# AN ONTOLOGY TO MODEL THE RESEARCH PROCESS IN INFORMATION SYSTEMS


## Abstract

*The IS community has relied mostly on two main paradigms to undertake IS research: positivist and interpretivist. This paper argues that the ongoing debate around which of these paradigms is better suited to undertake IS research has created confusion amongst IS researchers, particularly between those who are relatively inexperienced (e.g. PhD researchers). Inexperienced researchers tend to place emphasis on the justification of their research approaches in the context of existing paradigms without offering a clear description of how the chosen methods and paradigms are applied in the context of their own research, a key issue to assess and understand any research output. This paper does not attempt to give any suggestions as to which research methods/paradigms should be used for IS research, but to raise the awareness that the way we currently communicate our thoughts in the research methods domain may not be very effective. We argue that an initial step to undertake this challenge could be to take a more "practical" approach by focusing on the process of thinking and planning the research activity rather than focusing on the justification of the use of one or many research methods usually "loaned" from other disciplines.*



*Keywords: research process, research methods, research approach, research paradigm, IS research, ontology*


## 1 INTRODUCTION:

Any academic discipline substantiates its existence on the basis of a rich and comprehensive set of research methods. New topics wanted to be classified as disciplines will be nervously seeking a body of knowledge of this kind to sustain its academic reputation. Unfortunately in the early days of any discipline, such a body of knowledge is hard to determine specially in term of its uniqueness. Therefore, there is a tendency to borrow "ripe" research methods from neighbouring discipline's trees. Whilst in the short term is probably the best that can be done, there is no guarantee that such a collection of research methods are appropriate or usable. IS is a new discipline/subject that neatly exemplifies this situation. There is a collection of research methods which have been "borrowed" and for which there is not a great deal of evidence that there are either appropriate or inappropriate.

New entrants into a discipline will seek the security of the research method to justify the approach they take during the research. It follows then that in a new discipline such reassurance, whilst desired by the student, may not be appropriate at all. One can imagine a new student in IS taking a bag full of research methods, and likely, dip pulling research methods one after the other from the bag, trying to see if they fit together and with the appropriate handles turned, this will do the trick. Clearly, this is unlikely.

In this paper we endeavour to experiment into the provision of a system's to the uninitiated to this problem of selecting research methods. We are going to argue that it may be possible to provide some rational structuring of how to go about using research methods to do research. We expect this guidance to fail. However, we also expect in the process of trying to constructing and testing it we will learn a lot about our research methods and their inadequacies, and also get a better understanding of how new researchers blunder around. This paper tells the story of this adventure. The reader will be thrill to know that he outcome of this story is to encourage all researchers to use their intelligence in preference to a cook-book.

# 2 DEFINITION OF TERMS

The ongoing debate in the IS research methods arena has lead to the spread of related terms, in particular to what we understand as Information Systems (IS), paradigm, research method, and research methodology. These terms are used differently depending on the author's views, beliefs and the research context. This section endeavours to provide the reader with an analysis of such definitions. The definitions used in this section are not meant to be "correct" in an absolute sense, but are used to provide a common understanding of these terms between the reader and the author to develop the arguments of this paper.

## 2.1 IS Definition (Paul 2007)

Paul starts by distinguishing Information Technology (IT) from IS. He argues that IT is a collection of devices, software and accessories which when combined provide a part or all the delivery mechanism for any IS that uses this mechanism. Thus, the IS is what emerges from the *usage* that is made of the IT delivery system by the users. In addition to this, Paul argues that the usage could be made of two parts:

1. Formal Processes, which are currently assumed to be pre-determinable with respects to the decisions about what IT to use. He argues that these processes need to change quickly due to two main reasons a) whenever the system is found not to work as anticipated and b) the IS can appropriately be adapted to the changing world around it.
2. Informal processes, which are what the human beings create or invent in order to ensure that the useful work is done.

IS is, thus, continuously being created or emerging from the adaptive usage made by the users of the IT in combination with the formal and informal processes so as to make things work. The IS, then, is what emerges from the usage and adaptation of the IT and the formal and informal processes by all of its users. For the rest of the paper this definition will be used for IS unless stated otherwise.

