Geofencing Engineering Design and Methodology

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Abstract-The aim of this paper is to evaluate the research methods used in Geofencing Engineering and its associated design and methodology. In so doing the paper will consider the research approaches used by other authors in this field before adopting an approach. Once this is done the author will justify why the selected approach has been adopted and should be used in preference to others. However before this is done it is necessary to restate the variables that are under consideration as the variables that are to be collected decide what kind of method is used and why. It is also necessary to restate the methods used in collecting our data which were by observation in a laboratory and by questionnaire. These two methods of collection are the justification of how we collected our data and why those research methods had to be used. According to social scientists research design is the science and art of planning procedures for conducting studies so as to get the most valid findings as such this paper is key to validating our research findings

***Index Terms*— Engineering Design, Theory, Methodology, Research Data, Constructs, Variables, Independent, Dependent**

I. INTRODUCTION

Before we began constructing our research design for our experiment we had determined our research paradigm and chosen our topic. This was because our choice of paradigm would have serious implications on our choice of methodology and also the methods we would use in collecting our data. Our research paradigm also has serious implications on our chosen research problem and research questions, so it was important to get this right, as the whole research would collapse if adequate consideration wasn't given to our choice of paradigm. So in order that we got this right we decided to follow a formal procedure that had been used by so many other researchers so as not to stray off giving adequate consideration to our eventual choice of paradigm. Table I show an overview of the research design used in this thesis and the literature review undertaken as sown in Figure I and Figure II enables the research to highlight the gaps in knowledge which also act as justification for the research to be undertaken. Table II shows the research topic and research problem which are developed by the literature search. The two main dimensions of a design theory are a product and process where the product is a set of properties that exist within the product and the processes the method for constructing the product [1]. Table 3 shows this papers design structure and theory. Table III shows the four components of an Information Systems Design Theory (ISDT) about the design product according to [1] which are (1) meta-requirements, (2) meta-design, (3) kernel theories, and (4) testable design product hypotheses. Meta-requirements concern the class of goals to be addressed by the application/use of the design product. They are called meta-requirements rather than just requirements because they address a generalised class of goals rather than particular, situated goals (e.g. in some particular organisation at some point in time)

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II. DEFINING TERMS

We had defined the key terms used in our research; this was done so that there would be consistency throughout the research. We noted that in a phenomenological research that it is slightly more difficult to define the terms because of the exploratory nature of the research. The advantage of defining terms in positivistic studies is that it enhances the precision and rigour of the research. In defining the terms the product is one aspect of the design theory and has meta-requirements which describe the goals to which the design theory applies. The Meta design describes the design principles used to meet the meta-requirements and then a set of testable product hypotheses are used to verify the design satisfies the requirements [2].

III. THE LIMITATIONS AND DELIMITATIONS

As with all large or small research projects we constrained our research enquiries in a number of ways and excluded some potential areas of investigation which we will disclose for ethical reasons and so that future researchers are aware of our exact work. We used diagrams to highlight these limitations as in Figure 3

IV. METHODOLOGY USED

Paradigms refer to the progress of scientific practice which are based on individual's philosophies and assumptions

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about the world and their knowledge; which if related to the context of this thesis would mean how the author thinks the research done in this thesis should be conducted. Paradigms have continued to provide renowned researchers with a headache of how "models problems" should be solved using "model solutions" [3]. This has meant that paradigms continue to mean different things to different people; however one researcher [4] attempted to sanitise the situation by suggesting that the term paradigm should be classed into three different levels as seen in Table 4. From this we can see that the researchers are suggesting that one's basic beliefs about the world in which they live is reflected in the way that they design their research, how they collect their data, how they analyse their data and even the way in which they write their research papers. Table 5 highlights the dynamics of the three philosophical levels in relation to our research

