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# Using XML topic maps to create a knowledge model of postgraduate computer science degrees in Ireland for the purpose of marketing analysis

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# Using XML Topic Maps to Create a Knowledge Model of Postgraduate Computer Science Degrees in Ireland for the Purpose of Marketing Analysis

**Catherine Mulwa**

A dissertation submitted in partial fulfilment of the requirements of

Dublin Institute of Technology for the degree of

M.Sc. in Computing (Knowledge Management)

**Month 2008**

I certify that this dissertation which I now submit for examination for the award of MSc in Computing (Knowledge Management), is entirely my own work and has not been taken from the work of others save and to the extent that such work has been cited and acknowledged within the test of my work.

This dissertation was prepared according to the regulations for postgraduate study of the Dublin Institute of Technology and has not been submitted in whole or part for an award in any other Institute or University.

The work reported on in this dissertation conforms to the principles and requirements of the Institute's guidelines for ethics in research.


*Signed:*          *Catherine Mulwa*


*Date:*            *DD Month Year*

# 1    ABSTRACT

Marketing intelligence is a future-oriented activity that helps an organization cope in its market.  It includes all ways an organization acquires and uses information. It is comprised of all kinds of information on the market and marketing research; the collection and analysis of internal data, competitive analysis; analysis and reverse engineering of competitor's products; understanding how and where to add value for customers; and the process of synthesizing large amounts of informally gathered information about the industry and business environment.   While marketing and marketing intelligence are widely used in business, they are less used in non-business organisations such as academic institutes. Yet academic institutes now find themselves in a very competitive market place, competing for students from their traditional audiences and forced to seek out new audiences for their programmes. Marketing intelligence is therefore very relevant to academic institutes. Knowledge management has been burgeoning in importance during the last one and half decades. Both profit making and non-profit making organizations have had to and continue to embrace and practice knowledge management.   Knowledge capture, knowledge integration and knowledge delivery are the essential parts of dynamic knowledge management.   As such, marketing intelligence can be seen as a knowledge management activity.

The aim of this thesis is to investigate the usefulness of a knowledge model of postgraduate computer science education in Ireland to support marketing intelligence in a single institute, the Dublin Institute of Technology. Knowledge models are structured representations of knowledge using symbols to represent components of knowledge and relationships between them. This knowledge model will capture the type of knowledge used in marketing postgraduate computer science programmes and expose it in the form of an XML Topic Map which can then be used to support query and analysis by all those involved in marketing of postgraduate education: producer, consumer and competitor.

**Key words:** Knowledge management, Ontology, Knowledge Models, XTM Topic Maps, Marketing Intelligence,

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Any inaccuracies, misreporting or oversight in this work should be entirely attributed to me as the author of the work.

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# 1. INTRODUCTION

## *Project Introduction*

In today's new economy, learning and knowledge have become key success factors for international competitiveness with the result that intangible and immaterial resources have overtaken physical and tangible assets in order of importance. In particular, knowledge has become the primary resource for power, prestige and creating wealth in the modern economy and society (Coates & Warwick 1999). The generation, acquisition and use of knowledge have turned out to be vital in sustaining economic, social and cultural development (Skyrme 1999).

The goal of this research is to specify, design and implement Knowledge Model of Postgraduate Computer Science Degrees in Ireland for the purpose of marketing intelligence in the Dublin Institute of Technology (DIT) and to assess its usefulness. The knowledge model will contain details of the types of knowledge used to market computer science programmes. This model will be used as a tool for marketing analysis that will enable the programme co-ordinators with the DIT gain a clear vision of what knowledge they are providing, compare their programmes with those offered by other academic institutes and identify potential errors, omissions or new details to include. It will provide valuable insight in the decision making of the programme co-ordinator. In addition, the model would be valuable to the consumers of the academic institute, the student, who will be able to get a clear comparison of computer science programmes in all institutions.

The model will be constructed by first of all completing a knowledge audit of existing marketing knowledge used in both DIT and other academic institutes to market their postgraduate computer science programmes. The results of audit will be used together with concept maps to start building the model and express it in a visual format. Concept maps are an important means of knowledge representation; they are graphical

representations used for organizing and communicating knowledge and are intuitive and easy to understand (Novak & Cañas 2006).

Once a model has been built it will be translated into topic maps and expressed as XML topic maps (XTM) (Pepper S 2004).  Topic maps are standardization on concept maps (Pepper S 2004).  Using a topic map the model will be able to convey knowledge about resources through a superimposed layer, or map, of the resources and capture the subjects of which resources speak, and the relationships between resources, in a way that is implementation independent.  Topic Maps will help visitors to navigate and discover information on Web sites.  The XTM activity is to engage in technical activities to facilitate the use of topic maps based on XML, including but not limited to application on the Web.  XML Topic Maps are used in building Knowledge Repositories.  XML Topic Maps (XTM) is a product of the TopicMaps.Org Authoring Group (AG), formed in 2000 by an independent consortium named TopicMaps.Org. The design goals for XTM are; it is straightforwardly usable over the Internet, XTM support a wide variety of applications and is compatible with XML, XLink, and ISO 13250 and also it is easy to write programs that process XTM documents.  A particularly valuable aspect of topic maps is the variety of tools available to create visual maps from an XTM specification. Once built, the XTM visual was evaluated by potential users.

### *Background*

Postgraduate education in Ireland has been the focus of major redevelopment and restructuring in recent years.  In 2006, the Government stated its ambition to double the number of PhD graduates by 2012 (Ahern T.D 2006).  This drive to secure a place for Ireland among the top research destinations in the world is benefiting the thousands of international students who arrive here every year seeking a fourth level qualification.  The emergence of Ireland's knowledge economy, based on innovation and high tech industries such as Information Technology, has highlighted the importance of continuous improvement in the science and technology sectors of postgraduate education. The National Development Plan (NDP) (Levitt 2008) and the Strategy for Science, Technology & Innovation (SSTI) (Levitt 2008) are investing a

total of €8.2 billion in research and development during the period 2006-2013. Course providers in Ireland are increasingly focused on producing postgraduates who bring a well rounded skill set to their jobs. However, course providers are in a competitive situation, while each academic institute is focusing on increasing postgraduate student numbers so is every other institute. There are however not enough students to go around. This means that academic institutes must compete to get a market share and that academic institutes now find themselves faced with actively engaging with marketing activities.

Marketing activities are all those associated with identifying the particular wants and needs of a target market of customers, and then going about satisfying those customers better than the competitors(Dibb & Simkin 2001). This involves doing market research on customers, analyzing their needs, and then making strategic decisions about product design, pricing, promotion and distribution. Using market information, defining market segments, and target marketing are now crucial components of the business plan (Webster 1998). Marketing expertise helps a firm make better marketing decisions that can improve the performance and profitability of the firm. Marketing expertise is an important skill required by every firm.

Most academic institutes have been engaged in marketing for many years. In order to improve on marketing it is important to first of all establish a baseline of the types of knowledge an organisation presents about itself, in what form and to assess the type of knowledge needed by its customer. A knowledge model would provide a structured representation of knowledge using symbols to represent pieces of knowledge and relationships between them (Leiba & Nachmias 2006). Knowledge models include: Symbolic character-based languages, such as logic Diagrammatic representations, such as networks and ladders, Tabular representations, such as matrices and structured text, such as hypertext (Leiba & Nachmias 2006). The generation and modification of a knowledge model is an essential aspect of knowledge acquisition, as the model helps to clarify the language being used and quickly convey information for validation and modification where necessary. Thus, the use of knowledge models is of great benefit during: knowledge elicitation (from an expert), validation (with the same expert), cross-validation (with another expert), knowledge publication and maintenance and updating of the knowledge system or publication (Deirdre 2007).

A topic map is a collection of topics with appropriate structures (ISO/IEC 2000). A topic is considered as an aggregate of topic characteristics, including a topic name and its variances, occurrences, and roles played in associations with other topics (ISO/IEC 2000). XTM is a syntax for the interchange of topic maps. The syntax is not designed to be extended or modified, although topic maps expressed in XTM may be embedded in other XML syntaxes. Using XML Topic Maps will help because they can structure unstructured information objects, or to facilitate the creation of topic-oriented user interfaces that provide the effect of merging unstructured information bases with structured ones. Using Topic Maps' syntax, topics and associations can be encoded as XML documents and links established with resources (occurrences) that are relevant to these topics. Topic maps allow tidily coupling of topics and topic resources through the use of occurrences.

Expressing the model as an XTM could help with marketing analysis because the goal of a market analysis is to determine the attractiveness of a market and to understand its evolving opportunities and threats as they relate to the strengths and weaknesses of the firm. By using XTM it could help marketing analysis because XTM is a standard for implementing data exchange services XML (Extensible Markup Language), which provides a simple yet powerful and flexible way to encode structured data into a format that is both human and machine-readable, so XTM could help in data analysis.

### *Research problem*

The aim of the project described in this dissertation was to investigate the usefulness of a knowledge model created using XML topic maps of postgraduate computers science programmes in Ireland to support marketing intelligence Dublin Institute of Technology (DIT).

The researched involved:

- Conducting a literature review on marketing intelligence, postgraduate computer science degrees, and use of xml topic maps to build a knowledge model.

- Assessing the usefulness of marketing intelligence as knowledge management activity for postgraduate education in Ireland.

- Conducting a knowledge audit of existing marketing material of postgraduate degrees in computer science in a number of academic institutes and through a survey of the principle stakeholders involved in this area: the management of programmes and postgraduate students.

- Conducting both primary and secondary survey to gather information for providing guidelines in implementing the knowledge model.

- Designing, analysing and implementing a knowledge model for DIT and other institutions.

- Expressing the knowledge model for DIT and other institutions in an XTM representation and visual expression of this representation.

- Assessing the usefulness of these models and visual representation for the purpose of marketing intelligence.

### *Intellectual challenge*

To integrate small components of knowledge into a complete and elaborate knowledge structure is by no means an easy task (Y. Chang & S. Chang 2001).
The challenges which were faced included:

- Research on marketing intelligence and its role in third level postgraduate education in the republic of Ireland.

- Knowledge auditing of different third level institutions to gather information on postgraduate degrees offered with an intention of auditing postgraduate computer science degrees being offered in these institutions. Knowledge audit requires expertise in deciding what information to use or what to eliminate. An online analysis of information was conducted from eight third level institutions in Ireland. The huge amount of information provided and the style in which it was presented in different websites was a big challenge.

- The validation and extension of the knowledge audit through a survey of principal stakeholders in the marketing of postgraduate programmes: programme management and postgraduate students. This survey collected information from Heads of department, programme Co-ordinators, present and past students in different third level institutions to test whether the knowledge model of postgraduate computer science degrees for Dublin Institute of Technology created for the purpose of marketing analysis is correct.

- To Analyze, Design and implementing a knowledge model of postgraduate computer science degrees for Dublin Institute of Technology and other third level institutions in Ireland using XML Topic Maps.

- Working out criteria for comparing information obtained on computer science degrees from these institutions and then building and providing a mechanism to show the results of comparisons of courses in Dublin Institute of Technology and courses in DIT with other colleges

- Evaluate and critique the findings in the context of marketing analysis for postgraduate education.

## *Research objectives*

The following objectives have been achieved throughout the dissertation and contributed to the overall outcome:

- Knowledge Audit of the following third level institutions in the Republic of Ireland ; Dublin Institute of Technology (DIT), Trinity College (TCD), Letterkenny Institute of Technology (LYIT), University College Dublin (DCU), University College Cork (UCC), University of Limerick (UC), National University of Ireland Galway (NUIG) and Queens University Belfast (QUB)

- Conduct primary and secondary survey on the problem area. The primary survey is intended to target audiences, who include current and past students of postgraduate computer science degrees in the Republic of Ireland, Heads of Department and Course Coordinators in these institutions.

- Interview Knowledge Experts on the area, review materials and publicly available information.
- Perform a market analysis on the relationship between marketing and academic institutions in Ireland
- Build Knowledge Model, using XML topic maps
- Summary XML Topic Maps of other colleges (Trinity College, University College Dublin, Dublin City University, University College Cork and Grafton College of Management Sciences)
- Measure the success of the Knowledge Model

## *Research methodology*

Both primary and secondary researches were performed throughout the duration of this project.

The secondary research comprised of a literature review of material pertaining to topics:

- Third Level Postgraduate Education in Ireland and its importance
- Marketing Intelligence and the Influence it has on Third Level Postgraduate Education in Ireland.
- Knowledge Audit based on postgraduate degrees in computer science.
- knowledge management
- Relationship of computing and knowledge management
- Concept Maps, Topic Maps and XML Topic Maps
- Gap analysis usefulness
- Visual Map and its usefulness
- Knowledge Model and why the model is important

- Knowledge Model for postgraduate computer science degrees

The main sources used to complete the literature review topics included:

- Third Level Institutional websites
- Conference proceedings
- Journals
- Books
- White papers

The primary research conducted for this project involved:

- Chosing a sample of third level institutes representative of all regions (provinces) of the Island of Ireland (Republic of Ireland and Northern Ireland).
- Targeting audiences mainly from current and past students in these institutions, Course Coordinators and Heads of Departments of these Institutions.
- Conducting a survey in Form of Questionnaire
- Collecting feedback of the survey results and analysing these feedbacks.

### *Resources*

**Human Resources**

- Access to supervisor
- Access to subject experts for views on the area.

**Technical**

- Personal Laptop
- XML Topic Map tools
- Apache Tom-cat
- Java Software
- Excel Software

- SmartDraw5 Software
- Ontopia Omnigator

## *Scope and limitations*

Research focus was on Marketing Intelligence, Computer Science Postgraduate Programmes, Knowledge Audit and Designing and Implementing a Knowledge Model for DIT and DIT and other institutions using XTM Topic Maps.

Limitations included:
- Limited tools for implementing XTM Topic Maps. This academic area of visual mapping is very new in the market and so not a lot of tools exist.
- Time; Very short time and a lot of work to be done to be able to implement an accurate knowledge model.
- Collecting online materials; Links to where information not clear from some of the institutions
- Style of presenting information used by some of the colleges; Information was not found where expected and was mixed up

## *Organisation of the dissertation*

This thesis is divided into seven chapters as follows:

**Chapter 2** introduces the topic of knowledge management to introduce key concepts in the area and clarify some of the debate on these concepts. A discussion of what knowledge is, the processes of knowledge management and how it is used in organisations and the role of computing in knowledge management.

**Chapter 3** introduces the topic of marketing intelligence, introducing the key concepts and concepts and strategies of marketing intelligence. The chapter investigates the role of marketing intelligence in academic institution and assesses marketing intelligence from the knowledge management perspective.

**Chapter 4** presents the topic of knowledge mapping, introducing the key concepts of knowledge mapping and how knowledge maps are created. Knowledge maps are discussed in relation to concept maps and topic maps. The key concepts of XML topic maps are introduced and the process of creating an XTM map are discusses.

**Chapter 5** presents an overview of postgraduate education and assesses current marketing intelligence used by academic institutions to promote computer science programmes in Ireland. The details of the knowledge audit and supporting survey are presented and the knowledge models of postgraduate computer science education in all academic institutions considered are presented.

**Chapter 6 discusses** XTM representation of the knowledge model, discussing the requirements of this representation, the process and tools used to create this representation. The prototype XTM representations for a number of academic institutions are presented and the evaluation of the DIT representation is discussed.

**Chapter 7** includes results, conclusions and an evaluation of the research conducted for this dissertation and discusses some areas of future work.

## 2 KNOWLEDGE MANAGEMENT

The project described in this dissertation is concerned with investigating the usefulness of a knowledge model to support marketing activities in postgraduate education. Marketing activities are all those associated with identifying the particular wants and needs of a target market of customers, and then going about satisfying those customers better than the competitors (Dibb & Simkin 2001). This involves doing market research on customers, analyzing their needs, and then making strategic decisions about product design, pricing, promotion and distribution, these can all be seen as knowledge management activities. The generation and modification of a knowledge model is an essential aspect of knowledge acquisition, as the model helps to clarify the language being used and quickly convey information for validation and modification where necessary. This chapter therefore introduces key concepts of knowledge management.

In order to understand what knowledge management is in depth, some questions and answers to these questions have been initiated: *What is knowledge? What is knowledge Management? What are the Roots of Knowledge Management? And Why Knowledge Management?* This chapter begins by providing an overview of what knowledge management is and as part of this discussion, the issue of what knowledge is is also assessed. The chapter continues by presenting a definition of knowledge management, discussing the processes of knowledge management and the role of knowledge management in organisation. The chapter concludes by assessing the role of computing for knowledge management and the usefulness of computing tools for knowledge management.

### *An overview of knowledge management*

Knowledge management has been defined variously and by professionals of varying academic backgrounds. The term "knowledge" is not new as ancient scholars such as Plato and Aristotle in their philosophical works have addressed it extensively. They have even attempted to define it and explain its place in society. However, knowledge management as an academic discipline is still relatively young. Phrases like "knowledge society"' and "knowledge economy" started appearing in the 1990s and may be a little earlier (Barnes 2002). Economists, sociologists, philosophers, psychologists, specialists in human resource management and information scientists have all tried to define knowledge management and claim it as their academic discipline (Barnes 2002). . This has led to a variety of published definitions and it is important to get a clear perspective of what view of knowledge management is most suitable to understand the context of this dissertation. The following section looks at what knowledge is

### *What is knowledge?*

Information with meaning (Skyrme, 1999). It is the potential to take effective action. In an organization, knowledge needs to be assimilated so that the individuals in the organization can take effective action. Not until information is assimilated and put into action is it really knowledge (MacSweeney, 2003).

(Tiwana 2002) sees knowledge as actionable information. Tiwana says that *actionable* refers to the notion of relevant and being available in the right place at the right time, in the right context, and in the right way so that anyone (not just the product) can bring it to bear on decisions being made every minute. Tiwana looks at knowledge as the key resource in intelligent decision making, forecasting, designing, planning, diagnosis, analysis, evaluation, and intuitive judgment. Knowledge is formed in and shared between individual and collective minds. Knowledge does not grow out of databases but evolves with experience, success, failures, and learning over time

According to (Nonaka & Takeuchi 2004), knowledge is first about beliefs and commitment. Knowledge is a function of a particular stance, perspective, or intention. Secondly, knowledge, unlike information is about action. Third, knowledge, like information, is about meaning. On the other hand, information provides a new point of view for interpreting events or objects, which make visible previously invisible meanings or sheds light on unexpected connections.