## 2.2 Research Paradigm

Broadly speaking, a paradigm is a philosophical or theoretical framework of any kind (Merriam-Webster Online). In the context of IS research, there are many interpretations of this term, some of these explicit and others are left to the reader's interpretation. For instance, (Galliers 1992) does not explicitly define what a research paradigm is, though; the reader can assume that is a way to categorise IS research methods (also referred as approaches). A more explicit definition and the one used for this paper is the one provided by (Mingers 2001, p. 242). Mingers argues that a paradigm is "a construct that specifies a general set of philosophical assumptions covering, for example, ontology (what is assumed to exists), epistemology (the nature of valid knowledge) ethics or axiology (what is valued or considered right), and methodology".

According to (Galliers 1992, p 148) there are two different paradigms in IS: scientific (empirical) and interpretivist. Galliers defines scientific approaches as those that "have arisen from the scientific tradition – characterized by repeatability reductionism and refutability and which assume that observations of the phenomena under investigation can be made objectively and rigorously". Interpretivist approaches are those that "argue that the scientific ethos is misplaced in social scientific enquiry because of, *inter alia*,

- The possibility of many interpretations of social phenomena;
- The impact of the social scientist on the social being studied;

- The problems associated forecasting future events concerned with human activity given the fact there will always be a mixture of intended an unintended effects and the danger of self-fulfilling prophecies or the opposite”

In a more recent work, (Mingers 2001) provides a list of different considerations as to which paradigms are available today. He argues that most authors distinguish at least two paradigms: Positivist (also known as Empirical-Analytic, Objectivist, and Functionalist) and Interpretive (also known as Subjectivist and Constructivist). Many other authors add another paradigm: Critical (Orlikowski, Baroudi 1991) or Pragmatism (Robey 1996), and others distinguish four: Functionalist, Interpretive, Radical Humanist, and Radical Structuralist (Burrell, Morgan 1979);(Hirschheim, Klein 1989). Finally, Mingers (2001) advocates the idea of different paradigms to emphasise the alternative of combining different methods, but he explicitly wishes not to restrict this idea within any particular paradigm boundary currently available.

## 2.3 Research Methods

Galliers, wishes to differentiate between Research Methods and Research Approaches. Galliers (1992, p.147) coincides with Weick (1989) in the sense that Research Methods are “simply ways to systematize observation” whereas, according to Galliers, Research Approaches are “a way of going about one’s research. They may embody a particular style and employ different methods or techniques. Approaches are therefore a more generic concept than methods.” Although Galliers wishes to differentiate between those two terms, the definitions provided and the examples given leave some room for interpretation. For instance, he provides a list of alternative Research Methods with reference to different Research Approaches (p. 147). These, however, are mapped one to one, thus it is difficult for the reader to differentiate between Methods and Approaches with the examples given. Additionally, in page 146 he uses the terms Approaches and Methods indistinctively. For Galliers, examples of Research Approaches are: laboratory experiments, field experiments, surveys, case studies, theorem proof, Empirical, Engineering, Reviews, action research, longitudinal, descriptive/interpretive, forecasting/future research, and simulation.

Mingers (2001, p 241) argues that research is conducted by undertaking particular activities, such as administering and analysing a survey, conducting controlled experiments, etc. He thus refers to research methods as a “Well defined sequences of operations that if carried out proficiently yield predictable results". Mingers explicitly uses the terms Research Method and Research Technique synonymously. Other authors use the term Research Methodology as a synonymous of Research Method (e.g. (Tashakkori, Abbas, Teddlie, Charles, Kervin,John 2000)) and others use Research Design to describe what Mingers considers to be Research Methods (e.g.(Orlikowski, Baroudi 1991))

Although many different terms are used to describe the same concept, a consensus can be reached leaving aside the terms used to describe it and concentrating in the examples given. For example, Mingers’ definition of Research Method and Galliers’ definition of Research Approach make references to the same concepts (e.g. administering and analysing a survey, conducting controlled experiments, etc). Similarly, Orlikovski does not explicitly define Research Design, though the author refers to Research Design to the same concepts described by Galliers and Mingers. Considering the variety of terms used to describe those concepts and for the purposes of clarity, this paper will use the definition provided by Mingers when referring to Research Methods.

## 2.4 Research Methodology

There are many connotations of the term Methodology and, particularly within the IS domain there is some confusion when referring to IS development Methodologies and IS Research Methodologies. Although there may be some instances when a Research Methodology may be actually an IS development Methodology (e.g. when researching the field of IS design and development) the latter differentiates from the former mainly in the sense that it concentrates on the software development cycle and not in the process of research itself. Although there are some synergies between IS research

and IS development, this paper will concentrate on those definitions that are clearly concerned with the research process.

