text-genre conventions.

The level of literacy, and functional literacy, is a continuum between the lowest and highest level. Most often the comparison between the level of functional literacy of two persons is expressed in relative terms, that is the functional literacy of one person is more than, or less than that of another person. This does not assist in determining whether or not a person is functionally literate according to accepted development standards or norms. It is also not practical to measure functional literacy on a continuum but rather at discrete intervals or levels. For this purpose we must provide specific measures from which functional literacy can be established. In Britain, the Basic Skills Standards of the Basic Skills Agency (Life Long Learning, 2002) measure literacy at three levels, namely *Entry*, *Level 1* and *Level 2*. To be classified at a particular level requires the person to demonstrate a consistent performance of at least 80% at that level.

Based on these skills levels it is said that a person is functionally literate if they attain Level 1, and is functionally numerate if they attain the Entry level (Life Long Learning, 2002). Achieving the functional level does not mean that adults will not experience difficulties in certain areas, but once they reach the functional level they achieve a 'take-off' point from which to access mainstream education or vocational training (Life Long Learning, 2002).

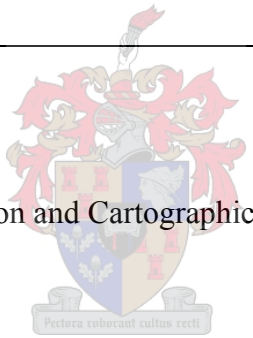
The following skills in the reading skills standards and numeracy skills standards are of particular interest for map literacy as they use visual information:

Table 4.1 Selected Reading and Numeracy Skills Standards (Life Long Learning, 2002)

Reading skill : Read and understand graphical material such as tables, signs, charts, labels, plans, maps etc.		
Skill standard :		
Entry level	Level 1	Level 2
Get the main idea from a simple source (e.g. safety signs with a single message). Find specific pieces of information from simple tables (no more than 2 variables).	Understand and act on a graphical source up to one page long (e.g. a town map, price list, sign with multiple messages). Find information from complex tables, with at least 2 variables and with additional sources/keys.	Select material from more than one graphical source (e.g. complex tables, plans).

Reading skill : Use reference systems such as filing systems, libraries, databases.		
Skill standard :		
Entry level	Level 1	Level 2
Use a simple list	Consult a reference source to obtain simple information	Use a reference source to find specific information. Organise material into a given reference system – alphabetical, numerical, or date order and use the system created.

Numeracy skill : Calculate lengths, areas, weights or volumes accurately using appropriate tools, e.g. rulers, calculators etc.		
Skill standard :		
Entry level	Level 1	Level 2
Simple calculations on familiar items in either metric or imperial units, e.g. calculating areas of rectangles from lengths in the same whole unit.	Calculations on items of unfamiliar or irregular shape in either metric or imperial units.	Calculations on items of complex or composite shape, use scale drawings, convert between metric and imperial units.



4.3 Cartographic Communication and Cartographic Language

The above discussion on literacy, or functional literacy, provides a good platform from which to discuss map literacy, or functional map literacy. But what is the link between the two? If literacy is about written natural language then map literacy must be about the map (cartographic) language.

Cartographic epistemology has, particularly from the latter 1970s, been discussing cartographic communication and the cartographic language (Head, 1999:15 –16). There have been two main areas of focus, namely carto-semiotics and carto-linguistics, drawing from studies in semiotics and linguistics respectively. The

carto-semiotic school has been more technical, considering the sign system in particular, while the carto-linguistic school has considered language construction and how meaning is derived. Head (1999:17), however, is of the opinion that there is no real distinction between the schools of thought as most authors appear to make little or no distinction between the two or incorporate concepts from both. There is an underlying concept to most of the approaches taken, and that is the concept of information processing (Eastman, 1985:96). This ties in well with the approach taken in this research.

The cartographic communication model is based on the classic general communication model of:

SOURCE → ENCODER → CHANNEL → DECODER → RECIPIENT

Although numerous authors have written about cartographic communication, the most widely accepted cartographic communication model put forward is that of Kolacny (1969:47–49) as follows:

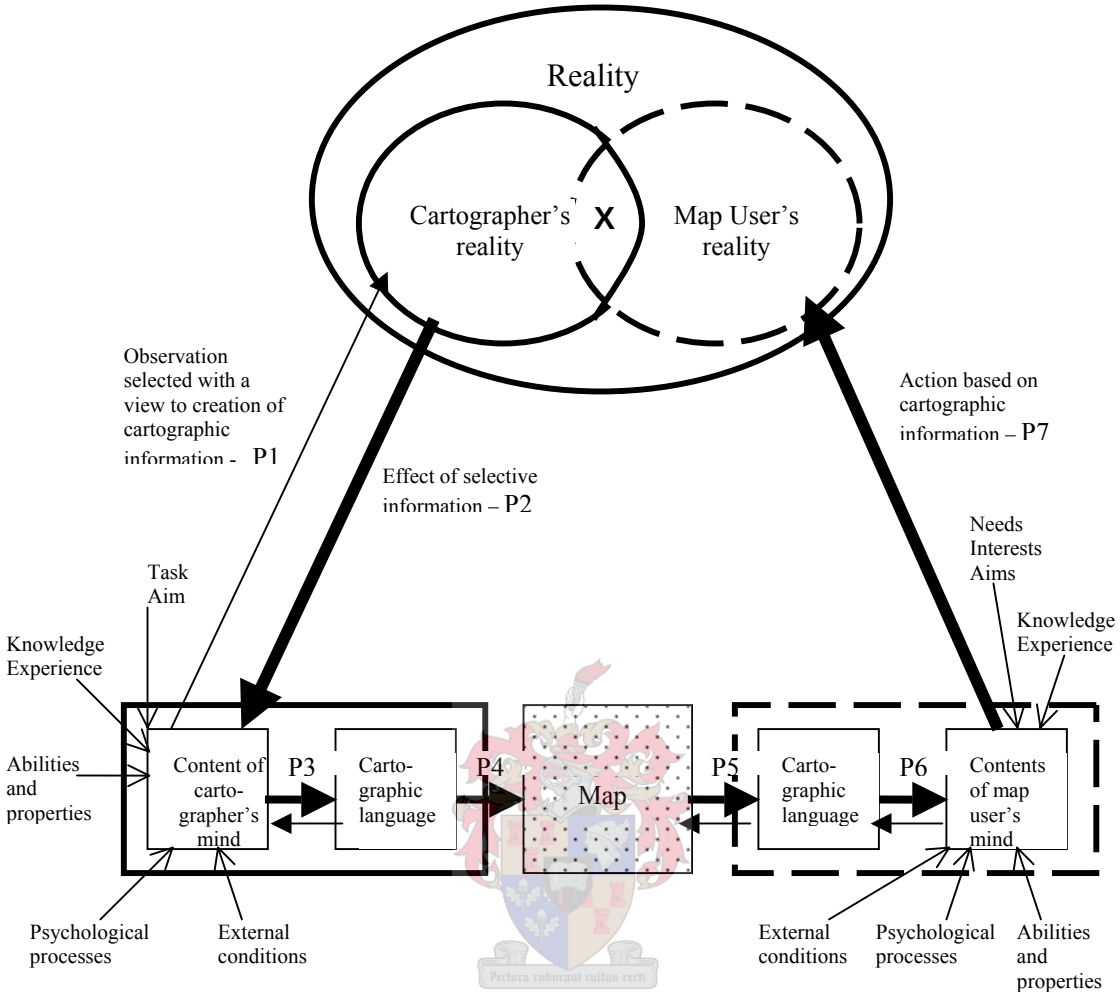


Figure 4.2 Cartographic Communication Model (from Kolacny (1969:48))

A simplified description of the cartographic communication process from this model is as follows:

P1: The cartographer observes reality (the universe) to form an image of reality, but is influenced by factors such as the task or aim of the observation, knowledge, experience and abilities, psychological factors and external conditions. These factors introduce bias within the cartographer, which

results in selective observation when forming the cartographer's view of reality;

P2: The cartographer receives the selective information, which is a multi-dimensional intellectual model of reality – and not reality itself;

P3: The cartographer transforms the intellectual model of reality into cartographic information, using the cartographic language;

P4: The cartographer creates a representation, using symbols, of the intellectual form of the cartographic language (encoding) – the map is produced. In this way the cartographic information is rendered accessible to perception by human senses;

P5: The user reads or senses the map which produces an informative effect on the user. Using the cartographic language (decoding) the user creates cartographic information;

P6: The cartographic information interacts with the user's knowledge and experience of reality to form a multi-dimensional model of reality (the user's). The formation of this model is further influenced by the needs, interests and aims of the user, the user's abilities and psychological state, and external conditions;

P7: The user's enriched model of reality provides the knowledge and experience from which the user can now act.

The objective of cartographic communication is to provide the user with a model, or knowledge of reality, which coincides with the relevant part of reality (the

universe) which the user requires, if not the whole reality. If the cartographer has understood the task perfectly, and the user has the requisite knowledge, experience and abilities, and there has been no cartographic 'noise' in the process, then the cartographer's reality and the user's reality will coincide – that is, 'X' is maximised. What must be avoided is that the user's model of reality includes co-missions, that is, the user's reality includes what is not part of actual reality.

The cartographic communication model can be compared with the sense-making and Information needs components of the Information Cognitive Subsystem of the Geo-spatial Information Decision-making Model (see Chapter 3).

The earlier communication paradigm has been criticised for being limited by focusing on how cartographers represent the universe, with the objective of improving map design (MacEachren, 1995:14, 23). That is, cartographers were inward looking and did not consider the other half of the equation, namely the map user. It is clear, however, from Kolacny's model above that the user's internal (private) space is taken into account, particularly in process P6. This translates into the user's public space when the knowledge and new experience are used – process P7.

Cartographic information is central to this process, with the cartographic language being an essential transformer, as is natural language in literacy. It can be

concluded then that the map user must have knowledge of, and abilities in, the cartographic language.

MacEachren (1995:12-14) considers cartographic representation at three levels, namely, the lexical, the functional and the cognitive. The lexical approach deals with how symbols achieve their meaning. Harley (1989:7-13) calls for the lexical approach to consider both the implicit meaning and the power inherent in maps as well as their explicit meaning. The functional approach takes the view of symbolism as anything that can carry meaning – the concepts of semiotics. In contrast to the lexical and functional approaches, the cognitive approach looks to the individual, and is concerned with facts and hypotheses about the acquisition and use of symbols in virtually every aspect of life.

The lexical and functional approaches to cartographic representation can be used to draw parallels in the natural language. From the lexical approach, a study can be made of the syntactics, semantics and pragmatics of the cartographic language. Semiotics can be applied to both natural language and cartographic language - where both use signs.

Semiotics is the study of signs, where a 'sign' is regarded as the relationship between an expression (e.g. a map symbol) and its concept (e.g. the category of geographic feature to which the symbol refers) (MacEachren, 1995:213-214). The triadic model of semiotics is preferred to the dyadic model, because the triadic

model relates to the real world (the referents). In the triadic model the sign is comprised of the sign-vehicle (expression or carrier of meaning), the interpretant (the concept or meaning of the sign), and the referent (the object of reference, what the sign stands for) (MacEachren, 1995:218-219; Rod, 2004:29). The semiotic triangle devised by Ogden and Richards (referred to by MacEachren, 1995:221) gives meaning to the sign in natural language, that is, a "word (sign-vehicle) has a causal relationship to a thought (interpretant), which in turn refers to a thing (referent). The 'stand-for' relationship between the word and the thing is depicted as less direct than that between interpretant and either sign-vehicle or referent. The word is thus portrayed as linking the thing, primarily through thought or concept (rather than the concept linking to the thing through the word)."

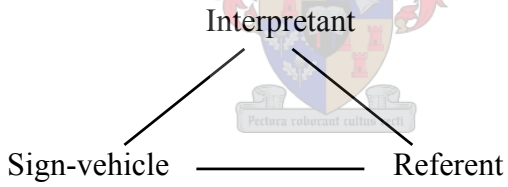


Figure 4.3 Ogden-Richards Semiotic Triangle

The Ogden-Richards semiotic triangle can likewise be applied to cartography, providing three semiotic relationships, namely:

Sign-vehicle ↔ Interpretant (with referent as mediator)

Sign-vehicle ↔ Referent (with interpretant as mediator)

Interpretant ↔ Referent (with sign-vehicle as mediator)

With the referent as mediator: the representation from sign-vehicle to referent to interpretant shows the link of two abstract representations, namely, physical (and usually visual) and mental, by virtue of their correspondence to the referent they both refer to. This stresses the fact that map marks are just one of many possible representations of their referent. It draws attention to the importance of considering various categories of referent.

With interpretant as mediator: the representation from sign-vehicle to intrepretant to referent puts weight on the role of map signs as a means of shared understanding between cartographer and map user. Key to this understanding is the nature of the code linking the sign-vehicle and the referent. The map mark comes under closer scrutiny.

Of particular significance is the degree of arbitrariness of the map sign, as this will affect the cartographer's assigning meaning and the map user's interpretation of meaning (Rod, 2004:30-31). Generally, the higher the level of iconicity of the sign-vehicle, the less arbitrary it is. Pictorial and associative sign-vehicles are generally of higher iconicity. Sign conventions are an attempt to reduce arbitrariness in signs through standardisation (Board, 1973:232). Signs, however, are not free from values and are also based in society and its culture, which directly and indirectly influences the meaning of the sign (MacEachren, 1995:15; Wood and Fels, 1986:56, 65). For example, cultural differences can create potential problems in the use of colour, as different cultures define the colour

spectrum differently and also associate colours differently with respect to the same phenomenon (Board, 1973:232-233; MacEachren, 1995:160, 202). Map users from different cultures could then bring different schemata to the act of map reading.

Signs can be ambiguous, also referred to as being polysemic, with two levels of meaning: firstly, the denotational level, where signs denote meaning or have explicit, conscious meaning; secondly, the connotational level, where signs connote meaning or have indirect, implicit, unconscious meaning. Signs denote via convention but connote via signification (MacEachren, 1995:230). It is at the connotational level that the map user brings together prior knowledge and experience to derive new meaning. Woods and Fels (1986:68-90) group signs into two categories of codes, namely codes of intrasignification (those which the map exploits) and codes of extrasignification (those by virtue of which the map is exploited – operating outside the map). The codes of extrasignification include the thematic, the topical, the historical, the rhetorical and the utilitarian. The codes of intrasignification are:

a) Iconic – the code of inventory, the source and principle of the map's analogy to objects, places, relations, and events;
b) Linguistic – the code of classification, of ownership (identifying, naming, assigning);
c) Tectonic – the code of space (and position) and spatial relationships;
d) Temporal – the code of time, of duration;

e) Presentational – the code of instantiations of order, arrangement, organisation.

With sign-vehicle as mediator: the representation of intrepretant to sign-vehicle to referent emphasises the role of the sign-vehicle as the link between the referent (object) and an associated meaning of that referent in a particular context, provided by a map schema. MacEachren (1995:246-250) indicates that there are two referent-intrepretant relationships that can be distinguished for which a map sign-vehicle can be mediator, namely those that apprise (apprisive sign aspects – purporting to provide attribute and/or location information about objects or concepts) and those that stimulate some reaction (stimulative sign aspect – those for which a behaviour is the primary aspect).

Rod (2004:28) indicates the link between the semiotic approach and the linguistic/lexical approach, describing:

Syntactics – studies the relation between a given sign-vehicle and the other sign vehicles;

Semantics – studies the relation between sign-vehicles and their referents;

Pragmatics – studies the relation between sign-vehicles and their interpreters.

This relationship is depicted in Figure 4.4:

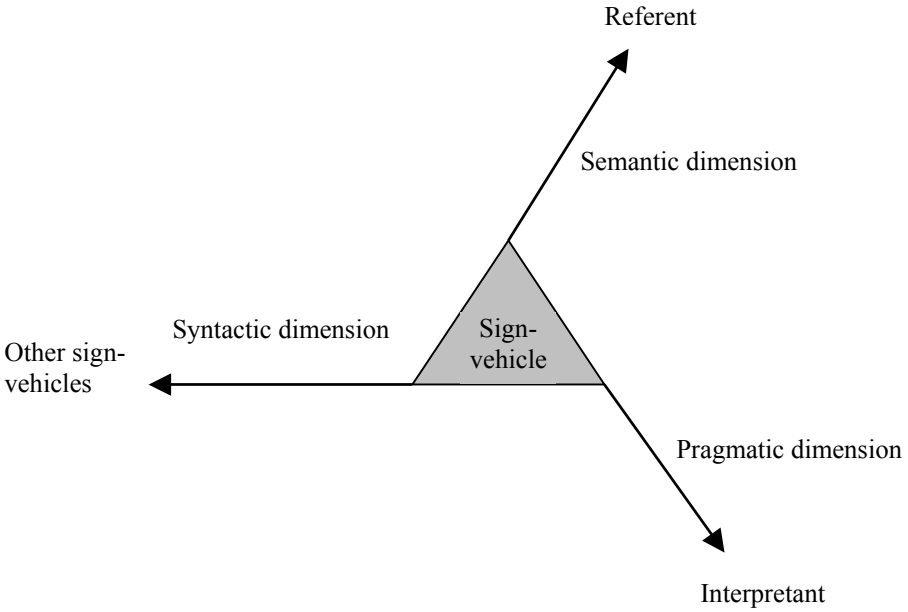


Figure 4.4 The three dimensions of linguistics and of semiotics
(Adapted from Rod, 2004:28)

Other authors confirm this link between the semiotic and linguistic approaches (Board, 1973:229-231; Bjorke, 1996:79). Syntactics (syntax) deals with the internal structure of the map symbol/mark (sign-vehicle), and how it differs from the other map symbols. As a visual sign the visual variables of shape, size, orientation, colour hue, colour brightness, pattern and dimension (point, line, area, 3-D) are important descriptors. The semantics of cartographic language deals with the ways or rules in which the signs on the map represent geographical concepts of the real world (and not the real world itself).

Head (1984:8-9) compares the cartographic language with natural language through the constructs of natural language, namely syntagmes, which are

constructed from words, which are constructed from morphemes, which are constructed from phonemes. In the cartographic language map symbols are constructed from their visual variables, but there is no smaller unit that carries meaning. The map symbol is then equivalent to the morpheme. The equivalent of 'word' is then the combination of meaningful map symbols into a geographical concept. Further spatial relationships can be likened to syntagmes, giving meaning to the concepts conveyed in the cartographic language.

Robinson and Petchenik (1976:43-44) are of the opinion that cartographic language cannot be compared with natural language. They argue that cartographic language is not ordered sequentially, as are the words in a sentence in natural language, but rather that the map symbols are ordered according to their 'place in space'. They contend that, because a map is read randomly and not sequentially as in natural language, the two are not the same. As far as this researcher is concerned, map reading is not as random as Robinson and Petchenik make out, because there is a sequence to the order of map symbols, which depicts the spatial relationship to other map symbols to conceptualise geographical reality. There is also a sufficient amount of similarity between cartographic language and natural language to reject the argument of Robinson and Petchenik for the purpose of this research.

The discussion on the semiotic and the linguistic/lexical approaches of cartographic language indicates sufficient similarity to the semiotics and

linguistics of natural language. Through this comparison it can be stated that the concepts of natural language can be applied to cartographic language. We can therefore apply the concepts of literacy and functional literacy as applied to natural language to map literacy and functional map literacy.

4.4 The Meaning of Map Literacy

What is meant by map literacy? How is map literacy determined? These are not easy questions to answer, mainly because map literacy is not well defined.

Balchin (1976:33-34) introduced the term 'graphicacy', which according to him is the 'fourth ace', the other three being literacy, numeracy and articulacy. Graphicacy can be viewed as an understanding of graphs - this includes a map. So graphicacy includes the understanding of a map. If graphicacy is related to literacy, then it is possible to say that map literacy is related to literacy. To help us understand map literacy we can therefore draw from the understanding of literacy.

Head (1984:5) argues that map reading "fits comfortably into the information processing model of the reading of printed text … Map reading, like all reading, then, is cognitive." The studies into reading can therefore be applied to map reading. There is, however, some difference in that the very nature of maps means that information is not sequenced as in text, and cartographic semantics are far from standardised (Head, 1984:7).

There is very little research on map literacy itself. What research there is has focused mostly on the understanding of children's developmental behaviour and on map-reading tasks associated with improving map design. Researchers have recognised the role of the map user and extended their concept of cartographic communication to include the "representations of phenomena in space that a user may draw upon as a source of information or an aid to decision making and behaviour in space" (MacEachren, 1995:12). This tended to be based mainly on the concept of spatial information processing. However, most research into map design and the efficacy of maps has made assumptions about the competence of research subjects in map use, based on their schooling level or claimed experience with maps. That is, the level of map literacy was assumed and not empirically measured. There appears to be little evidence that the level of map literacy of research subjects was ever established. Nonetheless, this research can be used to better understand what is meant by map literacy.

The prior knowledge and the abilities of the map user influence the efficiency and success rate of the map user in reading, analysing and interpreting the information from the map (Dobson, 1979:18-19; Gerber, 1984a:211; Kulhavy *et al.*, 1992:8). There must be differentiation between prior knowledge and abilities with map understanding, and domain-specific knowledge and abilities. Kulhavy *et al.* (1992:5) showed that experienced map users used conceptual schemas not related specifically to cartography or geography. This implies that during the

interpretation activity the map user requires more than an ability with maps. For example, a user can be given maps that give the soil type and rainfall information and be asked to select areas where maize can successfully be cultivated. Without prior knowledge of the requirements to successfully cultivate maize, the map user would be at a loss. Gerber (1984a:207) goes on to indicate that map users' abilities are "influenced by their visual perception of symbols, their general experience with maps, their ages and education, their cultural backgrounds, imaginations, interests and temperaments … [and] socio-economic levels". Some studies have suggested that the gender of the map user influences their map abilities as well, with males performing better than females (Rieger, 1999:128, 135-136; Gilmartin, 1982:150). Other studies have shown that gender (in itself) is not a factor in performance (Kulhavy *et al.*, 1992:8; Kitchin, 1996:285). Kitchin (1996:285) reasons that any gender differences in adults are "likely to be socially and culturally produced, greatly influenced by gender-constricting roles." A female not burdened by these gender-constricting roles performs as well as a male.