**Opinion**

The researcher does not agree with Nonak & Takeuchi definitions of what knowledge is but agrees with Tiwana definitions who looks at knowledge as key to intelligent decision making, forecasting, designing, planning, diagnosis, analysis, evaluation, and intuitive. The researcher strongly agrees that knowledge is formed in and shared between individual and collective minds and it does not grow out of databases but evolves with experience, success, failures, and learning over time. Knowledge is power

After looking at what knowledge is, it is important to discuss what knowledge management is about;

### *What is knowledge Management?*

Knowledge Management supports the concept that the ability to identify and utilize the knowledge that resides within the organization is a critical component of acquiring a competitive and strategic advantage over adversaries (Cross & Baird, 2000; Hiser, 1998). The key is how to best apply an organization's knowledge to achieve that strategic advantage. Knowledge Management is an emerging discipline that has been tasked specifically to achieve that objective (Brown & Duguid, 1998).

There exists very many definitions of knowledge management today:

*"Knowledge Management involves the acquisition, explication, and communication of mission specific professional expertise in a manner that is focused and relevant to an organizational participant who receives the communication".*

*(King 1999)*

*"Set of systematic and disciplined actions that an organisation can take to obtain the greatest value from the knowledge available to it."*

*( Davenport & Prusak 1998)*

*"...the systematic and organisationally specified process for acquiring, organising and communicating knowledge of employee so that other employees, may make use of it to be more effective and productive in their work."*

*(Alavi & Leidner 1999)*

*"The systematic approach to create, capture, organise, access and use organisation knowledge and learning's"*

*(Raw 2002)*

*"... the effective learning process associated with exploration, exploitation and sharing of human knowledge(tacit and explicit) that use appropriate technology and cultural environments to enhance an organization's intellectual capital and performance. "*

*(Jashapara 2004)*

*"Knowledge management is about enhancing the use of organisational knowledge through sound practices of information management and organisational learning."*

*(Brooking 1998 )*

It is important to after defining knowledge management to present the roots of knowledge management. By looking at these roots, a clear view of what is involved in knowledge management is presented. This is shown in **Figure 1** below:

14
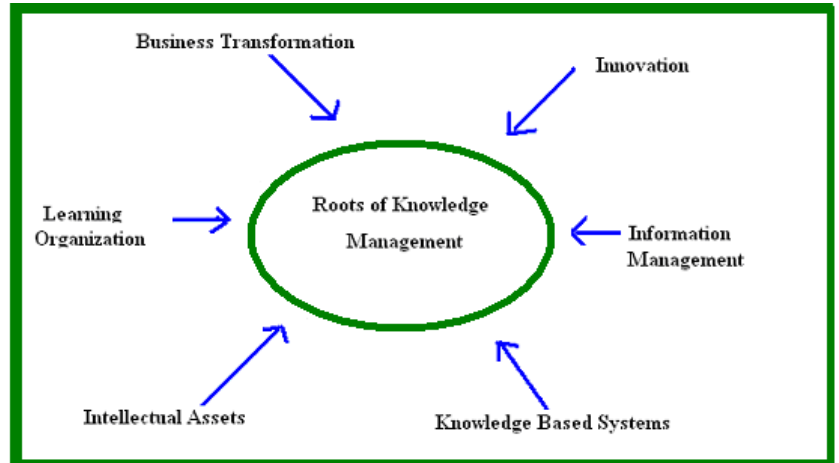
**Figure 1:  Roots of Knowledge Management**   (Mulwa 2008)

A brief explanation of the subsections which form these roots of knowledge management is presented below (Mulwa 2008):

- **Learning organisation:**  If an organisation conforms to the required norms and can be termed as a learning organisation, then it becomes one of the start points of knowledge management.

- **Intellectual asset:**  The intellectual asset in an organisation is in the people who have gained expertise through years of work experience and is tacit in nature. This knowledge has to made explicit and managed in order to leverage on it and gain competitive advantage.

- **Knowledge based systems:**  The systems that are evolved in an organization to facilitate the smooth functioning of the organization should facilitate harnessing

the existing knowledge in the organization. These systems could be a basis of knowledge management.

- **Information management:** Information is the core of knowledge management, since information combined with experience and intuition leads to knowledge. Hence, proper information management systems can result in an effective knowledge management system.

- **Innovation:** Creativity and innovation are methods by which new knowledge is created. Innovation comes out of increment changes to existing products or processes and a radical change, which is different from the original process or product. Radical changes give a new dimension to the existing knowledge base and incremental changes result in changes in perceptions and line of thinking leading to new knowledge insights.

- **Business transformation:** Business transformation acts as another catalyst for knowledge management. Organisations respond to the various changes in the market place through transformation processes like business process re-engineering.

Having looked at the roots of knowledge management, we ask ourselves, why then do we need knowledge management? The next section below looks at some of the reasons as to why we need knowledge management

*Why knowledge management?*

The field of knowledge management has gained currency in recent times due to a wide variety of reasons. The speed of change in the market place has become so rapid that the time available for organisations to gain experience and acquire knowledge has diminished. Organisations are required to differentiate their product or produce them in fastest possible time and the lowest possible cost (Morrow, 2001).

Competition in the market place has forced organisations to reduce costs. One of the methods followed is reduction in manpower. This has led to early retirements and increasing mobility of work force resulting in a loss of knowledge. Also they have been an increasing dominance of knowledge as a basis for organisational effectiveness and also the failure of financial models to represent the dynamics of knowledge. The diffusion of global capabilities causing developed countries to become service based economies depending on labour from developing countries has increased and unintended consequences of universal information access.

The main reasons as to why knowledge management is important is that Organizations have come to recognize that acquisition of and speedy distribution of information, coupled with business experiences, form the basis of knowledge capital assets with which to build great business; Marketplaces are increasingly competitive and the rate of innovation is increasing, hence, knowledge must evolve and be assimilated at an ever faster rate; Early retirements and increasing mobility of workforce lead to loss of organizational knowledge; (Teo 2005).

The field of knowledge management has gained currency in recent times due to a wide variety of reasons. For example; the speed of change in the market place has become so rapid that the time available for organisations to gain experience and acquire knowledge has diminished; Competition in the market place has forced organisations to reduce costs. One of the methods followed is reduction in manpower. This has led to early retirements and increasing mobility of work force resulting in a loss of knowledge; Organisations are forced to compete on the basis of knowledge; Market place is increasingly competitive, Reduction in staffing create a need to replace informal knowledge with formal methods; Reduction in work force due to competitive pressure and Increasing dominance of knowledge as a basis for organisational effectiveness

The importance of knowledge management is also corroborated by various research studies; A survey by Price water house Coopers and World economic forum found that

95% of CEO's saw Knowledge Management as an essential ingredient for the success of their company. According to the International Data Corporation, companies worldwide are expected to dramatically increase their knowledge management expenditure from $2 million in 1999 to $12 million in 2003.

**Justification**

Some of the reasons as to why the researcher concludes as to why knowledge management is because:

- **Globalization and competition:** Many organizations rely on knowledge to create their strategic advantage. With available knowledge widely dispersed and fragmented, organizations often waste valuable time and resources in 'reinventing the wheel' or failing to access the highest quality knowledge and expertise that is available.

- **Knowledge can command a premium price in the market:** Applied know-how can enhance the value (and hence the price) of products and services. Examples are the 'smart drill' that learns how to extract more oil from an oil field, and the hotel chain that knows your personal preferences and so may give you a more personalized service.

- **Restructuring and downsizing:** Without effective mechanisms in place to capture knowledge of experienced employees, organizations make costly mistakes or have to pay again for knowledge they once had on tap.

- **Sharing of best practices:** Organizations save considerable sums of money each year by taking the knowledge from their best performers and applying it in similar situations elsewhere.

- **Successful innovation:** Organizations applying knowledge management methods have found that through knowledge networking, they can create new superior products and services.

These were also some of the reasons (Skyrme 2003) outlined as to why knowledge management. The reasons provided above of why we need knowledge management provide a clear justification that we need knowledge management and we can not do without it.

*Knowledge Management Processes*

Knowledge management is a continuous process that does not stop in organizations. According to (Alavi & Leidner 2001), knowledge management consists of a dynamic and continuous set of processes and practices embedded in individuals, as well as in groups and physical structures. Alavi and Leidner further argue that at all times and in any part of a given organization, individuals and groups may be engaged in several different aspects and processes of knowledge management. For that reason, knowledge management should never be treated as a discrete, independent and monolithic organizational phenomenon.

A process should be characterised with specific activities that mark the different stages of that process. According to (Ruggles 1998), there are eight activities which constitute the basic knowledge management processes. Ruggles identifies the activities as:

- Generating new knowledge;
- Accessing new knowledge from outside sources;
- Using accessible knowledge in decision making;
- Embedding knowledge in products and/or services;
- Representing knowledge in documents, databases and software;
- Facilitating knowledge growth through culture and incentives;
- Transferring knowledge into other parts of the organization;
- Measuring the impact of knowledge assets and/or impact of knowledge management.

The prime work of a knowledge manager is to separate the knowledge management of knowledge processes from knowledge management of knowledge workers (Gao, Li & Nakamori 2002). Gao, Li and Nakamori further argue that a knowledge manager must be able to "manage" the favourable environment for knowledge workers to be engaged in

knowledge processes and also "manage" these knowledge workers. According to Gao, Li and Nakamori, a knowledge manager must be able to create a favourable environment, manage the environment and also manage knowledge workers.

Gao, Li and Nakamori do not however say what they mean by a favourable knowledge environment nor do they say what they mean by knowledge workers who must be managed by a knowledge manager. ( Wiig 1994) alludes to a favourable knowledge environment. It is that environment which provides internal, physical and social environments that are desirable to employees at all levels of an organization. Such environment should also be concerned with creating and maintaining desirable external environments – physical, economic, social and so on. (Wiig 1995) defines a knowledge worker as the individual who makes her/his contributions through exercising intellectual expertise and understanding. On the other hand, (Drucker 1999) defines knowledge workers as those workers not employed full time by an organization and who are not subordinates but "associates". Drucker further argues that knowledge workers must know more about their job than their boss does or else they are no good at all. Knowing more about their jobs than anybody else in the organization should be looked as part of the definition of knowledge workers.

(Gao, Li & Nakamori 2002) identify the major knowledge management activities as including managing existing knowledge which includes developing of knowledge repositories and knowledge compilation; managing knowledge acquisition; creating new knowledge; distribution of knowledge; communication/transfer of knowledge; sharing of knowledge; and application of knowledge. In order to sustain these processes, Gao, Li and Nakamori aver that both "hard" conditions and "soft" environments have to be created and nurtured.

The hard side refers to technological platforms which may include facilities and necessary devices. The soft side consists of trust, team spirit, and a learning climate for improving the productivity of contributors. At organizational level, distinctive organizational visions and strategies should be formulated to guide and regulate

knowledge management; evaluation and reward institutions should be created to define responsibility and liability of individuals and organization. The knowledge management process in this case requires a knowledge manager to be able to evaluate the knowledge management technologies, build trust, build team work spirit in an organization, advise on knowledge management strategies and assist in evaluation and reward policies.

In their work with highly skilled and specialised development and consulting teams, (Eppler & Sukowski 2000) suggested four crucial team knowledge management processes:

(1) *Team knowledge auditing:* The goal of this process, which should take place at the beginning of team collaboration, is to make the present team knowledge (skills, experiences, contacts, assumptions) transparent and discover knowledge deficits in the team for the tasks at hand. Specifically, the "know-what" (available information), "know-how" (skills and prior experiences), "Know-who" (inside and outside contacts, and "know-why" (goals, motivations, expectations and basic assumptions should be made explicit. A simple form of knowledge audit consists of every team member being able to describe another team member's professional background and experience in a plenary session.

(2) *Team knowledge development:* An on-going process, this consists of knowledge acquisition from outside sources and knowledge creation activities through experimentation or conceptual collaboration in the team. This process culminates in common knowledge "artefacts" such as concepts, prototypes, formalised ideas, protocols or reports.

(3) *Mutual updating and briefing:* The goal of this process is to combine the individual insights with the team stock of knowledge. This process can have a simple team presentation or it can take on more elaborate briefing formats such as question and answer sessions, poster rooms, or meta-plan workshops.

(4) *Reviewing:* The goal of this process is to reflect systematically about the insights that the team was able to gather during a process or project phase. Questions to be answered in this phase include: what has worked well in our collaboration? What has not worked and why? What are we going to do differently as a result of these insights?

(Zolingen, Streumer & Stooker 2001) state that knowledge management is characterised as a cyclical process consisting of five phases: acquiring knowledge; establishing knowledge; disseminating knowledge; developing knowledge; and applying knowledge. Acquiring knowledge means incorporating new knowledge in the organization. Establishing knowledge means making knowledge explicit and accessible so that, if desired, other people can acquire the knowledge any time anywhere. Dissemination of knowledge is making knowledge available and accessible to those who need it in the execution of their tasks. In the fourth phase, knowledge is being developed by means of existing knowledge. By combining elements of existing knowledge, new insights can be formed and thus new knowledge can be developed. The fifth phase of the process of knowledge management is the application of newly developed knowledge. In this final phase, knowledge is being used on behalf of the organization.

There appears to be a general agreement that a knowledge design process is required to identify and leverage collective knowledge of an organization (Wild, Griggs & Downing 2002). Writing in 1997, Weggeman as cited by (Wild, Griggs & Downing 2002) defines the knowledge value chain as four successful constituent processes:

- An organization's strategic knowledge requirements need to be identified.
- The knowledge gap (the quantitative and qualitative difference between the knowledge need and that available) needs to be determined.
- The knowledge gap needs to be closed either by developing new knowledge, buying knowledge, improving existing knowledge, or getting rid of out of date or irrelevant knowledge.
- The knowledge available needs to be disseminated and applied to serve the interests of customers and other stakeholders.

(Hooff, Vijvers & Ridder 2003) agree with Weggeman on the importance of the processes, but they do not think the processes are sufficient to focus an organization's knowledge management activities. They think that for effective knowledge management, it is necessary to align these processes with an organization's mission, vision, strategy and goals. (Hooff, Vijvers and Ridder 2003) come up with a knowledge management processes model that they call a "fly-wheel." The essence of the "fly-wheel" model is to demonstrate that the different processes and aspects of knowledge management should receive simultaneous attention, while the frequency and intensity with which attention is paid to each of the knowledge management processes and aspects vary across time.

Turner and (Makhija 2006) identify what they call four critical stages of an organization as: (1) knowledge creation and acquisition; (2) the transfer of knowledge to other individuals or organizational units; (3) the interpretation of this knowledge in a manner conducive to the objectives of the organization and (4) the application of any indication of how one may apply knowledge toward an organization's goals.

(Wild, Griggs and Downing 2002) consider organizational readiness to be part of the knowledge management process in an organization. They assert that organizational readiness is a prerequisite for supporting the knowledge management processes in an organization. They further say that organizational readiness is determined by having in place: infrastructure, knowledge editor, a sharing organizational culture, and positive employee attitude, identification of the organizational strategic knowledge needs, computer literate employees and an organization that is sufficiently "wired" for information and knowledge transfer and sharing.

### *Knowledge Management in Organisations*

One of the major ways companies are using knowledge management is to develop more knowledge about and services for their customers. Customer satisfaction has been shown to be strongly related to Market Value Added and has the ability to keep existing customers and improve sales (Steward 1999). Knowledge Management is a wise

investment in the core business of a company, rather than an overhead expense because; existing customers provide more sales at lower costs; loyal customers are hard to lose and generate additional sales through word of mouth and blended service and selling can provide incremental revenue and great customer support builds more aggressive channel partners, further lowering sales costs (Holsapple 2003).

A broader perspective on knowledge management is to use knowledge to continuously improve all types of company processes. Knowledge can be integrated into almost any organizational process to improve such things as efficiency, effectiveness, productivity and quality. Many companies are trying to tap into the tacit knowledge in people's heads in order to document or codify it and use it to improve how work is done.

Organizations are using knowledge by developing communities of practice and special interest groups and guilds. Companies are having increasing success building knowledge communities. A knowledge community is a network of people who create, disseminate and retain knowledge in a particular area.(Holsapple 2003). The major benefit of these communities is they shorten a company's "time to Intelligence"

Organizations are using knowledge by developing new measures (Holsapple 2003). One of the most interesting and challenging aspects of knowledge management is how to measure and value knowledge and also companies are developing knowledge management processes. Probably the most common knowledge management activity at present is implementing the processes to collect and disseminate knowledge in large organizations.

Organizations are using new tools and methodologies for knowledge management. Tools make it easier to implement Knowledge Management processes and functions but they do not take the place of them. Tools help a knowledge manager deliver the right information at the right time, but do not tell him or her, what to collect, how to collect it or how to get people to use it.(Holsapple 2003)

*Computing for Knowledge Management*

Technology is an enabler for knowledge management (Milner 2002). Modern Knowledge Management has been tremendously enriched by advances in computer based technology (CBT). The main aim of computing for knowledge management is the effective utilization of information and knowledge within different organizations. By organizations it is meant that the; Conventional international organizations (Types A to D), Federations of international organizations, Universal membership organizations, Intercontinental membership organizations, Regionally defined membership organizations and Other "international organizations" technologies enable knowledge management people create knowledge management systems, like expert systems and decision support systems which allow in knowledge management processes and also enable them make correct decisions within a short period of time. (Mulwa 2008)

This section highlights different types of tools for the processes discussed previously. Knowledge Management tools are tools which help and support the knowledge processes in the organizations and all related activities of the managers and employees. As defined by (Ruggles 1997), KM tools and technologies are "designed to ease the burden of work and to allow resources to be applied efficiently to the tasks for which they are at most suited". Subsequently, tools could hardly generate knowledge on their own, but they stimulate, facilitate and support human beings in finding, accessing, generating, transferring and finally archiving the old and new knowledge. Following are some of the tools for the knowledge processes:

> ➤ **Knowledge content generation tools** include various authoring tools (Bergeron, 2003) – word processing editors, multimedia editors, graphics programs, image and sound editors, video editing systems, as the focus is put on time-saving and effort-saving technologies facilitating the process of creation of relevant high-quality content.