Mingers (2001) distinguishes three connotations of the term Methodology: a) the study of methods (Checkland 1981), b) the actual Research Method(s) used in a certain piece of research (Tashakkori, Abbas, Teddlie, Charles, Kervin,John 2000). In this context, every research study has its own individual methodology, and c) a generalization of the previous one. Particular combination of methods may be used many times in practice, or are designed a priori. As time progresses these come to be called a Methodology. Using the term this way, Mingers argues, a Methodology is more general and less prescriptive than methods. He adds, "it is a structured set of guidelines or activities to assist in generating valid and reliable results. It will often consist of various methods or techniques, not all of which need to be used every time."

Once again, many different terms are used to describe the same concept. For instance, Galliers refers to Research Approaches as "a way of going about one's research. They may embody a particular style and employ different methods or techniques. Approaches are therefore a more generic concept than methods." This definition is close to the third definition provided by Mingers for Research Methodology. For the same purposes exposed in the methods section, the author arbitrarily will refer to the term Research Methodology as described by Mingers (2001). Finally, some authors suggest that Research Methodologies and the corresponding Research Methods are explicitly or implicitly based on a given Research Paradigm, thus these are constrained by the philosophical assumptions of the related paradigm.

### 2.5 Discussion

A couple of conclusions can be derived from the terms discussed before. First, the variety of interpretations as to what are research methods, paradigms, methodologies and methods, makes difficult to communicate the researcher's thinking when adopting these methods. Moreover, the justification of the adoption of these paradigms needs to be justified by a clear description of the terminology used to avoid any confusion, which is usually omitted. The IS community has long relied on modelling techniques and languages to avoid similar problems in the IS design arena. We argue that a similar modelling approach can be adopted to solve ambiguous and conflicting terminology in this domain.

An interesting contribution from Paul's definition of IS is that brings to the people's attention the idea that IS is constantly *adapting* to need as the people *change* their usage and the Information Technology (IT) is updated or extended. Moreover, it describes an intrinsic and complex relation between people, processes and technology. The complexity described in this IS definition suggests that IS practitioners could benefit from research approaches that rely less on methods loaned from other disciplines and are more innovative and practical at the time of describing the research process. More importantly, the justification or validity of innovative approaches relies strongly on how well the rationale for the adoption of the methods chosen is communicated to the audience. Thus, a common modelling language that can help to communicate these aspects of the research seems to be appropriate to solve this challenge.

## 3 RATIONALE FOR THE DEVELOPMENT OF THE PROPOSED ONTOLOGY

The purpose of this ontology is to provide IS researchers with a simple and common language to describe the research process. This is done by identifying the objects (things) that are used during the research process in a graphical representation. Therefore, the emphasis is on the graphical representation of the research process and related activities, methods and techniques rather than the philosophical assumptions that underline the selection of these before and during the research process. In principle, the ontology is developed to be applied in projects undertaken by inexperienced

researchers (e.g. PhD, MSc and Bachelors projects). It is foreseen, however, that this ontology can also be applied to larger research projects. The benefits derived from the development of these models are those found in the modelling domain in general. First, it can help the researcher to develop visual roadmaps of the process to be undertaken to achieve the desired outcome. Thus, it can help the researcher on the identification of the advantages, limitations and possible bottlenecks that may arise in the proposed roadmap. Second, it can enhance the communication between participants in the research process (e.g. Supervisors, Advisors, Researchers, and Examiners) as the models are a representation of the researcher's plans and thus can be used as the base for discussion. Third, the models created can help the target audience of the proposed research (the reader/reviewer/examiner) to enhance their understanding of the way the research process was performed and the different decisions that were made during the process. This can help the reader to better understand the paradigms underpinning the research. Finally, if we accumulate a considerable number of models depicting instances of research projects, these can be used to categorise research projects with similar characteristics, which in turn can help to identify possible research patterns. The information obtained from such exercise can contribute to the ongoing debate related to which research methods are more suitable to undertake IS research.