Muehrcke and Muehrcke (1978:8) breaks up map-use activities into the convenient categories of map reading, map analysis and map interpretation. Head (1984:19) refers to these three activities as "the ability of readers to understand the [cartographic] language". These categories are consistent with the research on literacy as discussed above in section 4.2. Muehrcke and Muehrcke (1978:15) identifies the initial tasks of map reading as recording visual stimuli, identification

and recognition. Meanwhile in the analysis tasks the patterns and interrelationships are discerned. This could include measurement, calculation, comparison and manipulation. According to Muehrcke and Muehrcke (1978:193), map analysis gives descriptions but not explanations or interpretations. Lastly, interpretation makes sense of, or gives meaning to, the relationships and patterns and involves inferring. This implies that the user is drawing on prior knowledge and experience. There is a natural order in these activities, not only in the sequencing but also in the levels of task difficulty.

Board (1978:6-8) grouped the main map reading tasks under *navigation*, *measurement* and *visualisation* as follows:

Table 4.2 Main Map Reading Tasks (Board, 1978:6-8)

Navigation	*Measurement*	*Visualisation*
Search	Search	Search
Identify and locate own position on map	Identify	Identify
Orient map	Count	Describe
Search for optimum route on map	Compare	Compare
Search for landmarks en route	Contrast	Contrast
Recognise landmarks on route	Estimate	Discriminate
Search for destination	Interpolate	Delimit
Identify destination	Measure	Verify
Verify		Generalise
		Prefer
		Like

Morrison (1978:105-107), drawing on the earlier work of Board, offered an alternative arrangement of map reading tasks, indicating that often the more complex tasks are composed of combinations of the more elementary tasks:

Pre-map reading tasks:

Obtain, unfold, etc.

Orient

Detection, Discrimination, and Recognition Tasks:

Search

Locate

Identify

Delimit

Verify

Estimation Tasks:

Count

Compare or contrast

Measurement

a) direct estimation

b) indirect estimation

Attitudes on Map Style:

Pleasantness

Preference, etc.

Some tasks require other tasks to have been completed first (prerequisite tasks). For example, the estimation tasks require that objects have first been searched for, located and identified (Morrison, 1978:106).

Head (1984:12) considers the map-reading tasks as being divided into the broad categories of 'measurement' and 'visualisation'. Measurement is assisted by visualisation and often requires the use of aids (e.g. scale ruler, protractor). "The map-use types that rely upon natural language methods may be considered as a) landscape visualisation, b) navigation, and c) interpretation for place and space" (Head, 1984:12). The important difference here is in the meaning of 'place' and 'space'. 'Place' is used in the context of location or 'being in place', while 'space' involves identifying spatial forms and patterns or 'knowing about space' (Head, 1984:14-15). The latter would then be at a more complex level than the former. Gerber (1984b:98-99) supports this broad categorisation in establishing that competence in cartographic language consists of two components, namely, identification and comprehension. Identification is the simpler of the two. He breaks comprehension down into four hierarchically ordered elements:

- "knowledge of the sign in context (i.e. on the map);
- knowledge of the sign out of context (i.e. in a separate legend);
- understanding of the concept represented by the sign; and,
- the ability to make inferences using the knowledge from the sign."

The above implies that the map user must have the ability of identification to produce comprehension.

Olson (1976:152) organised map reading tasks into three levels of increasing difficulty:

Level 1 – "involves comparison of the characteristics of individual symbols: shape, relative size, importance, and so on";

Level 2 – "recognising properties of symbol groups on the map as a whole: spatial pattern, likeness to other map patterns, etc". The tasks are more complex, but still deal with abstract symbols. "Symbol-referent relationships are not involved but rather relationships within or among whole sets of symbols";

Level 3 – "using the map as a decision-making or content-knowledge-building device through integration of the symbols with other information. At this level the symbol-referent relationship is directly involved and the symbols themselves are important only insofar as they represent phenomena and their spatial characteristics."

Board (1984:85-86) confirms Olson's hierarchy of map reading tasks in the context of the needs of geography. The Level-3 tasks are considered necessary in geography, particularly because the 'map is not an end in itself". He summarises the main geographical questions as "questions involving location and extent,

distribution and pattern, spatial associations, spatial interactions and spatial change" (Board, 1984:86).

Head (1984:15) relates his concept of 'interpretation of place' as being equivalent to Olson's level 1, and 'interpretation of space' as being equivalent to Olson's level 2 and higher. Level 2 will then require the construction of mental models and visualisation.

It has been shown above that map literacy can be regarded as being similar to literacy. Map literacy though, like literacy, is conceptual and difficult to express in practical terms. We therefore turn to the use of functional map literacy.

Drawing from the studies of functional literacy and the understanding of maps (the cartographic language) the following definition of functional map literacy is proposed:

Functional map literacy is the ability to understand and use maps in daily life, for work and in the community.

Functional map literacy forms part of a person's fundamental life skills, together with literacy, articulacy and numeracy, to fulfil basic needs of survival and socio-economic well-being. Being functionally map literate places a person at an

advantage over a person who is functionally map illiterate, by empowering them with knowledge that is otherwise not accessible.

4.5 Measuring Functional Map Literacy

In the broadest context we can understand functional map literacy as consisting of the following components:

- Knowledge
- Comprehension
- Application
- Analysis
- Synthesis
- Evaluation.

These components can be described by the following tasks (in no particular order):

- recognition (searching, locating and identifying);
- orient map;
- recall (from memory);
- detect;
- reorganisation (classify, outline, summarise, generalise, synthesise);

- estimation (count, calculate, compare, measure, interpolate, delimit);
- inferential comprehension (including prediction and interpretation);
- evaluation (including judgment);
- appreciation;
- decoding the perceived visual patterns;
- symbol group recognition and lexical interpretation;
- parsing a spatial relationship into its meaning constituents and establishing a local coherence of meaning;
- compare;
- describe;
- contrast;
- discriminate;
- forming the spatial mental-model or message.

This list is by no means exhaustive.

It is obvious that these tasks require different levels of skill. Also, the same task can be performed at different skill levels depending on the application. It is also obvious that there are cases where a particular task requires the completion of another task – a prerequisite or elementary task – such as ‘detect’ or ‘recognise’. A more complex task can consist of two or more simpler tasks.

Functional map literacy then requires competency (albeit at varying levels) in the different map-use tasks. Taking these together with the three hierarchical levels of

Olson (1976:152) and that of the BSA (Life Long Learning, 2002), we can arrange them in levels of difficulty. In this way it will be possible to determine the different levels of functional map literacy. A three-skills level is proposed Table 4.3.

Table 4.3 Functional Map Literacy Skill Levels

Functional map literacy skill:		
Entry level	**Level 1**	**Level 2**
Get the main idea from a single or simple symbol (search, locate, identify, compare a single symbol). Simple estimation (measure, calculate, relative size) on familiar symbols.	Recognising properties of symbol groups on the map as a whole and analysing spatial patterns (more complex recognition, reorganisation, decoding, detection, comparing, discriminating, contrasting). More complex estimation.	More complex tasks leading to understanding the meaning of spatial phenomena for knowledge enhancement. At this level inferential reasoning is used from the spatial relationships, patterns and map phenomena of one or more referents or source. Higher-order mental models are constructed. The user draws on domain specific knowledge.

These three levels can be thought of as equating to Muehrcke's (1978:8) three main activities of map reading, map analysis and map interpretation, respectively.

It will be possible to test competency at each of these levels. To be competent at a level will require an average rating of at least 80% (see the requirement of BSA). Competency at the levels is cumulative, i.e. to achieve competency at Level 1 assumes competency at the Entry level, and likewise competency at Level 2 assumes competency at Level 1.

Guided by the BSA definition on functional literacy, it is proposed that:

A person is functionally map literate if the person is competent at Level 1 (the second level) of the functional map literacy skill.

To be able to function adequately the map user will be required to do more than simply identify a single symbol or measure a single distance. They will have to recognise patterns of symbols, perform spatial operations and to understand the cartographic language. This cannot be expected from every person, but professionals working in a development environment should achieve competency at Level 2 (the third level).

4.6 Testing of Functional Map Literacy

A test has been prepared by this researcher to enable competence in functional map literacy to be measured. The test is based on the tasks of functional map

literacy and the three skill levels given above. This test quantitatively measures a map user's competence level in functional map literacy.

The following 18 map-use tasks are tested (the skill level is given under the map-use task in the sequence of Entry level, Level 1 and Level 2):

Table 4.4 Eighteen Map-use Tasks

a) **Identify a symbol(s)**
Identify a single symbol on the map, with its characteristics (size, shape, colour, orientation, etc.), using a symbol legend (that is, match it to the legend).
Identify symbol groupings and their characteristics.
Interpret the meaning/concept of the symbol; and relate the symbol to the referent phenomena (in the real world); and infer knowledge from the symbol.

b) **Search for a particular symbol(s)**
Given a single symbol, locate an occurrence of this symbol on the map (that is, find it on the map).
Locate a grouping of symbols, or associated but not identical symbols on the map.
Search for the location of an occurrence of a real-world phenomenon on the map.

c) **Discriminate between different symbols**
Discriminate between two colour/pattern areas on a thematic map (e.g. different soil types on a soil map).
Discriminate between colours/patterns on a multi-phenomena thematic map (e.g. soil and rainfall and slope).
Interpret the relationship between different symbols/patterns.

d) **Describe the phenomena represented by a symbol(s) / pattern at a location**
Describe a single symbol (phenomenon) at a location (relate the representation by the symbol to the real world).
Describe a grouping of symbols (phenomena) at a location.
Describe the phenomenon at a location.

e) **Orientate a map**
Orientate the map with North at the top.
Orientate the map in a specified direction – North not at the top but at any direction.
Orientate the map so that it corresponds with the surrounding landscape.

f) **Understand the scale of a map**
Basic understanding of the meaning of scale of a map.
Full understanding of map scale. Have an appreciation of the meaning of various map scales; and use the scale bar to measure distances.
Determine the scale of a map from ground measurement or from the coordinate grid on the map; and relate information from maps of different scales.

g) **Determine direction / bearing**
Basic understanding of the meaning of direction/bearing and the cardinal (main) points of the compass.
Determine the direction between two points (e.g. point A is NW of point B, or the direction from C to D is 90° - relative to north).
Measure the direction between two points using the graticule (latitude, longitude lines) or grid.

h) **Navigate a route**
Navigate from a given start point along a simple given route.
Navigate from a given start point along a more complex given route.
Search for the optimum route between the start and end points.

i) **Describe the topography/ terrain of a location/area**
Determine elevation (height) from the contours on a map.
Analyse the topography of an area from the contours; and calculate the slope/gradient between two points.
Interpret and infer knowledge of the topography of an area (including landforms and slope).

j) **Discern/explain patterns of occurrence of phenomena**
(Not applicable at the entry level).
Analyse the occurrence (spatial location) of a phenomenon.
Explain/infer knowledge from the occurrence of phenomena.

k) **Compare the characteristics of symbols/patterns**
Make a simple comparison between two symbols/patterns from their characteristics.
Make comparisons between more complex symbols/patterns from their characteristics.
Infer knowledge from the comparison between more complex symbols/patterns from their characteristics.

l) **Interpret/infer knowledge from the spatial interrelationship of symbols/phenomena**
(Not applicable at the entry level).
Analyse/interpret the spatial relationship between adjoining or nearby symbols/phenomena (why do they occur next to each other).
Interpret/infer knowledge from the spatial relationships between symbols/phenomena in a region.

m) **Determine the coordinate/geographical position of a place on the map**
(Not applicable at the entry level).
Determine a grid square on a map using the grid locator (e.g. A6).
Determine the co-ordinate of a point from the grid (X,Y) or graticule (lat., long.) on the map.

n) **Locate a place/position on the map from its coordinates/geographical position**
Given the grid square (C5) of a point, locate its position on the map.
Given the geographical coordinate (lat., long.) of a point locate its position on the map.
Given the grid coordinate (X,Y) of a point locate its position on the map.

o) **Determine the distance between two positions**
Use the scale bar to measure the distance between two points.
Measure the distance between two points using a scale rule.
(Not applicable at Level 2).

p) **Determine the area (extent) of a region**
(Not applicable at the entry level).
Estimate the area (extent) of a region/polygon.
Calculate the area (extent) of a region/polygon.

q) **Determine the length of a linear feature**
(Not applicable at the entry level).
Estimate the length of a curvilinear symbol (line).
Measure the length of a curvilinear symbol (line).

r) **Understand the map projection**
Basic understanding of elementary characteristics of a map projection (representation of the Earth on a flat surface introduces distortions).
Understand characteristics and differences between map projections (equal area, equidistant, conformal).
High level of understanding of map projection; and transform/convert coordinates of points/lines from one projection to another.

The skill level test given above is broad-based to cater for various application environments. In applying the test these tasks should be adapted to the preferred environment by providing appropriate test maps and symbol sets.

4.7 Validating the Functional Map Literacy Test

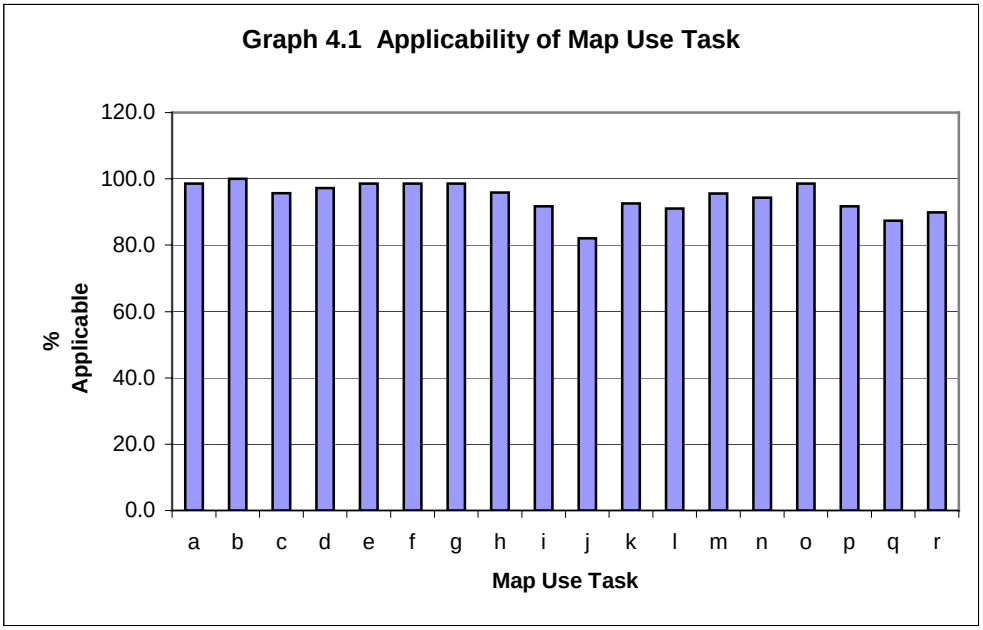
In order to validate the functional map literacy test given above, a questionnaire survey was conducted - refer to Chapter 3 (section 3.5) for details of the sample and responses, and Annexures A, B and C. The survey confirmed that the majority of the respondents are professionals working in a public sector development environment. As indicated in Chapter 3, it can be expected that the respondents have knowledge and experience of geo-spatial information. It can therefore be assumed that they are functionally map literate – although this was not measured in the survey. The conclusion is that the respondents are a reliable reference source against which to validate the test for functional map literacy.

Analysis of Responses to Map-Use Tasks and Skill Level

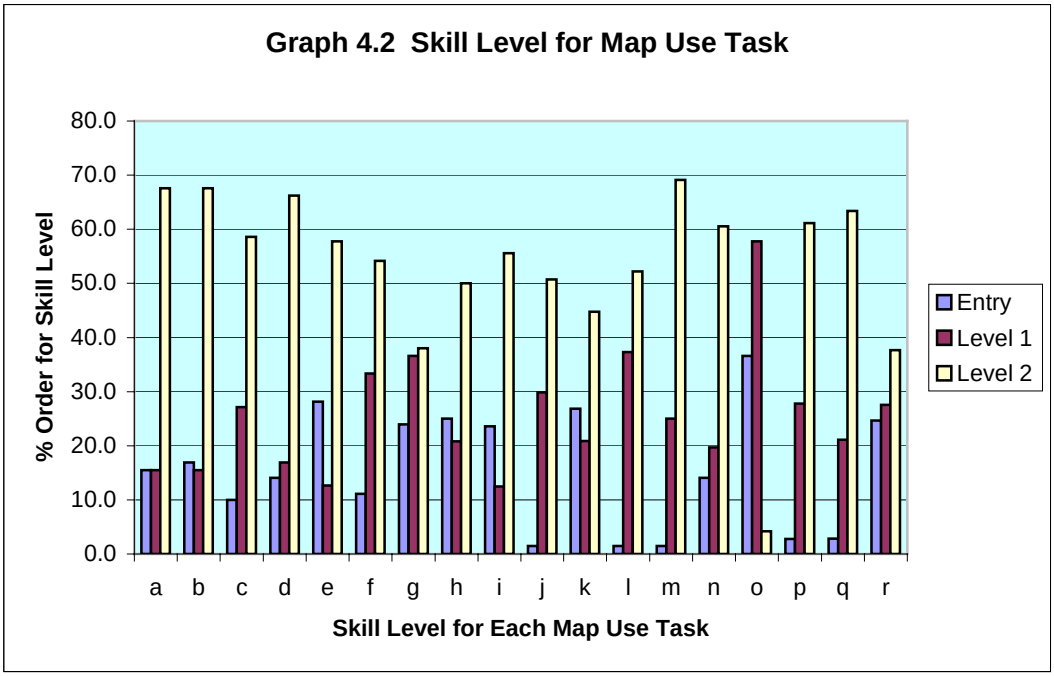
Respondents were asked to indicate the applicability of each map-use task. From the data in Annexure C, the graph below indicates the percentage of applicability for each of the 18 map-use tasks – see section 4.6 above for corresponding lettering of map-use tasks. With the exception of three map-use tasks, the map-use tasks were deemed to be more than 90% applicable. The three exceptions were map-use tasks (j): Discern/explain patterns of occurrences of phenomena – 82.1% applicable, (q): Determine the length of a linear feature – 87.3% applicable, and (r): Understand the map projection – 89.9% applicable.

Map-use task (j): Discern/explain patterns of occurrences of phenomena, is indicated in the test as not being applicable for entry-level skill as it is an advanced task requiring in-depth knowledge of the particular subject area and high levels of inferencing and pattern-recognition abilities based on spatial correlations. It is possible then that some respondents did not understand the applicability of this task. This is supported by the fact that map-use tasks (j) and (l) are similar and map-use task (l) scored 91.0% applicability. Map-use task (q): Determine the length of a linear feature, is a cartometric task, which may not be required in certain functional areas. Users of a geographic information system would have a function to perform this task with ease. Map-use task (r): Understand the map projection, is a technical task which many users would probably avoid, particularly those who are not concerned with a high level of spatial accuracy. Using spatial/map information from different maps which have differing map projections will require knowledge and skill of these map projections.

As all 18 map-use tasks are in excess of the 80% applicability level it can be concluded that all are applicable to test functional map literacy. The respondents did not indicate any additional map-use tasks that should be used.



Respondents were asked to indicate which skill level, namely Entry level, Level 1, or Level 2, as given in section 4.6 above, was deemed necessary for each map-use task in their work environment. Graph 4.2 gives the responses accordingly for each skill level as a percentage of the responses. It must be noted that not all respondents responded to all of the map-use tasks, with the average being 70 responses and the lowest being 67 responses, out of the 72 usable responses. The lack of responses is a small percentage and does not invalidate the information.



It must be noted that the following map-use tasks were given as not being applicable at the Entry level and therefore should not have received any responses for this level:

(j) Discern/explain patterns of occurrences of phenomena;

(l) Interpret/infer knowledge from the spatial interrelationship of symbols/phenomena;

(m) Determine the coordinate/geographical position of a place on the map;

(p) Determine the area (extent) of a region;

(q) Determine the length of a linear feature.

Likewise, the following map-use task was given as not being applicable at Level 2 and therefore should not have received any responses for this level:

(o) Determine the distance between two positions.

Entry-level skill in the map-use tasks was not deemed to be the highest skill level required for any of the 18 tasks. While Level 1 skill was deemed to be the highest skill level required for map-use task (o): Determine the distance between two positions, remember that this task was given as not applicable at Level 2. For the remaining 17 map-use tasks, Level 2 skill was deemed necessary.

Graph 4.3 depicts the difference between the percentage response for Level 2 skill as opposed to the next (lower) skill level of importance – data for map-use task (o) is excluded. As can be seen from the graph Level 2 skill was deemed to be the most important level by a significant number of respondents (greater than one-third more) for the following seven map-use tasks:

(a) Identify a symbol(s);

(b) Search for a particular symbol(s);

(d) Describe the phenomena represented by a symbol(s)/pattern at a location;

(m) Determine the coordinate/geographical position of a place on the map;

(n) Locate a place/position on the map from its coordinates/geographical position;

(p) Determine the area (extent) of a region;

(q) Determine the length of a linear feature.

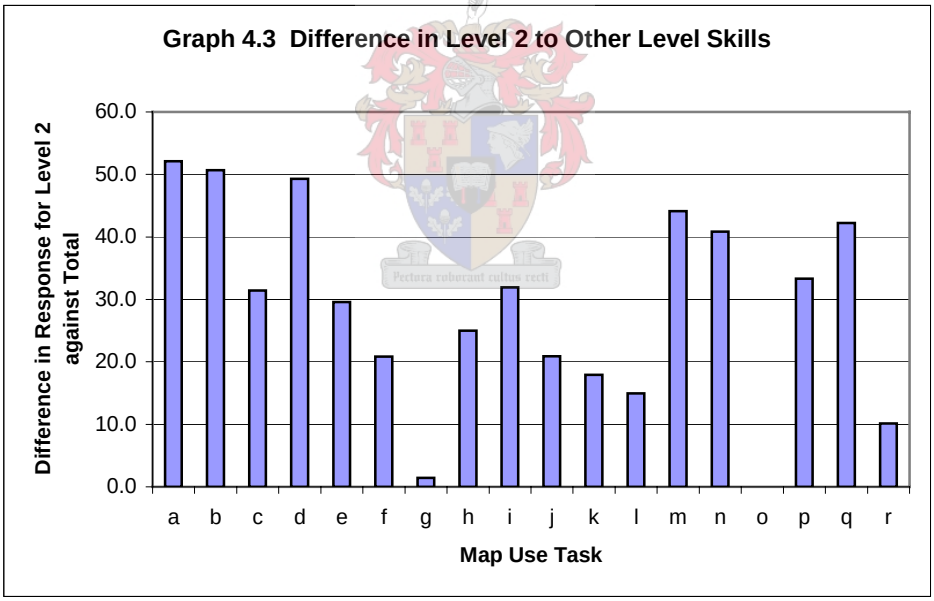
Level-2 skill is not significantly higher (difference of less than 15%) in the responses than the next level skill indicated for the following three map-use tasks:

(g) Determine direction/bearing;

(l) Interpret/infer knowledge from the spatial interrelationship of symbols/ phenomena;

(r) Understand the map projection.