The research paradigm or philosophy for this paper can be defined as the process of the research – which is the way in which I intend to collect and analyse my data. Based on the key areas of my research and its aim the relevant research approaches I will use are the: Qualitative: "Which is subjective in nature and involves examining and reflecting on perceptions in order to gain an understanding of social and human activities". Quantitative: "Which is objective in nature and concentrates on measuring phenomena; therefore it involves collecting and analysing numerical data and applying statistical tests". There is considerable blurring in the use of these philosophies which are classified as either positivist (Quantitative) and phenomenological (Qualitative). Therefore suggesting that the ontological debate of what is reality can be kept distinct of the epistemological question with regards how do we obtain knowledge of that reality? In effect we are being told that the act of investigating reality has no effect on that reality, this is what Positivists believe. These researchers also argued that it was impossible to separate the researcher from the research and that what existed was what the researchers thought existed [5]. The researchers paid considerable regard to the subjective state of themselves; this qualitative approach stressed the subjective nature of human activity by focusing on the meaning rather than the measurement of social phenomena. Table 6 shows how we collect our data. The researchers practicing phenomenology believe that social reality is dependent of the mind; therefore they argue that what is researched cannot be unaffected by the process of the research [6]. Fig 1 shows the literature search done to show the problem which in turn based on previous research done in the area defines the methodology used in this research paper. Figure 2 shows the design theory product and design process which show the formulation of the method used to state the problem in terms of research theories

V. APPROPRIATENESS OF OUR RESEARCH ANALYSIS

By looking at the appropriateness of the analysis done in our research, it is important to look at the following which form the foundation of an appropriate analysis a) why we collected the data b) what data we collected c) from where we collected the data d) when we collected the data e) how we collected the data f) how we intend analysing the data. These are shown in Table 7. By using the following questions the research will try to gather the knowledge needed as required by the philosophy of science to answer by development the purpose of the research. As the Information required in my research is quantitative & qualitative, I also need to define the way in which I intend to use the knowledge gathered from the questions. Hence I have defined how I intend to use the questions and what kind of data I am looking to get from the question. Table 8 highlights the type of questions used in our research

VI. METHODS USED

Research Approach: The research approach adopted by this thesis is that of quantitative and qualitative, both were adopted because of their unique characteristics. Quantitative was adopted because of its measuring concentration which involves collecting and analysing numerical data and applying statistical tests. The other adopted approach was qualitative research which has an understanding concentration of social and human activities.

VII. STATISTICAL ANALYSIS OF THE DATA

In order to obtain and analyse the correct sample data the research shall adopt the approach used for statistical studies which comprises of (Surveys, experiments, observational studies etc). This will enable a big enough effect to be of scientific significance [8]. In contrast to this other researchers have however suggested the use of a methodology of discrete-event simulation for manufacturing systems. This is so as to benefit from the analysis and interpretation of simulation results that come with using the model [9]. This model is also very useful for this research and whilst the author will not adopt the recommendations in all entireties the data collation procedures and processes shall be adopted in order to maximise the results. In comparison other researchers have said that the rules used have to be tested not by statistical means but by validating the prohibitions, authorisations and obligations which can be integrated into one by restricting predicates or by adding transitions and states [10]. However due to the significance of this studies results and the size of the data it would not be possible to validate the data using this method [11]. How do these approaches link into a wider discourse (in other words, how do they fit into histories of knowledge production or the philosophy of science)? "One research methodology to be adopted is Quantitative. However, within the philosophical tradition of ontology and epistemology, the work adopts the method of objectivism, which affirms the notion that objective reality exists out there for research to go and discover it. Hence truth and meaning does exist in some external world, and are created by objective action within the positivist purview. Hence the theoretical approach for this research is the naturalist, approach which is akin to the positivist perspective, using the method of data collation and description of isolated scientific variables" [12]. "Another research methodology to be adopted is qualitative. However, within the philosophical tradition of ontology and epistemology, the work adopts the method of constructivism which rejects the notion that objective reality exists out there for research to go and discover it. Rather, truth and meaning does not exist in some external world, but are created by subjective action within the constructivist purview. Hence the theoretical approach for this research is the interpretivist approach which is akin to the phenomenologist perspective, using the method of critical analysis to evaluate and interpret the available works" [13]