# 4 THE PROPOSED ONTOLOGY

The Research Ontology (RO) was developed with the Object Paradigm (Partridge 1996). In the Object Paradigm (not to be confused with object-orientation) the existence of an object (or a thing) is determined by its extension in the universe, i.e. the space and time that is occupied by an object. The Object Paradigm adopts the principles underlying perduratism (Sider 2001) in which the identity of an object or thing is determined by its spatiotemporal extension. Consequently, given a thing, such as an individual person, the whole of the person is determined by their extension form birth to death. Therefore, any given instant or period of a person's existence represents a temporal part of that person, i.e. an individual is not fully present at a given point in time, but only partially present (i.e., a temporal part or stage or state of the individual is present). As such two things are different if they occupy different extensions in the universe. The foundational ontology used to develop the Research Ontology is depicted in Figure 1.

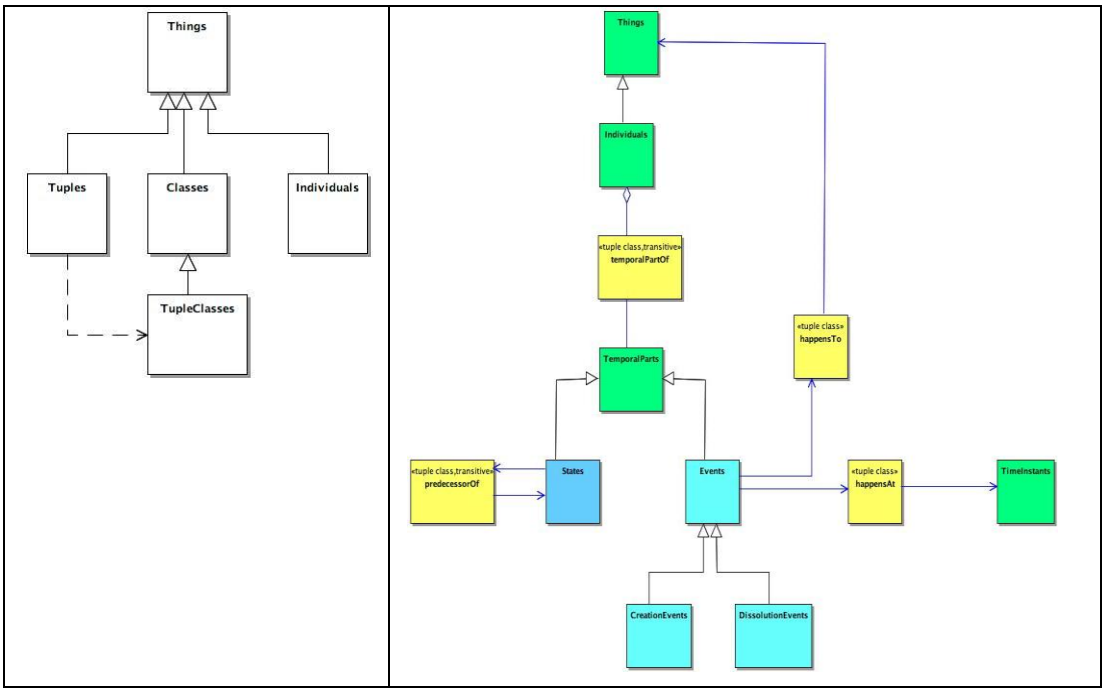


*Figure 1. Foundation of the Object Paradigm*

## 4.1 Foundational Ontology

The foundational ontology represents the basic things that can be used to model any real-world system or domain. Figure 2 (left) focuses on high-level foundational things. These include:

- Things (or Objects): Anything that exist or can exist in any possible universe.
- Individuals: Things with a spatio-temporal extension.
- Classes or (Types): Sets of things.
- Tuples: Relationships between things.
- Tuple Classes: Classes of similar tuples.

Figure 1(right) represents fundamental temporal whole-part relationships between things and specific types of temporal parts such as states and events. More specifically this part of the foundational ontology includes:

- Temporal Parts: A temporal part is an individual that is part of the overall temporal extension of an individual. There are two types of temporal parts, states and events.
- States: A state is a temporal part of an individual over a period of time (i.e. with a time length greater than zero).
- predecessorOf: A predecessorOf tuple represents chronological ordering of states
- Events: An instantaneous temporal part of an individual with no time length. An event has only a spatial extension.
- Creation Events: An event that triggers the creation (coming into existence) of an individual.
- Dissolution Events: An event that dissolves an individual, i.e. a dissolution event coincides with the last instant of an indiviudal's spatio-temporal extension.
- temporalPartOf: A temporalPartOf tuple represents the relationship between a temporal part and its individual whole.
- happensTo: A happensTo tuple represents the relationship between an event and an individual affected by that event.
- happensAt: A happensAt tuple represents the relationship between an event and the time instant it occurs at.
- Time Instants: A time instant is an individual moment in time.