For these three map-use tasks the next skill level of importance was Level 1.



It can be concluded that the respondents deemed it necessary, for their work environment, to have competence at least at skill Level 1, but preferably at skill Level 2 in the map-use tasks for functional map literacy. This confirms the

statement made in section 4.5 above that professionals working in a development environment should achieve competency at Level 2.

4.8 Summary of Chapter

The previous chapters have shown that it is necessary for development planners and communities involved in the development planning process to have good spatial performance, that is, to be competent in using maps. This requires them to be map literate. But map literacy is not a well-defined concept. This chapter turned to the understanding of literacy in natural (written) language to see if this would help to understand map literacy. One approach is to determine if there is a similarity between natural language and cartographic (map) language.

In looking at the meaning of literacy, it was found that this concept is vague and that it is more meaningful to turn to functional literacy, which is practical and applies to everyday life. The constructs of functional literacy were explored, emphasising competencies required. Reading abilities are more relevant than writing abilities in literacy for the purpose of this research and so more attention is paid to reading abilities. The reading process is likened to the information processing approach. This gives a basis to objectively understand the meaning of functional literacy and a model for assessing competence in functional literacy. This looks promising for understanding map literacy and assessing map literacy.

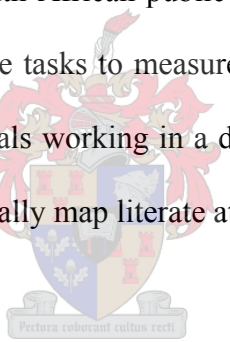
A discussion on cartographic communication and cartographic language followed to contextualise map literacy. Cartographic communication is based on the information-processing approach. It fits with the processes of the Information Cognitive Subsystem of the Geo-spatial Information Decision-making Model. Cartographic (geo-spatial) information, with the cartographic language being an essential transformer, is central to cartographic communication. The cartographic language was further explored in terms of semiotics (the study of signs), and linguistics (syntactics, semantics and pragmatics). It was found that the cartographic language can be adequately described in these terms. The natural language can be similarly described. From this comparison it was concluded that the concepts of the natural language can be applied to the cartographic language. Map literacy can therefore be based on the concepts of literacy.

The chapter then provided a meaning for map literacy, or more specifically functional map literacy. The map reading tasks were focused upon. Drawing from this discussion and the definition of functional literacy, a definition for functional map literacy was derived as the ability to understand and use maps in daily life, for work and in the community.

To further understand the concept of functional map literacy, the measurement of functional map literacy was discussed. Various tasks describing the components of functional map literacy were given. This lead to a proposed three levels of skill in functional map literacy. The levels are ordered with increasing levels of

difficulty, providing increasing competence levels. A person can now be objectively assessed to determine if they are functionally map literate, using these three skill levels. It is proposed that a person is functionally map literate if the person is competent at Level 1 (achieves 80% at the second level) of the functional map literacy skill.

Eighteen map-use tasks have been identified that can be used in the measurement of the levels of functional map literacy. These map-use tasks have been validated through the responses received from a purposive questionnaire survey conducted with professionals in the South African public sector. This survey confirmed the applicability of these map-use tasks to measure functional map literacy levels. It also confirms that professionals working in a development planning environment should preferably be functionally map literate at Level 2 (the third level).

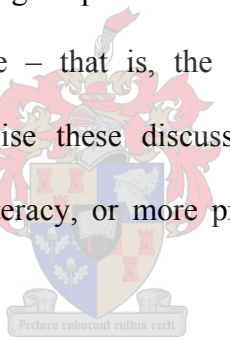


CHAPTER 5

THE IMPLICATIONS OF FUNCTIONAL MAP LITERACY FOR DEVELOPMENT PLANNING

5.1 Introduction

In the previous chapters it has been established that geo-spatial information is essential in the development planning process, in particular in decision-making, and that effective use of geo-spatial information requires competence in cartographic (map) language – that is, the user must be map literate. It is appropriate then to synthesise these discussions into conclusions about the relationship between map literacy, or more practically functional map literacy, and development planning.



It is all very well to draw conclusions about the relationship but what about the implications of this relationship in the light of the development problems discussed in Chapter 1. In the context of these implications, is the current situation with respect to functional map literacy in South Africa a matter of concern? If so, what can be done to achieve improved effective development planning and execution?

5.2 Relationship between Functional Map Literacy and Development Planning

The development planning process has been given (see Chapter 2) as a cyclical process, with the main stages being :

- community/societal problem or opportunity;
- identification of development need;
- planning goals and objectives;
- data collection and analysis;
- identify alternative courses of action;
- appraise and select course of action;
- conduct pilot project/feasibility study;
- implementation;
- monitoring and evaluation;
- capacity-/capability-building, and
- knowledge creation.

The decision-making process, consists of:

- analysis of the problem;
- development of alternative options;
- evaluation of various alternatives;
- selection of the best alternative.

The decision-making process is an integral component of the development planning process. The match between the decision-making process and the development planning process is as follows:

- analysis of the problem → planning goals and objectives
- development of alternative options → identify alternative courses of action
- evaluation of various alternatives } → appraise and select course of action
- selection of the best alternative }

It has also been shown that information and knowledge are essential for rational decision-making. Information is required to create knowledge, and both information and knowledge are used extensively in the decision-making process. In the context of development planning, the main type of information and knowledge used is spatially related – it is claimed by some authors (Malczewski, 1999:3; Ostensen, 2001:16) that as much as 80% of the information is spatially related, that is geo-spatial information and spatial knowledge. It has been shown that geo-spatial information is essential in the development planning process – to the extent that it is postulated that without geo-spatial information there can be no effective development planning.

The role of geo-spatial information (and spatial knowledge) in the development planning process, particularly in decision-making, is described in the new Geo-spatial Information Decision-making Model. Geo-spatial information and spatial knowledge, with its various constructs, interact with each stage of the decision-making process. The objective is to achieve the highest level of rationality

possible for effective decision making (although complete rationality is not considered to be practical).

Geo-spatial information is complex information and is processed using the cognitive mapping skills and abilities of the user. This complex geo-spatial information is reduced to a visual representation, namely a map. It is claimed that geo-spatial information is best represented on a map, either in digital or hardcopy format. It can be deduced, then, that there is a transitive relationship between the map and the development planning process. The map then plays an essential role in the development planning process.

Continuing with the information processing approach, geo-spatial information is processed by the cartographic communication process. Cartographic (map) language is central to the cartographic communication process. It can be stated that geo-spatial information is read, analysed and interpreted using map reading, map analysis and map interpretation respectively, that is, using cartographic language. The user of geo-spatial information must be competent in cartographic language. Competence in cartographic language requires map literacy, as in natural (common) language where literacy is required. The concept of map literacy is not well defined, so it is more practical to use the notion of functional map literacy. It can therefore be deduced that the user of geo-spatial information must be functionally map literate.

As geo-spatial information is essential for effective development planning, which gives a transitive relationship between the map and the development planning process, it can be deduced that there is a relationship between functional map literacy and development planning.

Any person who participates in development planning, be they a community leader or member, a professional development planner, a politician, or a technician or professional in an associated discipline, and is not functionally map literate will not be able to participate as effectively as possible in the development planning process. This has significant implications for effective development planning and the success of development projects.

To illustrate some of the implications of functional map illiteracy on development planning some possible scenarios are given below. Some of these may seem absurd, but could occur. All processes, where defective geo-spatial information is used or where relevant geo-spatial information is not used, will be defective because of the incorrect information (hence knowledge) used. The resultant selection made (decision) could then be defective. The extent of the defect (sub-optimal or totally incorrect) will depend on the contribution that the specific piece of geo-spatial information makes to the processes leading up to the selection (decision).

- Misidentification of the meaning of a symbol, assigning an incorrect meaning to that piece of geo-spatial information. For example, a railway line may be misidentified as a road. It could then be decided that a railway line should be constructed to a town, since no such railway line exists, when in fact it does. Alternatively, a new road could be planned to link into the erroneous road, which is actually a railway line. A route may be planned to travel along the road (erroneous), only to find that it is a railway line when you get there.
- Inability to determine the existence of a phenomenon (locate), resulting in the assumption that such phenomenon does not exist at the particular location. For example, siting a new school on the opposite side of a major river (not located) from the village, not realising the impact the river will have on access to the school.
- Inability to determine direction/bearing, resulting in lack of common meaning in a group or wastage of time and resources because of searching/travelling in the wrong direction. For example, the development planner describes a phenomenon located to the north-east of another phenomenon and the community leader searches for it in another direction and is notable to locate it. In a further example, the community leader indicates that a clinic must be constructed to the east of the village, but actually means to the west, or the development planner does not know the correct direction and locates it incorrectly.
- Inability to discriminate between phenomena represented on the map, resulting in misclassification of information. For example, incorrectly

interpreting a land-cover type will result in erroneous calculation of the coverage of a land-cover type.

- Spatial patterns of phenomena not recognised, resulting in the loss of important information about those phenomena or the spatial relationship with other phenomena. A particular pattern of geomorphological features, such as dykes, could signify the presence of a geological occurrence, but without recognising this pattern the geological occurrence will go unnoticed. A pattern of population distribution in relation to surrounding economic activity, either agriculture or industrial, will indicate the relationship of workers to place of employment or potential employment. It could also indicate the absence of economic activity in areas of high population. In most of these cases the development planner or decision maker relies on inference.
- Inaccurate measurement or estimation of dimensions, such as length and area. The inaccurate measurement of a boundary will result in an erroneous costing of fencing that boundary. The inaccurate measurement of the area of a population census district will result in the incorrect determination of the population density of that district.
- The inability to identify or deduce a causal link between two phenomena A and B where the spatial distribution of A coincides in geographical space with the location of B. Homesteads that are located within the floodplain of a river would be subject to flooding, and hence loss of property and possibly human life would occur if this danger is not identified.

The above scenarios are not what we would want to occur as a result of ineffective development planning. How bad is the situation in South Africa?

In Chapter 1 it is reported that the situation of functional map literacy in South Africa is poor. This is deduced from the low number of school leavers (the future development planners and community leaders) who can be regarded as being functionally map literate, and the low use of geo-spatial information (maps). A study by Liebenberg (1998:114-116) showed that students studying for a degree course in Geography were not competent at the first level of map literacy - achieving less than 80%.

The map literacy/map awareness project, called MapAware, of the Chief Directorate of Surveys and Mapping has included measuring functional map literacy in South Africa, albeit at an elementary level. The MapAware Project is described in more detail below. An analysis of the level of functional map literacy (see Annexure D) has been done on 400 participants of the MapAware workshops (adult learning). The pre-test on functional map literacy, done at the commencement of the map literacy training intervention, tests the participant's level of functional map literacy. The pre-test has indicated that only 3.5% of the participants achieved a score of at least 80% - indicating that 96.5% are considered to be functionally map illiterate. Of this group, 254 (63%) are directly involved in development projects, with the balance being high school educators –

teaching the future development planners and community leaders, but yet not functionally map literate themselves.

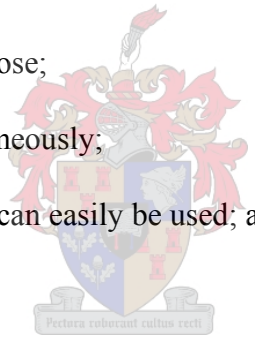
It can be concluded that the functional map literacy levels in South Africa are inadequate for effective development planning. Can something be done to improve development planning?

5.3 Thoughts on Improving Development Planning

Effective development planning resulting in the achievement of the objectives of sustainable development is essential for any less developed country, including South Africa. It has already been shown that the optimal use of geo-spatial information, directly and through spatial knowledge creation, is required for effective development planning. It will be necessary to ensure that the development planning process inculcates the utilisation of relevant geo-spatial information – see Chapter 1 for support of this requirement. The revised development planning process model (proposed by this researcher), given in Chapter 2 (section 2.11), comprised of the knowledge-creation component, caters for this requirement. The relationship between geo-spatial information, spatial knowledge and development planning, particularly the decision-making stage, is described in the Geo-spatial Information Decision-making Model (see section 3.6). This model must be used in development planning systems and procedures to improve development planning.

Acknowledging that geo-spatial information must be used is only half the battle won. This geo-spatial information must be relevant to the particular development need and it must be accessible to all involved in the development planning process. Providing geo-spatial information which is not relevant will cause information overload, making it difficult and time consuming to process the information and will lead to confusion rather than anything else. Also, by not using geo-spatial information that is relevant will diminish and even bring into question the validity of decisions made – as has already been discussed above. To be relevant the information must be:

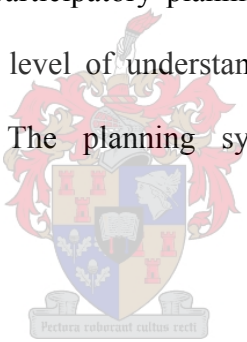
- appropriate to the purpose;
- received by the user timeously;
- in a format in which it can easily be used; and
- reliable.



Infrastructure comprising of policies, procedures, standards, systems and organisational remits must be in place to ensure proper access to the relevant geo-spatial information. In the case of digital maps and geographical information systems reliable information and communication technology (ICT) and an electrical power supply is essential. These should not be restricted to the main urban centres but reach out to all areas subject to development needs. Policies must be in place to democratise geo-spatial information access, ensuring that no one group has access to geo-spatial information denied to another group – this

does not only include access to the geo-spatial information itself but also the skills and technology to process the geo-spatial information. Geo-spatial information must not be priced so as to deny access to this information. Mechanisms, such as meta-data search engines, must be in place to make all parties involved aware of what geo-spatial information is available and how to access it.

People-centred development requires the full involvement of the community or society targeted for development. Besides making the geo-spatial information available, it is also required that the whole development planning process be participatory. To achieve participatory planning requires all the role-players to have a minimum common level of understanding and the tools with which to undertake the planning. The planning systems used must then support participatory planning.

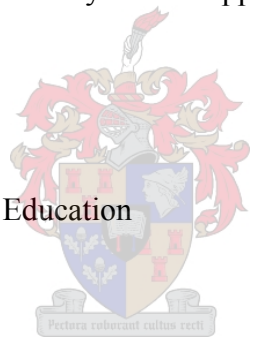


The geo-spatial information must, as a prerequisite, be available so that it can be accessed. In most countries it is the national mapping organisation's responsibility to collect and make available the fundamental geo-spatial information. Other government agencies, such as the national statistical office, add specialised or thematic information to the fundamental geo-spatial information. The governments of developing countries must then ensure that the correct organisational remits exist to designate responsibilities and cooperative information-sharing arrangements. It is also necessary that adequate funding is provided by the government for the collection and processing of all relevant

fundamental geo-spatial information and the secondary, but essential, thematic geo-spatial information. The development of the country is a public good and therefore the collection and making available of the geo-spatial information must be seen as an aspect of this public good.

It is in the interest of the government to establish training programmes in functional map literacy, not only for community leaders and members, but also for their own employees who are the professional development planners and the supporting technicians and professionals. Such a training programme is provided by the Chief Directorate of Surveys and Mapping, called MapAware – see below for more discussion.

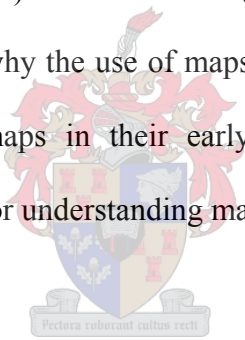
5.4 Map Literacy Training and Education



It has been shown that something must be done to raise the level of functional map literacy. Is it possible that the reason why people have little or no functional map literacy is because they have never been taught map literacy (cartographic language)? But can cartographic language be taught?

It would seem that most of the teaching of map literacy or map skills is done as part of the teaching of Geography at school and tertiary education level. Map literacy is considered necessary to explain geographical concepts and occurrences, as depicted on maps. Downs *et al.* (1988:684) are of the opinion that Piagetian

theory offers a particularly productive structure for geography education. This is because Piagetian theory emphasises three sets of ideas, namely, representation, space and logic, which are central to the comprehension and production of maps. They therefore support using the Piagetian development stages in children for teaching map skills. Research by Shimron (1978:17-18) found that "learning a map is a gradual process whereby local connections between map elements are learned first and overall integration of map units is only achieved later". This supports the Piagetian development stages. The teaching of map skills appropriate to the development age of the child is further supported by Charlton (in Balchin, 1976:36), Board (1984:91) and Gerber (1984b:112). Ottosson (1988:28) concludes that the reason why the use of maps is regarded as difficult is children are seldom exposed to maps in their early years. Understanding of spatial relationships is necessary for understanding maps (Ottosson, 1988:32).



Since cartographic language is a cognitive process, the more the reader brings to the map, the more he/she is likely to take from it (Head, 1984:23). Teaching cartographic language should be sequential with experience. It has been shown that experience and prior knowledge leads to higher performance in the use of maps (Rieger, 1999:136; Kulhavy *et al.*, 1992:2; Eastman and Castner, 1983:126). According to Chang *et al.* (1985:93) map reading is a skill that can be improved through experience. Gerber (1984b:113-114) promotes the teaching of both semiotics (identification of signs) and semantics (differentiate between the sign and its referent) to improve map-use skills. MacEachren (1991:157) reports on

different learning strategies studied, where he found that segmenting map information spatially into regions (regionalisation) gave better recall results than functional segmentation – layers of information, such as roads, topography, rivers etc.

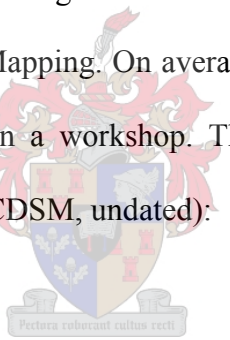
It can therefore be concluded that the cartographic language can be taught. However, it would be wise to learn from the findings of the research in this field and design the learning of cartographic language with the learner's developmental age and experience in mind – an adult should have achieved a mature developmental age already.

In 1993 this researcher conceived the idea of, and started, a map awareness/map literacy project called MapAware in the Chief Directorate of Surveys and Mapping, South Africa's national mapping organisation. The primary objective of this project was to improve the utilisation of geo-spatial information among the user community and potential users. This would be achieved through addressing the lack of awareness of the existence of geo-spatial information, in particular maps, and to improve levels of map literacy. The project consists of two main parts, namely the schools component and the adult learning component.

Primarily, the schools component deals with the provision of suitable teaching aids and materials, including maps of the school's local area (at no charge), for the teachers to educate the school learners in map-use skills, as part of their studies in

Geography. It is hoped that through this project the future development planners and community leaders would be more map aware and map literate by the time they complete their formal education. This part of the project is not discussed further in this research.

The adult learning component consists mainly of a two-day intervention (practical workshop), with the intention of raising the levels of awareness of the existence of maps and their sources, and to raise the levels of functional map literacy. These workshops are held at venues around the whole of South Africa and can be attended by any group requesting that a workshop be conducted by the Chief Directorate of Surveys and Mapping. On average 8 workshops are held annually, with up to 20 participants in a workshop. The two-day workshop consists of various exercises and tasks (CDSM, undated):



- Exposure to various types and scales of maps;
- How to acquire maps and related geo-spatial information;
- Concepts of scale and using scale of maps;
- Orientation skills;
- Location skills;
- Topography and relief (contours) and elevation determination;
- Conventional map symbols, identification and location;
- Boundaries on maps.

At the start of the workshop a 'pre-test' assessment is conducted on the participants and upon conclusion of the workshop a 'post-test' assessment is conducted (CDSM, undated). A test map, representing a variety of terrain types and features, is used for the assessments. The main purpose of these assessments is to determine whether the workshop is effective in raising the level of functional map literacy. The pre-test and post-test assessments assess certain map-use tasks (refer to Chapter 4). Each assessment consisted of 14 questions. The MapAware workshop also included the use of aerial photography and interpretation of the imagery, and the assessments included an evaluation of this aspect - but this is not included in this research.

Three staff members of the Chief Directorate of Surveys and Mapping have been assigned to work on the MapAware Project. These staff members conducted the pre-test and post-test assessments.

An analysis of the map-use tasks has been made of 400 participants in the two-day MapAware workshop (see Annexure D) over the period May 2002 to July 2005. These participants have come from the public sector, working in development projects (63%), either as planners or implementers, and secondary school educators in Geography (37%). The pre-test and post-test assessments consist of the map-use tasks (refer to Chapter 4) shown in Table 5.1 and Table 5.2 respectively. The skill level for each map-use task is also given.

