Combining Soft Systems Methodology and the Process Outcomes Model for the Evaluation of Location Based Services in South Africa

Sean WIID, South Africa and Michael BARRY, Canada

Key words: evaluation methodology, soft systems, process outcomes, measurement, metrics

SUMMARY

Aspects of soft systems method have been applied to evaluating cadastral systems in South Africa by the second author. This paper represents extensions of this work into the area of evaluating spatial information and positioning technology in uncertain situations. This theory in turn is contributing to a theoretical framework which is being developed to guiding the implementation of technological tools for land administration.

The ever-increasing pervasiveness of Science and Technology (S&T) in society has led to questions concerning the contribution and value of S&T, and to what extent a particular innovation, invention, product, theory or technological development affects society. The attempt to answer these questions has led to the development of evaluation methodologies to provide a structured approach to this process of inquiry. In most cases, evaluation methodology can be classified as either fundamentally holistic or reductionist in its approach. In the context of evaluating Location Based Services (LBS) in South Africa, a conceptual framework was developed to combine the holistic, systems thinking approach of Soft Systems Methodology (SSM) and the reductionist approach of quantitative and qualitative metrics embodied in the Process-Outcomes model. The conceptual framework allows for a model of evaluation to be constructed that draws on the desirable aspects of both methodologies. This paper discusses the pertinent aspects of SSM and the Process-Outcomes model, proposes theoretical connections between the methodologies and constructs a framework to combine them. Finally, the paper explains how the conceptual framework was used to evaluate LBS in South Africa, from the perspective of a network operator, in its technological, social, economic and organisational contexts.

Combining Soft Systems Methodology and the Process Outcomes Model for the Evaluation of Location Based Services in South Africa

Sean WIID, South Africa and Michael BARRY, Canada

1. INTRODUCTION

Location based services are a recent development in the application of mobile telecommunication and positioning technologies. As with many similar spatially based decision support tools, actual usage of LBS has not matched early predictions. Implementing new information and communication technology (ICT) is a high risk venture, even in the most stable political economies. In highly complex situations, such as South Africa which has been experiencing fifteen years of far reaching social, political and economic transformation, marketing and implementing new technology is fraught with even more uncertainty. Drawing on working experience in a number of projects in South Africa, we present a framework to evaluate implementing LBS from the perspective of a network operator wishing to implement or improve LBS. The theoretical foundation is based on a synthesis of Checkland's (1999) Soft Systems Method (SSM) and the Process-Outcomes model (Geisler 2000).

For this discussion, we define LBS as any service available on cellular networks that makes use of the user's geographical position to provide value to the user (Wiid 2005). Value in this context can be measured using a number of different quantitative and qualitative criteria, such as attributes relating to financial value and quality of life. For example, in addition to the benefits of enhanced security and emergency services, LBS could be beneficial to consumers by offering value-added services such as personalised information, directory services and navigation. From a network operator's perspective, LBS can create new revenue streams and assist in retaining customers by allowing network operators to introduce new cellular services and add value to existing services (D'Roza and Bilchev 2003, Gale Group 2002).

The framework couples aspects of holism and reductionism, two seemingly contrasting methodological approaches to evaluating a particular set of phenomena. We argue that they are not exclusive and should be applied in combination if one is to conduct an effective evaluation. In developing a model for evaluating LBS in South Africa, we will show that applying a combination of systemic (SSM) and reductionist (Process-Outcomes) methodologies may yield a richer understanding of the problem situation than either one alone.

The paper begins by briefly describing LBS in South Africa and why evaluating it is desirable. Following this, some of the fundamental principles and difficulties of evaluating complex phenomena are introduced, and we argue why combining holism and reductionism is advisable. The Process-Outcomes model as a framework to construct and evaluate a set of metrics is described and we present initial difficulties and shortcomings experienced with this approach. Following a discussion of pertinent aspects of SSM, we describe a relationship between the methodologies, and develop theory to create formal links between the methodologies. We then explain how the conceptual framework was used to create a model for the evaluation of LBS in South Africa and describe its application.

2. EVALUATING LOCATION BASED SERVICES IN SOUTH AFRICA

In South Africa, the majority of the initial LBS knowledge and opinion resulted from observing both the successes and the failures of global LBS activities, as discussed above (Wiid 2005). In addition, through involvement in several commercial LBS endeavours, the first author discovered a number of social, organisational and political factors specific to South Africa that affected the implementation of LBS (Wiid 2005). For these reasons we determined that LBS in South Africa needed to be evaluated from a number of different perspectives which are common to most strategic analyses; technological, social, economic, political and organisational. We discuss these in more detail below.

Technological Perspective

Although cellular technology is converging, South African cellular operators are still faced with a complex puzzle of disparate software, hardware, and connectivity components that still need to be harmonised (Rao and Minakakis 2003). Furthermore, there has been a lack of understanding of the technical feasibility of LBS using location determination methods and cellular technology available on South African networks.

Social Perspective

Unsurprisingly, LBS was first mooted as a new technology which could supposedly improve quality of life in a number of ways (e.g. personal security). The main social concerns relate to the balance between societal benefits, privacy and security (Casal 2004).

Economic Perspective

As with any new technology, especially ICT, there are high financial risks attached to implementing LBS. The primary reason cellular network operators in South Africa were initially hesitant to implement LBS is that they had difficulty establishing a business case for the system, i.e. projected revenues did not exceed projected costs (Wiid 2005). One informant noted that there was an inadequate understanding of the potential market for LBS in South Africa and of the possible positive or negative affects of LBS on society. This understanding is crucial, as it follows that market acceptance will determine the extent to which a technology is adopted.

Organisational and Political Perspective

The complexity of the LBS Value Network dictates that sound strategy and the formation of partnerships with other industry stakeholders is vital for the implementation of LBS (Gulati et al 2002). Other organisational factors such as marketing strategy and obligations in terms of the license agreements may affect LBS. Furthermore, the implications of various legislation, policies and regulations on the provision of LBS need to be understood (Casal 2004). Specifically, these could include policy to regulate the cellular industry, protect personal privacy and control access to information. Thus, as with any corporate strategic analysis, one needs to examine factors within the organisation and how the organisation interacts with competitors and partners, as well as the policy and regulatory environment.