- Technologies and tools contributing to the effective storage, archiving and codification of knowledge focuses the attention on another important aspect in the Knowledge management process ; the quality, quantity, accessibility and representation of the acquired knowledge. (Milner 2002)

- Content management software represents the convergence of full-text retrieval, document management, and publishing applications. It supports the unstructured data management requirements of KM initiatives through a process that involves capture, storage, access, selection, and document publication. Content management tools enable users to organize information at an object level rather than in binary large objects or full documents. The information is broken down by topical area and usually tagged via extensible markup language (XML). Both capabilities dramatically increase the opportunity for re-use (Gupta et al., 2004).

- Business Intelligence often encompasses a mixture of tools, databases, and vendors in order to deliver an infrastructure that not only will deliver the initial solution, but will incorporate the ability to change with the business and current marketplace. Three types of tools are referred to as Business Intelligence Tools:

  - **Multidimensional Analyses software**, that gives the user the opportunity to look at the data from a variety of different dimensions;

  - **Query tools** allowing the user to ask questions about patterns or details in the data;

  - And **Data Mining tools** which automatically search for significant patterns or correlations in the data (Mertins et al., 2003).

- Visualization tools can also facilitate knowledge processing and re-use. Graphics and animations, when appropriately rendered, can decrease the time required for knowledge workers to grasp complex processes and allow non-experts to verify the accuracy of relationships that would have been unwieldy to describe with tables of data. (Bergeron 2003).

> ➤ The appearance of web technologies provides Knowledge Management with very rich tools for **knowledge access and transfer** in a timely and machine independent way. In fact, the Web offers a very powerful platform for tools supporting all stages of Knowledge management, allowing unprecedented degrees of integration of different representational and communicational media (Wensley, 2000).

This tools help the managers and knowledge workers of different types of organisations and organisations are using them daily in process their work.

### *Conclusion*

Modern Knowledge Management has been tremendously enriched by advances in computer based technology. For people to come up with better decisions, they need computing.

# 3    MARKETING INTELLIGENCE

## *Introduction*

As the project described in this dissertation is concerned with creating a model to support marketing intelligence it is important to understand the key concepts of marketing, marketing intelligence and the role they play in academic institutions. This chapter presents an overview of marketing intelligence introducing the key activities and presenting some strategies for marketing intelligence. The chapter then moves on to assess the role marketing intelligence currently plays in academic institutions, and will play in the future, and concludes by offering an assessment of marketing intelligence from a knowledge management perspective.

One way to visualize market intelligence is to picture a pyramid. Each face of the pyramid represents an aspect of market intelligence (Crowley 2004). The three faces of the pyramid are information, communication, and people/processes. Each of these faces is built upon a foundation of basic capabilities, with movement "up" the face of the pyramid representing increasing capabilities and proficiency. Market intelligence is the culmination of each of these areas at their highest levels.   Figure 2 shows this visualization of marketing intelligence
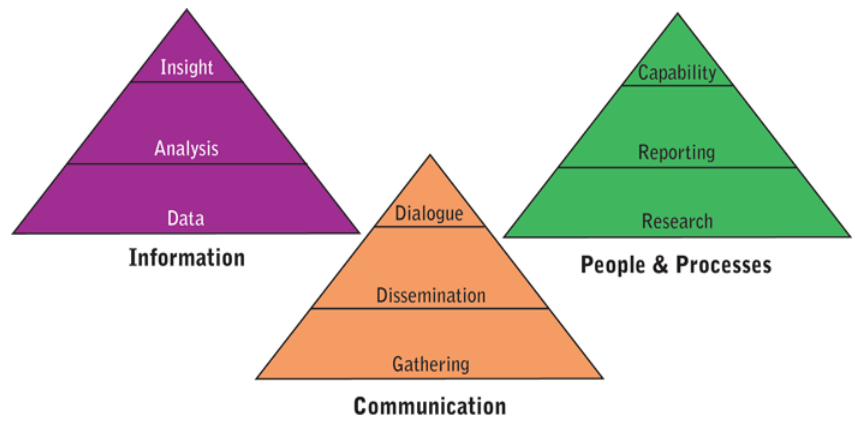
**Figure 2:  Visualizing Marketing Intelligence (Crowley 2004)**

The best way to describe marketing intelligence is to focus upon each phase of the marketing intelligence pyramids.   The information face of the market intelligence pyramid is built upon a foundation consisting of four basic areas: competitor information, product information, market information and customer information. This is depicted in **Figure 3**.
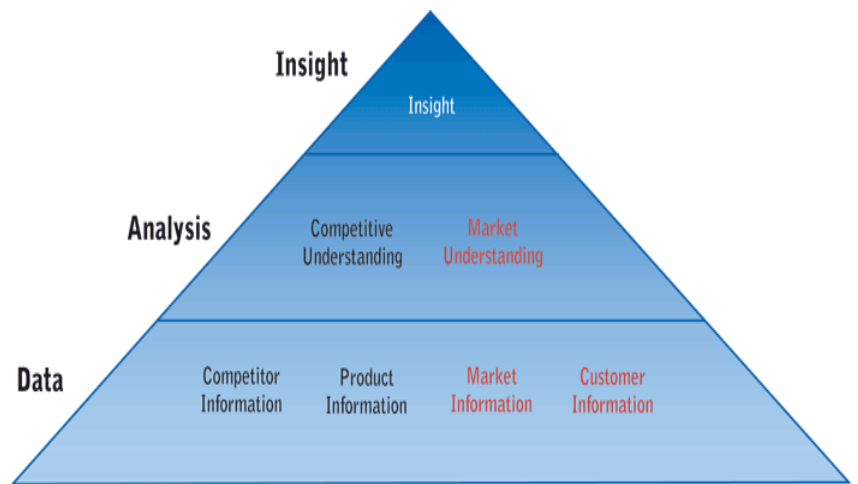
**Figure 3: Each Phase of the Marketing Intelligence Pyramid (Crowley 2004)**

The information face of the market intelligence pyramid is built upon a foundation consisting of four basic areas: competitor information, product information, market information and customer information. This is depicted in Figure **2**.

Product information refers to an understanding of the products in the marketplace, how they are priced, and what tactical marketing activities (promotions, advertising, etc.) are being used with these products.

Competitor information refers to the understanding of competitors' strategies, organizational structure, product investment portfolio, and future product plans.
Market information encompasses a view of the market at a macro level including the current market size, market segments, market share trends, and the forecasted growth of the market and the respective market segments.

Customer information involves fully understanding the customer preferences, drivers of customer behaviour, brand loyalty, satisfaction rates and any other customer views that impact their behaviour in relation to your firm's products or services.

It is important to note that each of these areas of knowledge can be a unique discipline in and of itself. However, the real powers of the information lies in combining all of these areas to create a complete view of the market, the market intelligence view **Figure 4.**



**Figure 4: Complete View of Market, Market Intelligence View (Crowley 2004)**

Market intelligence yields an ongoing and comprehensive understanding of the market. Each of the four knowledge areas: competitor intelligence, product intelligence, market understanding, and customer insight, interacts to form a complete understanding of the market.

Market intelligence yields an ongoing and comprehensive understanding of the market. Each of the four knowledge areas: competitor intelligence, product intelligence, market understanding, and customer insight, interacts to form a complete understanding of the market.

Each competitor's strategies will impact their product actions, the overall trends of market growth and segment interaction will impact the strategies, and underlying all of this, the customer's behaviors and attitudes will ultimately drive the market dynamics in terms of growth rates and product acceptance. This integration of all four knowledge areas is the ultimate deliverable for market intelligence.

In communication face market intelligence involves a dialogue between the market intelligence analyst and the client/decision maker.

The third and final face of the pyramid deals with people and processes. By its very nature market intelligence is a process. One which constantly captures information from many difference sources, assesses it, and then uses the information during the ongoing business decision-making process.

**Researchers Opinion**

After an introduction of what marketing intelligence is, it is clear that marketing intelligence is very important in any type of organization. The academic institutions managers rely mostly on it to know who their competitors and what new programmes are being introduced in the market. Without marketing intelligence, it would be very difficult for these institutions to retain a competitive advantage over their competitors.

After an introduction of what marketing intelligence is and how to visualize it using the marketing intelligence pyramid, a brief overview of marketing intelligence is introduced in section 3.2 below

### *Overview of Marketing Intelligence*

Marketing is a management function that offers a framework for increasing productivity. It is a communication process that manifests itself in carefully formulated programs designed to bring about exchanges of values with target markets to achieve the objectives of the college. The marketing mix must include product development, pricing, promotion, distribution, advertising, media relations, publications, and market research. The marketing plan is part of the business plan and defines the target markets,

competitive environment, demographic profiles, and the needs of the clientele. The goal of marketing is to create customer satisfaction by building value based relationships with customers, in conjunction with other internal and external business units. The end result is gaining market leadership by understanding consumer needs and finding solutions of superior value, quality, and service.

Marketing intelligence is a future-oriented activity that helps an organization copes in the market. It includes all ways an organization acquires and uses information. It is comprised of all kinds of market and marketing research; the collection and analysis of internal data, competitive analysis; analysis and reverse engineering of competitor's products; understanding how and where to add value for customers; and the process of synthesizing large amounts of informally gathered information about the industry and business environment. This environment can be divided into a number of areas of study; economic, political, social, technological, infrastructural, ecological, legal, and demographic, which together illustrates the interdisciplinary nature of the subject. Marketing intelligence can be as comprehensive or as narrow as a company may want it to be.

Marketing intelligence and the information it produces tends to create change. Marketing intelligence is driven by the marketplace and by competitors. As competitors change strategy and introduce new products, customers respond to these changes by changing their preferences and purchase behaviour. Competing firms must therefore engage in intelligence work to understand exactly what is happening. As new intelligence emerges, competing firms find new ways of providing additional value to customers. They then deliver this new value to customers, which again produce change. This market-oriented information gathering is an ongoing process. Firms capable of learning by uncovering new information, and that can create knowledge through intelligence, are usually those that maintain their competitive position.

Marketing intelligence, like many other corporate functions, has changed dramatically over the last few years. Today marketing intelligence is global and very much influenced

by changing customer behaviour and new technology. Not only large multinational corporations, but also small and medium size firms are sourcing goods and services to a much greater extent across borders. The extent of sourcing varies from product to product and industry to industry. Sourcing is used extensively in the technology related areas; for example, in electronics it is very common for smaller firms to establish alliances and source products, components, or assistance worldwide. This substantially increases the need for intelligence activities. It also influences the resources required to do intelligence work and the organization of such efforts.

Market Intelligence is about  providing a company with a view of a market using existing sources of information to understand what is happening in a market place, what the issues are and what the likely market potential is.  Market Intelligence can be divided into two spheres: market intelligence based on external data and market intelligence based on internal data

Marketing intelligence information can come from making better use of existing information.  For instance by carrying out survey analysis on postgraduate computer science degrees which are taken in the Republic of Ireland,  it may be possible to understand what information to include in the DIT  Knowledge Model being implemented, or to understand what type of audiences are most profitable.  Database information is not the only source of market data, website may also include a high degree of valuable information about who is looking for courses being offered in different institutions and services.  Often Market Intelligence relies purely on external data such as analysts reports, but there is often a great deal of untapped information internally that would give an insight into the market.

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competing firms find new ways of providing additional value to customers. They then deliver this new value to customers, which again produce change. This market-oriented information gathering is an ongoing process. Firms capable of learning by uncovering new information, and that can create knowledge through intelligence, are usually those that maintain their competitive position. Marketing intelligence, like many other corporate functions, has changed dramatically over the last few years. Today marketing intelligence is global and very much influenced by changing customer behaviour and new technology. Not only large multinational corporations, but also small- and medium-size firms are sourcing goods and services to a much greater extent across borders.

Focus areas on marketing intelligence are shown in Figure **5 below**



**Figure 5: Focus Areas: The Three Pillars of Market Intelligence**

Market intelligence information is required in three primary areas of focus: Each focus provides a different perspective and insight that supports decision making. Synergistically, it's best to have all three. The whole is greater than the sum of the parts in that, when considered collectively, decision making encompasses a far greater understanding of all aspects of the market.

### *Strategies for Marketing Intelligence*

A **marketing strategy** serves as the foundation of a marketing plan. A marketing plan contains a list of specific actions required to successfully implement a specific marketing strategy. An example of marketing strategy is as follows: "Use a low cost product to attract consumers. Once our organization, via our low cost product, has established a relationship with consumers, our organization will sell additional, higher-margin products and services that enhance the consumer's interaction with the low-cost product or service."

A good marketing strategy should integrate an organization's marketing goals, policies, and action sequences (tactics) into a cohesive whole. The objective of a marketing strategy is to provide a foundation from which a tactical plan is developed. This allows the organization to carry out its mission effectively and efficiently.

Marketing strategy deals essentially with the interplay of three forces known as the strategic three Cs: the customer, the competition and the corporation. Marketing strategies focus on ways in which the corporation can differentiate itself effectively from its competitors, capitalizing on its distinctive strengths to deliver better value to its customers. A good marketing strategy should be characterized by:

- A clear market definition;
- A good match between corporate strengths and the needs of the market;
- Superior performance , relative to the competition, in the key success factors of the business

Marketing plays a vital role in the strategic management process of a firm. The experience of companies well versed in strategic planning indicates that failure in the marketing can block the way to goals established by the strategic plan.

Business marketing strategy:

- Customer satisfaction
- Retaining competitive advantages of products

Marketing Strategy  for the product/service:

Segmentation

Targeting

Positioning

There are many different General Marketing Strategies, though most can be viewed as falling into one of the following categories:

**General Marketing Strategies:**

- **Market Expansion**  This strategy looks to grow overall sales in one of two ways: Grow Sales with Existing Products – With this approach the marketer seeks to actively increase the overall sales of products the company currently markets. This can be accomplished by: 1) getting existing customers to buy more; 2) getting potential customers to buy (i.e., those who have yet to buy); or 3)   selling current products in new markets.
- **Grow Sales with New Products**:  With this approach the marketer seeks to achieve objectives through the introduction of new products. This can be accomplished by: 1) introducing updated versions or refinements to existing products; 2) introducing products that are extensions of current products; or 3) introducing new products not previously marketed.
- **Market Share Growth:**  This strategy looks to increase the marketer's overall percentage or share of market. In many cases this can only be accomplished by taking sales away from competitors. Consequently, this strategy often relies on aggressive marketing tactics.
- **Niche Market** :  This strategy looks to obtain a commanding position within a certain segment of the overall market. Usually the niche market is much smaller in terms of total customers and sales volume than the overall market. Ideally this

strategy looks to have the product viewed as being different from companies targeting the larger market.

- **Status Quo:** This strategy looks to maintain the marketer's current position in the market, such as maintaining the same level of market share.
- **Market Exit:** This strategy looks to remove the product from the organization's product mix. This can be accomplished by: 1) selling the product to another organization, or 2) eliminating the product.

**Decision Area Strategies**

These are used to achieve the General Marketing Strategies by guiding the decisions within important marketing areas (product, pricing, distribution, promotion, target marketing). For example, a General Marketing Strategy that centers on entering a new market with new products may be supported by Decision Area Strategies that include:

- **Target Market Strategy :** employ segmenting techniques
- **Product Strategy:** develop new product line
- **Pricing Strategy:** create price programs that offer lower pricing versus competitors
- **Distribution Strategy:** use methods to gain access to important distribution partners that service the target market
- **Promotion Strategy**: create a plan that can quickly build awareness of the product

Achieving the Decision Area Strategies is accomplished through the development of detailed Tactical Programs for each area. For instance, to meet the Pricing Strategy that lowers cost versus competitors' products, the marketer may employ such tactics as: quantity discounts, trade-in allowances or sales volume incentives to distributors.

### *Marketing Intelligence and Its Role in Academic Institutions*

Marketing intelligence plays a very important role in academic institutions all over the world:

- Through marketing intelligence different institutions located globally are able to communicate by passing important information regarding the programmes offered and its students.

- The competitive advantage in the market of different academic institutions is retained since these institutions are able to know what is happening from its competitors who are other academic institutions.

- An increase in number of students registering in the institutions practising marketing intelligence is higher than its opponents.

- Increase in income generated by institutions is expected to be higher where marketing intelligence is being practised.

### *Marketing Intelligence as a Knowledge Management Activity*

Gaps in the knowledge chain, which runs along the traditional supply chain, account for much of the ineffectiveness in leveraging the market information that is produced through customer transactions.  In trying to convey market intelligence across the organization, for example, it is often difficult for the sender to know what information the recipient needs today or may need at a future date.

*Conclusion*

This chapter has looked into marketing intelligence, the strategies for marketing intelligence and marketing intelligence and its role in academic institutions and finally marketing intelligence and where it fits in knowledge management.

# 4    KNOWLEDGE MAPPING

## 4.1  Introduction

As part of the project described in this project is to express the knowledge used to support marketing intelligence as a knowledge model using XML Topic Maps (XTM) it is important to understand the concepts of knowledge mapping and how knowledge maps can be created and used to support better knowledge management. This chapter will provide an overview of knowledge mapping, discussing how knowledge maps are created and used. The chapter moves on to deal with concept maps and their relationship with knowledge maps concluding by discussing topic maps and also XML Topic Maps (XTM) in particular since this is the representation chosen for this project.

### *Overview of knowledge Mapping*

Knowledge Maps are a topology of patterns that are driven by the Software Stability Concepts approach (Fayad, 2002a, 2002b; Fayad & Altman, 2001). They consist of knowledge core sets or stable patterns that host the pertinent features and functionality of a particular domain.

Knowledge Maps' representation is driven by "divide and conquer," which is applied throughout the Knowledge Maps' structure. For instance, the Knowledge Maps are product of partitioning a particular domain into different levels of granularity, so that each level can be managed with ease. In addition to this, the Knowledge Maps are stratified into five main concerns: analysis concerns (called goals), design concerns (called capabilities), knowledge concerns (goals and capabilities together), development concerns (called development scenarios), and deployment concerns (called deployment scenarios) (Fayad, 2002a, 2002b).