Table 5.1 MapAware Pre-test Assessment

No.	Question	Map-use Task	Skill Level
1	Name the type of transport feature shown in black in block E16	-Identify a symbol	- Entry
2	At which special function building identified in F6 will you regularly find large numbers of young people during the day?	- Identify a symbol	- L2
3	What natural feature does the Brinkspruit flow through in J10?	- Identify a symbol	- L1
4	What kind of construction is indicated along the transport feature in A6?	- Identify a symbol	- Entry
5	What kind of boundary extends from the trigonometrical station in D16 to the edge of the map (J19)?	- Search for a particular symbol - Identify a symbol	- Entry - Entry
6	A permanent supply of water is available for the buildings near Clewer Station (B6). Where does the water come from?	- Search for a particular symbol	- L2
7	A confluence is where two rivers join. In which block does a non-perennial tributary join a perennial river?	- Search for a particular symbol - Determine the coordinates / geographical position of a place on the map.	- Entry - L1
8	What is the height of the index contour line indicated in F16?	- Determine the topography/ terrain of a location/ area.	- Entry
9	What is the length of the game reserve boundary between the trigonometrical station on Devil's Peak (C13) and the international boundary beacon in C17?	- Search for a particular symbol - Determine the distance between two points.	- Entry - Entry
10	In which direction is the river in G14 flowing?	- Determine direction/ bearing - Search for a particular symbol	- L1 - Entry
11	What is the approximate range of altitude on the mapped area?	- Determine the topography/ terrain of a location/ area.	- Entry
12	Which constructed feature is found at 22º 12' 20" S and 29º 51' 20" E?	- Locate a place/ position on the map from its coordinates/ geographical position.	- L1
13	Move along the eastern border of F16 from the perennial river northwards until you reach the prominent rock outcrop of D16. How would you describe this slope?	- Search for a particular symbol - Determine the topography/ terrain of a location/ area.	- Entry - L2
14	How would you describe the relief of the farm Schagen in E15	- Search for a particular symbol - Determine the topography/ terrain of a location/ area.	- Entry - L2
*	For all questions having a grid identifier/locator (e.g. E15)	- Locate a place/ position on the map from its coordinates/ geographical position.	- Entry

Table 5.2 Mapaware Post-test Assessment

No.	Question	Map-use Task	Skill Level
1	Name the type of transport feature shown in D4	- Identify a symbol	- Entry
2	If you went to stay at Montana (C3 – D3) in False Bay, what kind of holiday accommodation would be available?	- Identify a symbol	- L2
3	Name the feature that starts in E5 and leaves the map area in A2.	- Identify a symbol	- L1
4	What feature occupies the area between Mowbray Aerodrome (H9 – H10) and Salt River Station (H10)?	- Search for a particular symbol - Identify a symbol	- Entry - Entry
5	What kind of construction is indicated along the transport feature in B6?	- Identify a symbol	- Entry
6	What kind of boundary goes from the trigonometrical station in C13 to the square shaped beacon symbol in C17?	- Search for a particular symbol - Identify a symbol	- Entry - Entry
7	In which of the following block does a non-perennial river occur?	- Search for a particular symbol - Determine the coordinates / geographical position of a place on the map.	- Entry - L1
8	What is the length of the international boundary between the trigonometrical station in D16 and the edge of the map in J19?	- Search for a particular symbol - Determine the distance between two points.	- Entry - Entry
9	What is the height of the index contour line indicated in H19?	- Determine the topography/ terrain of a location/ area	- Entry
10	In which direction are the rivers in H17 flowing?	- Determine direction/ bearing - Search for a particular symbol	- L1 - Entry
11	What is the difference in height between the highest point indicated on the Drakensberg and the mine dumps in G10?	- Determine the topography/ terrain of a location/ area. - Search for a particular symbol	- Entry - Entry
12	Which natural feature is found at 22º 14’ 10” S and 29º 54’ 10” E?	- Locate a place/ position on the map from its coordinates/ geographical position.	- L1
13	How would you describe the slope along the southern border of A7?	- Determine the topography/ terrain of a location/ area.	- L2
14	How would you describe the relief of the Clewer Agricultural Holdings in C5?	- Search for a particular symbol - Determine the topography/ terrain of a location/ area.	- Entry - L2
*	For all questions having a grid identifier/locator (e.g. E15)	- Locate a place/ position on the map from its coordinates/ geographical position.	- Entry

In the pre-test assessment 6 (42.9%) questions are measuring at the Entry skill level, and 4 questions (28.6%) each at the Level 1 and Level 2, as shown in Table 5.3. In the post-test assessment 7 (50%) questions are measuring at the Entry skill level, 4 questions (28.6%) at the Level 1 and 3 questions (21.4%) at the Level 2, as shown in Table 5.3.

Table 5.3 Summary of Skill Levels for Pre-test and Post-test Assessments

Skill Level	Pre-test No.	Post-test No.
Entry	1; 4; 5; 8; 9;11 = 6	1;4;5;6;8;9;11 = 7
L1	3;7;10;12 = 4	3;7;10;12= 4
L2	2; 6;13;14 = 4	2;13;14 = 3

To be functionally map literate requires competence (attaining a score of 80%) at Level 1. The MapAware Workshop assessment has included four and three questions at Level 2 for the pre-test and post-test respectively. This number of questions may be deemed to be excessive in comparison with the four questions at Level 1. Also there are six and seven questions, respectively, at the Entry Level. The assessment of the spread of questions at each level indicated a shortcoming in the MapAware Workshop. It would be more appropriate to have had a better spread of questions between the Entry Level and Level 1, and fewer questions at Level 2. Ideally, there should be more questions to better assess competence at

each level. However, in a workshop environment of only two days there is a limitation on the amount of time that can be used for the pre-test and post-test assessments.

A comparison, as shown in Table 5.4, between the pre-test and post-test questions shows sufficient equivalence in the map-use task used to make comparisons in the performance of the participants between the pre-test and the post-test assessments.

Table 5.4 Comparison of Pre-test and Post-test Questions

Pre-test Question No.	Post-test Question No.
1	1
2	2
3	3
4	5
5	4
6	5
7	7
8	9
9	8
10	10
11	11
12	12
13	13
14	14

From the list of map-use tasks tested in the questions it can be seen that a number of questions cover more than one map-use task. Most of the questions require the map-use task "locate a place/position on the map from its coordinates/geographical position" at the Entry level – the participant must use the map grid reference system of the test map to locate or search for symbols or features on the test map. Other map-use tasks require a prerequisite task to be completed in order to answer the question.

The assessments were not testing the participants' ability to use the map grid reference system and assistance was available to the participants in this regard. It is therefore assumed that all participants could use the map grid reference system and therefore this was not a reason for an incorrect answer to any of the questions.

The list of 400 participants and their respective scoring for the pre-test and the post-test assessments are given in Annexure D. The performance of the whole group of participants for each question is given Table 5.5.

Table 5.5 Performance of Participants in Pre-test and Post-test Assessment

Pre-test Assessment:

Question	1	2	3	4	5	6	7	8	9	10	11	12	13	14
% correct	60	81	69	55	59	44	47	21	42	48	24	17	14	22

Post-test Assessment:

Question	1	2	3	4	5	6	7	8	9	10	11	12	13	14
% correct	74	91	80	77	77	72	70	58	64	66	33	40	44	50

In the pre-test assessment only Question 2 achieved a score of at least 80%. This question tests the map-use task of "identify a symbol" at the skill level L2 (third level). This is an anomaly as other questions testing the same map-use task at a lower skill level achieved much lower scores e.g. Question 1 – Entry level achieving only 60%. A possible explanation could be that most people, through common knowledge, know that during the day young people are generally at school. The participants therefore would know the answer without having to interpret the information on the map.

Only Questions 1, 3, 4 and 5 in the pre-test assessment achieved a score of more than 50%. These questions tested the map-use task "identify a symbol" – which is a simple task, given that the map contains a symbol legend.

Questions 8, 11, 12 13 and 14 scored less than 30% for the group. Of these questions, Question 12 tested the map-use task "locate a place/position on the map from its coordinates/geographical position" – skill Level 1, and the others were testing the map-use task "determine the topography/ terrain of a location/area" – at Entry level and skill Level 2. It may not be reasonable to expect a good score for the questions at Level 2, but the participants performed equally badly at the Entry skill level for the latter map-use task.

An analysis of the results shows that, as a group, the participants performed poorly in the map-use tasks prior to the intervention of the MapAware workshop. The only map-use task having any measure of success was the simple task to "identify a symbol". As a group they had a particular difficulty with the tasks related to using geographical coordinates and working with contour/elevation information.

Taking the individual scores of the participants indicated that only 14 participants (3.5%) achieved a score of at least 80% in the pre-test assessment - indicating that 96.5% are considered to be functionally map illiterate.

In the post-test assessment the participants, as a group, scored at least 80% in two questions, namely Questions 2 and 3. Both these questions tested the map-use task "identify a symbol". The remarks made on Question 2 in the pre-test above apply once again, although probably not as intuitively as in the pre-test assessment. The

lowest scores were for Questions 11, 12, 13 and 14 – which indicates the same trend as in the pre-test assessment. Once again, taking the individual scores of the participants' in the post-test assessment indicated that 101 participants (25%) achieved a score of at least 80%.

There is a significant improvement in the group's scoring for the questions in the post-test assessment over the pre-test assessment, as shown in Table 5.6.

Table 5.6 Improvement from Pre-test to Post-test Assessments

Pre-test	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Post-test	1	2	3	5	4	5	7	9	8	10	11	12	13	14
%	23	12	16	40	31	75	49	205	38	38	38	135	214	127

It is interesting to note that the questions that scored the worst in the pre-test assessment showed the best improvement.

On an individual basis, 67.1% of the participants improved their scores in the post-test assessment by more than 25%, and 49.8% improved by more than 50%; 46 (11.5%) of the participants showed a negative improvement. Of these, 10 participants (2.5%) had scores of at least 80% in the pre-test assessment and it is conceivable that because of their high score in the pre-test they would not

improve on their score in the post-test assessment. Six of the participants who did not improve their score had such poor scores in their pre-test assessment that they were starting off at a low base. The workshop intervention, which is only of two days duration, would not have been able to help these participants improve their skills in the map-use tasks tested.

The results of the pre-test and post-test assessments show that the MapAware workshop is successful in significantly improving the abilities of participants in the map-use tasks. This workshop is contributing to raising the levels of functional map literacy – from 3.5% to 25% of participants being considered functionally map literate (score of at least 80%). In the pre-test assessment only 28% of the participants score more than 50%, while in the post-test assessment this figures rose to 72%. This further shows the impact that the workshop is having. A participant with a score of 50% is not considered to be functionally map literate, but at least they should have a basis on which to develop their ability.

The pre-test and post-test assessments were not designed specifically to evaluate the participants' functional map literacy, but rather to evaluate the effectiveness of the workshop intervention. These assessments could be better utilised to evaluate functional map literacy. This will require more map-use tasks to be tested and at the appropriate skill level – only at the Entry and Level 1 levels.

The shortcomings in the MapAware Workshop assessments identified in this research have now been addressed and the pre-test and post-test assessments have a better spread of questions, at the different skill levels, and for testing more map-use tasks. The questions now being used in the assessments have been taken from the eighteen map-use tasks given in Chapter 4.

5.5 New Representations of Geo-spatial Information

To further improve the understanding and use of geo-spatial information, which is complex, further attention must be paid to cartographic language. The language used in cartography to represent geo-spatial information must be appropriate to the socio-cultural and technical environments in which it is to be used.

It has been shown that a person's gender and cultural background does not inherently affect their ability to form and use cognitive mapping models and therefore their performance in the cartographic language. Rather, any lack of performance in the cartographic language can be attributed to the environment in which they developed and currently exist. The conventional map symbols found on most maps, including in developing countries, are Euro-centric, that is, they have been taken over from the conventional symbology used predominantly in European countries. It can be questioned as to whether or not these conventional map symbols and colours are appropriate in a non-European society, particularly one with different cultures, such as South Africa. Using an image for a symbol,

where the image has a common meaning in a European country and therefore instantly recognisable by a European, will not necessarily be recognisable by a person with no experience of Europe. This could result in the misidentification and interpretation of the symbol and its meaning. An example of this is the sign for a ski slope – a pictorial of a person on ski's – not many people in a developing country where there is little or no snow will recognise such a symbol. Colour associations differ from culture to culture and religion to religion – compare the meaning of the colour 'white' or 'black' in Christianity to that in Hinduism. Not all cultures define the colour spectrum the same as Europeans (Board, 1973:232).

Cartographic language will be a new language to many (and definitely not their first or mother-tongue language). Besides this obstacle, the map user will also encounter a natural language, such as English, on the map, which is used for descriptive and geographic names and the explanations in the map surrounds. Lack of competence in this natural language will be problematic for the map user. The ideal would be to use multi-lingual text, covering the major languages. Space is limited on a map, however, and therefore the number of languages that can be accommodated is limited. The cartographer will have to determine what is the most appropriate language(s) when working in a multilingual environment. Digital interactive maps can help in that the map user can select the language of their choice for the map.

Access to geo-spatial information by persons with visual impairments is receiving attention in recent times by the International Cartographic Association (Commission on Cartography and the Visually Impaired). This includes researching alternatives to the conventional map, where visually impaired map users can make use of touch to identify information on the map. Cartographers must be aware of the effects of certain colours, such as red, on persons with colour-blindness.

The cartographer should be aware of the socio-cultural environment in which the geo-spatial information (maps) will be used and to use symbology that is appropriate. This will improve the understanding of the cartographic language and therefore the utilisation of geo-spatial information. This subject is beyond the scope of this research.

Other ways of improving the use of geo-spatial information is to consider alternative forms of representation (visualisation) for different types of information. This will still use the basic premises of the cartographic language, but exploiting modern technologies for aiding visual interpretation. Some of these include:

- dynamic maps - such as 'fly-throughs' giving a three-dimensional view of the terrain as a route is navigated, or sequencing time slices to monitor change dynamically. Many of these dynamic maps break from tradition and use

perspective views instead of orthogonal (straight down) views. The map user may also dynamically zoom in and zoom out to suit the view they require;

- interactive maps – allowing the map user to interactively display geo-spatial information, or components of it, and then adding on additional geo-spatial information or taking away some information. In this way the map user controls the level of detail and complexity of the geo-spatial information displayed;
- web maps – similar to interactive maps, using the World Wide Web to access the geo-spatial information and the tools available on the web to manipulate the information.

5.6 Summary of Chapter

This chapter brings together the research and findings of the previous chapters on the key issue of the implications of functional map literacy on development planning. The role of geo-spatial information (and spatial knowledge) in the development planning process, particularly in decision making, was described in the new Geo-spatial Information Decision-making Model in Chapter 3. It was postulated that without geo-spatial information there can be no effective development planning. This complex geo-spatial information is reduced to a visual representation, namely a map. It was claimed that geo-spatial information is best represented on a map, and therefore that there is a transitive relationship

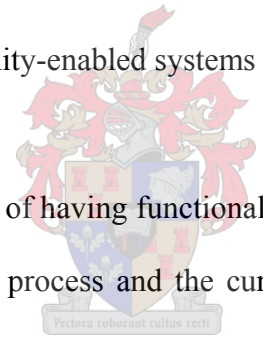
between the map and the development planning process. It was concluded that the map plays an essential role in the development planning process.

It was noted that because cartographic (map) language is central to the cartographic communication process geo-spatial information is read, analysed and interpreted using map reading, map analysis and map interpretation skills respectively, that is, using the cartographic language. The user of geo-spatial information must thus be competent in cartographic language i.e. the user of geo-spatial information must be functionally map literate. Given the relationship between the map and the development planning process, it was deduced that there is a relationship between functional map literacy and development planning.

Some examples were given of the implications of functional map illiteracy on development planning. This shows that the resultant selection made (the decision) could be defective in cases where defective geo-spatial information is used (as a result of user error) or where relevant geo-spatial information is not used. Drawing on what was reported in Chapter 1, as well as findings from studies on university students and the MapAware workshops, it was concluded that the functional map literacy levels in South Africa are inadequate for effective development planning.

Some thoughts on improving the development planning process were offered. These include:

- Inculcating the utilisation of relevant geo-spatial information in the development planning process;
- Using the Geo-spatial Information Decision-making Model in development planning systems and procedures to improve development planning;
- Ensuring that relevant geo-spatial information is available;
- Ensuring that relevant geo-spatial information is accessible and usable; and
- Ensuring that development planners, associated professionals and the community leaders are functionally map literate through conducting training programmes; and
- Providing for community-enabled systems for participatory decision-making.



Because of the importance of having functionally map literate persons involved in the development planning process and the current low levels of functional map literacy in South Africa, the chapter considers whether functional map literacy can be taught. It is shown that most of the current training is conducted as part of the Geography teaching at school and at institutions of higher learning. The Chief Directorate of Surveys and Mapping has been conducting functional map literacy training through the MapAware Project. An analysis of the pre-test and post-test assessments conducted as part of the MapAware map literacy training intervention (workshop) shows that such an intervention, of only two days duration, significantly improves the levels of functional map literacy of the participants. It was shown that 67.1% of the participants improved their scores in the post-test

assessment as against the pre-test score by more than 25%, and 49.8% improved by more than 50%. It can be concluded that functional map literacy can be taught. This conclusion is supported by other researchers.

The assessments of the MapAware workshops show that, of the map-use skills tested, the lowest skill was in the map-use tasks of "locate a place/position on the map from its coordinates/geographical position" and "determine the topography/terrain of a location/area".

New representations of geo-spatial information should be considered to improve the understanding of cartographic language. Consideration should be given to the appropriateness of the conventional map symbols, colours and the natural language used on maps. Representations (visualisation) using the basic premises of the cartographic language, but exploiting modern technologies for aiding visual interpretation, such as dynamic maps, interactive maps, and web maps should be used. It is suggested that the language used in cartography to represent geo-spatial information must be appropriate to the socio-cultural and technical environments in which it is to be used.

CHAPTER 6

CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

Providing the basic needs of people and addressing injustice and inequality that they are subjected to, in a sustained environment is a fundamental challenge facing the less developed countries. To achieve these key objectives the less developed countries, supported by the international community, have sustainable development as a high priority. Over the years different approaches to development have been used, from the economic growth, modernisation, alternative development, human development, neo-liberalism, post-development and rights-based approaches. These do not necessarily represent paradigmatic changes in development theory but rather varying approaches to attempt to address the shortcomings of the previous approaches. The strong points in each approach can be found in the approach of today. The post-development approach, which calls for anti-development, not only to the means of development but also to the goals and results of development, is regarded as being more radical. The approach being followed by large international organisations, such as the World Bank, and others is the human development approach, with its influential Human Development Indices to measure the state of development in a country. The human development approach is people-centred, emphasising capacitation of

people and communities and enlarging peoples' choices. In this approach the development needs of the people or community are formulated by the community, with the assistance of the politicians and development planners. The rights-based approach adds to this approach by calling for a wider approach away from just poverty alleviation to injustice and inequality that exists. This approach in particular considers development as a power-laden environment with a need to balance power. Development theories appropriate in modern times supports the need to undertake proper development planning to ensure that the objectives of the development are achieved. These modern development theories, in particular the human development approach, supported by the rights-based approach, provide the framework for this research. This research however, is focused more at the process or implementation level and not at the development theory or macro level.

As no two development projects are the same and local conditions vary, the previously used 'blue-print' development planning process has been replaced with a process approach, involving all the stakeholders – this is the participatory or collaborative planning approach. The collaborative planning approach emphasises that communication and interactions are central to planning with the public interest being jointly discovered and willed and information and knowledge are embedded. Collaborative planning also recognises the power relations that exist. The collaborative planning approach for development planning provides for communities to identify their development needs and to take ownership of the

whole process – it is not something being 'dumped' on them. This approach does, however, often introduce tensions between the community and politicians and development planners, and at times also within the community. These tensions arise mainly because development is value-laden and there are limited resources available. There is also a level of uncertainty in the development planning environment which contributes to the tensions and doubts about the success of the development. Rationality in the development planning process should be maximised to ameliorate these tensions.

Based on the human development approach, the rights-based approach, the collaborative planning approach, what various authors have put forward for a development planning process, and the objective of maximising rationality while recognising that development is value-laden and requires community involvement – participatory development planning – a revised development planning process is used for a framework in this research. This revised process emphasises the community/societal participation in identifying the development need, and the cyclical nature of the process – using monitoring and evaluation to assess the achievement of the development needs, and the subsequent re-planning if required, through a learning process. The main differences from other processes put forward are the central components of capacity- and capacity-building and of knowledge creation. These interact at each phase of the process. All the role players, and in particular the community, must have the capability and knowledge to participate in the whole development planning process. They must also become

self-reliant and not remain dependent on the government or other development agencies, so that they can accelerate their own development. The old adage 'If you give a man a fish, you feed him for a day. If you teach a man to fish, you feed him for life' should be a primary basis of the development planning process.

Decision making and the decision-making process form an integral part of development planning and the development planning process respectively. The degree of rationality achieved in the development planning process is related to the degree of rationality achieved in the decision-making process. Total rationality would be the ultimate goal, but it is extremely difficult to achieve and is generally not expedient to achieve, particulary in the value- and power-laden environment of development planning. Bounded rationality is then generally accepted. An objective of this research is to contribute towards maximising rationality, or bounded rationality, in decision making within the development planning process.

The knowledge that the decision-maker has of the development problem or opportunity is paramount in achieving a rational decision. Knowledge can be expressed in its different forms and structures, such as tacit, explicit and cultural knowledge or declarative, procedural and configurational knowledge. Knowledge is created from the existing knowledge base, external knowledge, experience and from new information.

It has been shown that information is used extensively in the decision-making process. The information process can be discussed in terms of information needs, information seeking and information use. It is important to note that humans do not always know what their information needs are for a particular decision, and therefore may have to go through an iterative process – 'the more you know, the more you know what you don't know'. To be successfully used in the decision-making process, information must be relevant, reliable and accessible. Information that is perceived to be less accessible or of uncertain quality could be overlooked.

Having established the relationship between information, knowledge and decision-making, the research turns to geo-spatial information, a particular type of information, and spatial knowledge, a particular type of knowledge that uses geo-spatial information. Geo-spatial information is best represented on a map for human use – a visual representation. An important construct of spatial knowledge is the cognitive map (or mental map) – with the cognitive map being a metaphor for the understanding of the environment that humans construct.

The numerous examples of geo-spatial information use in development planning, the relationship that has been established between information and development planning and based on empirical evidence, have led to the conclusion in this research that there is a significant relationship between geo-spatial information and development planning, particularly in the decision-making process (see research question No. 1). The relationship is both direct and transitive through

spatial knowledge. It is postulated here that without geo-spatial information there can be no effective development planning.

A Geo-spatial Information Decision-making Model has been developed in this research. This model was developed from a synthesis and an enhancement of existing theories and models - the development planning process (based on the human development approach, emphasising capacitation of communities and other stakeholders and enlarging peoples' choices, supported by the rights-based approach to address injustice and inequality, together with the collaborative planning approach based on communication and participation by all stakeholders, with the emphasis on information use and knowledge creation), the nature and process of decision making, the general model of information use, the knowing cycle, the principle of rationality and the open systems approach, together with the nature of geo-spatial information and the spatial knowledge constructs. The model is an information/knowledge-centric model, emphasising the relationship between geo-spatial information, spatial knowledge and the decision-making process within the environment of the development planning process. The five main components of the model are: 1) Signals from the Environment; 2) Decision-making Process Subsystem; 3) Information Cognitive Subsystem; 4) Knowledge Subsystem; and 5) Technical Subsystem. These main components are linked to four other components, namely, a) Environment (internal and external); b) Community/Societal Problems or Opportunities, resulting in development needs; c) Implementation; and d) Monitoring.