3. HOLISM AND REDUCTIONISM

Simple physical phenomena are relatively easy to measure, as they normally only involve one measurable quantity using a standard unit of measurement. In contrast, many science and technology applications tend to be complex, multi-faceted and unstructured, because they involve the interaction between people and the technology and therefore defining what constitutes a successful implementation and then evaluating it effectively cannot be achieved using a single measure. The problem is not new either. For example, Smuts (1926), to whom the term holism is often attributed, noted the difficulty of understanding and analysing complex systems, which constitute a "a whole (comprising) …a synthesis or unity of parts, so close it affects the activities and interactions of those parts … (in which) …their independent functions and activities are grouped, related, correlated and unified in the structural whole". What comprises this whole is subjective, and depends, among many other things, on a particular observer's agenda, their personal biases, and the particular prior experience that they have of a particular situation (Barry 1999).

However, in order to understand a complex situation it is still necessary to evaluate certain facets that can represent the whole (Barry 1999, Geisler 2000). To this end, Geisler argues that the only viable way of measuring S&T phenomena is using a set of metrics that measure specific aspects of them (Geisler 2000). The difficulty lies in understanding and evaluating how the aspects selected for scrutiny interact with others, and thus the challenge is to evaluate specific metrics systemically (Barry 1999). In other words, a complex system cannot be understood holistically without looking at details, and conversely by reducing a complex phenomenon to its basic parts or facets, one must be mindful of the system as a whole in order to correctly evaluate each facet in its appropriate context and its interactions with other parts of the system(s).

The selection of which aspects of a complex phenomenon to measure is regarded as the first principle of measurement (Geisler 2000). Piore claims that uncertainty in the value or quality of the evaluation often stems from which aspects or variables were selected for the evaluation, and that a priori knowledge of the situation is required to select aspects to measure (Piore 1979). Thus, as stated above, the aspects selected vary depending on the biases and intentions of the evaluator and therefore what may be critical aspects to other analysts may be overlooked. This paradox highlights the need to start with a holistic appreciation of the problem before reducing it to measurable aspects, and the need to iterate the evaluation so that as the evaluator's understanding of the situation improves, additional relevant aspects of the situation are taken into consideration. Thus, the evaluation process is dynamic and changes as the observer learns more about the phenomenon under scrutiny.

The problem of evaluation then becomes trying to assess the whole, which in itself is often difficult to recognise - let alone define, with a degree of consensus between different analysts. Without a set of measurements, one is likely to end up with a vague statement of assessment which will not encourage action to improve a situation, if required. Thus, one needs to define a set of measurable components and then one should seek to interpret them meaningfully. We now discuss the Process Outcomes model and SSM as potential methodologies and a synthesis of them in a conceptual framework for the evaluation of LBS in South Africa.

4. METRICS AND THE PROCESS-OUTCOMES MODEL

By definition, a metric encapsulates the measurement, the reason for measurement and the context of the measurement (Geisler 1999). The term ‘metric’ can be used generically to describe a system of measurement that includes the item or variable being measured, the units or tool of measurement, and the value of the measurement as compared to other measurements (Luukkonnen-Gronow 1987). In reality, the metrics actually used tend to be an opportunistic selection based on available data, the human and technical resources available, and the purpose of the evaluation.

Geisler proposes a hierarchical approach moving from the general to the particular to be able to target certain aspects of a phenomenon accurately. In addition, the metrics should be chosen based on the following selection criteria.

- The selected metric must be relevant and tie in with appropriate view of the world.
- The selected metrics must be available, accessible and affordable.
- The set of selected metrics must allow for manipulation, analysis, interpretation and comparison with one another.

(Geisler 2000)

Therefore, a structured approach is enforced by specifying rules for metric creation and criteria for metric selection. In this way, the selection criteria take the focus off the data, and concentrates on the purpose of the evaluation, effectively focussing the data analysis into meaningful and purposeful answers to pertinent questions. In addition, the set of metrics requires an interpretive framework to guide the evaluation and the subjective assessment of different types of data (Kostoff 1998), for example the Process-Outcomes model.

The Process-Outcomes model is based on identifiable spatial and temporal stages in the innovation process (Geisler 2000), and attempts to overcome three problems identified with other evaluation frameworks, namely:

- The failure to consider the stage of development of a technology when performing S&T evaluation;
- Difficulties in linking R&D processes with eventual outcomes;
- Difficulties in linking S&T metrics with economic and social metrics

(Geisler 1999, Kostoff 1998)

In other words, the Process-Outcomes model recognises that S&T is a dynamic, on-going process and not a once off event. It takes the stage of development into account and provides a framework to link S&T processes with social and economic systems, allowing the tracking and evaluation of S&T from initial inputs to outcomes (Kostoff 2001).

Its main points are as follows:

- There are distinct identifiable stages in the innovation process
- These stages may serve as the building blocks to describe S&T processes
- S&T flows through the stages, from research, development, new products, to the final stage of technology that is commercialised and used
- Each stage has distinct outputs that are measurable and can be compared across stages, shown as 1-5 in Figure 1 below.
- Between each S&T stage, there are processes that transform the outputs of one stage into the inputs of the next. These processes are called transformation and diffusion activities, and are shown as A-D in Figure 1 below.
- Social and economic organisations take part in the transformation and diffusion activities.

(Geisler 2000)

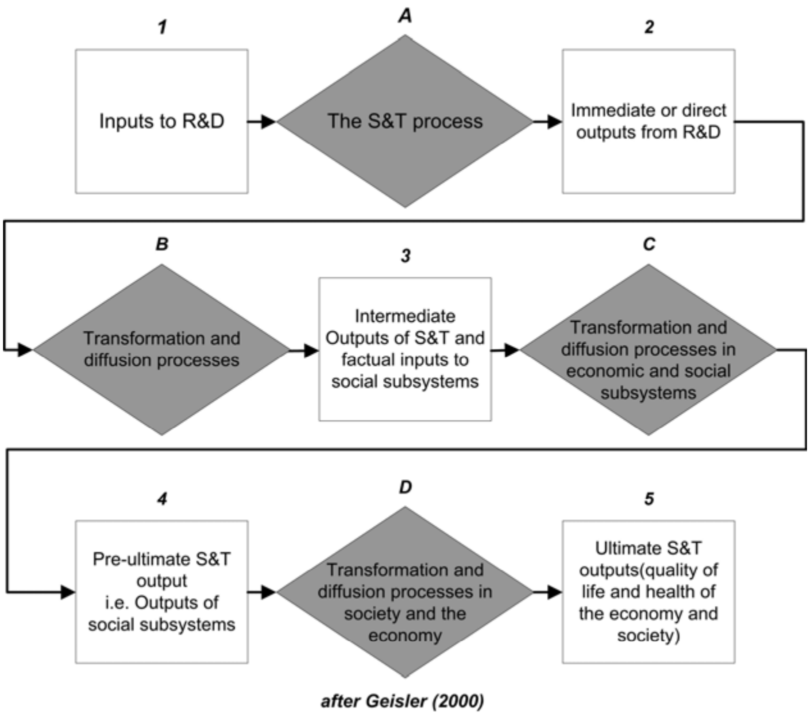

Figure 1: Stages of the Process Outcomes Model

By taking the stage of development of S&T into account, and focusing on the transformation processes of input into output at these different stages, the Process-Outcomes model provides a framework for the evaluation of the selected set of metrics in their appropriate context. Therefore, using the Process-Outcomes model aids to align the evaluation with the role and intentions of the evaluator, the purpose of the evaluation and the available data.