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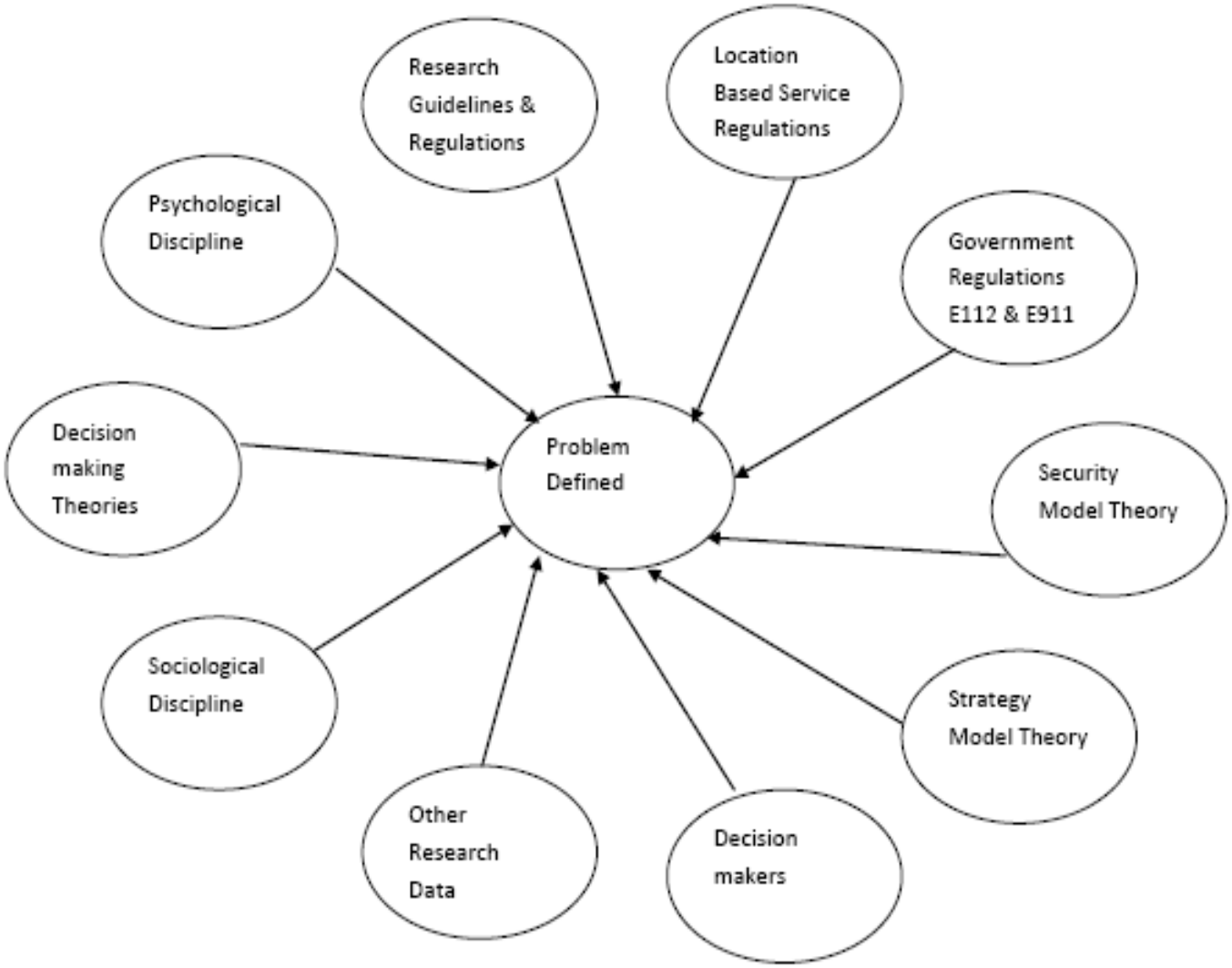

Fig 1: Literature Search

Table I: Overview of our research design

Identify research problem
Determine purpose of research
Develop theoretical framework
Define research questions / hypothesis
Define terms
Identify limitations of study
Decide methodology
Determine expected outcome

Table II: Research problem

Research topic	**Research problem**
Security Strategy Model for Wi-Fi using Geofencing	Using Geofencing as a Security Strategy Model