Table 1 below shows a full list of the goals of a knowledge map. A brief description of these goals is provided:

| Goal | Description |
|------|-------------|
| Learning | In this domain, learning is the cognitive process of acquiring skills or knowledge about a specific discipline. |
| Discovery | It is defined as the process or act of finding something or somebody unexpectedly or after searching. |
| Knowledge | In this domain, it portrays the distinct aspects (goals and capabilities) of the Knowledge Maps. |
| Abstraction | A view of a problem that extracts the essential information relevant to a particular purpose and ignores the remainder of the information. |
| Visualization | In this domain, it visualizes the existence of certain goals, capabilities, and transient aspects in the KMs, as well as their relationship to one another. |
| Synthesis | The ability to create new knowledge out of pertinent aspects of a particular domain. This includes the association of direct knowledge and remote knowledge. |
| Leveraging | This refers to the reuse of source and/or target patterns from one set of core sets in remote patterns' languages specific applications. |

**Table 1: Goals of Knowledge Maps (Fayad & Telu, 2005).**

An important aspect of knowledge management is the implementation of methods to share the idiosyncratic knowledge of expert practitioners within an organization. In order to make such knowledge sharable, it is necessary to have both an effective elicitation method and a useful representation scheme (Coffey, Hoffman & Cañas 2002). Knowledge mapping provides a mechanism to achieve this.

Knowledge mapping is defined as the optimization of the effective and efficient use of the corporate knowledge base by addressing the question how to best support finding the knowledge and building insights into the qualities of this knowledge (Huijsen, Driessen & Jacobs 2004). Knowledge mapping systems provide support for addressing these issues, collecting data on the corporate knowledge from various information systems. Therefore a knowledge map does not contain knowledge but points to it, as Cross et al. (Cross et al. 2001) states.

**Justifications**

Knowledge maps are very important, there main goals are very important in an academic institution

## *Creating Knowledge Maps*

Building Knowledge Maps for a determined discipline involves numerous skills, knowledge and steps beyond the identification of tangible artifacts bound to a specific context of applicability. It requires a systematic capture and full understanding of the problem domain. This includes describing the problem domain not from its tangible side, but focusing more on its conceptual side, describing underlying affairs related to the problem, and identifying the elements required to fulfil them.

In order to create a useful knowledge map it is important that a well thought process is to used to create it. The steps involved in building a knowledge map are logical and follow a typical life cycle approach. The success of the knowledge map depends on aligning it to a business problem, which enables the knowledge map to directly address that problem. It is recommended to use an iterative process to create the knowledge map, initially selecting a small group of data; the training set and then slowly adding to this training set. There are 11 steps required to build a Knowledge Map (Bargent 2002):

1. **Identify requirements:** For a Knowledge map to be successful, it must be aligned with a business goal or purpose. The smaller the scope of this goal, the easier it is to measure the success of the Knowledge map

2. **Conduct an information audit:** Before you can target data sources for inclusion into the Knowledge map, conduct an information audit. Initially, subject matter experts must identify all possible sources for the data and answer specific questions to ensure that they have captured enough information about a particular topic.

3. **Define the information sources:** Refine the list generated from the information audit and remove duplicate data, outdated information, and

information of little value. The objective is to make a new list that will be the total source of information for the Knowledge map. You then define a prioritized list known as the training set. This list identifies the most useful documents from which to train the initial Knowledge map. During the information audit, it's important to check the validity of each data source, including its metadata and security rights.

4. **Modify the stop word list:** Update list to be excluded from the Knowledge map.

5. **Configure the tomcat Server:** the type of information you want to use and rules to be applied. All these factors can affect performance and the result of the Knowledge map and are dependent on the data sources and the business objective of the final Knowledge map.

6. **Generate the people profiles:**

7. **Set up data sources**

8. **Create the Knowledge map:** Once successfully set up and reviewed the data sources, then create the Knowledge map.

9. **Train the Knowledge map:** The process of training the Knowledge map is an iterative cycle of adding in new data sources

10. **Generate Affinities:** Affinities reflect an individual's knowledge or expertise against knowledge map categories and are established by designers who can define affinities for specific users, automatic discovery based on documents that a person has authored, edited , read and self-nomination

11. **Test the Knowledge Map**

Having described the 11 steps of creating a knowledge map, this steps will be applied in the process of implementing a knowledge map for DIT and DIT and other institutions, the researcher will follow the steps mentioned above in order to obtain a fully functional knowledge map which contains the right information of the computer science postgraduate programmes.

Another alternative is to use a process that involves the identification of five main elements of the knowledge map: Goals or Classification, Capabilities and Properties of a particular discipline, Knowledge Maps formation, Development Scenarios, and finally Solution Deployment. The main reason for this methodology is to guarantee an efficient way to develop knowledge maps using a set of similar and different patterns.

This methodology consists of five main steps. Each step will generate a set of outcomes that will complement an entire system development process, such as functional requirements, design artifacts, development artifacts, extension points, and non-functional requirements. **Figure 6** visualizes the knowledge map methodology
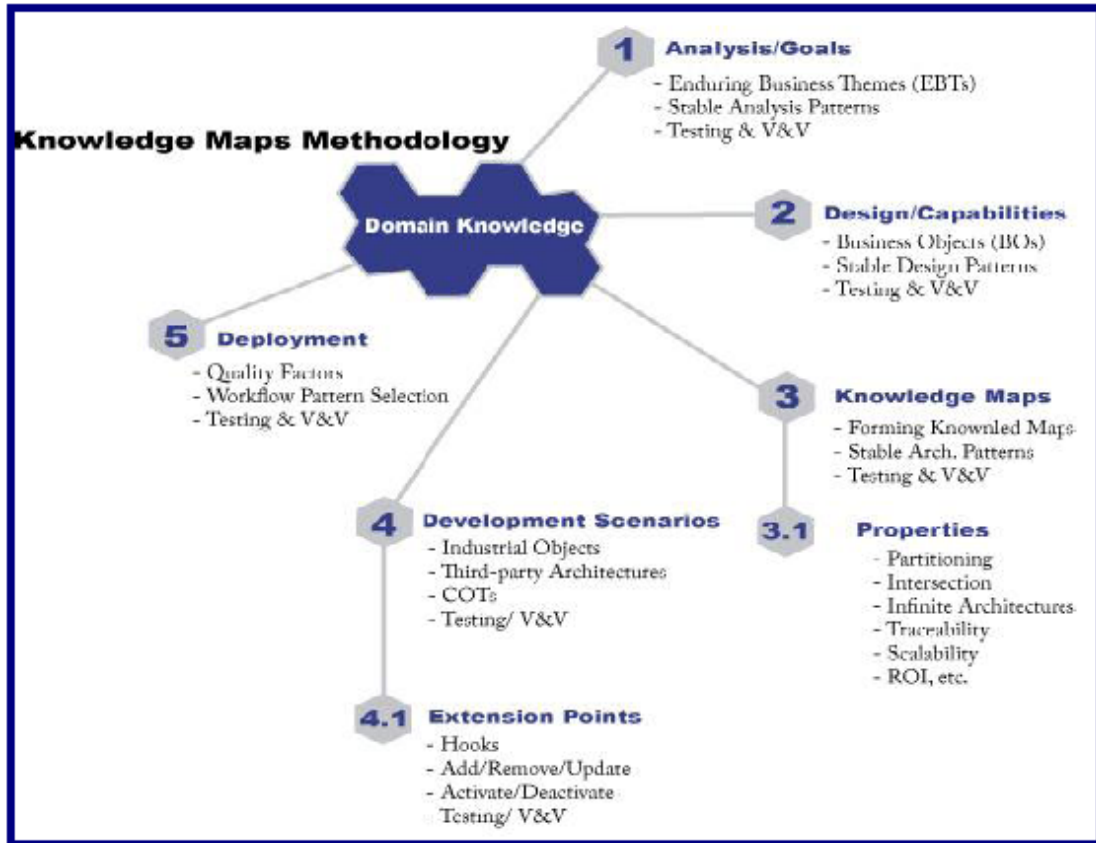


**Figure 6: Knowledge Maps Methodology**

Steps in the knowledge map methodology are:

- **Step 1 Analysis and Goals:** This is concerned with surfacing the implicit goals hidden within a particular discipline (Hamza & Fayad, 2004). This process requires a full understanding of the context wherein the desired solution would be used. This includes describing the goals not from their tangible side, but focusing more on their conceptual side.

- **Step 2 Design and Capabilities:** This emphasizes the discovery of the recipes required to fulfil the goals of a particular domain (Fayad, 2002)

- **Step 3 Forming the Knowledge Maps:** Intuition and experiences from practitioners e.g., analysts, designers, and developers; support the formation of the Knowledge Maps.

- **Step 4 Development Scenarios:** This step provides essential qualities to a future software solution, such as scalability, traceability, maintainability, stability, and return of investment (ROI).

- Step 5 Deployment: This is the final step and deals not only with how a particular solution and its enclosed knowledge core sets would be deployed in a particular domain, but also with the representation of the artifacts or domain specific patterns that will aid the deployment process. (Hamza & Fayad, 2002).

## *Concept Maps Verses Knowledge Maps*

A concept map is a special form of a web diagram for exploring knowledge and gathering and sharing information. Concept mapping is the strategy employed to develop a concept map. A concept map consists of nodes or cells that contain a concept, item or question and links. The links are labelled and denote direction with an arrow symbol. The labelled links explain the relationship between the nodes. The arrow describes the direction of the relationship and reads like a sentence (Fayad, 2002).

Concept maps are also graphical representation of relationships among concepts. Willis and Miertschin suggested the use of technology-based concept mapping as an active learning strategy that can enhance learning and thinking skills, particularly among students native to a digital environment (Willis & Miertschin 2006). In addition, modern concept mapping software tools enable instructors and students to create visual navigation structures through complex knowledge domains.

There are four major categories of concept maps. These are distinguished by their different format for representing information. Namely;

- **Spider Concept Maps**: This concept map is organized by placing the central theme or unifying factor in the centre of the map. Outwardly radiating sub-themes surround the centre of the map.

- **Hierarchy Concept Maps**:  The hierarchy concept map presents information in a descending order of importance. The most important information is placed on the top. Distinguishing factors determine the placement of the information.
- **Flow chart Concept Map**:  The flowchart concept map organizes information in a linear format.
- **System Concept Maps**:  The systems concept map organizes information in a format which is similar to a flowchart with the addition of 'Inputs' and 'Outputs'.  **Figure …..** below shows the four different categories of concept maps:

On the other hand, knowledge maps provide a systematic approach that assures focused solutions.  They classify patterns according to their rationale and provide a full traceability of their enclosed patterns.  Knowledge maps provide also full generality of their enclosed patterns and provide enduring solutions.  Maintenance is minimal and they are easy to understand and use when dealing with problems.  Everything is based on goals and capabilities.  Knowledge maps also distinguish between direct and remote knowledge

**Remarks:**

Concept maps are important in this thesis because the goal of this thesis is create a knowledge model using XML Topic Maps.  By *understanding of why concept maps?* is important for the successful delivering of a correct knowledge model since topic maps are a standard of concept maps.  On the other hand Knowledge maps are very important also because they are used in this thesis since they provide a systematic approach that assures focused approach, by using them in this thesis, the researcher is assured of the final solutions being accurate due to the structure of solving the problem in hand.

### *Topic Maps*

Topic maps enable knowledge structures to be codified and linked with arbitrary information resources (TopicMaps.Org 2001).  The topic map concept is based on a compact vocabulary and encloses mechanisms for merging.  Decision to make the

XML topic Map for DIT and other colleges was based on the fact that topic maps are not only suitable for knowledge representation and information management but also meet the requirements of DIT users demanding capable applications for retrieving and visualizing semantic information.

Topic maps are a standard for describing knowledge structures and associating them with information resources. The origins of the topic map paradigm date back until the early 1990's when an explicit model to merge document indices was requested.(Gartner 2003)

The difference between topic maps and concept maps is that Topic Maps can be used to qualify the content and/or data contained in information objects as topics to enable navigational tools such as indexes, cross-references, citation systems, or glossaries. They can also be used to link topics together in such a way as to enable navigation between them.   This capability can be used for virtual document assembly, and for creating thesaurus-like interfaces to corpora, knowledge bases, etc.  Topic maps can also be use to filter an information set to create views adapted to specific users or purposes. For example, such filtering can aid in the management of multilingual documents, management of access modes depending on security criteria, delivery of partial views depending on user profiles and/or knowledge domains, etc.  In most cases they are used to structure unstructured information objects, or to facilitate the creation of topic-oriented user interfaces that provide the effect of merging unstructured information bases with structured ones. The overlay mechanism of topic maps can be considered as a kind of external markup mechanism, in the sense that an arbitrary structure is imposed on the information without altering its original form.

On the other hand concept maps are a special form of a web diagram for exploring knowledge and gathering and sharing information.   For example a topic map of postgraduate computer science programmes in DIT is shown in figure 7 below
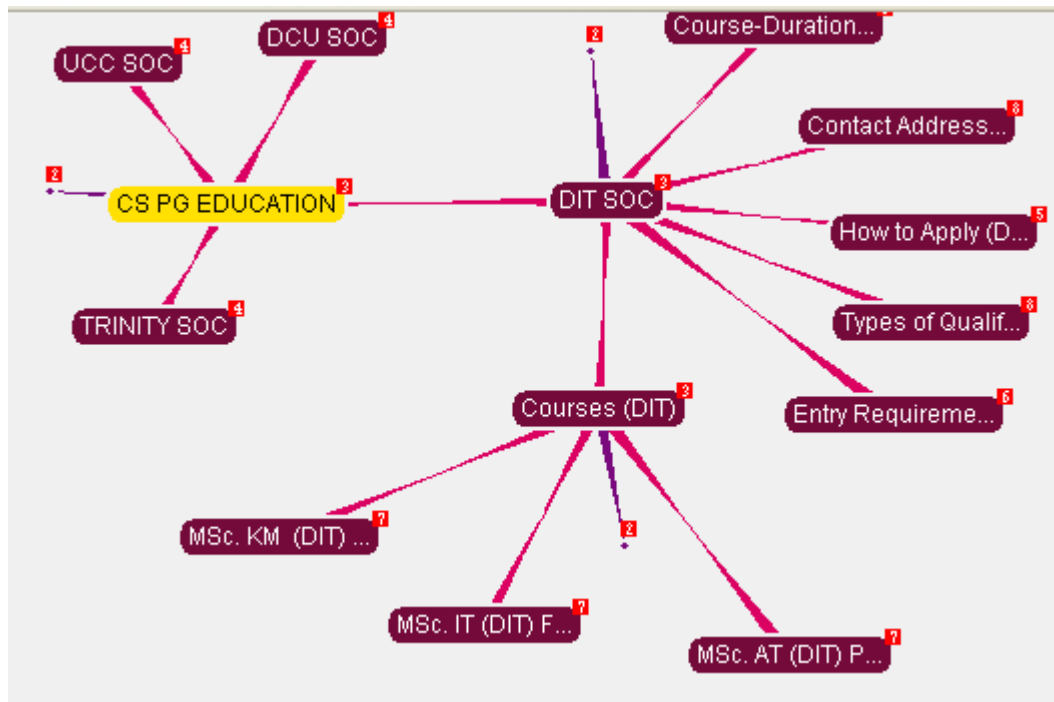
**Figure 7: Topic Map of DIT Postgraduate Computer Science Programmes**

**Remarks**

The difference between topic maps and concept maps is that:

The purpose of a topic map is to convey knowledge about resources through a superimposed layer, or map, of the resources. A topic map captures the subjects of which resources speak, and the relationships between resources, in a way that is implementation-independent. The concept map is a special form of a web diagram for exploring knowledge and gathering and sharing information. Concept mapping is the strategy employed to develop a concept map.

The reason as to why I am talking about topic maps is because the objectives of this thesis requires an implementation of topic maps for postgraduate computer science degrees in third level institutions in Ireland.

## *XML Topic Maps*

The relationship between topic maps and XTM is that Topic maps have an XML version of the topic maps paradigm called XML Topic Maps (XTM) (Pepper 2002), which is specified by the topicmaps.org consortium. Topicmaps.org is an independent consortium that aims in developing the applicability of the topic maps paradigm to the WWW. Members from companies including Empolis, InfoLoom, Mondeca, Ontopia, and Sun. Microsystems who have been working for the specification of XTM.

XML Topic Maps are extremely powerful and portable knowledge representation structures that can be used for the purpose of building a knowledge model for DIT postgraduate computer science programmes. A topic map, dubbed as the Global Positioning System of the web, is a recent ISO-IEC 13250 standard on the other hand XML Topic Maps (XTM) is a product of the TopicMaps.Org Authoring Group (AG), formed in 2000 by an independent consortium named TopicMaps.Org. The design goals for XTM are; XTM are straightforwardly usable over the Internet and they support a wide variety of applications. They are also compatible with XML, XLink, and ISO 13250 and it is also easy to write programs that process XTM documents.

**Remarks**

The reason as to why the researcher is discussing topic maps and XTM's is because the aim of this thesis is to create topic maps using the XTM verson of DIT School of computing and DIT and other colleges for the purpose of marketing intelligence analysis.

## *Conclusion*

In summary one can say that knowledge maps can help employees and clients remember, comprehend, and relate knowledge domains through the insightful visualization and aggregation of information about the company's experiences, skills, or intellectual resources in general. This chapter has discussed what knowledge mapping is all about. It has also introduced the methodology or the process of creating concept maps, what concept maps are and has also compared concept maps versus knowledge maps and finally has discussed topics maps and XML topic maps. The main reason as to why the researcher introduced this chapter is because the thesis

involves creating a knowledge model by using XTM version of topic maps. It has been important to discuss each of the concept and obtain an insight of what is involved before implementing the knowledge model.

# 5 KNOWLEDGE AUDIT OF MARKETING POSTGRADUATE CS PROGRAMMES IN IRELAND

## *Introduction*

The focus of this chapter will be on knowledge audit of marketing postgraduate computer science programmes in Ireland which was conducted as part of the research for this project. The chapter starts by introducing the concept of a knowledge audit and explores mechanisms for conducting such an audit. The chapter continues by presenting the knowledge audit conducted as part of this project and the initial knowledge model which resulted. The chapter continues by discussing the survey of stakeholders conducted and concludes by discussing the findings of this survey and the impact they had on initial knowledge model.

### Knowledge Audits

(Bergeron 2003) states that knowledge audits permit to determine exactly what intellectual capital exists in the company at a given point in time. Knowledge audits can take the form of informal interviews, self-reporting formal paper-based surveys, or through group meetings with management and employees.