While applying this methodology to the evaluation of LBS in South Africa, it was found that there were two main deficiencies. Firstly, while the Process-Outcomes model provides a general framework for combining qualitative and quantitative metrics, it does not include mechanisms for the subjective evaluation thereof. In addition, although a good understanding of the social and technological context of the evaluation is required, no tools or the methods are provided to generate this conceptual understanding. Applying SSM in conjunction with the Process-Outcomes model provides a method to do this. Pertinent aspects of SSM are discussed in the below, followed by a description of the conceptual framework to combine the methodologies.

5. SOFT SYSTEMS METHODOLOGY

Systems thinking is a way of thinking about, describing and understanding the forces and interrelationships that shape the behaviour of complex systems (Van Zyl 2001). In this respect, systems theory challenges the reductionist approach of breaking down complex phenomena into individual components without taking cognisance of the whole system. However, as stated above, although systems thinking is supposedly the opposite of reductionism, the evaluator still has to reduce a conceptual view of a situation to a manageable aspects (Barry 1999). Thus systems theory should be is a complement to conventional reductionist scientific enquiry (Rose and Haynes 2001). We note that the Process-Outcomes approach is not purely reductionist, as it does incorporate systemic processes.

Systems can be defined as hard or soft. Barry and Fourie state that hard systems apply to structured problems while soft systems apply to unstructured problems (Checkland 1999, Barry & Fourie 2002). Similarly, Rose classifies hard systems are those that are designed physical systems, and soft systems as those involving social, cultural and organisational considerations (Rose and Haynes 2001). Checkland argues further that the crucial intellectual distinction is that hard systems thinking tries to define the world itself as a set of systems, while soft systems thinking merely tries to organise the process of inquiry into the world as a set of learning systems. Therefore, soft systems do not exist in reality, but are conceptual constructs that aid in understanding reality (Checkland 1999).

This is the fundamental principle behind SSM, which can be described as an iterative learning process that begins with a real-world problem. Evaluators study the situation and develop conceptual models that generate overall understanding and insights into the way the problem might be addressed. These SSM conceptual models are then compared to the real-world situation, and any differences detected become the basis for formulating recommendations and planning changes. In accordance with the distinction between hard and soft systems thinking established in the previous section, SSM does not claim that reality actually is a set of systems (Johnson 1999), but helps to structure thinking about situations in the real world (Rose and Haynes 2001).

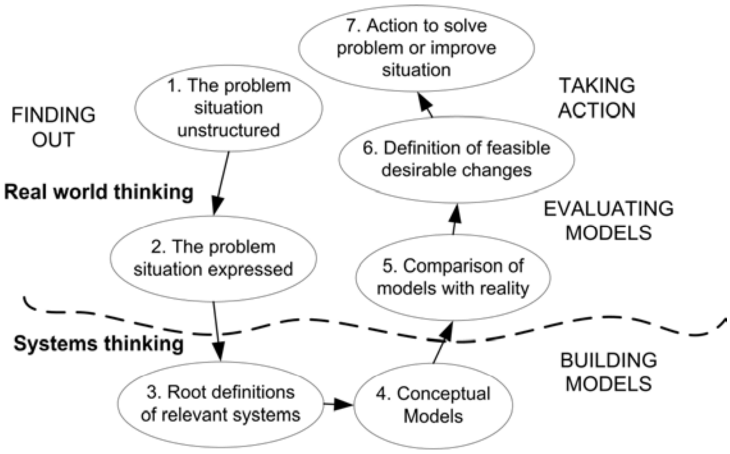

Figure 2: The Seven-Stage SSM Model

Figure 2 above shows the initial 7 stage model of SSM proposed by Checkland. This version of SSM is more suitable for combining SSM and Process-Outcomes than a later, supposedly superior, 4 stage version of SSM because from our perspective it provides a more structured approach to evaluation. Checkland notes that the 7 stage model is more suitable for inexperienced SSM evaluators (Checkland 1999).

The first stage of SSM involves a detailed expression of the situation by means of rich pictures. The rationale behind the use of rich pictures is that graphics are a better medium than prose for expressing relationships, as pictures promote holistic as opposed to reductionist thinking from the outset (Checkland 1999). The pictures are developed iteratively and depict the current situation, problems and the relationships between the stakeholders as a starting point to generate a general understanding of the situation (Barry and Fourie 2002). The second stage requires in depth examination of the situation from different perspectives known as Analysis One, Two and Three (Checkland 1981).

The combination of these analyses and the rich pictures described above generate an initial contextual understanding of the problem situation. An important note is that this process of finding out is never complete, and it must carry on through out an evaluation (Checkland 1999).

The first step in building a SSM conceptual model is the clear definition of the purposeful activity to be modelled. SSM uses the concept of a ‘root definition’ to construct these clear definitions. In order to ensure that the root definitions are well formed and precise, they need to be derived from the elements Customer, Actors, Transformation process, Worldview, Owner and Environment (CATWOE). Checkland identifies the primary element of a root definition as the expression of a transformation process or purposeful activity (Checkland 1999). So therefore the construction of conceptual models themselves is built around the identified processes of the system.

By clearly building the root definitions based on these guidelines, the evaluator expresses the problem situation in a structured manner that forms the basis for the actual constructing of the conceptual models. Structured and well-formed root definitions ensure that the conceptual models themselves are focused and aligned with the intentions and purpose of the evaluation.

The construction of the conceptual models is based on the preliminary structured thinking developed by means of the root definitions, and results in a number of diagrams which describe the system holistically. The following section develops a conceptual framework to combine SSM and the Process-Outcomes model.