This research concludes that, for the development planners and communities involved in the development planning process to undertake effective development planning, they must be competent in using maps (geo-spatial information). This requires them to be map literate.

But map literacy is not a well-defined concept. This research uses the understanding of literacy from the natural (written) language to develop an understanding of map literacy – the cartographic (map) language. It was found that the meaning of literacy is a vague concept and that it is more meaningful to turn to functional literacy, which is practical and applies to everyday life. The reading process can be likened to the information processing approach, which gives a basis for an objective understanding of the meaning of functional literacy and a model for assessing competence in functional literacy. Cartographic communication is also based on the information processing approach. Cartographic (geo-spatial) information, with the cartographic language being an essential transformer, is central to cartographic communication. Cartographic language was further explored in terms of semiotics (the study of signs), and linguistics (syntactics, semantics and pragmatics). It was found that cartographic language can be adequately described in these terms. Natural language can be similarly described. From this comparison it is concluded in this research that the concepts of natural language can be applied to cartographic language. Functional map literacy can therefore be based on the concepts of functional literacy.

A definition proposed in this research for functional map literacy is **the ability to understand and use maps in daily life, for work and in the community** (see research question No. 2). Functional map literacy then forms part of a person's fundamental life skills, together with literacy, articulacy and numeracy, to fulfil basic needs of survival and socio-economic well-being. In the broadest context, functional map literacy can be understood as consisting of the following components:

- Knowledge
- Comprehension
- Application
- Analysis
- Synthesis
- Evaluation.

To provide for the measurement of functional map literacy, this research proposes a process model consisting of three levels of skill in functional map literacy, called Entry Level, Level 1 and Level 2. The levels are arranged in increasing levels of difficulty, providing increasing competence levels. A person can now be objectively assessed to determine whether they are functionally map literate, using these three skill levels. It is proposed in this research that a person be regarded as being functionally map literate if that person is competent at Level 1 (achieves

80% at the second level) of the functional map literacy skill. Professionals working in a development planning environment should preferably be functionally map literate at Level 2 (the third level). Eighteen map-use tasks have been created in this research that can be used in the measurement of the skill levels of functional map literacy. (see research question No. 2).

It was stated that, as the cartographic (map) language is central to the cartographic communication process, geo-spatial information is read, analysed and interpreted using map reading, map analysis and map interpretation respectively, that is, using the cartographic language. The user of geo-spatial information must thus be competent in the use of cartographic language, i.e. the user of geo-spatial information must be functionally map literate. From the relationship between the map and the development planning process, it was deduced that there is a relationship between functional map literacy and development planning.

It can be concluded that functional map literacy has implications for development planning. All processes, in which defective geo-spatial information is used, or where relevant geo-spatial information is not used, will be defective because of the incorrect or inadequate information (hence knowledge) used. The resultant selection made (decision) could then be defective. The extent of the defect (sub-optimal or totally incorrect) will depend on the contribution that the specific piece of geo-spatial information makes to the processes leading up to the selection (decision). This shows that the resultant selection made (decision) could be

defective where defective geo-spatial information is used (as a result of user error) or where relevant geo-spatial information is not used. (see research question No. 3).

It has been shown in previous research and in this research that functional map literacy levels in South Africa are very low, and are inadequate for effective development planning. The current status of functional map literacy in South Africa therefore has a significant implication for effective development planning (see research question No. 3).

South Africa is a typical developing country and it is reasonable to extrapolate the findings in South Africa to other developing countries. It can then be stated that, in general, map literacy (or functional map literacy) has implications for development planning in developing countries.

The research concludes with some possible ways to improve development planning through improving the use of geo-spatial information (maps). It is shown that map literacy can be taught and that an adult-learning training intervention significantly improves the levels of functional map literacy of the participants.

6.2 Recommendations

The following recommendations are made on the basis of this research:

Recommendations for future research

a) Improvements to the understanding of cartographic language through new representations of geo-spatial information. This includes consideration to the appropriateness of the conventional map symbols, colours and the natural language used on maps in an African country, such as South Africa. It is suggested that the language used in cartography to represent geo-spatial information must be appropriate to the socio-cultural and technical environments in which it is to be used.

b) Increasing participatory development planning through better access to and use of geo-spatial information, with emphasis on new representations (visualisation) of geo-spatial information, using the basic premises of the cartographic language, but exploiting modern technologies for aiding visual interpretation, such as dynamic maps, interactive maps, and web maps.

Other recommendations

a) The revised development planning process (see Chapter 2, section 2.11) should be used to emphasis the capacity- and capability-building and the knowledge-creation components in a people-centred, participatory process.

b) The Geo-spatial Information Decision-making Model (see Chapter 3, section 3.6) should be incorporated into development planning processes and systems. This will enhance the use of geo-spatial information and spatial knowledge in achieving the highest level of rationality possible in decision-making.

c) The measure for determining functional map literacy as being competent (80% achievement) at Level 1 of the functional map literacy skill should be adopted (see Chapter 4, section 4.5 for the three skill levels).

d) Training programmes in functional map literacy should be conducted on a wide scale to improve the levels of functional map literacy among politicians, development planners, associated professionals and technicians and community leaders.

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ANNEXURE A

QUESTIONNAIRE TO ASSESS THE USAGE AND SKILL LEVEL OF GEO-SPATIAL INFORMATION

PLEASE COMPLETE AND RETURN THIS QUESTIONNAIRE TO:

Chief Directorate : Surveys and Mapping
Private Bag X10
Mowbray Fax No : 021-6891351
7705

BY **8 DECEMBER 2003** (OR AS SOON THEREAFTER AS POSSIBLE).

1. DETAILS OF PERSON COMPLETING QUESTIONNAIRE

   NAME : _____

   POSITION / RANK : _____

   NAME OF ORGANISATION : _____

   ADDRESS : _____ FAX No : _____

   _____

   _____

POSTAL CODE: _____ e-mail : _____

2. BRIEFLY DESCRIBE THE NATURE OF THE WORK OF YOUR ORGANISATIONAL COMPONENT (SERVICES/PRODUCTS/KEY OUTPUTS) :

   _____
   _____
   _____
   _____
   _____
   _____
   _____

3. DO YOU OR THE PERSONNEL IN YOUR COMPONENT USE MAPS/ GEO-SPATIAL INFORMATION IN UNDERTAKING PLANNING OR DECISION-MAKING IN YOUR WORK? That is, do you answer such questions :
   Where is it located?
   What is located at that place?
   What can be found at that place?
   What is the geographical distribution of XX?
   How far is it from Point A?
   What is next to Town B?
   Why is XX found next WW?
   Where is the best place to locate YY?

   YES ☐ NO ☐

   If you answered NO to this question then please go to 7.

4. TO WHAT EXTENT AND FREQUENCY IS GEO-SPATIAL INFORMATION USED IN YOUR PLANNING / DECISION-MAKING PROCESS?

   a) Very little ☐ Moderately ☐ Extensively ☐

   b) Very seldom ☐ Monthly ☐ Weekly ☐ Daily ☐

5. PLEASE GIVE AN ASSESSMENT OF THE SKILL LEVEL REQUIRED TO ADEQUATELY PERFORM THE WORK OF YOUR COMPONENT TO EACH OF THE MAP USE (GEO-SPATIAL INFORMATION USE) TASKS LISTED BELOW (in most cases the map could be either hard-copy or digital):
   Please only mark one choice for each task

a) Identify a symbol(s)

Not applicable	
Identify a single symbol on the map, with its characteristics (size, shape, colour, orientation etc), using a symbol legend (that is, match it to the legend)	
Identify symbol groupings and their characteristics.	
Interpret the meaning/concept of the symbol; and relate the symbol to the referent phenomena (in the real world); and infer knowledge from the symbol.	

b) Search for a particular symbol(s)

Not applicable	
Given a single symbol, locate an occurrence of this symbol on the map (that is, find it on the map).	
Locate a grouping of symbols or associated but not identical symbols on the map.	
Search for the location of an occurrence of a phenomena (real world) on the map.	

c) Discriminate between different symbols

Not applicable	
Discriminate between two colour/pattern areas on a thematic map (e.g. different soil types on a soil map)	
Discriminate between colours/patterns on a multi-phenomena thematic map (e.g. soil and rainfall and slope)	
Interpret the relationship between different symbols / patterns.	

d) Describe the phenomena represented by a symbol(s) / pattern at a location

Not applicable	
Describe a single symbol (phenomenon) at a location (relate the representation by the symbol to the real world).	
Describe a grouping of a symbols (phenomena) at a location	
Describe the phenomenon at a location.	

e) Orientate a map

Not applicable	
Orientate the map with North at the top	
Orientate the map in a specified direction – North not at the top but at any direction	
Orientate the map so that it corresponds with the surrounding landscape.	

f) Understand the scale of a map

Not applicable	
Basic understanding of the meaning of scale of a map	
Full understanding of map scale. Have an appreciation of the meaning of various map scales; and use the scale bar to measure distances.	
Determine the scale of a map from ground measurement or from the coordinate grid on the map; and relate information from maps of different scales.	

g) Determine direction / bearing

Not applicable	
Basic understanding of the meaning of direction / bearing and the cardinal (main) points of the compass.	
Determine the direction between two points (e.g. point A is NW of point B, or the direction from C to D is 90° - relative to north)	
Measure the direction between two points using the graticule (latitude, longitude lines) or grid.	

h) Navigate a route

Not applicable	
Navigate from a given start point along a given route, which is simple.	
Navigate from a given start point along a given route, which is more complex.	
Search for the optimum route between the start and end points.	

i) Describe the topography/ terrain of a location/area

Not applicable	
Determine elevation (height) from the contours on a map.	
Analyse the topography of an area from the contours; and calculate the slope/gradient between two points.	

Interpret and infer knowledge of the topography of an area (including landforms and slope).	

j) Discern/explain patterns of occurrence of phenomena

Not applicable	
*	
Analyse the occurrence (spatial location) of a phenomenon.	
Explain / infer knowledge from the occurrence of phenomena.	

k) Compare the characteristics of symbols/patterns

Not applicable	
Make a simple comparison between two symbols/ patterns from their characteristics	
Make comparisons between more complex symbols / patterns from their characteristics	
Infer knowledge from the comparison between more complex symbols / patterns from their characteristics	

l) Interpret/ infer knowledge from the spatial interrelationship of symbols/phenomena

Not applicable	
*	
Analyse / interpret the spatial relationship between adjoining or nearby symbols / phenomena (why do they occur next to each other)	
Interpret / infer knowledge from the spatial relationships between symbols / phenomena in a region	

m) Determine the coordinate/ geographical position of a place on the map

Not applicable	
*	
Determine a grid square on a map using the grid locator (e.g. A6)	
Determine the co-ordinate of a point from the grid (X,Y) or graticule (lat., long.) on the map.	

n) Locate a place/position on the map from its coordinates/geographical position

Not applicable	
Given the grid square (C5) of a point locate its position on the map	
Given the geographical coordinate (lat.,long.) of a point locate its position on the map.	
Given the grid coordinate (X,Y) of a point locate its position on the map.	

o) Determine the distance between two positions

Not applicable	
Use the scale bar to measure the distance between two points	
Measure the distance between two points using a scale rule	
*	

p) Determine the area (extent) of a region

Not applicable	
*	
Estimate the area (extent) of a region / polygon	
Calculate the area (extent) of a region / polygon	

q) Determine the length of a linear feature

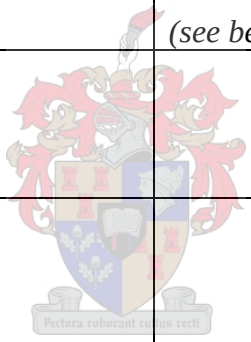
Not applicable	
*	
Estimate the length of a curvilinear symbol (line)	
Measure the length of a curvilinear symbol.(line).	

r) Understand the map projection

Not applicable	
Basic understanding of elementary characteristics of a map projection (representation of the Earth on a flat surface introduces distortions)	
Understand characteristics and differences between map projections (equal area, equidistant, conformal)	
High level of understanding of map projection; and transform/convert coordinates of points/lines from one projection to another.	

6. PLEASE LIST ANY OTHER MAP USE/ GEO-SPATIAL INFORMATION USE TASKS PERFORMED IN YOUR WORK THAT ARE NOT LISTED ABOVE:

TASK	*LEVEL OF SKILL REQUIRED (see below)*



7. THANK YOU FOR YOUR TIME AND CONTRIBUTION.
DO YOU WISH TO RECEIVE THE RESULTS OF THIS ASSESSMENT (by e-mail only)

YES ☐ NO ☐

Levels of skill in map use :

Level 1 :

Get the main idea from a single or simple symbol (search, locate, identify, compare a single symbol). Simple estimation (measure, calculate, relative size) on familiar symbols.

Level 2:

Recognising properties of symbol groups on the map as a whole and analysing spatial patterns (more complex recognition, reorganisation, decoding, detection, compare, discriminate, contrast) More complex estimation.

Level 3:

More complex tasks leading to understanding the meaning of spatial phenomena for knowledge enhancement. At this level inferential reasoning is used from the spatial relationships, patterns and map phenomena of one or more referents or source. Higher-order mental models are constructed. The user draws on domain specific knowledge.

For clarification or further information please contact Mr D Clarke at 0825775665 or e-mail: dclarke@sli.wcape.gov.za

ANNEXURE B : ANALYSIS OF RESPONSES ON USE OF GEO-SPATIAL (MAP) INFORMATION

No	Organisation	Position	Use Spatial Info		Extent of Use			Frequency of Use			
			Yes	No	V little	Moderate	Extensive	V. seldom	Monthly	Weekly	Daily
1	Nat: Dept of Health	Director: Health Facilities Planning	1				1		1		
2	Ethekwini Municipality	Manager	1				1				1
3	Local Gov & Housing	Control Industrial		1							
4	Spatial Planning Directorate	Chief Industrial Technician	1				1				1
5	I E C	Deputy Manager	1				1				1
6	Dept of Housing: West Cape	Senior Admin Officer	1				1				1
7	Dept of Correctional Services	Asst-dir: Admin Sec: Central Services		1							
8	Prov Admin: Dept of Health	Director	1				1				
9	RLCC-MP	Project Co-ordinator	1				1				1
10	Dept Envir Affairs &Dev Plan	Deputy Director	1				1				1
11	Capricorn District Municipality	GIS Officer	1				1				1
12	S A National Parks	Co-ordinator: Nat/Corp GIS	1				1				1
13	Prov Dept of Health	A S D	1							1	
14	Dept of Housing: West Cape	Chief Engineer	1			1				1	
15	NC DOT Roads and Works	Chief Engineer Construction	1			1			1		
16	Dept of Communications	General Manager		1							
17	Dept of Safety & Liaison	Assistant Driector	1				1		1		
18	Correctional Services	Dept Director	1				1			1	
19	Dept of Health	Chief Director		1							
20	Dept of Health (Gauteng)	Consultant Hospital Planner	1				1			1	
21	Uthungulu District Munic.	GIS Officer	1				1				1
22	Mpumalanga PLR0	Senior Planner	1			1		1			
23	City of Tshwane Metro Munic.	Act. Manager: Geomatics	1								1
24	Msundazi Municipality	Process MGR: IP&S	1								1
25	Buffalo City Municipality	Program Manager: Land Surveying	1								1
26	Uthukela Dist Municipality	Planning & IT Manager	1			1			1		
27	Dept of Land Affairs	Deputy Director	1				1				1
28	Dept of Agriculture N-Cape	Deputy Director	1								1
29	Land Claims (FS/WC)	D.D.	1				1				
30	National Dept of Health	Asst Director	1			1					
31	Gert Sibande Dist Mun.	Director: Planning	1								
32	Dept:Public works,road,temp.	Director: Works Infrastructure	1			1				1	
33	KZN: PLRO: Ladysmith	Chief Planner	1				1			1	
34	Eskom Distribution Group	Eskom Dist Group: Spatial Data Manager	1				1				1
35	Mintek	Head: Mineral Economics & Strategy ONIT	1			1			1		
36	Dept: works, transport & Road	Assistant Director: Engineer	1			1					
37	Ilemba District Municipality	GIS Officer	1				1			1	
38	Nelson Mandela Metro Mun.	Planning & Development Officer	1				1				1
39	Dept of Health	Director	1		1						
40	Dept of Health	Senior Statistical Advisor		1							
41	Dept of Agriculture N-West	Land Technician	1								1
42	Dept of Agruculture NWP	Industrial Technician	1								1
43	Umgungundlovu Dist. Mun.	GIS Manager	1								
44	DACEL. Veteninary Services	Chief Animal Health Technician	1				1				1
45	Dept. Roads and Public works	Chief Director: Roads	1				1			1	
46	O.R. Tampo Dist. Mun.	GIS Manager	1								1
47	Dept of Education E-Cape	Director: Physical Planning	1			1					
48	SANDF: Dire: Geospatial	Brigadier General	1				1				1
49	Southern Dist Municipality	Manager: Infrastructure dev. Strat plan.	1			1			1		
50	Dept land Affairs	Chief Town and Regional Planner	1								1
51	Dept: Water Affairs & Forestry	Manager: Business Information	1				1				1
52	Dept: Local and Housing	Chief Industrial Technician	1								1
53	Goespace International	Director	1								1
54	Ukhahlamba Dist. Mun.	Manager: Strategic Support	1			1					1
55	Umzinyathi Dist. Mun.	GIS Technician	1								1
56	Dept Enviro Affairs & Tourism	Director: State of Environment	1			1				1	
57	FS PLRO	Chief Planner	1							1	
58	Dept of Agriculture	Senior Agricultural Scientist	1								1
59	Enviro. & Conservation	Assistant Director: Dept; Agri & Cons.	1			1				1	
60	West Coast Dist. Mun.	Snr Town & Regional Planner	1				1			1	
61	Dept. of Education	Chief Education Specialist	1				1				1
62	Dept: Housing & Local Govt	SAO	1			1				1	
63	Central Karoo Dist. Mun.	Director: Technical Services	1			1			1		
64	Africon	GIS Specialist/Engineer	1				1				1
65	Land Affairs	Acting Deputy Director	1				1				
66	Amatole District Municipality	IT Manager	1			1			1		
67	Siyanda District Municipality	Head: Community Development Serv	1			1					
68	Dept Agric : Land Use & Soil Man	Acting Manager	1				1				1
69	City of Cape Town	Sustainable Resource Man Specialist	1				1				
70	City of Cape Town	Tech Support D Planning & Environ	1								1
71	Dept land Affairs	Chief Planner - Queenstown	1			1					
72	City of Cape Town	Coordinator Tech Support Planning & Env	1								1
73	Umhlabuyalingana Municipality	Municipal Manager		1							
74	Dept of Land Affairs	Principal Planner Vryheid	1				1				1
75	KZN Agric & Environ	GIS Analyst	1				1				1
76	Ekurhuleni Metro Municipality	Exec Manager Planning Info Manage	1				1				1
77	Dept of Health	DD Info Management	1				1				1
78	Ba-Phalaborwa Municipality	Acting Town Planner	1								1
		Column Totals =	72	6	1	18	34	1	8	13	38
		% of Total =	92.3	7.7							
		% of responses =			1.9	34.0	64.2	1.7	13.3	21.7	63.3