## 4.2 DESCRIPTION OF IDENTIFIED CLASSES (Foundation Classes)

Foundation classes are used to group those classes that are at the higher level. These classes were used as the foundation to develop the classes below together with their relationships. Foundation classes are: Persons, Researchers, Projects, ResearchProjects, Goals and Aims. A main difference between this group and the research classes is that foundation classes will rarely be represented as instanced in the models. The classes identified in figure 1 are listed below together with a description of each class.

***Persons***

Persons are involved in Projects. This class represents the group of persons that can be involved in a project.

***Researchers***

Researchers are one type of the class Persons, and thus will inherit those characteristics of the later class. Researchers are used to investigate in Research Projects.

***Projects***

There are many types of projects so this class represents this group. Projects have a main goal to achieve.

***ResearchProjects***

Research projects are one type of the class Projects and thus will inherit those characteristics of the later class. ResearchProjects have a main Aim to achieve.

***Goals***

A Project has a main goal to achieve. This class represents the group of goals that can be achieved in a Project.

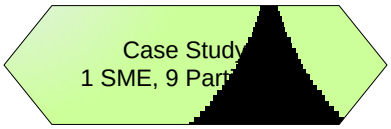
***Aims***

Aims are a type of Goals and thus will inherit those characteristics of the later class. Aims are achieved with the aid of Research Projects.

## 4.3 DESCRIPTION OF IDENTIFIED CLASSES (research Classes)

Research classes are very likely to be used as instances in the models. Identified research classes are: Methods, ResearchStages, Objectives, MilestoneEvents, Artefacts, TechniquesAndTools, Techniques, and finally Tools. Because these classes will be used to create a model of a specific research process (instances) we propose the use of alternative iconic representations of these classes so they can be easily identified in the model.

***Methods***

Icon: 

Connector type: 

For this ontology methods are defined as “a well defined sequences of operations that if carried out proficiently yield predictable results”. Although methods and methodologies may differ depending on interpretations, they are very similar in the context of this ontology, so they both are grouped in this class. Examples of methods/methodologies are case studies, theorem proof, Empirical, Engineering, Reviews, action research, longitudinal, descriptive/interpretive, forecasting/future research, Surveys, the Software Development Life Cycle, Business Process Reengineering, and Simulation. Methods are used to realise ResearchProjects and ResearchStages.

Information used in the class:

- Name: The name of the method
- Referenced publication: In case methods are domain specific this field can be used to add the corresponding reference for further explanation.
- Links: An instance of this class can be linked to instances of a Research Stage through a connector type:

***ResearchStages***

Icon: 

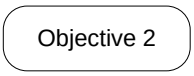
connector type: 

ResearchStages are temporal parts of a ResearchProject and can be used to divide the research project into more measurable stages. ResearchProjects should have at least one ResearchStage. ResearchStages have a particular objective to achieve. ResearchStages can produce an Artefact as an outcome of the stage and can also use Artefacts from other stages for the completion of the stage.

Information used in the class:

- Name: The name/brief description of the research stage
- Artefact used: The name of the Artefact that was used as an input in this stage
- Artefact Produced: The name of the Artefact that was outcome of this stage
- Links: An instance of this class can be linked to Tools, techniques and milestone events, through a connector type

***Objectives***

Icon: 

connector type: 

Objectives are achieved through ResearchStages. Objectives are a type of Goals, this inherits the characteristics of the later class.

Information used in the class:

- Name: The description of the Objective
- Links: An instance of this class can be linked to ResearchStages through a connectors type

***MilestoneEvents***

Icon: 

connector type: 

ResearchStages can be measured through the achievement of milestones. MilestoneEvents are temporal part of ResearchStages. MilestoneEvents can also be mapped against Objectives.