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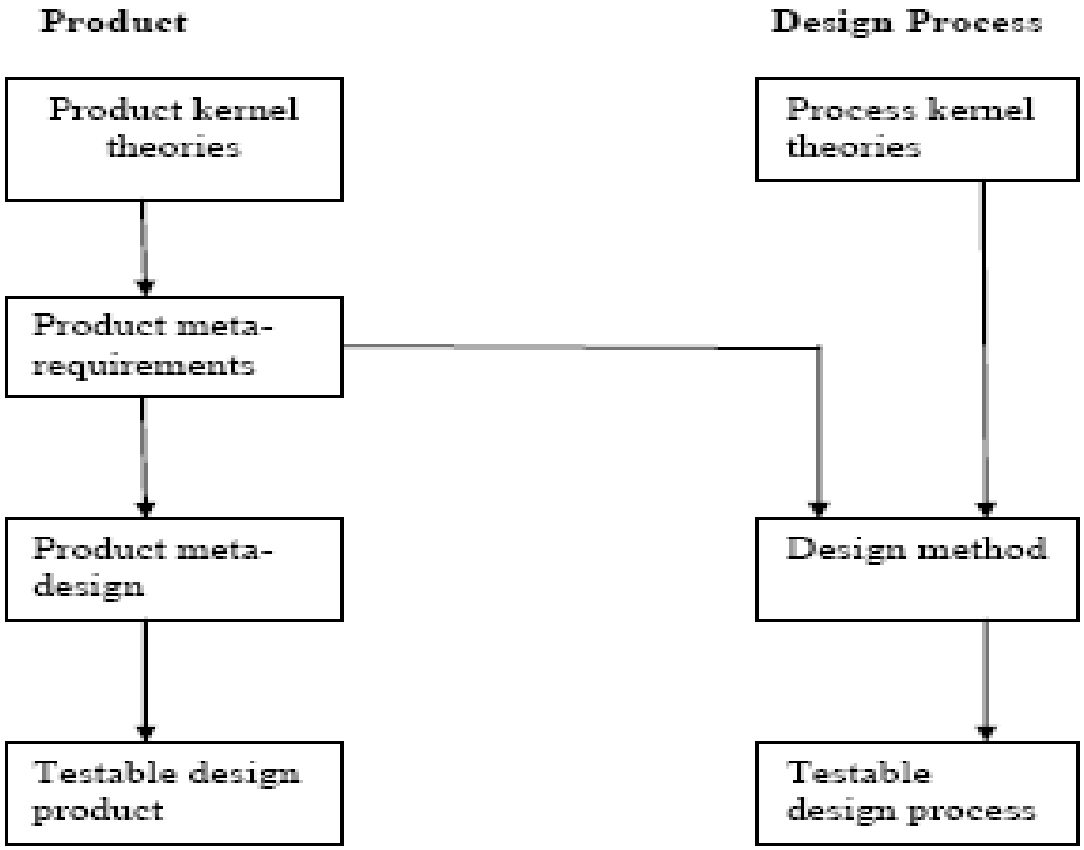

Fig 2: The design theory product and design process

Table III: Design Theory Features

Design Product	
Kernel theories	KT1: Universal Constructive Instructional Theory
	KT2: Geofencing as a Security Strategy Model
Meta-requirements	MR1: Geofencing application framework that can be used to grant access to a Wi-Fi network using a pre-defined parameter as control (KT1)
	MR2: Awareness and Compliance with the Geofencing application framework should be evaluated routinely (KT2)
Meta-design	MD1: Set up Geofencing application framework and use Security Strategy Model to control MR1 – MR2
Testable design product hypothesis	H1: Security Strategy Model maintains user compliance with Geofencing application framework
Design Process	
Kernel theories	KT1: Universal Constructive Instructional Theory
	KT2: Geofencing as a Security Strategy Model
Design method	a) Instructions are defined b) Expected conditions are defined c) Actual conditions are defined d) Effectiveness of instruction is measured
Testable design process hypothesis	PH1: It is feasible for practitioners to set up training that meets MR1 – MR2 and MD1