ANNEXURE C : ANALYSIS OF MAP USE TASKS AND SKILL LEVELS

MAP USE TASK AND SKILL LEVEL

No	Organisation	a				b				c				d				e				f				g				h				i				j				k				l				m				n				o				p				q				r			
		n/a	1	2	3	n/a	1	2	3	n/a	1	2	3	n/a	1	2	3	n/a	1	2	3	n/a	1	2	3	n/a	1	2	3	n/a	1	2	3	n/a	1	2	3	n/a	1	2	3	n/a	1	2	3	n/a	1	2	3	n/a	1	2	3	n/a	1	2	3	n/a	1	2	3	n/a	1	2	3	n/a	1	2	3	n/a	1	2	3
1	Nat: Dept of Health			1				1			1				1			1					1					1					1				1			1				1			1					1			1				1				1				1				1			1	1			
2	Ethekwini Municipality			1				1				1				1			1					1				1				1				1				1				1				1				1				1			1						1				1				1
3	Local Gov & Housing																																																																								
4	Spatial Planning Directorate				1		1						1		1				1						1				1				1				1			1			1						1				1				1				1				1				1				1
5	I E C				1				1				1				1		1						1		1						1				1	1				1							1				1						1				1				1			1	
6	Dept of Housing: West Cape		1						1				1				1			1					1						1		1			1				1				1							1					1			1							1					1		1						1		
7	Dept of Correctional Services																																																																								
8	Prov Admin: Dept of Health		1							1		1				1							1					1			1				1				1				1						1			1								1					1					1						1			1				1			
9	RLCC-MP			1				1					1			1								1					1				1				1		1																									1					1					1					1			1		
10	Dept Envir Affairs &Dev Plan				1				1				1				1				1				1				1				1				1				1				1				1				1				1					1				1				1				1
11	Capricorn District Municipality				1				1				1				1				1				1				1				1			1						1				1				1				1				1			1						1				1			
12	S A National Parks				1				1				1				1			1						1				1					1					1				1				1				1				1					1					1				1				1				1
13	Prov Dept of Health		1						1				1				1				1				1				1				1				1				1				1			1				1						1				1				1						1				1				1		
14	Dept of Housing: West Cape			1						1				1						1				1					1				1					1							1				1				1				1					1				1				1					1				1				1		
15	NC DOT Roads and Works				1				1				1				1				1				1				1				1				1				1				1				1				1				1					1				1				1					1	
16	Dept of Communications																																																																								
17	Dept of Safety & Liaison				1				1				1				1	1						1				1				1				1						1				1						1					1				1					1						1						1					1	
18	Correctional Services		1						1					1						1						1				1							1					1						1			1								1					1							1					1						1			1		
19	Dept of Health																																																																								
20	Dept of Health (Gauteng)				1				1				1				1						1				1			1				1				1						1						1				1					1						1		1								1				1			1		
21	Uthungulu District Munic.				1				1				1				1				1				1					1				1						1				1				1				1				1				1					1				1				1					1	
22	Mpumalanga PLR0				1				1						1				1				1					1				1						1				1				1				1			1					1								1							1				1				1			
23	City of Tshwane Metro Munic.				1				1				1				1				1				1				1				1				1				1				1				1				1				1					1						1				1				1
24	Msundazi Municipality	1						1			1				1								1				1			1						1				1		1				1						1						1					1				1		1							1			1		
25	Buffalo City Municipality				1				1				1				1						1				1				1				1				1						1						1										1				1						1				1				1				1
26	Uthukela Dist Municipality				1				1				1				1				1				1				1				1				1				1				1				1				1				1				1				1				1				1
27	Dept of Land Affairs			1				1							1						1				1				1					1				1				1				1				1				1				1					1						1						1						1						1	
28	Dept of Agriculture N-Cape			1						1						1				1				1				1						1						1				1				1				1				1												1						1						1						1		
29	Land Claims (FS/WC)				1				1			1				1				1				1				1						1			1						1					1						1				1				1						1						1						1				1		
30	National Dept of Health				1		1								1				1						1				1						1						1				1				1				1				1							1						1				1								1	1				1			
31	Gert Sibande Dist Mun.				1				1				1						1				1				1				1				1				1							1							1							1				1				1				1				1				1					1	
32	Dept:Public works,road,temp.		1						1			1						1				1					1				1				1					1							1				1						1				1				1				1				1				1					1	
33	KZN: PLRO: Ladysmith				1				1						1				1						1				1					1						1				1						1					1							1						1					1					1					1				1			1			
34	Eskom Distribution Group				1				1				1				1				1				1				1				1				1				1				1				1				1				1				1					1					1					1
35	Mintek			1				1			1							1			1						1						1				1				1			1						1				1						1						1						1				1						1			1		
36	Dept: works, transport & Road				1				1					1						1				1				1				1				1				1				1				1			1						1						1		1				1			1						1				1		
37	Ilemba District Municipality			1				1						1				1				1			1						1				1					1							1				1				1					1				1					1				1				1					1		
38	Nelson Mandela Metro Mun.				1				1				1				1				1				1				1				1				1				1				1				1				1				1					1				1				1				1
39	Dept of Health				1				1				1				1			1						1						1				1						1				1					1						1				1					1						1					1				1				1					1		
40	Dept of Health																																																																								
41	Dept of Agriculture N-West				1				1						1						1						1						1						1						1						1	1							1				1				1				1					1				1				1					1	
42	Dept of Agruculture NWP				1				1						1			1						1						1				1				1				1						1				1						1				1				1					1				1				1			1		
43	Umgungundlovu Dist. Mun.								1				1				1			1						1					1						1				1				1				1				1				1				1			1						1				1				1
44	DACEL. Veteninary Services				1				1				1				1				1				1				1				1				1																		1			1						1						1						1	
45	Dept. Roads and Public works				1				1						1				1				1						1						1				1						1						1						1						1						1				1						1		1								1				1		
46	O.R. Tampo Dist. Mun.				1						1				1				1				1				1				1						1				1				1				1						1				1				1			1							1	1							1	
47	Dept of Education E-Cape				1				1				1				1				1				1				1				1	1								1				1				1				1				1					1		1								1				1
48	SANDF: Dire: Geospatial				1				1				1				1				1				1				1				1				1				1				1				1				1				1					1				1				1				1
49	Southern Dist Municipality				1				1				1				1			1						1				1				1				1						1						1						1				1				1					1				1				1					1	
50	Dept land Affairs				1				1				1				1				1				1				1				1				1				1				1				1				1				1					1				1				1				1
51	Dept: Water Affairs & Forestry				1				1				1				1			1						1				1				1				1				1				1				1				1				1					1				1				1				1
52	Dept: Local and Housing				1				1				1				1				1				1				1				1				1				1				1				1				1				1					1				1				1				1
53	Goespace International		1				1						1						1				1							1						1				1				1																										1				1						1				1				1
54	Ukhahlamba Dist. Mun.				1				1				1				1				1				1				1				1				1				1				1				1				1				1					1				1				1				1
55	Umzinyathi Dist. Mun.		1						1						1						1			1				1				1				1				1						1						1						1				1				1					1						1				1				1
56	Dept Enviro Affairs & Tourism				1				1				1		1						1				1						1		1						1						1				1						1				1				1					1				1				1					1	
57	FS PLRO		1				1						1				1				1						1				1					1				1				1						1				1							1						1					1					1							1					
58	Dept of Agriculture				1				1				1				1				1				1						1						1				1						1						1						1				1						1				1					1				1						1	
59	Enviro. & Conservation				1				1				1						1				1						1						1				1						1				1						1				1				1						1			1						1				1						1	
60	West Coast Dist. Mun.				1				1				1				1				1						1						1						1				1				1				1				1				1				1					1				1				1					1	
61	Dept. of Education				1				1								1						1						1				1				1	1				1				1							1						1		1								1	1							1
62	Dept: Housing & Local Govt		1						1						1				1			1							1						1		1						1							1					1							1							1		1									1						1						1						1	
63	Central Karoo Dist. Mun.				1																		1				1				1				1				1																						1				1					1				1				1				1
64	Africon				1				1						1						1			1						1				1				1				1				1				1				1				1				1					1				1				1				1
65	Land Affairs				1				1			1						1					1			1				1						1				1						1												1						1						1						1				1				1					1	
66	Amatole District Municipality		1				1				1				1				1				1				1				1				1				1				1				1						1				1				1				1				1			1			
67	Siyanda District Municipality			1				1						1						1						1						1						1						1						1				1				1						1						1				1				1					1				1				1
68	Dept Agric : Land Use & Soil Man				1				1				1				1				1				1				1				1				1				1				1				1				1				1					1				1				1				1
69	City of Cape Town				1				1				1				1				1				1						1				1				1				1				1				1				1				1					1				1				1			1		
70	City of Cape Town				1				1				1				1				1				1						1			1			1				1						1						1				1				1					1				1				1					1	
71	Dept land Affairs				1				1				1				1				1				1							1				1										1						1						1					1											1									
72	City of Cape Town				1				1				1				1				1				1						1			1			1				1						1						1				1				1					1						1				1					1	
73	Umhlabuyalingana Municipality																																																																								
74	Dept of Land Affairs				1		1				1						1				1				1						1			1				1						1				1				1				1				1					1						1					1		1			
75	KZN Agric & Environ			1						1				1				1				1				1				1				1				1				1				1				1				1				1					1				1						1				1
76	Ekurhuleni Metro Municipality				1				1						1				1						1						1						1				1						1				1						1				1				1				1					1				1				1				1
77	Dept of Health			1						1						1				1				1				1	1				1							1						1						1						1		1				1						1						1						1						1		
78	Ba-Phalaborwa Municipality		1				1				1				1				1						1						1		1						1						1				1						1				1				1					1				1		1							1
	Column Totals =	1	11	11	48	0	12	11	48	3	7	19	41	2	10	12	47	1	20	9	41	1	8	24	39	1	17	26	27	3	18	15	36	6	17	9	40	12	1	20	34	5	18	14	30	6	1	25	35	3	1	17	47	4	10	14	43	1	26	41	3	6	2	20	44	9	2	15	45	7	17	19	26
	Total responses for map use task=	71				71				70				71				71				72				71				72				72				67				67				67				68				71				71				72				71				69			
	% indicated map use task not applicable =	1.4				0.0				4.3				2.8				1.4				1.4				1.4				4.2				8.3				17.9				7.5				9.0				4.4				5.6				1.4				8.3				12.7				10.1			
	% indicated skill level for map use task =		15.5	15.5	67.6		16.9	15.5	67.6		10.0	27.1	58.6		14.1	16.9	66.2		28.2	12.7	57.7		11.1	33.3	54.2		23.9	36.6	38.0		25.0	20.8	50.0		23.6	12.5	55.6		1.5	29.9	50.7		26.9	20.9	44.8		1.5	37.3	52.2		1.5	25.0	69.1		14.1	19.7	60.6		36.6	57.7	4.2		2.8	27.8	61.1		2.8	21.1	63.4		24.6	27.5	37.7

ANNEXURE D : ANALYSIS OF MAP LITERACY TESTS OF MAPAWARE INTERVENTION

NAME	PRE - TEST														POST - TEST														Pre-Test %	Post-Test %	Diff	Impro %	Pre-80+	Post 80+	Diff >0	Impro >25	Impro >=50
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	1	2	3	4	5	6	7	8	9	10	11	12	13	14									
Kimberley PLRO																																					
Mojapelo P	1	1	1	1	1	1	1			1				1	1	1	1	1	1	1	1	1		1				1	64	71	7	11	0	0	1	0	0
Lekgatsane L	1	1	1	1	1	1				1			1	1		1	1	1	1	1	1	1	1	1					64	64	0	0	0	0	0	0	0
Sitsila M		1	1	1		1		1	1				1	1		1	1	1	1		1			1				1	57	50	-7	-13	0	0	0	0	0
Mautlwa D	1	1	1	1		1	1	1	1						1	1			1		1	1		1				1	57	50	-7	-13	0	0	0	0	0
Sebaeng C	1	1	1				1	1						1	1	1	1		1	1	1			1					43	50	7	17	0	0	1	0	0
Booysen B	1	1	1	1	1	1					1			1	1	1	1	1	1	1	1	1	1	1			1		57	79	21	38	0	0	1	1	0
Madisa K		1		1	1	1		1		1	1			1	1	1	1	1	1		1		1	1					57	57	0	0	0	0	0	0	0
Ntehelang L	1		1	1			1		1			1		1	1	1	1	1	1		1	1		1				1	50	64	14	29	0	0	1	1	0
Nel C	1	1	1	1						1	1			1	1	1	1	1	1		1	1		1			1		50	64	14	29	0	0	1	1	0
May L	1	1	1	1		1								1	1	1	1	1	1	1	1		1	1	1				43	71	29	67	0	0	1	1	1
Mamabolo J	1	1	1	1		1			1	1					1	1	1		1	1			1						50	43	-7	-14	0	0	0	0	0
11	9	10	10	10	4	8	4	4	4	4	3	2	2	9	9	11	10	8	11	6	10	6	5	10	1	0	2	4	Average:								
%	82	91	91	91	36	73	36	36	36	36	27	18	18	82	82	100	91	73	100	55	91	55	45	91	9	0	18	36	54	60	6						
Educators Port Elizabeth																																					
Vumazonke Z	0	1		1												1	1	1	1	1	1				1	1		1	14	64	50	350	0	0	1	1	1
Mavengana J	1	1		1	1			1	1				1		1	1		1	1			1	1	1	1		1	1	50	71	21	43	0	0	1	1	0
Msutwana V	1	1	1	1	1	1	1	1	1	1					1	1		1	1	1	1	1	1	1		1		1	71	79	7	10	0	0	1	0	0
Sithembiso S	1	1	1	1	1	1	1	1	1	1					1	1			1		1	1				1	1	1	71	57	-14	-20	0	0	0	0	0
Dingani S	1	1	1	1	1		1	1								1	1		1		1	1	1	1		1		1	50	64	14	29	0	0	1	1	0
Hoboshe N		1		1			1				1	1			1	1	1	1	1	1									36	43	7	20	0	0	1	0	0
Bashman N	0	1	1		1		1	1							1	1	1	1	1	1	1	1	1		1		1	1	36	86	50	140	0	1	1	1	1
Majova N		1	1									1			1			1						1	1	1			21	36	14	67	0	0	1	1	1
Ntulu N		1		1	1	1				1						1	1	1	1		1					1		1	36	50	14	40	0	0	1	1	0
Makalima G	0			1	1	1			1				1			1	1	1	1	1	1		1			1	1	1	36	71	36	100	0	0	1	1	1
Mangcangaza N	0			1	1				1	1						1	1	1	1				1	1					29	43	14	50	0	0	1	1	0
Maloyi V	1	1	1	1	1		1				1	1	1			1	1	1			1		1	1	1	1	1	1	64	71	7	11	0	0	1	0	0
Mollies J	1	1	1	1		1	1	1	1				1		1	1	1	1	1	1	1	1	1	1			1	1	64	86	21	33	0	1	1	1	0
Ta Ta M				1						1	1			1	1		1	1	1					1			1	1	29	50	21	75	0	0	1	1	1
Tengwa N		1		1			1	1	1		1					1	1	1	1	1				1					43	43	0	0	0	0	0	0	0
Sizani P	1	1	1	1	1		1	1	1		1	1				1	1		1		1		1				1	1	71	50	-21	-30	0	0	0	0	0
Benjamin B	1	1	1	1	1	1	1	1	1	1		1	1		1	1	1		1	1	1	1	1				1	1	86	71	-14	-17	1	0	0	0	0
Smith E	1	1	1	1	1	1	1			1	1				1	1	1	1	1	1	1	1	1	1	1		1	1	64	93	29	44	0	1	1	1	0
Gallant L	1	1	1	1	1	1		1					1		1	1	1	1	1		1	1	1	1	1	1	1		57	86	29	50	0	1	1	1	0
Gora T	1	1	1	1	1	1	1			1						1	1	1	1		1	1				1		1	57	57	0	0	0	0	0	0	0
Gqabaza G	0	1		1												1	1	1	1										14	29	14	100	0	0	1	1	1

Wepener N	1	1	1	1		1	1	1	1	1					1	1	1	1	1	1	1	1	1	1		1	1	1	64	93	29	44	0	1	1	1	0
Sogoni D	1	1	1	1	1	1				1					1	1	1	1	1	1	1	1	1	1	1	1	1	1	50	100	50	100	0	1	1	1	1
Luke L	1	1	1	1	1	1			1	1			1		1	1		1				1		1			1	1	64	50	-14	-22	0	0	0	0	0
Botha M	1	1	1	1	1	1			1	1			1		1	1		1	1			1		1	1		1	1	64	64	0	0	0	0	0	0	0
Ngcelwane K	1	1	1	1	1	1	1	1	1	1					1	1		1	1	1	1	1	1	1		1		1	71	79	7	10	0	0	1	0	0
Mshumpela N	1	1	1	1	1	1	1			1					1	1	1	1	1	1	1			1					57	57	0	0	0	0	0	0	0
Majola N	1					1	1	1	1						1	1	1	1	1										36	36	0	0	0	0	0	0	0
Williams A		1	1			1	1		1	1		1			1	1	1		1		1		1		1		1	1	50	64	14	29	0	0	1	1	0
Petersen B	1	1	1	1	1	1	1	1		1		1			1	1	1	1	1	1	1	1		1		1	1	1	71	86	14	20	0	1	1	0	0
Henna N		1	1	1		1			1	1	1	1				1	1				1	1	1	1		1	1		57	57	0	0	0	0	0	0	0
De Klerk c			1	1	1	1	1	1							1	1	1	1	1	1	1	1	1	1		1		1	43	86	43	100	0	1	1	1	1
Masala B		1	1	1			1	1	1				1		1	1	1	1	1	1	1	1	1	1			1	1	50	86	36	71	0	1	1	1	1
Petrus J				1						1						1	1		1			1		1		1			14	43	29	200	0	0	1	1	1
Madubela n		1	1	1	1	1			1	1					1	1	1			1	1		1	1		1			50	57	7	14	0	0	1	0	0
Masondo C		1	1	1	1	1	1		1			1			1	1	1	1	1	1	1			1		1			57	64	7	13	0	0	1	0	0
Makeng R	1	1		1	1	1		1							1	1	1	1	1	1	1			1		1			43	64	21	50	0	0	1	1	0
Booysen C	1	1	1	1											1	1	1	1	1	1	1	1	1	1		1	1	1	29	93	64	225	0	1	1	1	1
Jacobs I		1		1		1	1			1		1			1	1	1	1	1	1	1	1	1	1		1	1	1	43	93	50	117	0	1	1	1	1
Van Rooyen A	1	1	1	1		1	1	1	1	1					1	1	1	1	1	1	1	1	1	1		1		1	64	86	21	33	0	1	1	1	0
Thomas P		1	1	1		1	1					1			1	1	1	1	1	1	1	1	1	1		1		1	43	86	43	100	0	1	1	1	1
Sezoe D		1	1	1	1	1	1					1			1	1	1	1	1	1	1	1	1	1		1		1	50	86	36	71	0	1	1	1	1
Rademeyer V	0	1	1	1	1	1	1	1		1	1				1	1	1		1	1	1	1	1	1		1		1	64	79	14	22	0	0	1	0	0
Lehman C	1	1	1	1	1	1	1			1					1	1	1		1	1	1	1	1	1	1	1	1	1	57	93	36	63	0	1	1	1	1
Abrahams s		1	1	1			1	1		1					1	1	1		1		1					1	1	1	43	57	14	33	0	0	1	1	0
Louis E		1				1										1			1							1	1	1	14	29	14	100	0	0	1	1	1
Benya A									1						1	1	1		1	1				1				1	7	50	43	600	0	0	1	1	1
Mjekula L		1													1	1	1		1		1			1				1	7	50	43	600	0	0	1	1	1
Tsako A		1			1		1		1						1	1	1	1				1	1			1		1	29	57	29	100	0	0	1	1	1
Machona L		1		1	1	1									1	1	1	1	1	1	1	1	1			1		1	29	79	50	175	0	0	1	1	1
Stefane B	1	1	1	1		1	1	1	1	1		1	1		1	1	1	1	1	1	1	1	1	1		1		1	79	86	7	9	0	1	1	0	0
Athonie J		1		1		1		1								1	1	1	1	1	1	1	1	1	1		1		29	79	50	175	0	0	1	1	1
Ngwabeni N	0														1	1	1		1		1						1		0	43	43	inf	0	0	1	1	1
Nthako K		1	1		1		1		1							1	1		1		1						1		36	36	0	0	0	0	0	0	0
Tshamgana L	0	1								1						1	1		1		1				1		1		14	43	29	200	0	0	1	1	1
Neff R	1	1	1	1	1		1			1					1	1	1	1	1	1	1	1	1	1		1	1	1	50	93	43	86	0	1	1	1	1
Ruiters M			1	1	1	1	1		1						1	1	1	1	1	1	1	1	1	1	1	1	1	1	43	100	57	133	0	1	1	1	1
Gallant L		1		1		1	1		1	1					1	1	1	1	1	1	1	1	1	1		1		1	43	86	43	100	0	1	1	1	1
Jordaan S		1		1		1									1	1	1		1			1	1			1	1		21	57	36	167	0	0	1	1	1
Dennis M	1	1	1	1	1		1	1	1	1	1	1	1		1	1	1	1	1		1	1	1	1		1		1	86	79	-7	-8	1	0	0	0	0
Rawat Z				1	1	1	1	1							1	1	1	1	1		1	1	1	1			1	1	36	79	43	120	0	0	1	1	1
Jooste T	1		1	1	1	1	1	1	1	1		1			1	1	1		1	1	1	1		1	1	1	1	1	71	86	14	20	0	1	1	0	0
Swart E		1		1	1		1	1	1	1					1	1	1	1	1	1	1		1	1		1	1	1	50	86	36	71	0	1	1	1	1

Muller K		1		1	1				1	1		1			1	1	1		1	1	1	1	1	1	1	1		1	43	86	43	100	0	1	1	1	1
Draai J				1			1	1	1						1	1	1	1	1		1	1	1	1	1	1		1	29	86	57	200	0	1	1	1	1
Mbengashe N	0	1					1				1				1	1	1	1	1	1	1	1							21	57	36	167	0	0	1	1	1
Saleem A	1	1	1	1	1	1	1	1	1	1						1	1	1	1		1	1	1	1	1		1	1	71	79	7	10	0	0	1	0	0
67	28	55	39	55	38	39	41	28	32	33	10	16	11	1	50	65	59	47	60	37	53	41	42	47	18	38	35	49	Average:								
%	42	82	58	82	57	58	61	42	48	49	15	24	16	1.5	75	97	88	70	90	55	79	61	63	70	27	57	52	73	45.4	68.3	23					
Public Works PE																																					
Ngcolomba M	0	1	1				1			1				1		1	1							1				1	36	29	-7	-20	0	0	0	0	0
Masiza S	1	1	1		1	1									1	1	1	1	1	1	1	1	1	1		1		1	36	86	50	140	0	1	1	1	1
Mbzelu b	1	1		1						1					1	1	1	1	1	1	1	1	1	1				1	29	79	50	175	0	0	1	1	1
Nomgalo E	1	1				1				1					1	1	1	1	1	1	1	1	1	1			1	1	29	86	57	200	0	1	1	1	1
Maletye M	1	1	1	1	1				1	1			1		1	1	1			1		1	1	1					57	50	-7	-13	0	0	0	0	0
Nogantshi X	1	1	1		1					1			1		1	1	1	1		1	1	1	1	1	1	1	1	1	43	93	50	117	0	1	1	1	1
Mgudlwa N	0	1				1				1	1			1				1				1	1			1			36	29	-7	-20	0	0	0	0	0
Nortier s	1	1	1		1	1			1	1	1	1			1	1	1	1		1	1	1	1	1	1	1	1	1	64	93	29	44	0	1	1	1	0
Kweba M	1	1	1		1	1				1					1	1	1		1		1			1			1	1	43	57	14	33	0	0	1	1	0
Mkunqwana M	1	1	1												1	1	1	1	1	1		1	1	1		1	1	1	21	86	64	300	0	1	1	1	1
Jikela N		1	1				1						1		1	1	1	1	1		1	1	1	1	1		1	1	29	86	57	200	0	1	1	1	1
Taai R	1	1	1	1	1	1	1		1	1					1	1	1	1	1	1	1		1	1		1	1	1	64	86	21	33	0	1	1	1	0
Cikolo N		1	1	1	1	1									1	1	1	1	1	1	1	1	1	1	1	1	1	1	36	100	64	180	0	1	1	1	1
Majeke s	1	1	1		1	1			1	1			1		1	1	1	1		1	1	1	1	1		1	1	1	57	86	29	50	0	1	1	1	0
Siginanda N	0	1	1	1	1										1	1	1	1		1	1	1	1	1	1	1		1	29	86	57	200	0	1	1	1	1
Mdoda A	1	1	1	1	1		1										1	1	1				1		1				43	36	-7	-17	0	0	0	0	0
16	11	16	13	6	10	8	4	0	4	10	2	1	4	2	13	14	15	13	9	11	11	12	14	14	6	9	9	13	Average:								
	69	100	81	38	63	50	25	0	25	63	13	6.3	25	13	81	88	94	81	56	69	69	75	88	88	38	56	56	81	40.6	72.8	32					
Water Affairs George																																					
Louw, A		1		1											1	1	1	1		1			1	1	1				14	57	43	300	0	0	1	1	1
Meyer, P	1	1	1				1		1		1				1	1	1	1	1	1	1	1	1	1	1	1	1	1	43	100	57	133	0	1	1	1	1
Hattingh,D	1	1	1	1	1					1						1		1	1	1	1	1	1	1	1		1	43	79	36	83	0	0	1	1	1
Mvunyiswa,S		1			1	1	1		1		1				1	1	1	1	1	1	1	1				1		1	43	71	29	67	0	0	1	1	1
Steyn, R	1	1			1	1	1		1						1	1	1	1	1	1	1	1				1		1	43	71	29	67	0	0	1	1	1
Arendorff, D	1	1	1	1	1	1	1		1	1					1	1	1	1	1	1	1	1		1		1		1	64	79	14	22	0	0	1	0	0
Pretorius, B		1								1			1		1	1		1		1	1	1	1	1				1	21	64	43	200	0	0	1	1	1
Harrison, P	1		1		1				1	1						1		1	1	1	1	1	1			1	1	1	36	71	36	100	0	0	1	1	1
Manzini, M	1	1	1	1	1				1	1	1			1	1	1	1	1	1	1	1	1		1			1		64	71	7	11	0	0	1	0	0
Maya, K		1								1			1	1	1	1	1	1	1	1	1	1	1	1				1	29	79	50	175	0	0	1	1	1
Swanepoel, S	1	1	1	1	1		1		1	1	1	1			1	1	1	1	1	1	1	1	1	1	1	1	1	1	71	100	29	40	0	1	1	1	0
Kortje, H	1	1	1	1	1					1	1				1	1	1	1	1	1	1	1	1	1		1	1	1	50	93	43	86	0	1	1	1	1
Neethling, H		1	1	1	1		1		1	1	1		1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	64	100	36	56	0	1	1	1	1
Erfmann, W	1	1	1	1	1		1		1	1	1				1	1	1	1	1	1	1	1	1	1	1	1	1	1	64	100	36	56	0	1	1	1	1
Witbooi, S	1	1	1	1	1	1	1		1	1					1	1	1	1	1	1	1	1	1	1		1		1	64	86	21	33	0	1	1	1	0
Opperman, R	1	1	1	1	1		1		1	1	1				1	1	1	1	1	1	1	1	1	1	1	1	1	1	64	100	36	56	0	1	1	1	1