Information used in the class:

- Description: A brief description of the milestone.
- Links: An instance of this class can be linked to ResearchStages and Objectives through a connector type

***Artefacts***

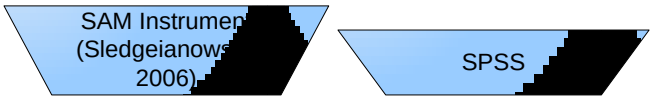
Icon & connectors: 


Artefacts can be seen as the outcome produced during a Research Stage that will have a specific use in the research process. Examples of Artefacts could be the results derived from a survey, the data derived from a simulation run, a piece of software, a product prototype and literature review. Artefacts are produced through ResearchStages. ResearchStages also may use Artefacts produced in other ResearchStages as a point of entry.

Information used in the class:

- Description: A brief description of the artefact
- Links: An instance of this class should be linked to ResearchStages through flow connectors an arrow in the direction of the Artefacts indicates the stage that produced it, whereas an arrow in derived from the Artefact towards indicates the stage that will use it

***TechniquesAndTools***

Icon: 

connector type: 

This class represents the group of techniques and tools available to undertake research. For the purpose of this ontology techniques are defined as "A way of doing a particular activity in the research process". Each technique may involve the use of one or more tools. This supper class is created because there are tools that are also techniques like business process simulation. Additionally, tools and techniques are used for the same purpose. Examples of techniques are Use Cases, Interviews, laboratory experiments, field experiments, Process Modelling, Literature Review. Examples of Tools are SPSS, Simul8, QuestionPro, QSR NVivo, etc. A Technique, a Tool or a combination of both are used to realise Artefacts.

Information used in the class:

- Name: The name of the technique or Tool

Links: An instance of this class should be linked to the Artefact/technique that used the tool/technique through a connector type

# 5 RESEARCH ONTOLOGY: DESIGN METHODOLOGY

The Research Ontology presented here was developed with the Object Paradigm, hence a view of the universe in which individual things exist if they have a spatiotemporal extension. This was the theoretical lens used to answer questions such as: What is a research project? What is a research method? And so on. The research design that was adopted to develop the Research Ontology is illustrated in Figure 2.

This study produces a conceptual artefact that resolves a recognized problem in the field of Information Systems *(this problem needs to be explained previously to set the context of the model)*. As such the methodological framework adopted is Design Research (Hevner, March et al. 2004). More specifically the research was carried out in three iterative phases:

- Design: In this phase successive versions of the Research Ontology were developed. The first version was based on a systematic analysis of the IS research literature. Further iterations developed refinements of the ontology based on the outcome of the evaluation phase.
- Deployment: In this phase researchers (academics, doctoral students and Masters dissertation students) applied the ontology (in its successive versions) to model their research. The researchers were initially briefed on the ontology and the meaning of its representations. The modeling of their research projects was then carried out. This activity was documented along with the participants' feedback (which included questions, doubts, suggestions for improvement, etc.).
- Evaluation: After each deployment the instantiated models were evaluated along with the participants' feedback. Deficiencies with the ontology emerged and fed into the subsequent design phase.

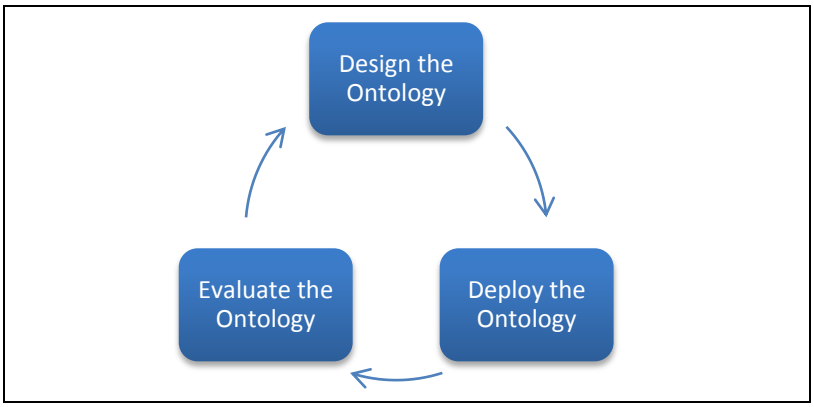



*Figure 2. Iterative Research Design*

This research then will end once the ontology appeared stable and reached a 'saturation point'. This means that after the final iteration it appeared that the ontology was capable of coping with (and modelling) all situations and concerns of the research participants. Table 1 summarizes the iterations and the main features of the individual phases.