Table IV: Research Paradigms

Philosophical level	Where it is used to reflect my basic beliefs about the world
Social level	Where it was used to provide guidelines about how we should conduct our research
Technical level	Where it is used to specify the methods and techniques to be adopted in our research

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Table V: My research data compared to that used in industry

Telecommunication Systems	**Geolocation Systems**
Quality of Service • Signal to interference ratio • Packet error rate • It error rate	Accuracy of service • Percentage of calls located within an accuracy of meters • Distribution of distance error at Geolocation receiver
Grade of service • Call blocking probability • Availability of resources • Unacceptable quality	Location Availability • Percentage of location requests not fulfilled • Unacceptable uncertainty in location
Coverage area	Coverage area
Capacity • Subscriber density that can be handled	Capacity • Location requests / frequency that can be handled
Other system parameters • Delay (call setup, channel assignment, etc.) • Reliability • Database lookup time • Message and time complexity • Network management system	Other system parameters Delay in location computation Reliability Database look-up table Management and complexity

Table VI: Data source and collection methods used in our research

Source	**Data Collected**
Documentation	Emails, letters, minutes of meetings, published studies
Interviews	Open ended questions,
Questionnaires	Using a questionnaire that was designed to ask questions relating to the variables
Direct Observation	Observed personnel using the technology
Participant observation	The author was involved as a temporary member of staff at the laboratories test bed
Physical artefacts	Print outs and screen shots of the results

Table VII: The method and the outcome of or analysis

Method	**Outcome**
Pattern Matching	We predicted the results of our experiment and compared them with our actual ones
Explanation building	We used explanations to analyse our data because our data was linked to theory
Complex Time Series Analysis	Our analysis was complex because we had one significant finding that did not span over a long period of time
Logic models	We made a partial use of logic models because our experiment looked at the interplay between independent variables (causes) and dependent variables (events). We predicted the causes and then compared them with the actual events

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Table VIII: Types of Research Questions to be used in my research

What precisely is Geo fencing?	Descriptive question (open ended)
What are security strategy models?	Descriptive question (open ended)
What are the Quality of Software (QoS) issues associated with Geo fencing?	Relational question (open ended)
What are the limitations in the current Geo Fencing model?	Descriptive question (open ended)
What are the possible areas of further research in Geo Fencing?	Probe question (open ended)
What are the ethical issues in Geo Fencing?	Sensitive question (open ended)
What are the wireless protocols for Geo fencing?	Descriptive question (open ended)
What are the Information Technology (IT) Governance standards for Geo fencing?	Relational question (open ended)
What are the security threats to wireless networks?	Sensitive question (open ended)
What are the proposed solutions to the wireless security threats using strategy model?	Strategic questions (open ended)

Table IX: Research approach used in our research

Research approach: Triangulation; is the combination of methodologies in the study of the same phenomenon [7]
Strength: Overcomes potential bias and sterility of a single method approach. Leads to greater validity and reliability than a single methodological approach; [7] Triangulation has vital strengths and encourages productive research, enhances qualitative methods and allows complimentary use of quantitative methods.
Purpose: Gives a much fuller picture by asking different person s to describe different aspects of a situation
Theoretical framework: data triangulation, investigator triangulation, methodological triangulation, triangulation of theories
Weaknesses: Exceedingly difficult to perform where you have a mixed method approach, particularly where qualitative data is generated and data collection and analysis is time consuming and expensive. Triangulation cannot be used to rectify a poor research design but must be integral to a good design

VIII. CONCLUSION

Research Approach will be by Methodological Triangulation which is a mixture of qualitative and quantitative methods of data collection. Our paper is a brief description of the design methodology used in our Geofencing experiment and why we choose the methods we did. The research is completely holistic in its approach and the security strategy model will be unique. To the best of the author's knowledge, no previous work has attempted to create a security strategy model using LBS within and outside a geographical test bed that is conditioned by wireless protected access protocols and Information Technology Governance standards. The primary contribution of the research will be the design of the security strategy model and the development of a supporting theoretical framework for the model

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