Alexander, A		1	1		1					1	1		1		1	1	1	1	1	1	1	1	1	1	1			1	43	86	43	100	0	1	1	1	1
Vaas, J	1	1	1	1	1	1			1						1	1	1	1	1	1			1			1		1	50	64	14	29	0	0	1	1	0
Makampies, J	1	1	1	1					1						1	1		1		1		1	1	1					36	50	14	40	0	0	1	1	0
James, J		1								1			1		1	1	1	1	1	1	1	1	1	1				1	21	79	57	267	0	0	1	1	1
20	13	19	14	12	14	5	9	0	13	14	9	1	5	2	18	20	16	20	17	20	17	18	16	16	8	13	8	17	Average:								
	65	95	70	60	70	25	45	0	65	70	45	5	25	10	90	100	80	100	85	100	85	90	80	80	40	65	40	85	46.4	80	34						
Working for Water North West																																					
Nkwe, M	1	1	1				1				1				1	1	1	1	1	1	1		1	1			1	1	36	79	43	120	0	0	1	1	1
Tsobo, X	1		1	1	1						1				1	1	1	1	1	1				1		1			36	57	21	60	0	0	1	1	1
Matlhabegoane,	1	1	1		1											1	1	1	1	1		1		1				1	29	57	29	100	0	0	1	1	1
Segone, H	1	1			1										1	1		1	1	1		1	1	1	1	1		1	21	79	57	267	0	0	1	1	1
Ndlovu, S	1	1	1	1	1		1				1					1	1	1	1	1	1	1		1			1	1	50	71	21	43	0	0	1	1	0
Mekgoe, K	1	1	1	1	1		1			1					1	1	1	1	1	1	1	1		1			1	1	50	79	29	57	0	0	1	1	1
Molaane, O		1	1					1		1	1					1	1		1	1	1	1	1					1	36	57	21	60	0	0	1	1	1
Dickinson, M	1	1	1	1	1		1		1	1				1	1	1	1	1	1	1	1	1	1	1		1	1	1	64	93	29	44	0	1	1	1	0
Kaekae, A		1	1	1	1		1			1					1	1	1	1	1	1						1	1	1	43	64	21	50	0	0	1	1	0
Venter, G		1				1										1			1	1				1			1	1	14	43	29	200	0	0	1	1	1
Mthombothi, N	1	1	1		1					1			1	1	1	1	1	1	1	1	1	1		1	1	1			50	79	29	57	0	0	1	1	1
Lekhuleni, G	1	1	1		1						1				1	1	1	1	1	1			1		1	1		1	36	71	36	100	0	0	1	1	1
Mpolokeng, L	1	1	1	1	1						1				1	1	1	1		1	1	1							43	50	7	17	0	0	1	0	0
Seale, T	1	1	1		1				1	1		1			1	1	1	1	1	1	1	1	1	1		1	1		50	86	36	71	0	1	1	1	1
Gangashe, K		1	1	1	1									1	1		1	1	1	1	1		1		1	1	1	1	36	71	36	100	0	0	1	1	1
Mathebula, W	1	1	1	1					1							1			1		1							1	36	36	0	0	0	0	0	0	0
Twala, M	1	1			1				1	1						1	1	1	1		1	1		1	1	1		1	36	71	36	100	0	0	1	1	1
Zwane, D	1		1				1								1	1	1	1	1	1	1	1		1		1		1	21	79	57	267	0	0	1	1	1
Motsele, A		1	1								1					1	1	1	1	1				1	1	1			21	57	36	167	0	0	1	1	1
Moyo, E		1				1	1								1	1	1	1	1					1			1		21	50	29	133	0	0	1	1	1
20	10	15	13	7	10	2	6	1	4	7	5	1	1	3	10	15	14	13	15	13	11	9	5	11	4	9	8	11	Average:								
	50	75	65	35	50	10	30	5	20	35	25	5	5	15	50	75	70	65	75	65	55	45	25	55	20	45	40	55	36.4	66.4	30						
Working for Water Kimberley																																					
Roman, L	0	0	0	0	0	0	0	0	0	0	0	0	0	0				1	1	1			1	1	1	1		1	0	57	57	inf	0	0	1	1	1
MacKenzie, R	1	1	1		1	1			1	1					1	1	1	1	1	1	1	1	1	1			1	1	50	86	36	71	0	1	1	1	1
Van Neel, P			1	1						1	1					1			1			1	1	1			1	1	29	50	21	75	0	0	1	1	1
Loxton, D	1	1	1												1	1	1	1	1	1		1	1	1	1	1		1	21	86	64	300	0	1	1	1	1
Thebe, M	1	1	1		1	1					1				1	1	1	1							1			1	43	43	0	0	0	0	0	0	0
Barnett, W	1	1	1		1		1		1						1	1	1	1	1	1	1	1		1		1		1	43	79	36	83	0	0	1	1	1
Pillay, R		1	1		1	1			1				1			1		1	1	1	1	1		1		1		1	43	64	21	50	0	0	1	1	0
Rispel, D	1	1	1		1				1	1	1				1	1		1	1	1	1	1		1	1	1		1	50	79	29	57	0	0	1	1	1
Van Wyk, P	1	1	1		1		1				1				1	1	1	1	1	1	1	1	1	1	1		1	1	43	93	50	117	0	1	1	1	1
Pienaar, E			1						1									1	1	1		1	1	1					14	43	29	200	0	0	1	1	1
Taole, M		1	1	1	1								1		1	1	1	1	1	1		1		1		1			36	64	29	80	0	0	1	1	1
Mangate, J				1												1		1		1								1	7	29	21	300	0	0	1	1	1

Byleveldt, N	1	1	1	1	1		1		1	1					1	1	1	1		1	1	1	1	1	1	1	1	1	57	93	36	63	0	1	1	1	1
Motlhanke, L	1	1	1		1		1			1					1		1		1		1						1	1		43	43	0	0	0	0	0	0	0
Vetbooi, M	1	1	1						1						1	1	1	1	1	1		1					1	1	1	29	71	43	150	0	0	1	1	1
15	9	11	13	4	9	3	4	0	7	5	4	0	2	0	10	12	9	13	12	12	7	11	7	11	6	9	6	12	Average:								
	60	73	87	27	60	20	27	0	47	33	27	0	13	0	67	80	60	87	80	80	47	73	47	73	40	60	40	80	33.8	65.2	31						
Water Affairs PE																																					
Groom, K	1	1		1		1	1			1				1	1	1	1	1	1	1	1	1	1	1		1	1	1	50	93	43	86	0	1	1	1	1
Gqamana, W		1	1		1	1	1		1	1					1	1	1	1	1	1	1	1		1	1	1			50	79	29	57	0	0	1	1	1
Mrubata, N		1			1					1	1				1	1	1		1		1		1	1				1	29	57	29	100	0	0	1	1	1
Ndzimbovu, L		1	1	1	1					1					1	1	1	1	1	1		1	1					1	36	64	29	80	0	0	1	1	1
Lesenyego, K	1	1	1	1	1										1	1	1	1	1	1		1	1	1		1	1	1	36	86	50	140	0	1	1	1	1
Mvinjelwa, V	1	1	1		1	1				1						1		1	1	1		1	1	1	1			1	43	64	21	50	0	0	1	1	0
Jansen, J	1		1	1	1					1	1					1	1	1				1		1			1	1	43	50	7	17	0	0	1	0	0
Zweni, M	1										1				1	1	1	1	1			1	1		1	1	1	1	14	79	64	450	0	0	1	1	1
Klaas, L	1	1	1		1	1			1						1	1	1	1	1	1	1	1					1	1	43	71	29	67	0	0	1	1	1
Nkunkuma, K	1	1	1	1	1		1			1					1	1	1	1	1		1	1	1				1	1	50	71	21	43	0	0	1	1	0
Mooi, K	1	1														1	1	1	1	1		1					1	1	14	57	43	300	0	0	1	1	1
May, U	1	1	1	1	1				1						1	1	1	1	1	1	1	1	1	1	1		1		43	93	50	117	0	1	1	1	1
12	9	10	8	6	9	4	3	0	3	7	3	0	0	1	9	12	11	11	11	8	6	11	8	7	4	5	7	11	Average:								
	75	83	67	50	75	33	25	0	25	58	25	0	0	8.3	75	100	92	92	92	67	50	92	67	58	33	42	58	92	37.5	72	35						
Working for Water Polokwane																																					
Mzimba, W		1	1				1			1	1				1	1	1	1	1	1	1	1	1		1	1			36	86	50	140	0	1	1	1	1
Sefefe, M	1	1	1	1	1	1	1								1	1	1	1	1		1	1	1			1			50	64	14	29	0	0	1	1	0
Mashele, B	1	1	1	1			1								1	1	1	1	1	1	1	1	1			1	1		36	79	43	120	0	0	1	1	1
Basson, S		1	1	1	1		1		1	1				1	1	1		1	1	1	1	1	1		1	1			57	71	14	25	0	0	1	0	0
Louw, B	1	1	1	1	1				1						1	1	1	1		1				1		1	1	1	43	64	21	50	0	0	1	1	0
Singo, N	1	1	1	1		1									1			1	1	1	1	1		1			1		36	57	21	60	0	0	1	1	1
Madavha, M	1	1			1											1	1	1		1	1	1					1		21	50	29	133	0	0	1	1	1
Schlemmer, P	1	1	1	1	1	1	1		1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1			86	86	0	0	1	1	0	0	0
Anderson, B	1	1	1			1	1		1	1	1				1	1	1	1	1	1	1	1	1	1		1			57	79	21	38	0	0	1	1	0
Wessels, B	1	1	1	1	1		1		1	1					1	1	1	1	1	1	1	1	1	1	1	1			57	86	29	50	0	1	1	1	0
Maremba, N		1	1	1	1	1	1		1		1				1	1	1	1	1	1	1	1	1	1					57	71	14	25	0	0	1	0	0
Ngoasheng, T	1	1	1	1	1		1		1	1		1	1		1	1	1	1	1	1	1	1	1	1		1	1	1	71	93	21	30	0	1	1	1	0
Riekert, C	1		1			1	1								1	1	1	1	1	1	1	1	1			1			29	71	43	150	0	0	1	1	1
Belcher, N	1	1	1	1	1		1								1	1	1	1	1	1	1	1	1	1	1		1	1	43	93	50	117	0	1	1	1	1
Lemao, F	1	1		1	1					1					1			1	1	1		1	1	1				1	36	57	21	60	0	0	1	1	1
Sefolosi, C		1		1											1	1		1	1	1	1								14	43	29	200	0	0	1	1	1
Malebo, M	1	1	1		1		1			1			1		1	1	1		1	1	1	1	1	1					50	64	14	29	0	0	1	1	0
Hlungwani, M	1	1	1		1		1		1						1	1	1	1		1	1	1	1	1					43	64	21	50	0	0	1	1	0
Mudau, A	1	1	1		1	1	1			1					1	1	1	1	1	1		1	1	1		1		1	50	79	29	57	0	0	1	1	1
Roux, W	1	1	1	1	1		1	1	1	1	1				1	1	1	1	1	1	1	1	1	1		1	1	1	71	93	21	30	0	1	1	1	0
Joubert, P	1	1	1		1	1	1			1					1	1	1	1	1	1	1	1	1	1		1	1	1	50	93	43	86	0	1	1	1	1

Lithole, S	1	1	1	1	1					1					1	1	1	1	1	1	1	1	1			1			43	71	29	67	0	0	1	1	1
Sevenster, A	1	1	1		1		1			1					1	1	1	1	1	1	1	1	1	1	1	1		1	43	93	50	117	0	1	1	1	1
Van Heerden, H	1	1	1	1	1		1		1	1	1				1	1	1	1	1	1	1	1	1	1	1	1	1	1	64	100	36	56	0	1	1	1	1
Kola, E	1	1	1	1	1					1					1	1	1	1	1	1						1			43	50	7	17	0	0	1	0	0
Koopedi, O	1	1	1	1	1	1	1		1	1					1	1	1	1	1	1	1	1	1	1					64	71	7	11	0	0	1	0	0
Ratshikhopha, A	1	1	1	1	1	1	1		1	1					1	1	1	1	1	1	1	1	1	1					64	71	7	11	0	0	1	0	0
Nemutudi, E		1	1	1	1				1	1					1	1	1	1	1	1	1	1	1	1					43	71	29	67	0	0	1	1	1
Tshivhase, S	1	1			1				1	1					1	1		1	1	1									36	36	0	0	0	0	0	0	0
Machaba, M		1	1			1							1		1	1	1	1	1	1	1	1		1					29	64	36	125	0	0	1	1	1
Mashabane, B	1	1	1	1	1		1		1	1			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	71	93	21	30	0	1	1	1	0
Nemutandani,M	1	1	1		1	1			1							1		1	1	1	1	1	1	1			1		43	64	21	50	0	0	1	1	0
Soginga, D	1		1	1		1	1			1					1		1	1	1	1			1	1	1		1	1	43	71	29	67	0	0	1	1	1
33	23	25	23	16	22	11	18	1	14	19	5	1	5	2	25	25	23	26	25	27	22	23	22	21	7	13	8	10	Average:								
	70	76	70	48	67	33	55	3	42	58	15	3	15	6.1	76	76	70	79	76	82	67	70	67	64	21	39	24	30	47.8	72.7	25						
Working for Water Hazyview																																					
Zandamela, J		1	1	1	1		1			1					1	1	1	1	1	1	1	1		1					43	64	21	50	0	0	1	1	0
White, A	1	1	1	1					1	1					1		1	1	1	1	1	1		1				1	43	64	21	50	0	0	1	1	0
Gumede, D			1			1	1		1							1	1	1	1	1	1	1	1	1		1		1	29	71	43	150	0	0	1	1	1
Sibiya, E	1		1		1				1							1	1	1	1				1		1		1		29	50	21	75	0	0	1	1	1
Mogane, O		1	1		1	1	1			1	1				1	1	1	1	1	1	1	1		1			1	1	50	79	29	57	0	0	1	1	1
Strydom, D	1	1	1	1	1		1		1	1	1		1	1	1	1	1	1	1	1	1	1	1	1		1			79	79	0	0	0	0	0	0	0
Brink, J	1	1	1	1	1		1		1	1	1			1	1	1	1		1	1	1	1	1	1		1		1	71	79	7	10	0	0	1	0	0
Saunders, K	1	1	1	1	1		1		1	1	1				1	1	1	1	1	1	1	1	1	1		1		1	64	86	21	33	0	1	1	1	0
De Homann, M	1	1	1	1	1		1	1	1		1				1	1	1	1	1		1	1	1	1	1	1	1	1	64	93	29	44	0	1	1	1	0
Lepan, E	1	1	1	1	1	1	1				1				1	1		1	1			1						1	57	43	-14	-25	0	0	0	0	0
Mbangua, L	1	1	1		1		1						1		1	1	1	1	1	1	1	1	1			1		1	43	79	36	83	0	0	1	1	1
Nyundu, G		1		1		1									1	1	1	1	1	1	1	1				1		1	21	71	50	233	0	0	1	1	1
Maesela, D	1	1	1	1	1					1					1	1	1	1	1	1	1	1		1		1		1	43	79	36	83	0	0	1	1	1
Khoza, L		1	1				1		1						1	1	1	1	1	1	1	1	1	1			1		29	79	50	175	0	0	1	1	1
Mabaso, C		1	1		1	1									1	1	1	1	1	1									29	43	14	50	0	0	1	1	0
15	9	13	14	9	11	5	10	1	8	7	6	0	2	2	13	14	13	15	15	12	11	13	7	11	1	9	3	11	Average:								
	60	87	93	60	73	33	67	6.7	53	47	40	0	13	13	87	93	87	100	100	80	73	87	47	73	7	60	20	73	46.2	70.5	24						
Working for Water Pretoria																																					
Sambo, C	1	1	1						1		1				1	1	1	1	1	1		1		1	1			1	36	71	36	100	0	0	1	1	1
April, S		1								1						1	1		1				1					1	14	36	21	150	0	0	1	1	1
Molanoka, A		1	1		1		1									1		1			1		1					1	29	36	7	25	0	0	1	0	0
Moyo, R			1		1	1	1			1					1	1	1	1	1	1	1	1	1	1	1	1		1	36	93	57	160	0	1	1	1	1
Nkuna, G							1	1								1	1		1	1					1				14	36	21	150	0	0	1	1	1
Mollo, J	1	1	1		1					1						1	1	1	1	1	1	1						1	36	57	21	60	0	0	1	1	1
Gama, L			1	1						1	1							1	1	1									29	21	-7	-25	0	0	0	0	0
Mandlazi, R			1		1					1								1										1	21	14	-7	-33	0	0	0	0	0
Steenkamp, C	1	1	1	1	1		1		1	1	1			1	1	1	1	1	1	1	1	1	1	1	1		1	1	71	93	21	30	0	1	1	1	0

Ncube, O	1	1	1		1						1				1	1		1	1	1	1	1		1	1	1	1	1	36	86	50	140	0	1	1	1	1
Malatjie, N	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1		1	1	1	1	1				1			0	57	57	inf	0	0	1	1	1
Links, P		1								1					1	1	1		1	1			1	1		1		1	14	64	50	350	0	0	1	1	1
Simelane, A		1		1	1				1	1						1	1		1			1	1					1	36	43	7	20	0	0	1	0	0
Mavhutha, J	1	1	1				1		1						1	1	1	1	1	1			1	1	1			1	36	71	36	100	0	0	1	1	1
Kekana, L	1	1	1		1										1	1	1	1	1	1			1	1	1	1			29	71	43	150	0	0	1	1	1
Mabuza, L	1	1	1		1				1						1	1	1	1	1	1			1	1				1	36	64	29	80	0	0	1	1	1
Thabane, C		1	1		1		1											1	1	1	1		1				1		29	43	14	50	0	0	1	1	0
Mooketsi, T	1	1		1	1		1								1	1	1	1	1	1	1	1	1	1				1	36	79	43	120	0	0	1	1	1
Chimombe, T	1	1	1	1	1		1	1	1	1		1		1	1	1	1	1	1	1	1	1	1		1	1	1	1	79	93	14	18	0	1	1	0	0
Mlangeni, O	1	1	1			1									1	1	1	1	1	1				1	1	1			29	64	36	125	0	0	1	1	1
Ngobeli, B	1	1	1	1	1		1		1	1					1	1	1	1	1	1	1	1	1	1		1	1	1	57	93	36	63	0	1	1	1	1
Mokoana, Z	1	1	1		1		1		1	1					1	1	1	1	1	1	1			1	1			1	50	71	21	43	0	0	1	1	0
24	12	17	16	6	14	2	10	2	8	11	4	1	0	2	14	19	16	18	20	18	11	10	13	12	10	8	5	16	Average:								
	50	71	67	25	58	8	42	8.3	33	46	17	4.2	0	8.3	58	79	67	75	83	75	46	42	54	50	42	33	21	67	31.3	56.5	25					
PE Teachers																																					
Ncame, N	1	1	1	1	1		1	1	1		1			1	1	1	1	1	1	1	1	1	1		1	1	1	1	71	93	21	30	0	1	1	1	0
Daniels, L	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1		100	86	-14	-14	1	1	0	0	0
Makeleni, N		1	1		1	1	1	1	1			1	1		1	1	1	1		1	1		1	1					64	57	-7	-11	0	0	0	0	0
Stefane, B	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1		100	86	-14	-14	1	1	0	0	0
Reid, T		1		1	1		1	1				1		1	1	1	1	1	1	1	1		1		1	1	1		50	79	29	57	0	0	1	1	1
Reid, N	1	1	1	1	1	1	1	1	1		1	1		1	1	1	1	1	1	1	1	1	1	1	1		1	1	86	93	7	8	1	1	1	0	0
Ndoni, J	1		1	1		1	1	1	1	1			1	1		1	1	1	1	1	1	1	1	1			1		71	71	0	0	0	0	0	0	0
Paulsen, B	1	1	1	1	1	1	1	1	1	1		1		1	1	1	1	1	1	1	1	1	1	1	1		1		86	86	0	0	1	1	0	0	0
Groenewald, J	1	1	1	1	1	1		1	1	1		1		1	1	1	1	1	1	1	1	1	1	1	1		1		79	86	7	9	0	1	1	0	0
Ferreira, T		1		1	1	1	1	1	1			1	1	1	1	1	1	1	1	1	1		1	1		1	1	1	71	86	14	20	0	1	1	0	0
Madikane, Z		1			1	1	1	1		1			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		57	93	36	63	0	1	1	1	1
Somana, L		1	1		1	1		1	1					1	1	1	1	1		1	1	1	1	1	1	1	1	1	50	93	43	86	0	1	1	1	1
Masala, B		1		1	1		1	1					1		1	1		1	1						1		1	1	43	50	7	17	0	0	1	0	0
Sholoqu, Z	1	1	1	1	1	1		1	1	1	1		1	1	1	1	1	1	1		1	1		1	1	1		1		86	71	-14	-17	1	0	0	0	0
Kondile, N	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1		1	1	1	1	1	1			1		93	71	-21	-23	1	0	0	0	0
Ndlebe, C	1	1	1	1	1	1	1		1	1	1			1	1	1	1	1	1	1	1	1	1	1			1	1	79	86	7	9	0	1	1	0	0
Poti, T	1	1	1	1	1		1	1		1	1	1	1		1	1	1	1		1		1	1	1	1		1		79	71	-7	-9	0	0	0	0	0
Sello, M		1				1			1					1	1	1	1	1	1		1	1		1			1	1	29	71	43	150	0	0	1	1	1
Nqadini, M	1		1	1			1	1	1	1				1	1	1	1		1	1	1	1	1	1	1				57	71	14	25	0	0	1	0	0
Allen, J	1	1	1	1	1	1	1	1	1		1	1			1	1	1	1	1	1	1	1	1	1	1		1	1	79	93	14	18	0	1	1	0	0
Bell, J	1	1	1	1		1	1	1	1	1				1	1	1	1	1	1	1	1	1	1	1	1		1	1	71	93	21	30	0	1	1	1	0
Erasmus, D	1					1	1				1				1	1	1	1	1	1			1						29	50	21	75	0	0	1	1	1
Kilian, J	1	1	1	1	1	1	1	1		1		1		1	1	1	1	1	1	1	1		1	1		1	1	1	79	86	7	9	0	1	1	0	0
Whale, S	1	1	1	1	1	1			1			1			1	1	1		1	1	1		1		1			1	57	64	7	13	0	0	1	0	0
Rawat, Z	1	1	1	1	1				1			1			1	1	1		1	1	1		1	1	1				50	64	14	29	0	0	1	1	0
Davids, J	1	1	1	1	1		1								1	1	1	1			1		1		1				43	50	7	17	0	0	1	0	0