6. A CONCEPTUAL FRAMEWORK

In the first author's initial attempts to evaluate LBS in South Africa, SSM and the Process-Outcomes model were initially used independently without a conceptual framework to combine them. While the rigours of each methodology were followed and seemingly produced adequate results, it proved difficult to relate the work done using SSM to the work done using metrics and the Process-Outcomes model in a logical and meaningful manner. Without these consistent conceptual linkages, the justification for using both of these methodologies lacked credibility and the results of the evaluations seemed superficial. It was difficult to advocate any form of action as a result. Consequently, we examined how SSM and the Process-Outcomes model complement each other.

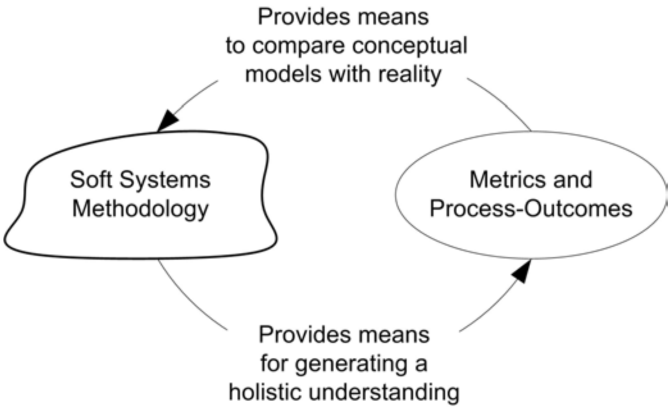

Figure 3: The Co-dependence of SSM and the Process Outcomes Model

Figure 3 illustrates a means of combining the two methodologies, which we are arguing strengthens the evaluation effort as a whole. SSM generates the holistic understanding required for the use of the Process-Outcomes model, while the metrics embodied in the Process-Outcomes model provide the means to compare the SSM conceptual models with reality. This comparison forms the basis for further action to improve the situation.

A possible structure for the framework would be to encapsulate the use of metrics and the Process-Outcomes model within the 7-stage model of SSM. Thus, metrics developed while applying the Process-Outcomes model form stage five of SSM as the means to compare the conceptual models with reality. Although this provides a basic structure for the framework, theoretical links between the methodologies are necessary, as developed in the discussion below.

The discussion on SSM earlier identified that the root definitions, and therefore the conceptual models of SSM, are based on the identification of transformation processes or purposeful activities. Furthermore, it was identified that the Process-Outcomes model is based on stages of transformation and diffusion activities, i.e. transformation processes. By comparing the processes identified while building the SSM conceptual models to the processes identified while constructing the Process-Outcomes model for LBS in South Africa, we noted that the same or similar processes were being identified in both cases. Thus the mutual focus on transformation processes provides the fundamental connection between the methodologies. Based on this proposal, three theoretical links can be established:

6.1. The Link between SSM Processes and Process-Outcomes Transformation & Diffusion Activities

The processes identified while constructing the SSM conceptual models provide a comprehensive set of processes that should be incorporated into the Process-Outcomes model. The intention is that if a process is not identified during the initial phase of generating an understanding of the problem as a whole using SSM, then the process falls outside the scope of the evaluation and should not be considered for inclusion in the Process-Outcomes model. In this way, it is possible to build the skeleton of the Process-Outcomes model from a set of processes previously identified through SSM.

6.2. The Link between SSM and Metrics

The link developed between SSM and metrics expands on concept of common processes discussed previously. In constructing and selecting the set of metrics, we noticed that many of the metrics that passed the selection criteria were similar to the inputs and outputs of transformation processes identified in SSM conceptual models. Thus, for a metric to be valid, one should be able to derive it from or incorporate it into one of the SSM conceptual models. Therefore, the metric selection criteria are expanded to include the criterion “Can the metric be associated with any of the SSM conceptual models?”

6.3. Linking Metric Construction to Process Outcomes

A solution for classifying metrics into the correct stage of outcome of the Process-Outcomes model is simple extension of the previous two conceptual links. By determining whether a metric is an input or an output of its associated process in the SSM conceptual model, the stage of S&T process for that metric can be inherently determined by examining where the process lies in the Process-Outcomes model.

Having defined these three formal links between the methodologies based on common transformation processes, we are now able to present a complete conceptual framework for evaluation, depicted in figure 4 below, which we believe improves the rigour of the overall evaluation.