(Tiwana 1999) considers the knowledge audit and analysis process as the key in his 10-step knowledge management roadmap. It is really a must for knowledge management to take into account at the beginning what knowledge already exists. There are a series of steps involved in the knowledge audit and analysis process proposed by Tiwana are given on **Figure 8**
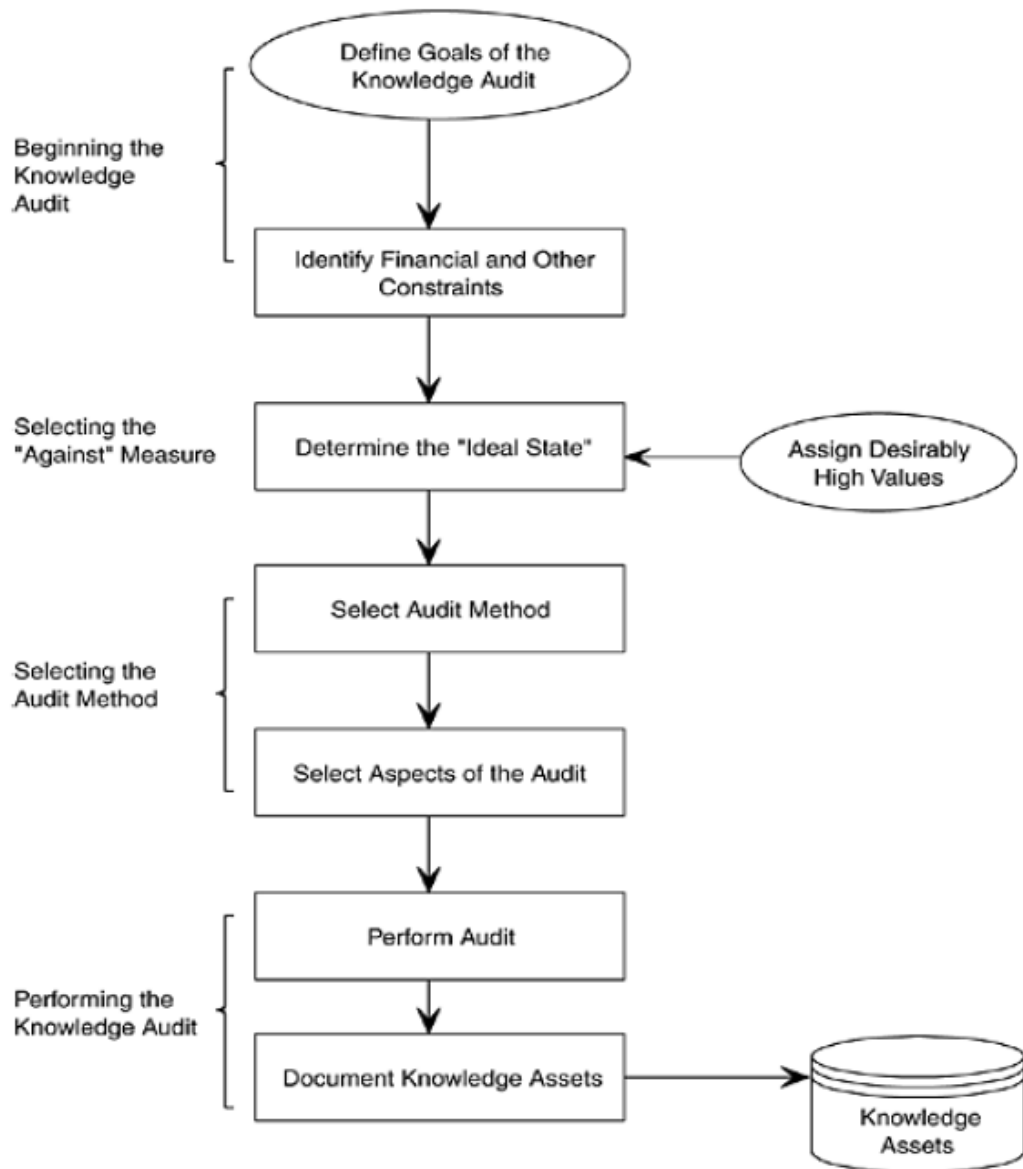
**Figure 8: Knowledge Audit Process**

(Doctor 2003) underlines that the knowledge audit should be the first step in the implementation of a KM initiative. During the audit the knowledge needs and existing knowledge sources within a company should be assessed, to determine its level of readiness.

The third method of knowledge audit is called the FKM-audit method (Fraunhofer KM Audit), based on the 5 objectives of the KM audit, presented by Mertins et al. (2003). The audit proceeding scheme includes a 7 step process:

1. **Initial state:** analyses of the documents about processes, procedures and structures;

2. **Focus setting:** choosing the target group – company, department or team;

3. **Adjustment of inventory:** customizing the audit to the company requirements;

4. **Survey:** gathering the data (questionnaires for the selected target group and face-to-face interviews with the process owners);

5. **Analyses and evaluation:** analyses of the data; modelling of the business process for a description of the procedures, creating a roadmap with recommendation for further actions;

6. **Feedback workshop:** by means of workshop, the results are reported back and the suggested measures prioritized – roadmap and action plan;

7. **Project start:** projects recommended in the roadmap are planned and realized.

**Concluding Remarks**

The method chosen for this thesis is Tiwana's method and analysis process because the analysis process systematically indicates what was required during knowledge audit of the institutions. Each of this steps was achieved by first reviewing of existing online marketing materials,

## *Postgraduate Education in Ireland*

Postgraduate education in Ireland has been the focus of major redevelopment and restructuring in recent years. In 2006, the Government stated its ambition to double the number of PhD graduates by 2012(Ahern T.D 2006). . This drive to secure a place for Ireland among the top research destinations in the world is benefiting the thousands of international students who arrive here every year seeking a fourth level qualification.

The emergence of Ireland's burgeoning knowledge economy, based on innovation and high tech industries such as biotechnology, has highlighted the importance of continuous improvement in the science and technology sectors of postgraduate education. The National Development Plan (NDP) (Levitt 2008) and the Strategy for Science, Technology and Innovation (SSTI) are investing a total of €8.2 billion in research and development during the period 2006-2013. (Levitt 2008)   Few destinations hold such promising prospects for aspiring young scientists and researchers all over the world.   Course providers in Ireland are increasingly focused on producing postgraduates who bring a well rounded skill set to their jobs, rather than just a couple of narrow areas of expertise. These 'soft skills' are essential to career development and include areas such as project management, communications skills and report writing.

To proceed to postgraduate education in Ireland, the student must hold a primary degree. In exceptional circumstances, it may be possible for holders of professional qualifications, or those who are not formally qualified but have substantial experience in a particular field, to be admitted to postgraduate study. For admission to a postgraduate diploma courses, a pass in the primary degree is required.  For a Master degree, it is generally necessary to have attained a good Honours standard in the primary degree.

The web is the main mechanism used in marketing of postgraduate computer science programmes. This is because there have not been other mechanisms which have been successful like the world wide web.   The web has dramatically impacted the business world in the last few years.   Many institutions have discovered the advantages of having a presence on the internet and have successfully addressed corporate objectives by integrating their web site as part of their business strategy.    A web site can generate awareness and provide a world wide store front for your company while automating many business procedures.   The web provides many services e.g. establishing a presence, networking, providing business information and services the organizational customers.

Section 5.2.1 below discusses the role of postgraduate education

### *5.2.1 Role of Postgraduate Education*

Postgraduate education constitutes a particular investment whether personal or national in human capital. Its overall objective is to educate highly skilled citizens and professionals able to address the specific issues of their national contexts as part of a wider globalised society. Postgraduate also contributes in building Knowledge Societies;

> *UNESCO's 2005 report Towards Knowledge Societies defines this entity as "a society that is nurtured by its diversity and its capacities."*
>
> *(UNESCO 2005).*

Today the Knowledge Society and the Knowledge Economy place cognitive resources at the centre of human activity and of social dynamics. This situation thus has critical implications for a country's human capital base: its citizens and workers.

**Remarks**

Postgraduate education faces multiple challenges in terms of demand, supply, quality and returns, both for providers and the clientele concerned. Why students decide to pursue this level of study and the incentives offered by institutions and employers are critical factors in changing and understanding trends.

### *5.2.2 Computer Science Education*

Computer science education involves the study of computer science which is the systematic study of algorithmic processes; their theory, analysis, design, efficiency, implementation, and applications that describe and transform information. The fundamental question underlying all of computing is what can be (efficiently) automated. This discipline was born in the early 1940s with the joining together of algorithm theory, mathematical logic, and the invention of the stored program electronic computer. The roots of computing extend deeply into mathematics and engineering. Mathematics imparts analysis to the field;

engineering imparts design. Computing discipline embraces its own theory, experimental method, and engineering, in contrast with most physical sciences, which are separate from the engineering disciplines that apply their findings (e.g., chemistry and chemical engineering principles). The science and engineering are inseparable because of the fundamental interplay between the scientific and engineering paradigms within the discipline. (Mulwa 2008)

Computing is divided into nine sub areas. Following is a brief description of each (Mulwa 2008):

- **Algorithms and data structures:** This area deals with specific classes of problems and their efficient solutions.
- **Programming languages:** This area deals with notations for virtual machines that execute algorithms, with notations for algorithms and data, and with efficient translations from high-level languages into machine codes. Fundamental questions include:
- **Architecture:** This area deals with methods of organizing hardware (and associated software) into efficient, reliable systems.
- **Numerical and symbolic computation:** This area deals with general methods of efficiently and accurately solving equations resulting from mathematic models of systems. Fundamental questions include:
- **Operating systems:** This area deals with control mechanisms that allow multiple resources to be efficiently coordinated in the execution of programs.
- **Software methodology and engineering:** This area deals with the design of programs and large software systems that meet specifications and are safe, secure, reliable, and dependable.
- **Databases and information retrieval:** This area deals with the organization of large sets of persistent, shared data for efficient query and update.
- **Artificial intelligence and robotics:** This area deals with the modelling of animal and human (intelligent) behaviour.

- **Human-Computer communication:** This area deals with the efficient transfer of information between humans and machines via various human like sensors and motors, and with information structures that reflect human conceptualizations.

**Remarks**

Due to the variety of computing areas, they have been a wide variety of programmes and it has been confusing to understand what this programmes are involved with and the nature in which they are presented to the postgraduate students.

## *Review of Online Materials*

As part of the knowledge audit undertaken the materials available on the web were reviewed and refined. A sample of third level institutes representative of all regions (provinces) of the Island of Ireland (Republic of Ireland and Northern Ireland) was selected from the following colleges:

1. Dublin Institute of Technology (DIT)

2. Trinity College (TCD)

3. Letterkenny Institute of Technology (LYIT)

4. University College Dublin (DCU)

5. University College Cork (UCC)

6. University of Limerick (UC)

7. National University of Ireland Galway (NUIG)

8. Queens University Belfast (QUB)

Review of information collected from these third level institutions was conducted. The methods used to create the models involved; first step involved the task of identifying which third level institutions to collect data from. This involved conducting preliminary research on the existing institutions which offer postgraduate computer science education in Ireland.

Decision to choose eight institutions representing each region of Ireland was made.

Analysis and design methods used involved performing an analysis of the identified institutions. This involved identifying eight of these institutions and then starting the process of knowledge auditing. Second step involved deciding on what information to collect from the college websites. Decision to identify any content which described programmes offered in postgraduate computer science was made.

The design method adopted was use flow charts method. Information collected was presented in a Hierarchal style, for example, the Institution name formed the root node and then any other information about the programmes ranked in superiority.

During the process of creating these models, it was discovered the amount of information collected online about these programmes was a lot. Therefore a decision to refine the models was made. This involved identifying what information was more important especially during the implementation of the final knowledge model and then presenting it. The information presented in these models was information which described the postgraduate programmes only, for example syllabuses, duration of courses, entry requirements and fees per course.

Following is a list of these institutions which were identified for knowledge audit, with the purpose of picking one or more of this institutions and creating a final knowledge model:

1. Dublin Institute of Technology (DIT 2008)

2. Trinity College Dublin (TCD 2008)

3. Letterkenny Institute of Technology (LYIT 2008)

4. University College Dublin (DCU 2008)

5. University College Cork (UCC 2008)

6. University of Limerick (Limerick 2008)

7. National University of Ireland Galway (NUIG 2008)

8. Queens University Belfast (Queens 2008)

Flow charts for DIT, Trinity College Dublin and Dublin City University are presented in the next page; they contain all the information which was refined from the university websites. This information describes only the computer science postgraduate programmes available in those institutions
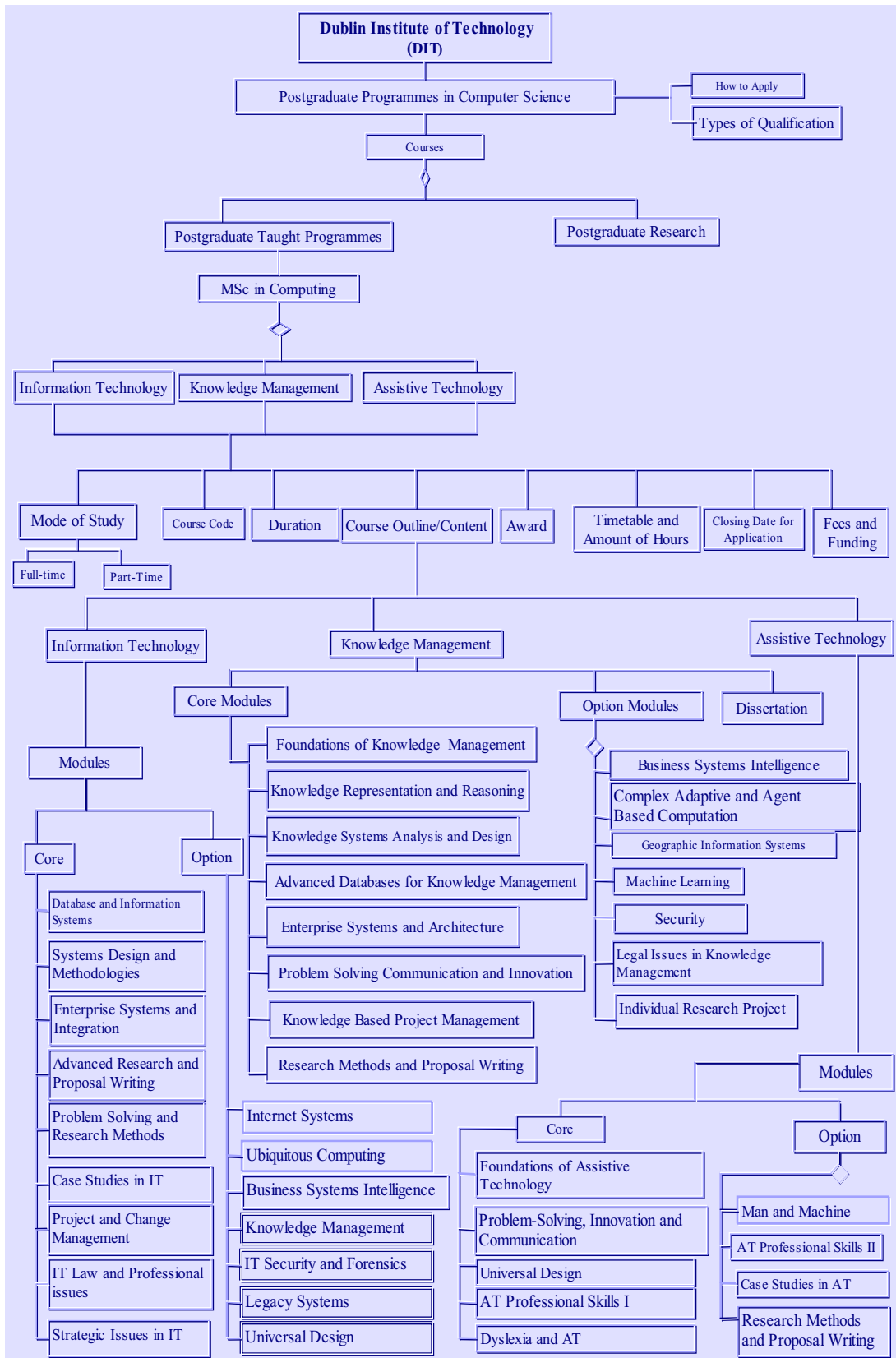
**Figure 9: Refined   Knowledge Model of DIT**
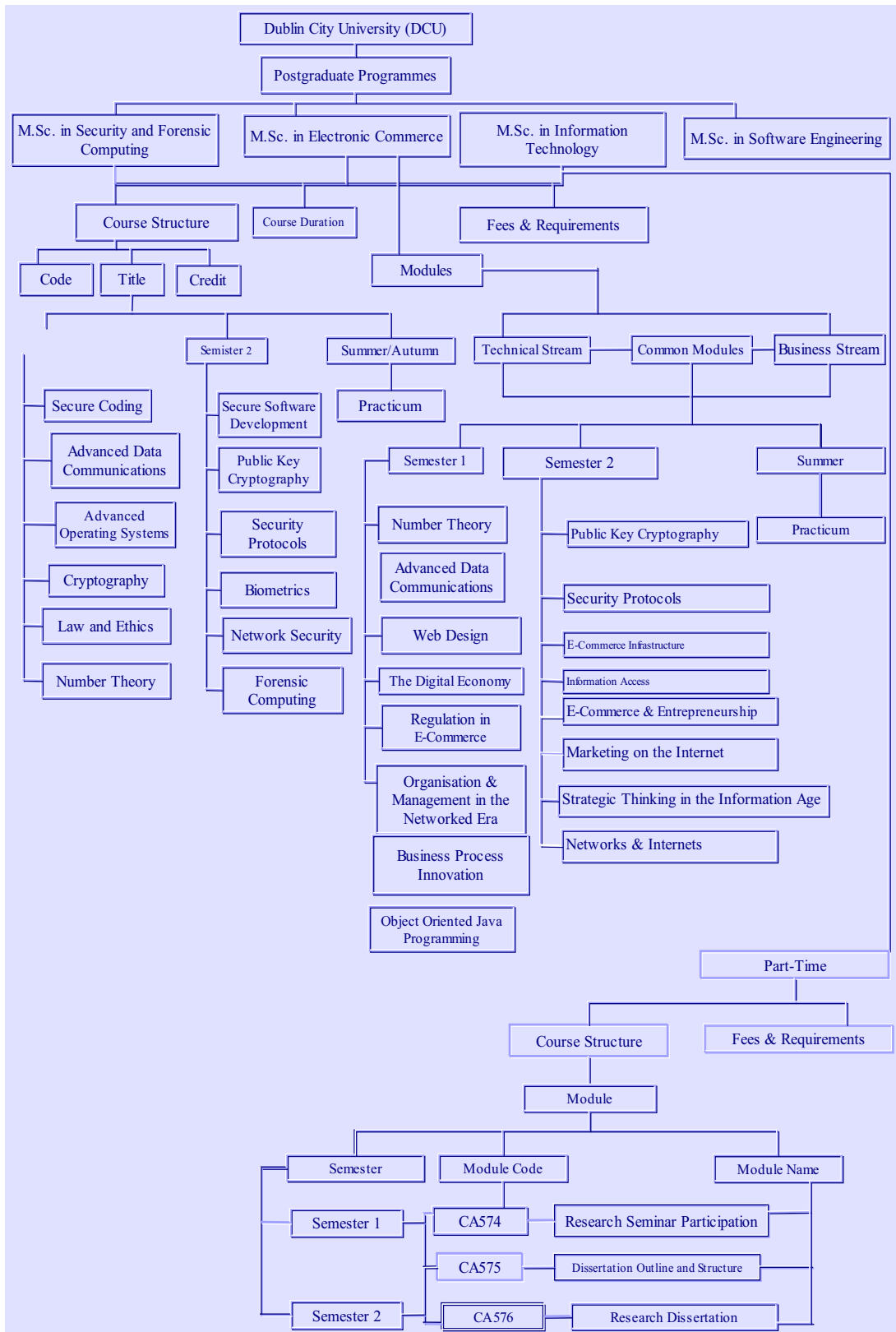
**Figure 10: Refined Knowledge Model of DCU**
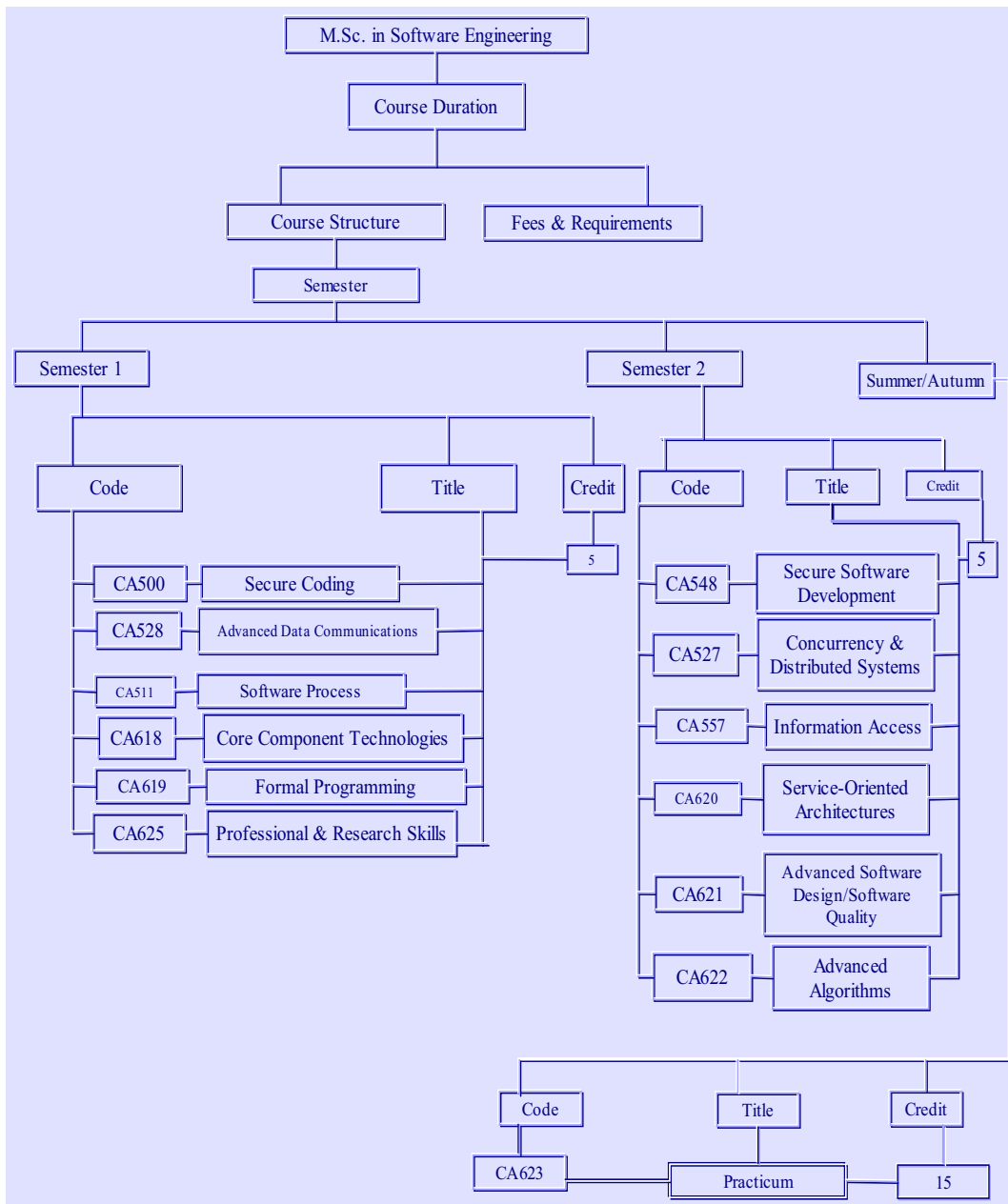
**Figure 11: Refined Knowledge Model of DCU (b)**
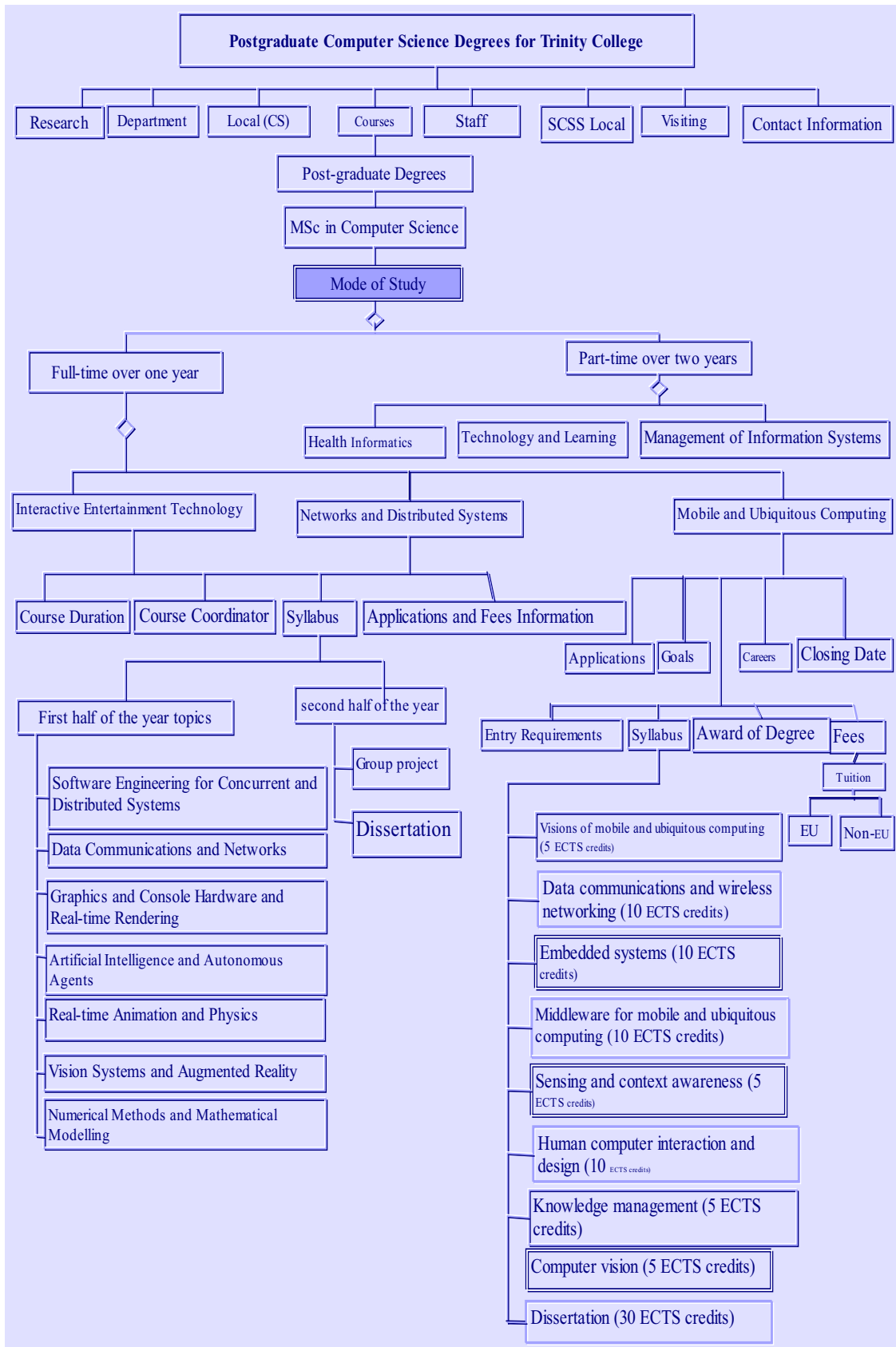
**Figure 12: Refine Knowledge Model Trinity College Dublin (a)**
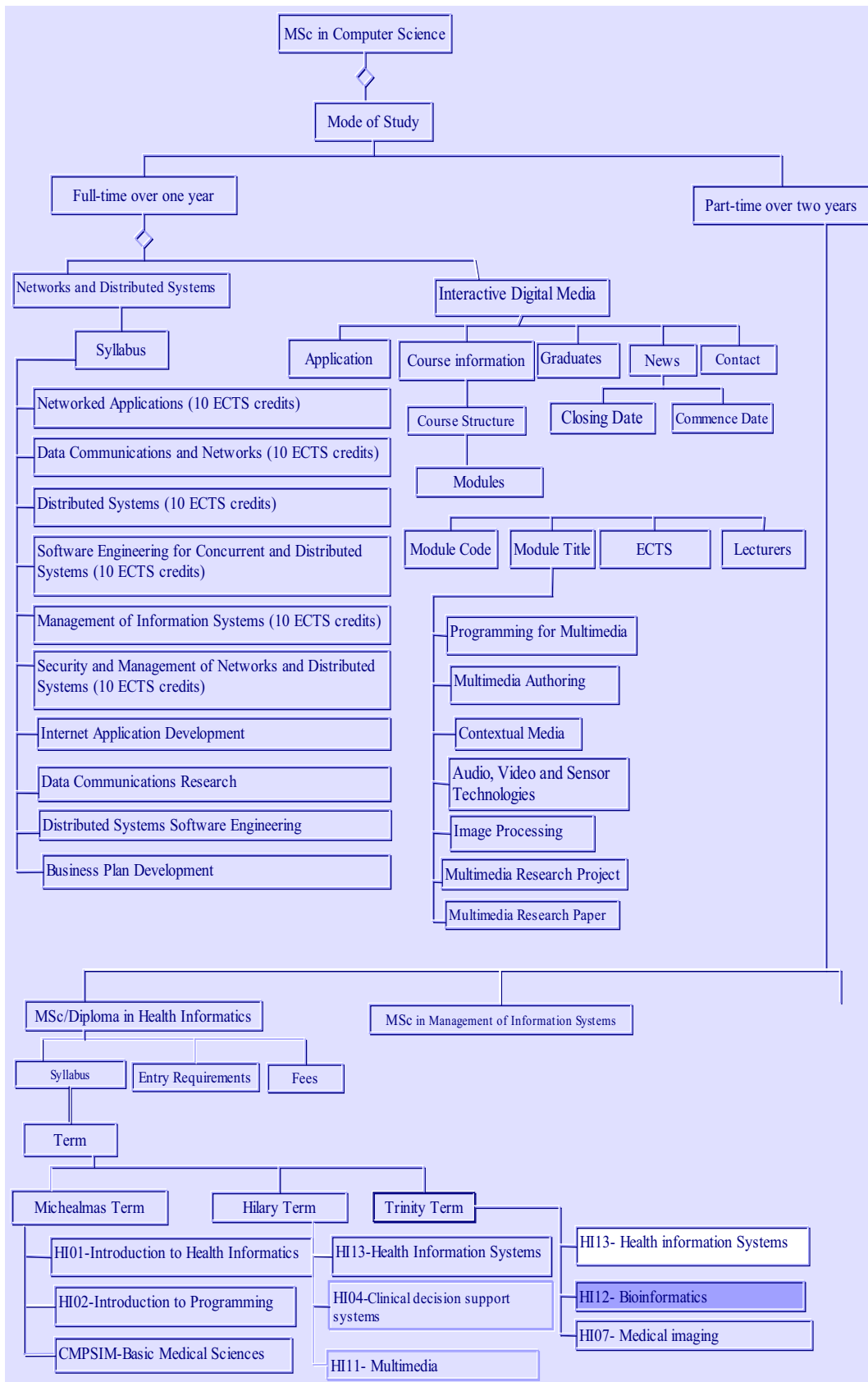
**Figure 13: Refined Knowledge Model of TCD (b)**
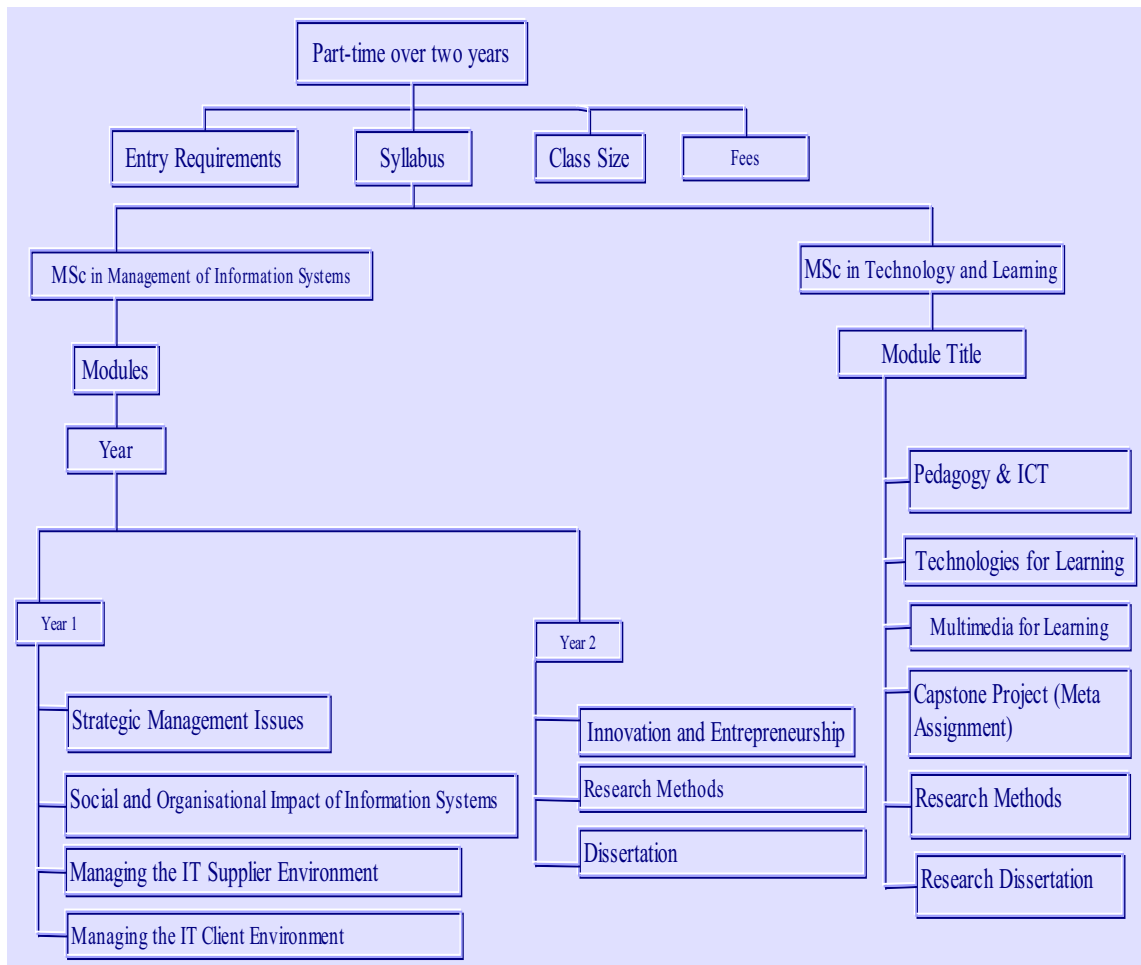
**Figure 14:  Refined Knowledge Model of TCD (c)**

**Concluding Remarks**

The researcher found out that these websites contained huge amount of data which was hidden due to the numerous links created by the website designers. Information from the three institutions; DIT, Trinity College Dublin and Dublin City University was organized different.  For example to obtained information on the module syllabus in Trinity College involved going though so many links and scrawling down once the link was located to find the information.  This involved a lot of time wastage.  For each of these institutions looked at there were different mechanisms needed to navigate though the college websites in order to find information required for comparisons.  These proved that it was

very important to conduct a gap analysis of these programmes. Due to the way information was presented and the huge amount, only 3 out of the eight institutions chosen previously their models were created at this stage.

### 5.3.1 Methodology

Both primary and secondary researches were performed throughout the duration of this project. The secondary research comprised of a literature review of material pertaining to topics of the dissertation. The main sources used to complete the literature review topics included, Third Level Institutional websites, Conference proceedings, Journals Books and White papers

The primary research conducted for this project involved use of the web and websites of institutions, this involved chosing a sample of third level institutes representative of all regions (provinces) of the Island of Ireland (Republic of Ireland and Northern Ireland), targeting the right audiences mainly from current and past students in these institutions, Course Coordinators and Heads of Departments of these Institutions and Conducting a survey in Form of Questionnaire and Collecting feedback of the survey results and analysing these feedbacks. The survey conducted is discussed in section 5.4

### 5.3.2 Constructing the preliminary knowledge model

A complete knowledge model must contain three phases in construction process; namely; identification, specification and refinement.