Ssekimpi, R	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	93	93	0	0	1	1	0	0	0
Drude, A		1		1					1			1		1	1	1	1	1	1									1	36	43	7	20	0	0	1	0	0
Mduba, V	1	1	1	1		1	1	1	1	1	1					1	1	1		1	1		1	1	1				71	57	-14	-20	0	0	0	0	0
Harris, V		1	1	1	1					1	1		1		1	1	1			1	1		1						50	43	-7	-14	0	0	0	0	0
Maqabangqa, X	1	1				1	1							1	1	1	1	1	1	1							1		36	50	14	40	0	0	1	1	0
Vonqo, P						1										1			1	1		1	1	1		1	1	7	57	50	700	0	0	1	1	1
Filmalter, H	1	1		1	1	1	1	1	1	1				1	1	1	1	1	1									1	71	43	-29	-40	0	0	0	0	0
Gora, T	1	1	1	1	1	1		1						1		1	1				1		1						57	29	-29	-50	0	0	0	0	0
Tata, M	1		1	1	1				1			1			1	1	1			1									43	29	-14	-33	0	0	0	0	0
Roberts, M		1		1		1			1	1	1			1	1	1	1	1	1	1									50	43	-7	-14	0	0	0	0	0
Prince, D	1		1	1			1	1		1				1	1	1	1	1	1	1									50	43	-7	-14	0	0	0	0	0
Fredericks, M	1	1	1	1		1		1						1	1	1	1		1						1			1	50	43	-7	-14	0	0	0	0	0
Kramer, D	1	1	1	1			1	1	1	1				1	1	1	1	1	1	1			1	1				1	64	64	0	0	0	0	0	0	0
Mahmood, F		1		1	1				1			1		1	1	1	1	1	1		1		1	1	1				43	64	21	50	0	0	1	1	0
Noble, A		1		1		1	1		1	1		1			1	1	1	1	1	1	1	1	1	1		1	1		50	86	36	71	0	1	1	1	1
Matiso, T	1	1	1	1		1			1						1		1		1				1	1					43	36	-7	-17	0	0	0	0	0
Xotyeni, K		1	1	1	1	1	1	1	1			1		1	1	1	1		1					1				1	71	43	-29	-40	0	0	0	0	0
Landu, P	1	1	1	1		1	1			1		1		1		1	1				1							1	64	29	-36	-56	0	0	0	0	0
Louw, G		1	1	1	1	1	1	1	1	1	1				1	1	1	1	1		1	1	1	1		1	1	1	71	86	14	20	0	1	1	0	0
Skweyiya, D							1	1	1		1			1	1	1	1			1			1		1			1	36	50	14	40	0	0	1	1	0
Manona, V	1	1		1	1					1				1	1	1	1	1	1	1	1	1	1	1		1			43	79	36	83	0	0	1	1	1
Dwe, WD	1	1	1			1	1	1	1		1					1	1	1	1				1					1	57	43	-14	-25	0	0	0	0	0
Hole, N	1	1	1		1		1	1		1				1	1	1		1	1		1	1				1	1		57	57	0	0	0	0	0	0	0
Ngcelwane, V	1		1	1		1	1		1			1		1	1	1				1		1							57	29	-29	-50	0	0	0	0	0
Plaatjie, B	1	1	1	1						1				1	1	1	1	1	1	1	1	1	1	1					43	71	29	67	0	0	1	1	1
Gqirana, M			1			1						1		1	1	1						1		1					29	29	0	0	0	0	0	0	0
Sawuka, M		1		1		1			1	1	1				1		1	1			1	1	1						43	43	0	0	0	0	0	0	0
Clarke, D	1	1	1	1	1	1	1	1	1	1			1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		86	93	7	8	1	1	1	0	0
Isaacs, S		1		1	1			1		1	1			1	1	1	1	1	1	1	1	1	1		1				50	71	21	43	0	0	1	1	0
Syce, A	1	1		1	1	1	1				1				1	1	1	1	1	1	1		1					1	50	64	14	29	0	0	1	1	0
Potgieter, L		1		1											1	1	1			1	1	1	1	1	1				14	64	50	350	0	0	1	1	1
Jonono, B		1	1	1	1	1								1	1	1			1	1	1				1				43	43	0	0	0	0	0	0	0
Siqwepu, M		1	1	1					1	1		1				1	1			1	1								43	29	-14	-33	0	0	0	0	0
Goeda, M	1	1	1	1	1	1	1	1		1	1	1			1	1	1		1	1	1		1	1	1		1	1	79	79	0	0	0	0	0	0	0
Mofokeng, L			1	1					1	1				1			1		1		1			1	1				36	36	0	0	0	0	0	0	0
Isaacs, D		1	1	1	1	1	1		1		1			1		1	1	1	1	1	1			1			1	1	64	64	0	0	0	0	0	0	0
Pikelela, T		1		1		1				1		1		1	1	1	1			1			1			1	1	1	43	57	14	33	0	0	1	1	0
Moore, A	1	1	1	1	1	1							1	1	1	1	1	1	1			1		1	1	1			1	57	64	7	13	0	0	1	0	0
Broughton, J	1	1	1	1		1	1		1		1		1	1	1		1		1		1		1	1	1		1	1	71	64	-7	-10	0	0	0	0	0
Templeman, C	1	1	1	1		1	1	1	1	1		1		1	1	1	1	1	1	1	1	1		1	1				79	71	-7	-9	0	0	0	0	0
Sizani, P	1	1		1	1		1								1	1			1					1					36	29	-7	-20	0	0	0	0	0
Vena, N	1	1	1	1	1	1		1	1		1			1	1	1	1	1	1	1	1		1	1					71	64	-7	-10	0	0	0	0	0

Madati, S	1	1	1	1			1			1					1	1	1		1	1	1		1						43	50	7	17	0	0	1	0	0
Aubert, H	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1				100	79	-21	-21	1	0	0	0	0
Lones, T				1		1	1	1	1	1	1	1		1	1	1	1		1		1	1	1	1	1		1	1	64	79	14	22	0	0	1	0	0
De Clerk, M	1	1	1	1		1	1		1					1	1	1	1	1	1	1	1		1						57	57	0	0	0	0	0	0	0
Mfanta, C		1		1	1	1						1		1	1	1	1	1	1		1	1	1	1		1			43	71	29	67	0	0	1	1	1
Williams, C			1		1	1	1	1	1					1	1	1	1		1	1	1				1		1		50	57	7	14	0	0	1	0	0
Jantjies, M		1		1			1	1			1				1	1	1		1	1	1		1	1	1		1		36	71	36	100	0	0	1	1	1
Kammies, R		1	1		1			1		1	1				1	1	1		1	1	1		1		1		1		43	64	21	50	0	0	1	1	0
Maloyi, V	1	1	1	1	1		1		1	1		1	1		1	1	1			1	1		1	1					71	50	-21	-30	0	0	0	0	0
Buys, A	1	1	1	1	1	1	1	1							1	1	1	1		1	1		1						57	50	-7	-13	0	0	0	0	0
Gcilitshana, S	1	1		1	1	1		1	1					1	1	1							1		1		1		57	36	-21	-38	0	0	0	0	0
79	49	67	54	66	47	53	49	44	47	39	27	31	17	52	70	75	71	49	57	55	60	30	57	48	39	14	37	29	Average:								
	62	85	68	84	59	67	62	56	59	49	34	39	22	66	89	95	90	62	72	70	76	38	72	61	49	18	47	37	58	62.5	4						
Agriculture East London																																					
Nkombi, J	1		1								1					1		1	1	1							1		21	36	14	67	0	0	1	1	1
Nomsenge, R						1	1							1		1	1			1	1	1	1	1	1	1			21	64	43	200	0	0	1	1	1
Mhluzi, N	1	1	1		1	1								1	1	1	1	1	1	1		1							36	57	21	60	0	0	1	1	1
Tito, L	1	1	1		1	1					1				1	1	1	1	1		1		1						43	50	7	17	0	0	1	0	0
Chubeka, M	1	1				1				1					1	1	1				1		1				1		29	43	14	50	0	0	1	1	0
Nqwaba, S					1	1				1								1		1	1		1				1		21	36	14	67	0	0	1	1	1
Mngonyama, L	1		1			1			1	1	1			1		1		1	1	1			1			1			50	43	-7	-14	0	0	0	0	0
George, C	1		1		1					1						1		1	1	1			1			1			29	43	14	50	0	0	1	1	0
Nodlela, P	1		1								1	1			1	1		1											29	21	-7	-25	0	0	0	0	0
Hombile, N	1	1	1	1	1	1	1					1			1	1	1	1		1	1	1	1	1	1	1	1		57	86	29	50	0	1	1	1	0
Ngxata, N	1	1		1	1		1			1		1		1		1	1	1	1	1	1	1	1	1	1	1			57	79	21	38	0	0	1	1	0
Nyosi, P	1		1		1	1				1	1				1	1	1	1	1				1	1	1				43	57	14	33	0	0	1	1	0
Nozaza, T	1	1					1							1							1		1	1	1				29	29	0	0	0	0	0	0	0
Tshobeni, D	1	1		1											1			1									1		21	21	0	0	0	0	0	0	0
Mkutshulua, X	1	1	1		1				1	1	1					1		1	1	1		1		1		1	1		50	57	7	14	0	0	1	0	0
Ntleko, M	1	1	1			1					1	1			1	1	1	1	1	1	1	1	1	1	1		1		43	86	43	100	0	1	1	1	1
Hubela, A		1		1												1	1	1	1										14	29	14	100	0	0	1	1	1
Zoya, T	1	1	1		1					1						1	1	1		1	1	1		1		1	1		36	64	29	80	0	0	1	1	1
Mbabe, P		1	1			1				1		1			1	1	1	1		1	1		1	1					36	57	21	60	0	0	1	1	1
Mafayi, B	0	0	0	0	0	0	0	0	0	0	0	0	0	0		1					1		1				1		0	29	29	inf	0	0	1	1	1
Gitywa, P	1	1														1				1	1	1		1					14	36	21	150	0	0	1	1	1
Santos, V		1		1	1										1	1	1	1	1	1	1	1	1	1	1		1		21	86	64	300	0	1	1	1	1
Sontange, S		1	1	1			1			1					1	1	1	1	1	1	1	1	1	1	1		1		36	86	50	140	0	1	1	1	1
Banzana, S	1	1	1	1	1	1									1	1	1	1	1	1	1	1	1	1	1		1		43	86	43	100	0	1	1	1	1
Mngeni, V	1	1	1													1	1			1	1	1		1					21	43	21	100	0	0	1	1	1
Kuboni, M	1	1	1	1			1				1					1	1	1		1		1	1						43	43	0	0	0	0	0	0	0
Gwabeni, C										1				1	1	1	1	1	1	1	1	1	1	1	1		1		14	86	71	500	0	1	1	1	1
Galeni, G			1		1					1						1	1	1						1			1		21	36	14	67	0	0	1	1	1

Mteki, B		1	1										1			1		1			1		1	1		1	1		21	50	29	133	0	0	1	1	1
Nelani, P	1	1	1		1		1								1	1	1	1	1	1	1	1		1		1	1		36	79	43	120	0	0	1	1	1
May, M		1					1			1					1	1	1	1		1		1		1			1		21	57	36	167	0	0	1	1	1
Xalisa, M	1	1			1				1	1					1	1	1	1	1	1	1		1	1			1		36	71	36	100	0	0	1	1	1
Ngqola, M	1	1	1		1					1					1	1	1	1		1	1	1	1	1			1		36	71	36	100	0	0	1	1	1
33	22	23	20	8	15	11	8	0	3	15	8	5	1	5	17	30	22	27	16	23	22	16	22	21	10	9	19	0	Average:								
	67	70	61	24	45	33	24	0	9.1	45	24	15	3	15	52	91	67	82	48	70	67	48	67	64	30	27	58	0	31.2	55	24						
DLA and Others Bloemfontein																																					
Raselemane, J		1		1												1		1	1	1			1				1		14	43	29	200	0	0	1	1	1
Tshabalala, P	1	1				1								1		1	1		1	1		1				1	1	1	29	57	29	100	0	0	1	1	1
Setewane, T	1	1	1		1		1		1	1					1	1	1	1		1		1	1	1		1	1		50	71	21	43	0	0	1	1	0
Van Zyl, C	1	1	1		1	1			1	1					1	1	1	1	1	1	1	1	1	1	1	1			50	86	36	71	0	1	1	1	1
Jacobs, R	1	1	1		1	1	1			1					1	1	1	1	1	1	1	1	1	1		1			50	79	29	57	0	0	1	1	1
Assegaai, D		1	1		1								1		1		1	1	1		1		1				1	1	29	57	29	100	0	0	1	1	1
Peters, R	1	1	1	1		1	1		1	1	1	1			1	1	1	1	1	1	1	1	1	1	1	1	1	1	71	100	29	40	0	1	1	1	0
Modise, E	1	1				1					1				1	1	1		1	1		1						1	29	50	21	75	0	0	1	1	1
Ferreira, N	1	1	1		1		1		1	1					1	1	1	1	1	1	1	1	1	1	1				50	86	36	71	0	1	1	1	1
Sitsila, M	1	1		1	1		1						1		1	1	1	1	1	1	1	1	1	1				1	43	71	29	67	0	0	1	1	1
Van Wyk, B	1	1	1		1		1		1	1					1	1	1	1	1	1	1	1	1	1	1	1	1	1	50	100	50	100	0	1	1	1	1
Senakgomo, S		1	1	1	1											1		1		1	1	1	1			1			29	50	21	75	0	0	1	1	1
Louw, A	1	1	1							1					1	1		1		1		1	1	1	1		1		29	64	36	125	0	0	1	1	1
Jantjie, S	1	1	1		1		1		1		1				1	1	1	1		1		1		1			1		50	57	7	14	0	0	1	0	0
Liebenberg, D	1	1	1	1			1		1	1						1		1		1	1	1	1	1					50	50	0	0	0	0	0	0	0
Musie, R	1	1		1	1											1		1	1	1	1		1	1		1	1	1	29	71	43	150	0	0	1	1	1
Kwagile, W	1								1	1			1			1				1			1			1			29	29	0	0	0	0	0	0	0
Leeme, V	1		1						1							1		1	1	1	1		1		1		1	1	21	64	43	200	0	0	1	1	1
Molefe, M		1	1		1		1									1	1	1	1	1	1	1				1			29	57	29	100	0	0	1	1	1
Machelebeta, P					1					1		1				1		1		1				1	1			1	21	43	21	100	0	0	1	1	1
20	15	17	13	6	12	5	9	0	9	10	3	2	3	1	11	19	12	17	13	19	12	13	14	13	7	11	10	9	Average:								
	75	85	65	30	60	25	45	0	45	50	15	10	15	5	55	95	60	85	65	95	60	65	70	65	35	55	50	45	37.5	64.3	27						
DLA Gauteng																																					
Jordaan, Z	1		1							1					1	1	1	1	1	1		1	1						21	57	36	167	0	0	1	1	1
Moeti, M			1		1	1					1					1		1		1				1					29	29	0	0	0	0	0	0	0
Goxo, N	1				1	1										1		1	1	1	1	1	1	1		1			21	71	50	233	0	0	1	1	1
Pungan, C	1	1	1			1	1			1					1	1	1	1	1	1	1		1	1		1	1		43	79	36	83	0	0	1	1	1
Sithole, L		1				1			1						1	1	1	1	1		1		1	1			1		21	64	43	200	0	0	1	1	1
Nxumalo, M		1	1		1						1				1			1	1				1	1				1	29	43	14	50	0	0	1	1	0
Lewis, M	1	1	1		1										1		1	1		1	1	1	1	1	1			1	29	71	43	150	0	0	1	1	1
Mudau, M		1														1	1	1					1						7	29	21	300	0	0	1	1	1
Mboma, B	1	1	1				1		1	1				1		1	1	1	1	1	1		1	1	1		1		50	71	21	43	0	0	1	1	0
Johnson, C	1	1	1	1	1	1	1		1	1					1	1	1	1	1	1	1	1	1	1	1	1		1	64	93	29	44	0	1	1	1	0
Luzipho, N	1		1		1		1								1	1	1	1		1	1	1	1	1	1	1			29	79	50	175	0	0	1	1	1

Walaza, Z	1	1	1	1	1	1	1		1	1	1	1	1		1	1	1	1	1	1	1	1	1	1		1	1		86	86	0	0	1	1	0	0	0
Msani, L	1	1	1	1	1	1				1					1	1	1	1		1			1			1	1		50	57	7	14	0	0	1	0	0
Nephawe, N										1						1		1	1	1	1		1						7	43	36	500	0	0	1	1	1
Kanama, N	1		1	1		1		1							1	1	1	1	1	1	1				1				36	57	21	60	0	0	1	1	1
Ramagadza, A		1	1				1			1				1	1	1	1	1	1	1	1		1	1			1		36	71	36	100	0	0	1	1	1
Tsoaedi, B	1	1			1				1		1	1			1	1	1	1	1	1	1	1	1	1	1		1		43	86	43	100	0	1	1	1	1
Tshukutswane, T		1	1			1	1		1		1				1	1	1			1	1	1	1						43	50	7	17	0	0	1	0	0
Venter, B	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1		93	86	-7	-8	1	1	0	0	0
Botes, M		1	1			1	1									1	1	1	1	1		1				1	1		29	57	29	100	0	0	1	1	1
Sekgote, B	1	1	1	1		1			1	1					1	1		1	1	1	1	1	1	1	1	1	1		50	86	36	71	0	1	1	1	1
Malaza, H														1			1		1	1	1			1			1		7	43	36	500	0	0	1	1	1
Mthethwa, S	1	1						1	1						1	1	1				1						1	1	29	43	14	50	0	0	1	1	0
Selepe, L	1	1	1	1	1	1			1			1			1	1	1	1	1	1	1	1	1					1	57	71	14	25	0	0	1	0	0
Motsaathebe, L	1					1									1	1	1	1	1	1	1		1			1			14	64	50	350	0	0	1	1	1
Matukane, K	1	1	1		1		1				1			1	1	1	1	1	1	1	1	1	1	1	1	1	1		50	93	43	86	0	1	1	1	1
Motsepe, C		1	1	1	1											1		1					1	1			1	1	29	43	14	50	0	0	1	1	0
Nkaletshane, M		1	1	1	1				1						1	1	1	1	1	1	1	1	1			1	1		36	86	50	140	0	1	1	1	1
Bartlett, D			1		1	1						1				1		1	1	1	1	1	1			1	1		29	64	36	125	0	0	1	1	1
Skosana, M						1									1	1	1	1	1	1	1	1		1					7	64	57	800	0	0	1	1	1
Pillay, S	1	1	1		1		1		1						1	1	1	1		1	1	1			1	1	1		43	71	29	67	0	0	1	1	1
Mabe, S		1			1										1	1	1	1	1				1						14	43	29	200	0	0	1	1	1
Gontsana, N	1		1		1	1									1	1	1	1	1	1	1								29	50	21	75	0	0	1	1	1
Makhanya, B		1	1		1				1		1					1	1	1	1		1	1	1	1			1		36	64	29	80	0	0	1	1	1
Phakathi, S	1	1	1	1	1	1				1					1	1	1	1		1	1	1		1					50	57	7	14	0	0	1	0	0
35	20	24	25	10	20	18	11	2	13	11	8	5	2	5	25	32	28	32	25	28	27	19	25	22	10	13	19	6	Average:								
	57	69	71	29	57	51	31	5.7	37	31	23	14	6	14	71	91	80	91	71	80	77	54	71	63	29	37	54	17	35.5	63.5	28						

Total No of participants:	**400**

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Total:	**239**	**322**	**275**	**221**	**235**	**174**	**186**	**83**	**169**	**192**	**97**	**66**	**55**	**87**	**294**	**363**	**319**	**309**	**306**	**289**	**280**	**232**	**257**	**264**	**131**	**160**	**176**	**198**
%	60	81	69	55	59	44	47	21	42	48	24	17	14	22	74	91	80	77	77	72	70	58	64	66	33	40	44	50

Total :	**14**	**101**	**50**	**69**	**199**
%	**3.5**	**25**	**13**	**17.3**	**49.8**