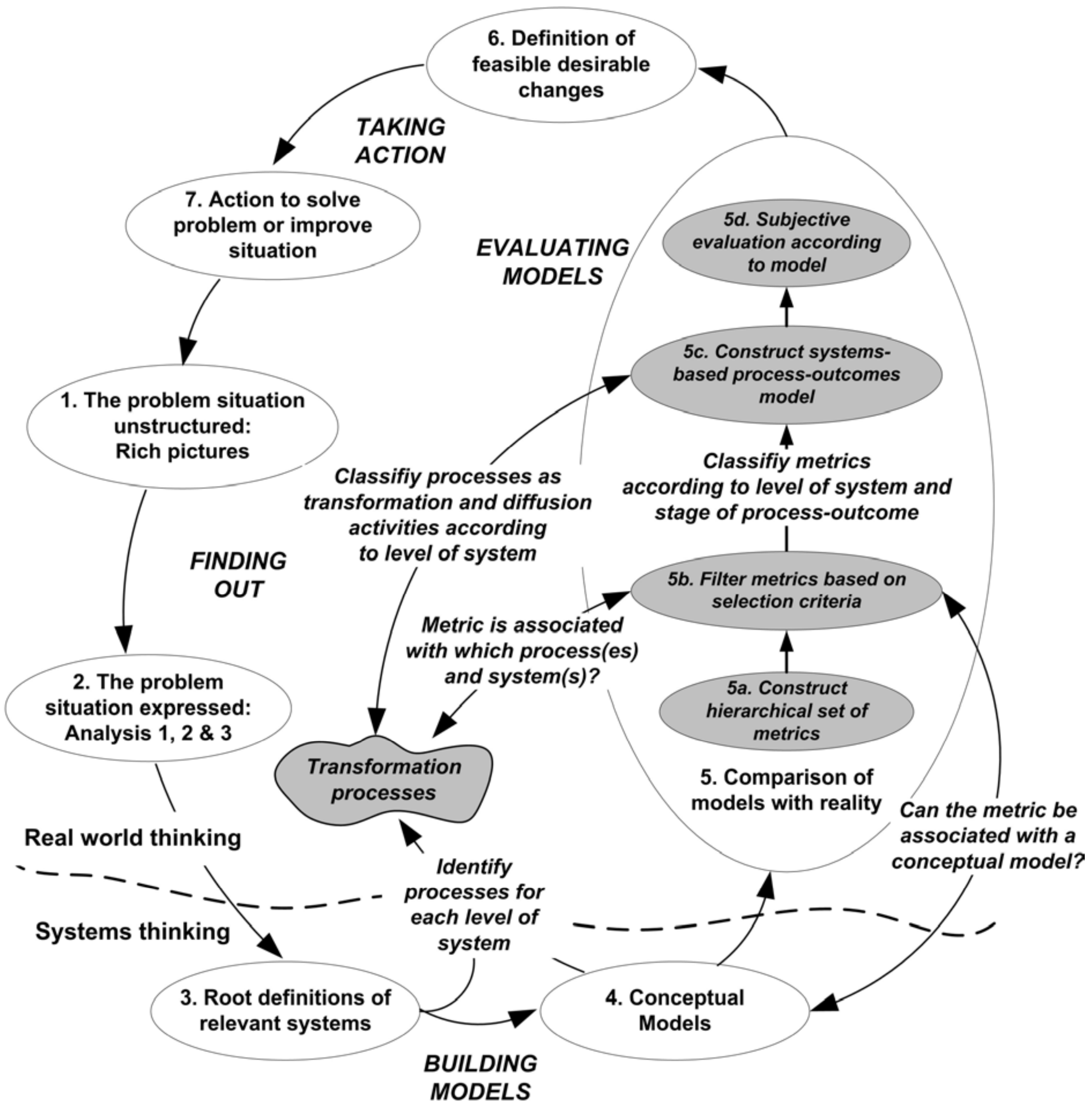

Figure 4: Combining SSM and the Process-Outcomes Model

The following section explains how the conceptual framework depicted above was tested against a real evaluation situation.

7. TESTING THE CONCEPTUAL FRAMEWORK

The conceptual framework was developed and tested on an evaluation of LBS in South Africa. This was based on a set of interviews with key role players in the industry and the first author's observations while being involved in seven LBS related commercial projects. An initial unstructured view of the problem was developed using rich pictures. These rich pictures were analysed in terms of the evaluator's role, and the political and social situation. This highlighted all the stakeholders in LBS in South Africa, the distribution of power and responsibility, and several social factors that may effect the situation. Based on this initial analysis, different levels of the system where identified for the construction of the root definitions. The identification of levels of systems proved to have a significant effect on the Process-Outcomes model at a later stage, which we describe more detail below.

Checkland maintains that the definition of what constitutes a system, the environment and sub-systems are entirely dependent on the observer. Thus, when attempting to define the root definitions of the various systems it is vital to understand different levels of the problem. In selecting relevant systems to model, there are always a number of levels available. The root definitions define the different levels of sub-systems, i.e. the level at which the transformation T of CATWOE is defined. Therefore, each root definition always covers three levels, the wider-system, the system and the sub-systems. In this manner, the initial rich pictures and analysis of the situation indicated there were three levels of systems that needed to be evaluated in order to address all the aspects of the complex phenomena of LBS in South Africa. This is shown below:

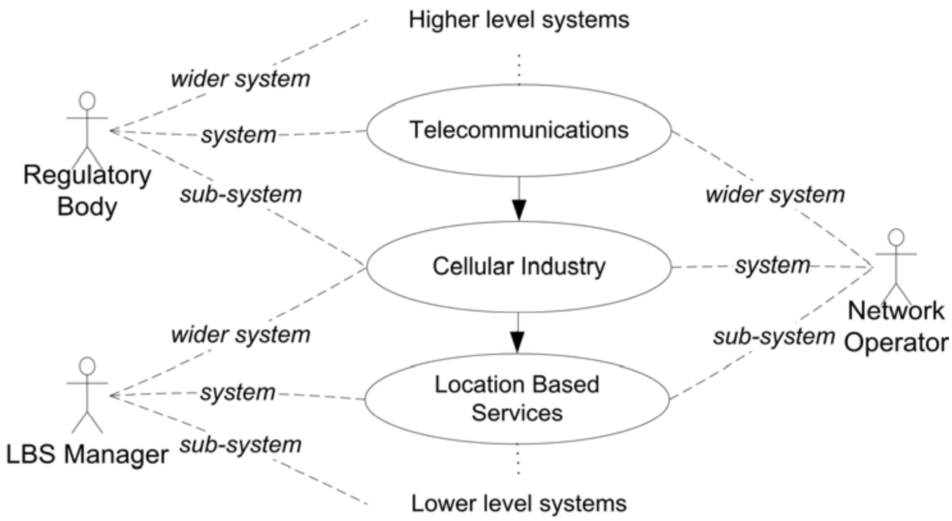

Figure 5: System Identification using Multi-level Thinking

Figure 5 above shows how the problem of LBS in South Africa was broken down into three levels of systems. From the point of view of a network operator, the provision of LBS is only a sub-system, while the regulation of the telecommunications industry is seen as the wider-system or the environment. Thus, the conceptual models of LBS in South Africa consist of three systems, as per the perspectives shown above.

By dealing with these three systems, the conceptual models also cover the broader requirements of the social system and the specific sub-systems or processes that form the LBS sub-system. In accordance with the view that the evaluation needs to serve the purposes of the evaluator, it is important to reiterate that the views of the higher-level systems are as they pertain to LBS specifically. Thus, only those aspects that are pertinent to LBS were included in the conceptual models. In the case of the regulation of the telecommunications industry for example, aspects such as the development of a government mandate for positioning technology would be included, while the administration of fixed-line telecommunications would not.

In accordance with the conceptual framework, root definitions and conceptual models were developed for each of the three identified systems. An analysis of these models resulted in a set of processes which are required to provide LBS in South Africa. Thus, the required contextual understanding of the situation has been generated to the best of the available knowledge. In addition, the processes to be included in the Process-Outcomes model have been identified.

The following stage of SSM would be to compare the conceptual models with reality. In the case of our conceptual framework, this means building a set of potential metrics, selecting suitable metrics, constructing the Process-Outcomes model and subjectively analysing the data based on the structure provided by the model.

A hierarchical set of metrics was created based on the initial understanding generated using SSM. This was achieved by abstracting the complex phenomena to measurable aspects, and moving from the general to the particular (Geisler 2000). As described above, these metrics spanned technological, economic, organisational and political, and social aspects of LBS in South Africa. The high-level dimensions of the sets of metrics are shown in the figure below.