**Identification:** Information sources that are useful for knowledge modelling are identified. During the identification phase of the knowledge model, the task involved, first identifying which information from the online material collected was to be used in modelling the preliminary knowledge model. The process of identifying this information involved knowledge auditing on this information and then refining this information based on the importance of the content to the

knowledge model identification, for example the information for course syllabus was more important than information on questions asked by prospect students. Since the researcher is a current postgraduate student of DIT institution, DIT was used as a template in this task. The identification phase a preparation phase for the actual knowledge model specification. A lexicon and/or glossary for domain terms are constructed. Existing model components such as generic task models and domain-knowledge schemas are surveyed, and components that could be reused are made available to the project. Based on an elaborate characterization of the application task and domain at hand, a decision is made about the components that will actually be reused.

**Specification:** Construction of a specification of the knowledge model. The specification language is the semi-formal language presented in the previous chapters. The reusable model components selected in the identification stage provide part of the specification. During this process the researcher performed a gap analysis between these predefined parts or sections of the information. Two approaches to knowledge model specification are either starting with the inference knowledge and moving then to related domain and task knowledge, or starting with domain and task knowledge and linking these through inferences. The main approach used in this stage involved starting with the inference knowledge, the researcher had about DIT School of Computing and then moved to related domain and task knowledge of the model being created. The next phase involved:

**Refinement:** During this phase attempts were made to validate the knowledge model as much as possible and to complete the knowledge base by inserting a more or less complete set of knowledge instances. The main technique used for validating the initial specification came out of the previous stage and involved simulation based on some externally provided scenarios. This simulation involved the construction of a small, dedicated prototype. The simulation was used to provide an indication whether the model constructed could generate the problem solving behaviour required. The whole process of knowledge model construction is shown in **Figure 15** below

STAGES

TYPICAL ACTIVITIES

Knowledge Identification

- explore information sources
    (listing of sources, glossary,
      summaries, scenario's)
- list potential components (for reuse)
    (task-related components,
      domain-related components)

Knowledge Specification

- choose task template
    ( provides initial task decomposition )
- construct initial domain conceptualization
    ( main domain information types )
- complete knowledge-model specification
    ( result - full knowledge model except for full domain contents

Knowledge Refinement

- fill contents of domain models
    ( should contain all knowledge required for applications )
- validate knowledge model
    ( paper simulation, prototype of reasoning system )

**Figure 15:  Phases in Knowledge Model Construction**

**Concluding Remarks**

The tasks performed in this section provided the basis for preparing the final knowledge model and gave an insight on what type of information would be used for comparisons of the DIT knowledge model and DIT and other institutions.  Without this task, the success of the final model would have been limited

## *Survey*

In order to construct the knowledge model to support marketing intelligence in DIT, once the initial review of material was complete and the initial models derive, a survey was conducted to test the assumptions in this model and to elicit further information about how the model could be used. The survey targeted audiences who were part of eight different third level institutions representing Ireland. From these results a preliminary knowledge model for DIT for the purpose of marketing intelligence was designed and implemented.

This section will describe the survey and its results.

## *Audiences*

The main audiences targeted by this survey were from three different perspectives; current students of the postgraduate programmes perspective, DIT's undergraduate computer science graduating class perspective and from management perspective targeting only the heads of department and course coordinators. The reason for choosing this group of audience was to get feedback of the survey which would enable the survey to design the knowledge model based on the most appropriate information. The total number of survey respondents was 90 broken down as follows:

- Current Postgraduate Students = 75
- Graduating Class Undergraduate = 3
- Heads of department and Course Coordinators = 12

All the surveys were distributed by email. Email addresses for current computer science postgraduate students were collected from the list of the eight universities which represented third level institutions in Ireland. These email addresses were sorted according to the surveys questions:

- A list of email address for the course coordinators and heads of department

- Another list for the current postgraduate computer science students from the eight institutions
- The last list was for the graduating class of undergraduate computer science class from only Dublin Institute of Technology.

Steps used in distributing the emails, involved; the researcher sending some of the emails to students directly and also writing an email to the colleges involved and requesting the course coordinators or heads of departments to distribute them.

The surveys to heads of departments and course coordinators and current postgraduate students lasted for 11 days (23$^{rd}$ of July to the 2$^{nd}$ of August 2008.). Those of undergraduate computer science students in DIT graduating class were sent very late and have not yet been analyzed because only 3 students have provided a feedback.

## *Survey Design and Questions Asked*

The survey was designed in the form of a questionnaire. A copy of the survey is included in an appendix. It can be found in **Appendix C**. Questionnaires are printed lists of questions used to find out what people think or feel about an issue, product or service. They can be filled in away from the researcher in the form of a self-administered, group-administered or postal questionnaire. The term 'questionnaire' is also often used to describe a set of questions administered face-to-face or by telephone in the form of a structured interview (Oppenheim, 1992). The function of a questionnaire is measurement (Oppenheim, 1992). What a questionnaire measures depends on the issues under investigation, the aims of the study, and the research design (Oppenheim, 1992).

Definition of a questionnaire:

*"Base document for research purposes, providing the questions and structure for an interview or self completion and providing space for respondent's answers".* (Dibb & Simkin 2001*)*

They are closely linked to research in the social sciences and in business and government organizations. Questionnaires are a natural knowledge acquisition. Marshall, Mary G. said *"questionnaires can help you collect information about what people do, what they have, what they think, know, feel or want."* She also classified the types of information as " **Knowledge** which involves what people know, how well they understand something, **Belief**, what people think is true; an opinion, **Attitude**; what people fee about something; a preference and **Behaviour**, what people do; may be a physical/manual or mental behaviour and also **Attributes**, what people are; what people have"

**Structure of the Survey Questions**

A total of 32 different types of questions were asked. There were eight different types of questions asked, namely;

- Multiple Choice ( Only one answer)
- Multiple Choice ( Multiple Answers)
- Rating Scale
- Single Text
- Multiple text boxes
- Comment / Easy
- Matrix of Choices (Multiple Answers)
- Matrix of Choice ( Only One Answer per Row)

The main reason as to why different types of styles were presented was to allow the surveyees respondent with different alternatives to provide the feedback. All the survey questions were presented online and these would enable ease of response. The tool used in presenting these questions was the Survey monkey tool (Mulwa 2008), which provides clear analysis from the feedback of the survey questions.

**Survey to Heads of Departments and Course Coordinators:** The purpose of this survey was to collect information from programme Co-ordinators, which will be used test whether the Knowledge Model of Post Graduate Computer Science Degrees for Dublin Institute of Technology created for the purpose of marketing analysis is correct. The survey was divided into eight sections:

1. Short statement on aim of the survey: This section was supposed to introduce the heads of departments and course coordinators into the survey. It also assured the surveyees that their identities would be kept confidential and that the survey was only for the purpose of completing a master degree. It also let the surveyees know that the deadline for collecting feedback was 2nd of August or shortly there after.

2. Part A: Postgraduate Computer Science Programmes in Ireland: This section introduced the questions on postgraduate computer science in Ireland. The reason for introducing these sections was to collect feedback from the heads of department and the course coordinators on which higher institutions they worked for and their role in those institutions, what postgraduate programmes were offered in their institutions, and what type of audiences they targeted. Also it aimed at obtaining feedback on entry requirements to the programmes offered, how those programmes were offered, areas which were covered and whether there were any exemptions provided.

3. Part B: Marketing Intelligence and Academic Institutions: This section was aimed at achieving in investigating what resources these audiences used in marketing and whether they did any marketing of their programmes, how effective different recruitment mechanisms were and whether they researched what other institutions did. This section would provide a clear view of whether they did any marketing intelligence at all.

4. Part C: Research about Other Institutions: The aim of this section was to find out the usefulness of selected types (web, newspapers, and colleagues) of sources of information were useful to them in the institutions. Also to find out when they were comparing programmes what factors influenced their comparisons. It also aimed at achieving on finding out if a resource that could provide summary information about other higher education institutions was introduced to them, whether they could accept using it.

5. Part D: Knowledge Model: This section introduced questions about the format and delivery mechanism of the knowledge model. It was aimed at achieving in finding out the researcher created the visual map of their programmes, whether it would be useful to them and also factors they would have considered when evaluating such a map. It was a very important section because if they responded negatively, then it meant the visual map would have no impact to them which was critical because the knowledge model was meant for them. Finding out whether they had any interest in receiving information showing gap analysis on their programmes and other programmes was crucial since the purpose of the model was mainly on gap analysis.

6. Part E: Gap Analysis : The gap analysis sections was aimed at finding insights on how they felt on the usefulness for delivering gap analysis and they had any willingness to evaluate a demonstration of a visual map and gap analysis from the researcher. This would enable the surveyor know whether they would be willing to provide an evaluation feedback once the knowledge model was implemented. If the evaluation feedback was positive then this let to success of the model.

7. Email Contacts: Email contacts provided by those who were willing to get a demonstration enabled keep of contact and these emails contacts allowing the researcher to communicate with them when the model was ready for demonstration.

8. Thank you for taking your time to fill in this survey: These were aimed at letting the surveyees know that the researcher really appreciated all the effort and time they took to provide a feedback.

The full survey is included in **Appendix C.**

The survey aimed to investigate whether the heads of department from different third level institutions in their role research what other institutions do and if they do what type of resources they use; To find out whether they make comparisons between courses offered by using Content, Fees, Entry Requirements, Exemptions and Duration or any other means; To evaluate the taught postgraduate programme; information such as a description of programme, identification of professional associations where relevant, Identification of Programme Co-ordinator, Articulation of modular curriculum for each programme, total overall credits for programme and List of modules with details and also entry requirements for students into this programmes; To find out the main sources they use to find this information; To find out if a visual map of the Programme and Gap analysis is provided would it be used by co-ordinators and management; To collect information which will facilitate later evaluation of the knowledge model created as part of this research.

**Survey to Students:** The purpose of this survey was to collect information from current postgraduate students in computer science and DIT's students from computer science undergraduate graduating class, which will be used to create a knowledge model of postgraduate computer science degrees for the purpose of marketing intelligence.

The survey was divided into two sections:

1. Section 0ne; Purpose of the survey: This section was aimed at introducing the postgraduate computer science students into the survey and also assuring them that any information they provided during feedback would be kept confidentiality and be used only for the purpose of completing the masters in computer science. It also let the students know that feedback was required by a particular date to allow the surveyor do an analysis and meet the thesis deadline.

2. Section two; Main questions: This section aimed to achieve insight of the programmes the students were studying, the factors that influenced a students choice of postgraduate programme, what type of programmes they studied, how they felt about the programmes. In general it would provide an overall overview of programmes and the content contained in these programmes. This was important because feedback was from a student perspective and how they felt about the computer science postgraduate programmes which were taught in their institutions. By receiving feedback the surveyor would use this information to structure the body of the knowledge model.

The full list of survey questions can be found in **Appendix C**

## *Student Survey Results and Analysis*

This section introduces the survey results and also provides an analysis of each question asked in the survey; following is a list of all the results from the different surveys:

**Part A: Response Percent by Current Postgraduate Computer Science Students.**

**Q1.**

When asked what programme level each student was studying at, there was a total of 75 responds from the students. The following pie chart with a 3-D visual effect shows the response percent of all the 75: The analysis results are presented in **Table 2**

| Programme Level in Which Each Student is Enrolled | Response Percent (%) | Response Count |
|---|---|---|
| Postgraduate Diploma | 4 | 3 |
| MSc Taught | 68 | 51 |
| MSc Research | 8 | 6 |
| PhD | 20 | 15 |
| Other | 2.7 | 2 |
| | | Total Response Count |

| | | = 75 |
|---|---|---|

**Table 2: Survey Results on Programme Level of Each Student**

These results were presented in a chart format for comparison purposes;

**Response Percent on Programme Level Students Were Studying**
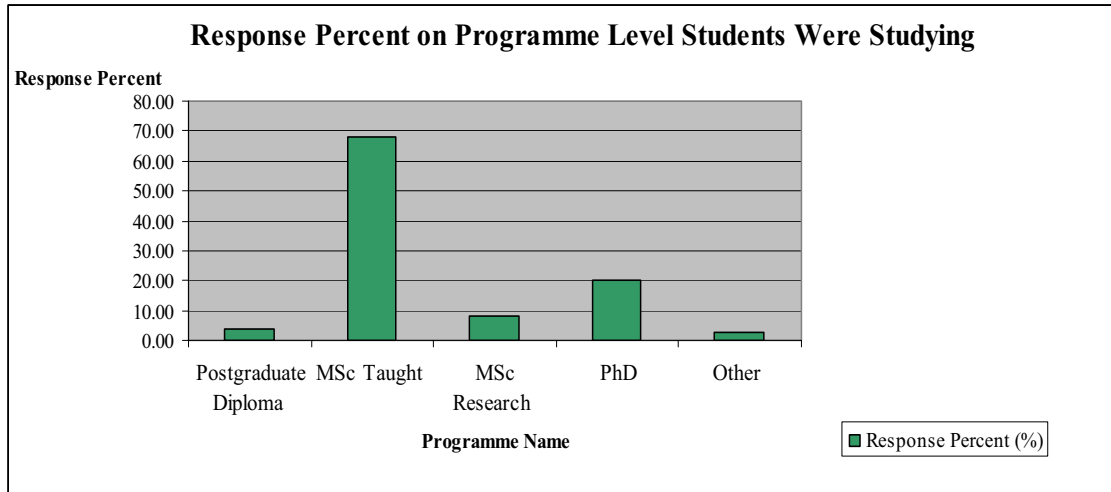


**Figure 16: Response Percent on Programme Level Students Were Studying**

The results showed that the highest percentage response was from students on taught masters. This was very good response from the right audiences because the target was to obtain good response on taught computer science postgraduate programmes.

**Q2.**

This question was aimed at finding out what title of programme the students studied. This was an open question where students filled in the programmes they were enrolled in without being provided with multiple questions. The results below showed they originated from a wide range of programmes. A total of 75 students responded to this question. These results are presented in **Table 3**

| Title | Response Count | Response Percent (%) |
|---|---|---|
| MSc in Health Informatics | 6 | 8.0 |

78

| | | |
|---|---|---|
| MSc Computing (Knowledge Management ) | 21 | 28.0 |
| Networks & Distributed Systems | 4 | 5.3 |
| PhD research - Personalised ELearning | 1 | 1.3 |
| MSc Management of Information Systems | 3 | 4.0 |
| PhD in Computer Science | 2 | 2.7 |
| Computer Science | 5 | 6.7 |
| Computer Science, Doctorate of Philosophy by Research | 1 | 1.3 |
| Interactive Entertainment Technology | 2 | 2.7 |
| comp. graphics | 2 | 2.7 |
| Technology and learning | 4 | 5.3 |
| Human computer interaction | 1 | 1.3 |
| stats, CS | 1 | 1.3 |
| Adaptive Information Systems (Research) | 1 | 1.3 |
| NDS | 1 | 1.3 |
| PHD | 2 | 2.7 |
| Cognitive Science | 1 | 1.3 |
| Software Development | 1 | 1.3 |
| MSc in Interactive Multimedia | 12 | 16 |
| PhD. Machine Learning and Text Classification | 1 | 1.3 |
| Recommendation Technologies for Waste Exchange Services | 1 | 1.3 |
| multimedia systems | 1 | 1.3 |
| Reasoning in time constrained pervasive environments | 1 | 1.3 |

**Table 3: Programme Titles Studied By Each Student**

The results of question 2 above showed that students came from a wide diversity of computer science programmes. This also provided an insight on how broad computer science education in Ireland was. The highest number of students was on students who studied MSc Computing (Knowledge Management).

The figure **17 below** shows the diversity of computer science programmes currently being student by the students
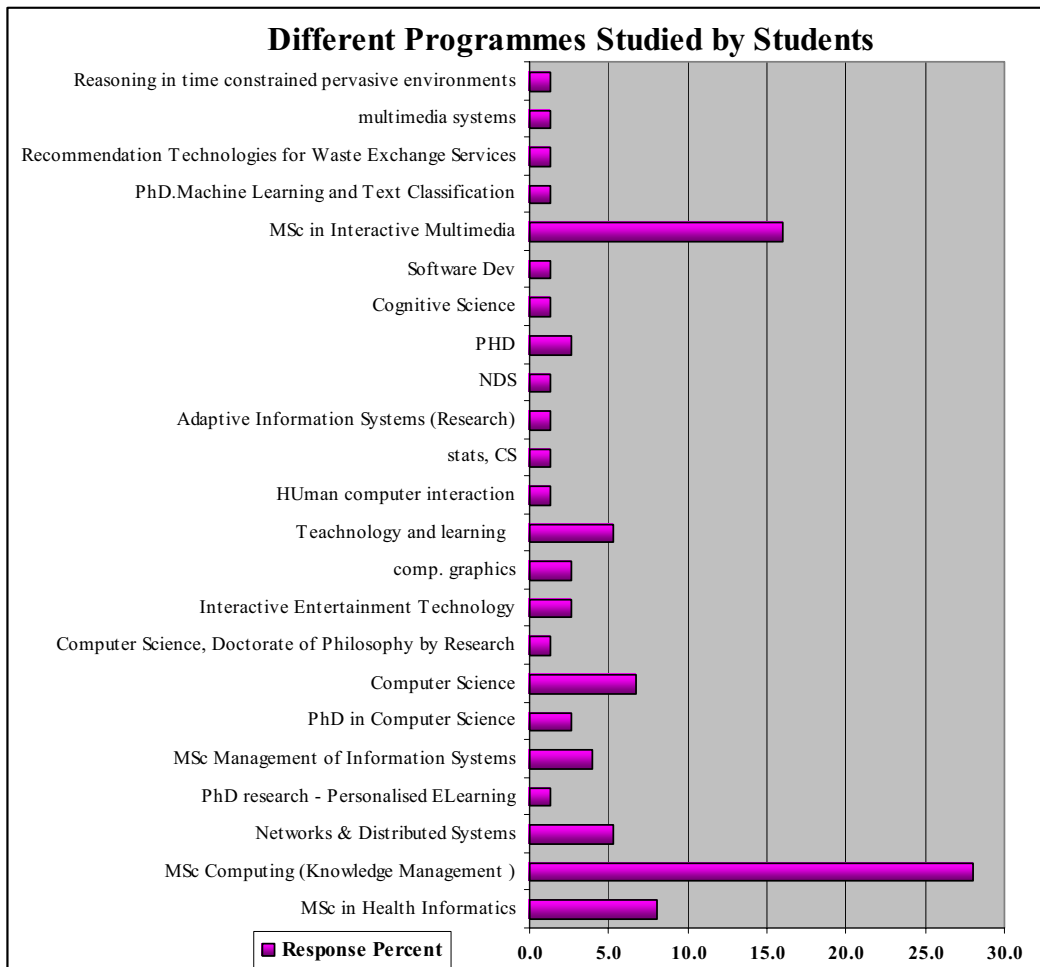
**Figure 17: Diversity of Programmes Studied by Students**

**Remarks**

Computing for Knowledge Management is an are of computer science which is very important in today's market, thus attracting huge number of students.