| | | |
|---|---|---|
| **Iteration 1** | | |
| | Design | Version 1: Definition of foundation classes, research classes, iconic representation of the classes. |
| | Deploy | 2 PhD researchers , 2 MSc students, and 2 BSc students all in the area of IS |
| | Evaluate | Researchers in the second year of their research placed more emphasis on methods and techniques and tools whereas researchers at the end of their research placed more emphasis on the methods.<br>Foundation classes and the milestone class were rarely used and created some confusion amongst researchers.<br>Most of the researchers to add information in the connectors to clarify the relationship between the classes<br>BSc and MSc researchers tend to use more the technique and tool class than PhD researchers |
| **Iteration 2** | | |
| | Design | Without changes |
| | Deploy | The deployment is targeted to PhD students at different stages on their own research (e.g. 1st, 2nd and 3rd year). It will also be applied to MSc and BSc students at similar stages (start, middle, end) and to examiners of such projects |
| | Evaluate | N/A |

*Table 1. Research Design Iterations.*

# 6 MODELLING THE RESEARCH PROCESS: A PHD EXAMPLE

Figure 3 represents the model (instance) of a PhD research process entitled: "*Alignment of IT Projects with Business Strategy: An analysis of the interrelationships between the factors affecting IS*

*alignment at strategic, tactical and operational levels*". Although the purpose of the model is to be self explanatory, a textual description of this model is presented below for better understanding of the way this model was constructed.

Aim: Despite numerous efforts to integrate business and IS strategic plans, organisations are not delivering the expected benefits from IS investment. To address this issue, IS alignment research has discussed extensively the idea of establishing two-way commitment between business and IS managers. This commitment, however, has proved to be difficult to achieve at strategic level and consequently difficult to transmit to lower levels within organisations. Given that current literature has identified the main factors affecting IS alignment, this research extends the analysis of those factors to tactical and operational levels to develop a model that depicts the dynamic interrelationships between the factors affecting IS alignment. Through an interpretative approach that combines quantitative and qualitative methods, the model was developed, tested and evaluated in three phases.

Research Stages: The project is composed of three research stages, in this particular case called Phases. During the **exploratory phase** the identified factors were scrutinised using a pilot case study and a survey. The results aided the selection of relevant variables that could be used in the model to assess alignment across different levels, and therefore, to develop a preliminary model that included the initial relationships between the factors. For the **testing phase**, a case study approach was selected. An *IS alignment assessment process* was designed and applied in one SME and one large organisation. Although the assessment process did not prove appropriate in an SME context, the application of the assessment process in the large organisation allowed the identification of the root causes of high or low levels of IS alignment of five strategic IT projects. For the **evaluation phase** further analysis was conducted to modify the preliminary model in the light of the outcomes from the large organisation. The model and the assessment process represent a contribution towards a better understanding of IS alignment. The dynamic factors can be assessed to monitor the strategy formulation and implementation across strategic, tactical and operational levels. The gradual adaptation of the dynamic factors might help to create conditions favourable to the improvement or change of structural factors.