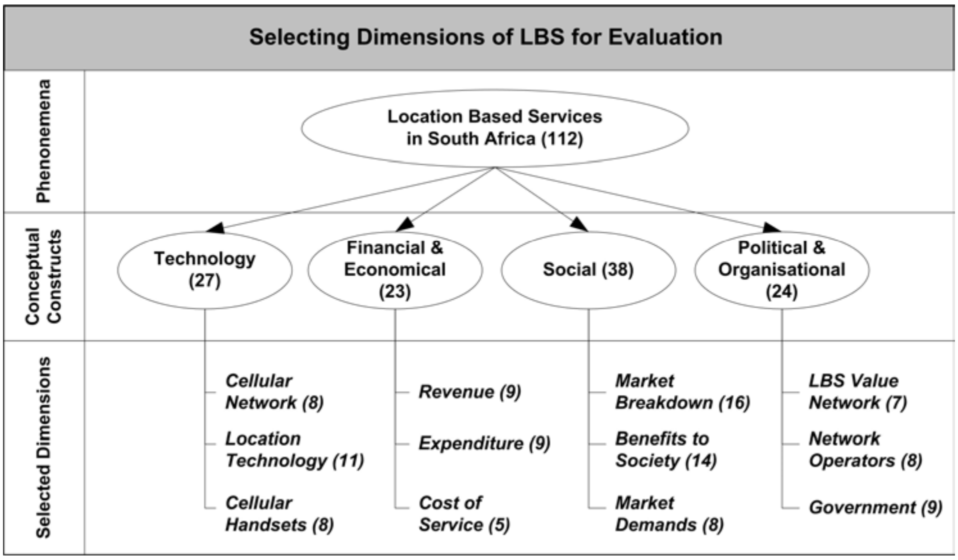

Figure 6: Selected Dimensions of LBS

Figure 6 shows the how we derived a set of 112 metrics for the evaluation of LBS in South Africa (e.g. 27 Technology related metrics and 23 Financial & Economic related metrics etc), starting with the required perspectives of the evaluation as outlined in earlier in this paper. Each of the metric groups or selected dimensions shown in the figure was further broken down until a comprehensive set of metrics addressing different aspects of the problem had been created – the number of metrics per group is shown in brackets in figure 6. The metrics were filtered by passing them through Geisler's (1999) selection criteria described earlier, plus applying the additional criterion defined by the conceptual framework i.e. we must be able to associate a metric with a SSM conceptual model. As per the definition and concept of a metric referred to earlier this paper, the associated data of the metrics was presented alongside with the definition of the metric.

To provide contextual meaning to the metrics, whether qualitative, quantitative, objective or subjective, they were analysed together with other information where appropriate. This included other metrics, data comparisons across technologies, organisations, regions or countries, and comparisons over time. No attempt was made to combine metrics by weighting and aggregation, as the specific intention of the conceptual framework was to provide the means for the holistic subjective evaluation of the available data. In addition to promoting holistic and subjective analysis, we wanted to avoid the potential biases introduced by numerically aggregating measures (Geisler 2000).

After the construction and selection of a set of metrics, the construction of the Process-Outcomes model for LBS in South Africa occurred in three stages; (a) the mapping of processes identified using SSM conceptual models to stages of transformation and diffusion; (b) the mapping of metrics to processes, and (c) the mapping of metrics to stages of outcomes. In addition to mapping metrics to stages of the Process-Outcomes model, the identification of three systems using SSM, as depicted in figure 5, allowed for the separation of the model into three separate but inter-related levels. Therefore, not only did the use of the SSM model help to identify processes and metrics for each stage of innovation, but also by separating the systems within the structure of the Process-Outcomes model, it was possible to add an additional insight whereby different levels of systems were assigned to different temporal stages. This is a vital additional aspect facilitated by the conceptual framework, as it allowed the appropriate metrics to remain associated with their respective systems, and allowed the flow of innovation to be more accurately represented across the sub-systems, as the sub-systems did not coincide temporally in terms of stage of innovation. Therefore, the evaluation model in fact consisted of three Process-Outcomes models, offset temporally with each other but with links between the processes and metrics established by the conceptual framework. This systems-based Process-Outcomes model is shown in Figure 7 below:

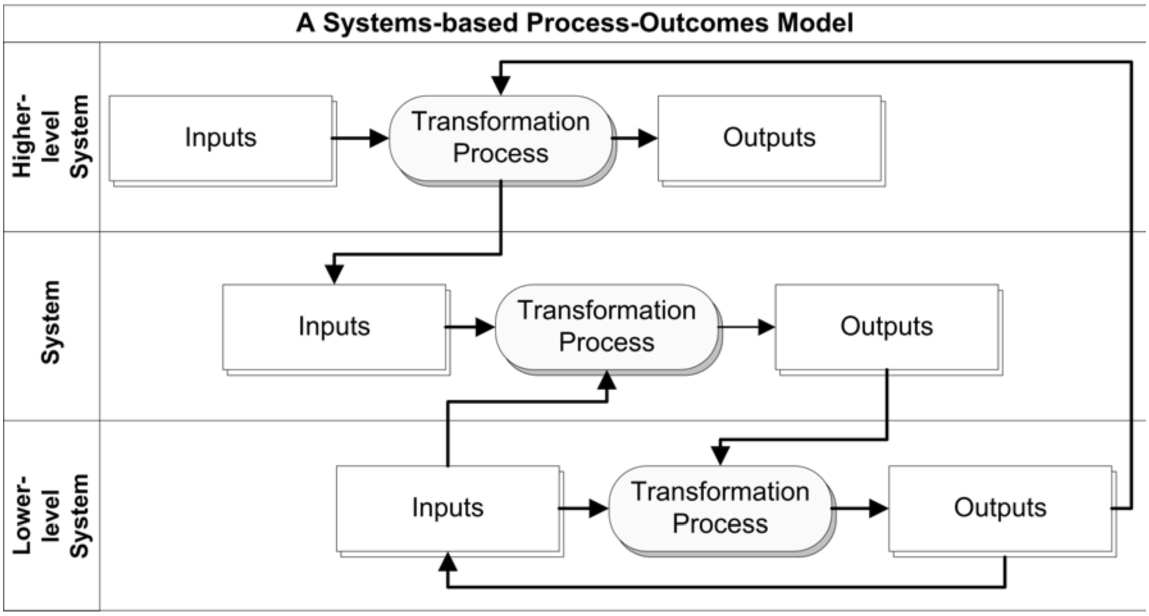

Figure 7: A Systems-based Process-Outcomes Model

After the Process-Outcomes model had been created, the metric data was analysed within the structural framework provided by the model. The framework of analysis was:

- technological, economic, social, organisational and political aspects;
- selected dimensions of metrics, as shown in figure 7;
- transformation processes associated with each stage of outcome of Process-Outcomes model;
- relevant SSM conceptual models, i.e. for each sub-system identified using SSM

Thus, the conceptual model provided the framework to analyse subjectively and holistically large amounts of data from different sources. Based on this subjective analysis, an initial set of opinions, recommendations for further action and suggestions for further research concerning LBS in South Africa were developed. In the following section, we examine the merits and shortcomings of the conceptual framework presented in this paper, and suggest improvements and avenues for further research.

8. EVALUATION OF THE CONCEPTUAL FRAMEWORK

Based on our experiences while applying the conceptual framework combining SSM and the Process-Outcomes model to the real situation of evaluating LBS in South Africa, we identify the following strengths:

- The SSM conceptual models generated a thorough contextual understanding of the problem situation, and therefore played a critical role in determining which aspects of the complex phenomenon should be evaluated, i.e. creating the set of metrics;

- The metric selection criteria filtered out metrics that were not available or not relevant, and focussed the data on the purposes of the evaluation;
- The conceptual framework included theoretical links between SSM and the Process-Outcomes model that acted at every stage of the model construction, thereby facilitating meaningful and valid connections between holistic and reductionist thinking;
- The rigorous merging of the SSM conceptual models and the Process-Outcomes model allowed for a detailed, multi-dimensional evaluation model to be constructed that provided a structure for the subjective evaluation of the model from a number of perspectives;
- The inherent strengths of the Process-Outcomes model were retained, i.e. the means to link metrics from different perspectives of the evaluation, namely social, technological, economic and organisational, through all stages of innovation whilst avoiding creating links between unrelated metrics at entirely different stages of innovation;
- The Process-Outcomes model provided the means to compare the SSM conceptual models with reality;
- The subjective analysis of the evaluation model created using the conceptual framework was fundamentally tied into the core concept of the framework, namely the identification of transformation processes. The analysis used this central theme of the conceptual framework to identify processes that could be improved, and thus process improvement provided the basis for the recommendations.

In addition to the strengths discussed above, we also present the following weaknesses of the conceptual framework:

- The practical application of all stages of the conceptual framework is highly labour intensive, and therefore potentially expensive if applied in a commercial environment;
- In an effort to avoid potential biases introduced by assigning values to qualitative data in an attempt to combine qualitative and quantitative data, aggregation of data was specifically avoided in favour of holistic subjective evaluation. However, the lack of numerical scores for metrics and categories of metrics makes it difficult to understand the results of the evaluation without understanding the whole evaluation model. This makes the evaluation model impractical for management purposes.
- The hierarchical approach used to construct the set of metrics drilled down through different layers of complexity until measurable aspects were reached. Due to the complexity of the phenomena, many of the resulting metrics were tightly related and in some cases were overlapping. This meant that data and analysis was duplicated in some metrics.
- The conceptual framework does not incorporate measures to assess the quality of the evaluation. This has been identified as a fundamental problem with qualitative evaluation (Kostoff 1998).

The weaknesses discussed above form the basis for our suggested improvements and recommendations for further research. The first weakness identified in the previous section was the lack of methods to aggregate and combine metrics into composite indicators, which would improve the understandability of the model, albeit at the expense of introducing further biases in the data. Thus, the authors recommend further research into methods of scoring and combining quantitative and qualitative data, and investigation into how these methods may be incorporated into the conceptual framework. This should be in addition to, rather than in replacement of, the subjective and holistic analysis described in this paper.

Another weakness was the issue of overlapping and repeating metrics. This suggests to the authors that further improvements to the conceptual framework could include the identification and combination of overlapping metrics. The authors believe that this current weakness could potentially be turned into an advantage, as overlapping metrics could provide insight into how different levels of systems interact with each other along the innovation continuum. In other words, the overlapping metrics could potentially be used as theoretical pivot points, or points of reference, that exist between the different sub-systems of the Process-Outcomes model. These pivot points could be used to align the stages of transformation between the different levels of the Process-Outcomes model, resulting in a better understanding of the interaction between the sub-systems and the flow of innovation of the system as a whole. Thus, the authors recommends further research into ways that overlapping metrics can be turned into an advantage in terms of structuring the systems-based Process-Outcomes model.

Our final recommendation for further research relates to the approach used for the subjective analysis. In creating a conceptual framework based on the identification of processes between SSM and the Process-Outcomes model, the authors created a framework for analysis that focused on process improvement as its key action for improving a situation. Thus, the authors recommend further research into process improvement concepts that could be incorporated in the conceptual framework. This would possibly improve the way that the resulting evaluation model is subjectively analysed for the purposes of recommending improvements to the evaluation situation.

9. CONCLUSIONS & RECOMMENDATIONS

Problems associated with the implementation of LBS in South Africa prompted an evaluation of the situation from the perspective of a network operator wanting to implement or improve LBS on their network. A conceptual framework was constructed to combine the Process-Outcomes model and SSM based on their common focus on transformation processes. This conceptual framework allowed for the construction of an evaluation model that benefited from both reductionist and holistic approaches.

A thorough contextual understanding of LBS in South Africa was obtained through the development of SSM conceptual models. This was imperative in deciding which aspects of the complex phenomenon to measure while creating the hierarchy of possible metrics. The set of metrics was reduced by applying the metric selection criteria, thereby focussing the evaluation on the intentions of the evaluators and the available data. The processes identified using SSM were used as the basis for the Process-Outcomes model, providing an extra level of detail in that we were able to represent the model in terms of the three identified systems as well as the stages of outcomes and transformation processes. This was of vital importance, as although the systems were interdependent, they did not necessarily correspond in terms of the stage of development within the Process-Outcomes model. Representing each system on its own level provided additional understanding of the relationships between the systems and their processes and metrics at various stages of the innovation process.