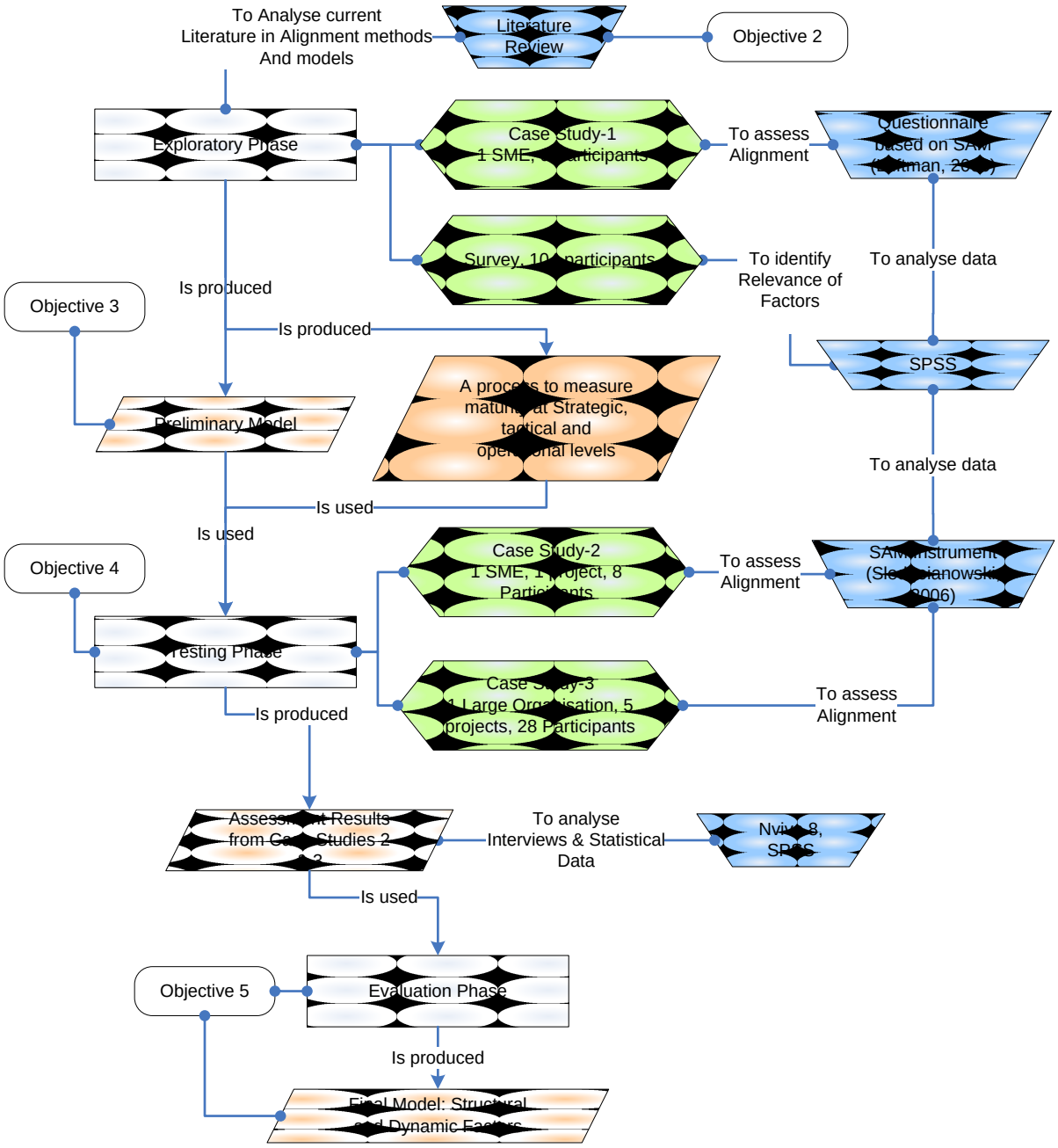



*Figure 3 Example model of a PhD research process*

# 7 CONCLUSIONS AND FURTHER RESEARCH

The initial results derived from the first iteration of this research yield positive results. For instance, the models used to depict different research projects provided the researchers a better understanding of how paradigms, methods, and techniques are combined to undertake a research project. Consequently, the models also helped to identify the advantages and limitations of the methods and techniques used, thus to better plan the research process. Another positive comment reported by a PhD researcher is that, although she has handed-in her dissertation, the model helped her to understand the weaknesses of the methods and techniques chosen and thus prepare for the oral examination. MSc and BSc students, being familiar with modelling techniques, found the use of the ontology much easier to use and thus easier depict their research approaches than relying only on the theory. They also reported to

help them to understand the differences between paradigms, methods and techniques and to better prepare the research activities.

Although this first iteration proved to have a positive impact on the researcher and advisors, it also showed some challenges to overcome and proved the necessity to continue with the remaining iterations of this research. For example, students add textual comments to the connectors between the classes. Despite the fact in many instances the relationships were clarified, the use of these was not consistent and thus it needs to be analysed in more detail in the following iteration. Another interesting observation is that seems to be a relationship between the granularity of the models and the stage of the research. The models showed that researchers in the early stages of the research tend to focus more in the techniques and tools used, than the overall method underpinning the research; whereas researchers in the last stages of the research tend to focus more on the methods and techniques, rather than the tools. Finally, examiners that did not have any knowledge of the ontology proposed (but familiar with the modelling techniques used in the IS domain) claimed that the models depicted a clear picture of the research proposed by the students. In conclusion, a second and third iteration will be undertaken to analyse these issues in more detail and to produce a revised version of the ontology. These iterations are also targeted to provide more data to validate these findings.

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What is research…
How they have done research so far?