In conclusion, holistic and reductionist approaches to evaluation are not separable. Through the conceptual framework presented in this paper, the Process-Outcomes model has provided the means to analyse the specific measurable aspects of LBS in South Africa, while SSM aided us in identifying which aspects to measure based on the generated holistic understanding. In addition, the metrics of the Process-Outcomes model have provided the means to compare the SSM conceptual models with reality, thereby forming the basis of recommendations for improvement. We note that, as with all evaluative systems, the methodology has it flaws and limitations. A major problem will be getting the relevant stakeholders to commit to it. However, it provides a rigorous approach to evaluating the introduction of technological systems which can be adapted to suit a particular set of circumstances.

REFERENCES

Adams, P., Ashwell, G. W. B., & Baxter, R. 2003, "Location-Based Services: an Overview of the Standards", *BT Technology Journal*, vol. 21, no. 1, pp. 34-43.

Barry, M. B. 1999, *Evaluating Cadastral Systems in Periods of Uncertainty: A Study of Cape Town's Xhosa speaking Communities*, Ph.D., University of Natal, Durban, South Africa.

Barry, M. B. and Fourie, C. 2002, "Wicked Problems, Soft Systems and Cadastral Systems in Periods of Uncertainty: South African Experience", *Survey Review*, vol. 36, no. 285, pp. 483-496.

Budde, P. 2001, *Wireless Market 2001*, Paul Budde Communication Pty Ltd, Australia, ISSN-1444-075x, 5th Edition.

Budde, P. 2002, *Telecommunications and Information Highway Industry Analysis*, Paul Budde Communication Pty Ltd, Australia.

Casal, C. R. 2004, "Impact of Location-Aware Services on the Privacy/Security Balance", *info*, vol. 6, no. 2, pp. 105-111.

Checkland, P. 1981, *Systems Thinking, Systems Practice* John Wiley & Sons, Ltd.

Checkland, P. 1999, "Soft Systems Methodology: A 30 Year Retrospective," in *Systems Thinking, Systems Practice*. John Wiley and Sons, Ltd. Chichester, UK.

D'Roza, T. and Bilchev, G. 2003, "An Overview of Location-Based Services", *BT Technology Journal*, vol. 21, no. 1.

Dao, D., Rizos, C., and Wang, J. 2002, "Location-Based Services: Technical and Business Issues", *GPS Solutions* no. 6, pp. 169-178.

Gale Group 2002, *Mobile Location Case Studies*, Informa UK Ltd.

Geisler, E. The Metrics Of Technology Evaluation: Where We Stand And Where Should We Go From Here. 15-7-1999. http://www.stuart.iit.edu/workingpapers/technology

Geisler, E. 2000, *The Metrics of Science and Technology*. Quorum Books. London.

Gulati, R., Sawhney, M., and Paoni, A. 2002, "The Wireless Value Chain and Infrastructure," in R. Gulati, M. Sawhney, and A. Paoni, eds. *Kellogg on Technology & Innovation*, , John Wiley & Sons, Inc, New Jersey, pp. 79-152.

Hofstadter, D. R. 1979, *Godel, Escher, Bach: an Eternal Golden Braid*. Penguin Books. London.

Johnson, A. L. 1999, "Using Soft Systems Methodology in the Analysis of Public Involvement in EIA". International Association for Impact Assessment Conference Proceedings, Glasgow. http://www.iaia.org

Kostoff, R. N. Science and Technology Metrics. 1998. US DoD Office of Naval Research. http://www.onr.navy.mil/sci_tech/special/354/technowatch/docs/50510_metrics_main_text.pdf

Kostoff, R. N. 2001, "The Metrics of Science and Technology", *Scientometrics*, vol. 50, no. 2, pp. 353-361.

Krenik, W. R. 2002, "Wireless User Perspectives in the United States", *Wireless Personal Communications*, vol. 22, pp. 153-160.

Luukkonnen-Gronow, T. 1987, "Scientific Research Evaluation - A Review of Methods and Various Contexts of their Application", *R&D Management*, vol. 17, no. 3, pp. 207-221.

McCabe, E. 1999. Location-Based Services Offer a Global Opportunity for New Revenue. Telecommunications Online. October 1999. http://www.telecommagazine.com/

Piore, M. J. 1979, "Qualitative Research Techniques in Economics," in *Qualitative Methodology*, pp. 71-86. 5th edn. J. Van Maanen, ed., Sage Publications, Beverly Hills, Ca.

Rao, B. and Minakakis, L. 2003, "Evolution of Mobile Location Based Services", *Communications of the ACM*, vol. 46, no. 12, pp. 61-65.

Rose, J. and Haynes, M. 2001, *A Soft Systems Approach to the Evaluation of Complex Interventions in the Public Sector*, Creative Strategies and Systems Management, Manchester Metropolitan University.

Smuts, J.C. 1926. *Holism and Evolution*. Macmillan, London.

Van Zyl, J. 2001, *The Process Innovation Imperative*, Ph.D., University of the Witwatersrand, South Africa.

Wiid, S. 2005, *A Model for the Evaluation of Location-Based Services in South Africa based on Soft Systems Methodology and the Process-Outcomes Model*, M.Sc. Engineering, University of Cape Town, South Africa.

BIOGRAPHICAL NOTES

Sean Wiid completed his MSc (Eng) at the University of Cape Town (UCT) in 2005. Prior to that, he was the first graduate of the GeoInformatics stream in the BSc Geomatics programme at UCT, where he also completed a major in computer science. Sean has five years working experience in software development relating to mineral licensing systems and numerous aspects of spatial information systems. He has worked in South Africa, Angola and Mozambique, and has recently moved to London where he is a Principal Developer for GDC, a GIS solutions provider. Sean is a registered Professional GeoInformatic Practitioner with the South African Council for Professional and Technical Surveyors.

Mike Barry is an Associate Professor in the Geomatics Engineering Department at the University of Calgary, where he his Associate Head, Undergraduate Studies. He has BSc(Survey) and MBA degrees from the University of Cape Town and a PhD from the University of Natal. His research interests are in developing software tools to support land tenure, analysing and managing change in applying cadastral systems and spatial data analysis. He was recently appointed a director of the FIG Foundation.

CONTACTS

Mr Sean Wiid
GDC
69 Wilson Street
London, UK
EC2A 2BB
Tel + 44 7876507544
Email: seanwiid@yahoo.co.uk

Dr Michael Barry
Department of Geomatics Engineering
University of Calgary
2500 University Drive NW
Calgary, Alberta
Canada T2N 1N4
Tel +1 403 220 5826
Email barry@geomatics.ucalgary.ca
www.geomatics.ucalgary.ca/~barry