**Q3**

This question required students to state which third level institutions they were studying at. The feedback came from students from five institutions (DIT, Trinity College Dublin, DCU and UCC and UCD). A total of 75 students responded to this question.

| Third Level Institutions | Response Percent (%) | Response Count |
|---|---|---|
| Dublin Institute of Technology (DIT) | 33.3 | 25 |
| Trinity College (TCD) | 48 | 36 |
| Dublin City University (DCU) | 1.3 | 1 |
| University College Cork (UCC) | 13.3 | 10 |
| University College Dublin (UCD) | 4 | 3 |

**Table 4: Name of Institutions Students Were Studying At.**

The flow chart in **Figure 18** shows this information presented in a graphical format
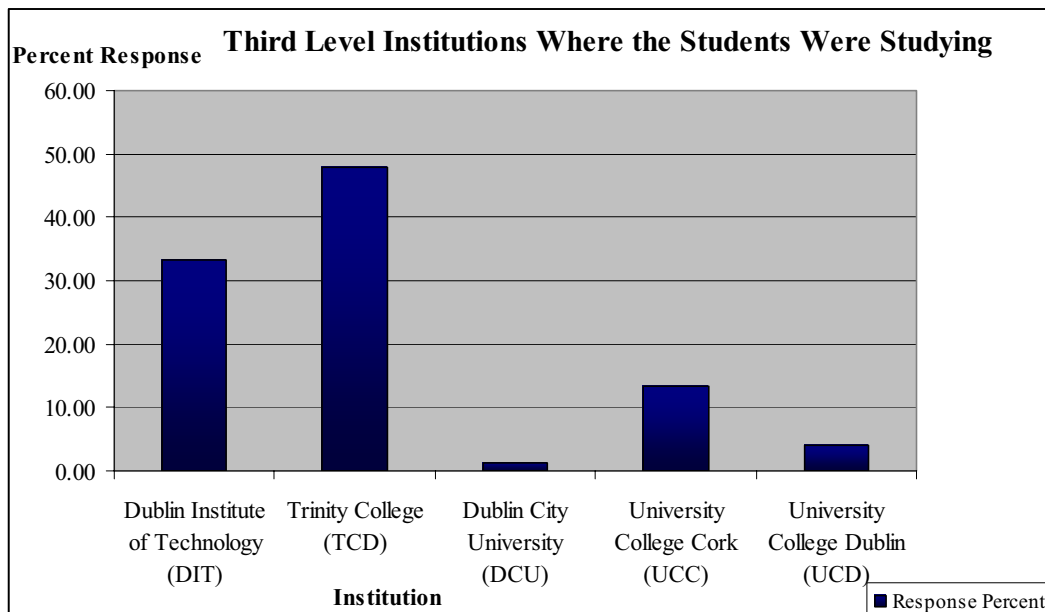


**Figure 18: Third Level Institutions Where the Students Studied**

**Decision**

Based on the percent response of students from these institutions, a Decision to Implement Knowledge Model based on these particular universities was made. From the response, Dublin Institute of Technology and Trinity College responded with a 33.3% and 48% respectively, so the model would contain comparisons starting with two colleges and if time allowed university college cork would be included.

**Q 4**

This question aimed at finding out the mode of study, studied by each student. A total of 72 students responded to these question.

| Mode of Study | Response Percent | Response Count |
|---|---|---|
| Full – Time | 65.3 | 47 |
| Part – Time | 34.7 | 25 |
| | | **Total Response** 72 |

**Table 5:  Mode of Study Studied by each Student**

The graphical represented of the feedback is show in **Figure 19 below**
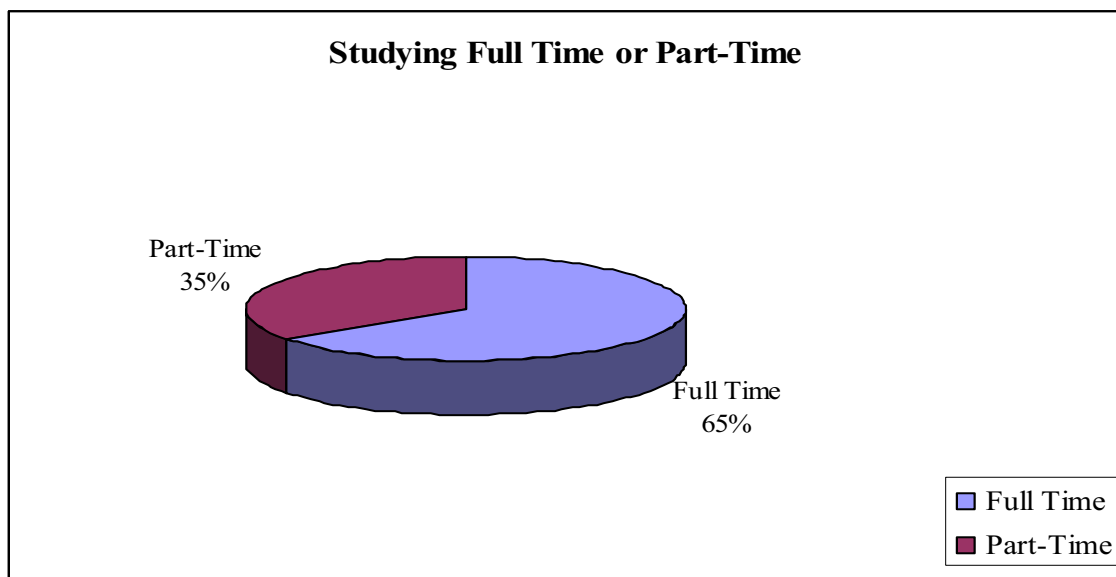


**Figure 19:  Mode of Study Studied by Each Student**

From the results of these responds, the highest of students was students who studied full time.  This showed that marketing intelligence of

**Q5**

Students were asked to rate the rate their influence on choice of postgraduate programme: Table contains their response percent

| | Main Influence Response Percent | Strong Influence | Some Influence | Little/No Influence | Rating Average | Response Count |
|---|---|---|---|---|---|---|
| Gain Qualification in Particular Field | 31.40% | 37.10% | 22.90% | 8.60% | 2.09 | 70 |
| Enhance Knowledge | 45.10% | 52.10% | 1.40% | 1.40% | 1.59 | 71 |
| Interest in subject | 36.60% | 54.90% | 7.00% | 1.40% | 1.73 | 71 |
| Improve Employability | 35.20% | 21.10% | 32.40% | 11.30% | 2.2 | 71 |
| Desire to Change Career Path | 19.70% | 18.30% | 28.20% | 33.80% | 2.77 | 71 |

**Table 6:  Influence to Students on Choice of Programme**

The results are represented graphically for the purpose of comparisons as shown in **Figure 20**
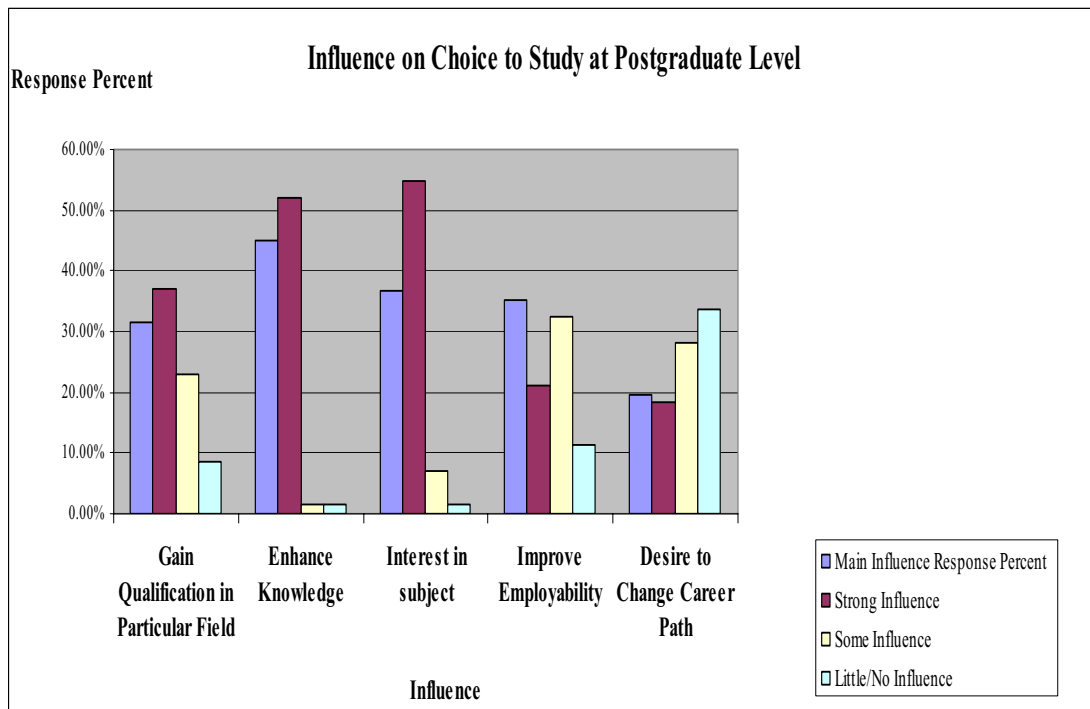
**Figure 20: Students Influence on Choice to Study Postgraduate Programme**

Response from those students who had interest of subject was very good. These showed that the students studied these programmes because they had a strong interest on the subject; 54.90% indicated they had strong interest on the subject. This was followed by many whose interest was in enhancing their knowledge; 52.10% responded.

**Q 6**

The students were asked to rank the reputation of programme, reputation of institution, programme (title, content, cost and duration) in terms of how they influenced their choice of programme to study when they were seeking for admission into the programmes to study. There responds provided a basis for the researcher to use when deciding what information concerning the programmes to be used in knowledge model, for example programme content was the most influential with a 38.8% response that meant it would be included in the final knowledge model being implemented as part of the comparison item. **Table 7 below** contains the response percent of these rankings:

| Rank the following in terms how they influenced your choice of programme of study. | Most Influence | Strong Influence | Some Influence | Little/No Influence | Rating verage | Response Count |
|---|---|---|---|---|---|---|
| Reputation of programme within industry | 14.10% | 28.10% | 28.10% | 29.70% | 2.73 | 64 |
| Reputation of institution | 26.20% | 44.60% | 21.50% | 7.70% | 2.11 | 65 |
| Programme Title | 12.90% | 38.70% | 22.60% | 25.80% | 2.61 | 62 |
| Programme Content | 38.80% | 40.30% | 17.90% | 3.00% | 1.85 | 67 |
| Programme Cost | 8.20% | 24.60% | 27.90% | 39.30% | 2.98 | 61 |
| Programme Duration | 15.20% | 19.70% | 34.80% | 30.30% | 2.8 | 66 |

**Table 7: Ranked by in Terms of how they Influenced students Choice of Programme**

Following is a graphical representation of these results as shown in **Figure 21**
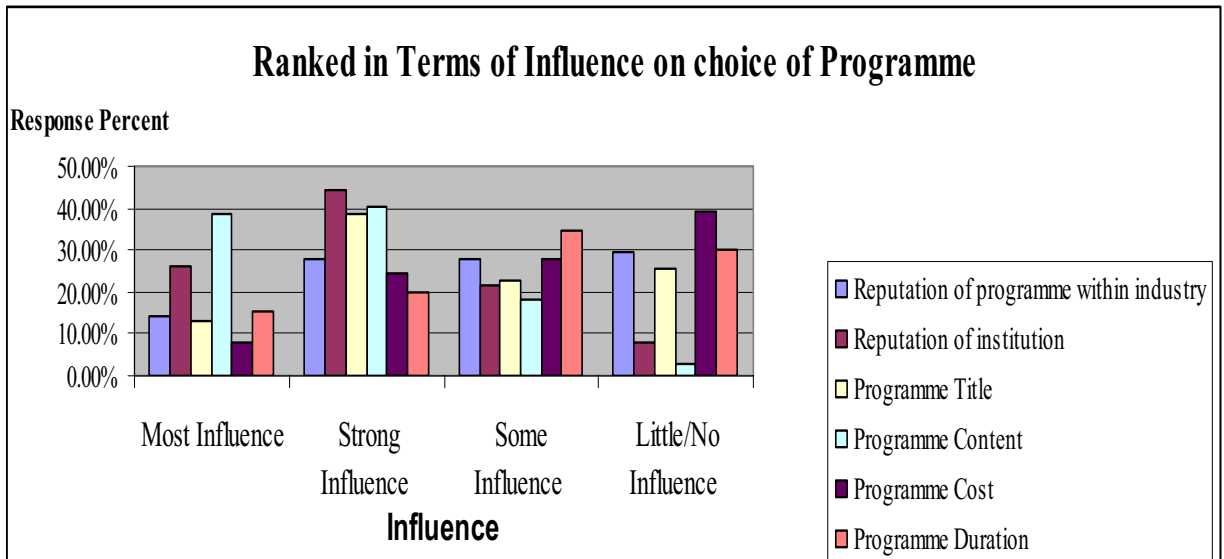
**Figure 21: Ranked in Terms of how they Influenced Students Choice of Programme**

**Concluding Remarks**

There response was very interesting, Reputation of Institution had the highest score of 44.60%, the researcher expected programme content to have highest response but it came in second with a percent response of 40.30%. The programme cost had the highest influence of little or no influence to most students with a response of 39.30%

**Q7**

When asked to rank different sources of information which they used while researching on programmes to study. **Figure 22** below contains the response percents:

| Source of Information | Poor (%) | Average (%) | Good (%) | Very Good (%) | Excellent (%) | Rating Average | Response Count |
|---|---|---|---|---|---|---|---|
| Web | 0.00 | 10.00 | 24.30 | 35.70 | 30.00 | 3.86 | 70 |
| Newspapers | 54.50 | 28.80 | 9.10 | 7.60 | 0.00 | 1.76 | 66 |
| Work Colleagues Employer | 15.70 | 24.30 | 27.10 | 27.10 | 5.70 | 2.83 | 70 |
| Students (Past/Present) | 16.40 | 20.90 | 26.90 | 29.90 | 6.00 | 2.88 | 67 |
| | | | | | | | |

**Figure 22:  Sources of Information used by Students while researching on Programmes to Study**
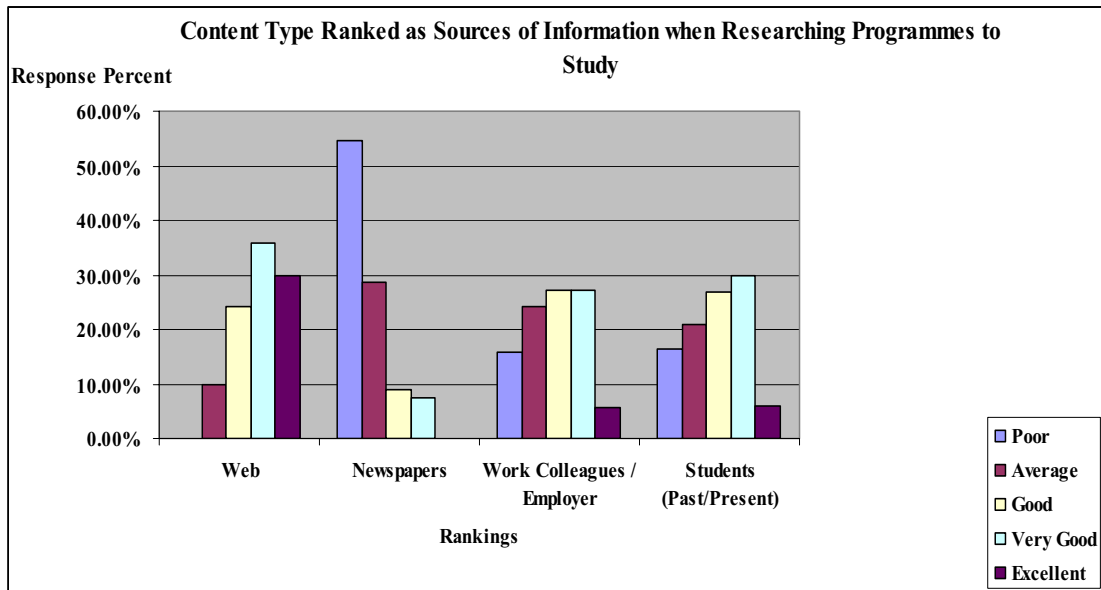
The web was the most excellent source of information the students used. Newspapers had the highest poor rank. From these it showed that the web was the main dominant source of information.

**Justification**

The world wide web played an important role in marketing the academic institutions information. If a visual map was introduced, it would be accepted because the process of retrieving information from the websites involved a lot of work especially if the user did know where that information was located. It would be quick to access the same information if presented in graphical nature and also perform comparisons of programmes offered in different institutions

**Q8**

Rating information provided by their institutions about the programmes they were studying. **Table 23** contains the response percent of these rankings

| Source of Information | Poor (%) | Average (%) | Good (%) | Very Good (%) | Excellent (%) | Rating Average | Response Count |
|---|---|---|---|---|---|---|---|
| Content | 2.80% | 16.70% | 34.70% | 30.60% | 15.30% | 3.39 | 72 |
| Duration | 2.80% | 22.20% | 25.00% | 34.70% | 15.30% | 3.38 | 72 |
| Relevance to industry | 9.90% | 16.90% | 36.60% | 25.40% | 11.30% | 3.11 | 71 |
| Job Opportunities | 15.70% | 24.30% | 41.40% | 14.30% | 4.30% | 2.67 | 70 |
| Award | 9.70% | 19.40% | 31.90% | 30.60% | 8.30% | 3.08 | 72 |

**Figure 23: Rankings provided by Students on Programmes they were Studying**

Figure   contains the graphical representations of these rankings
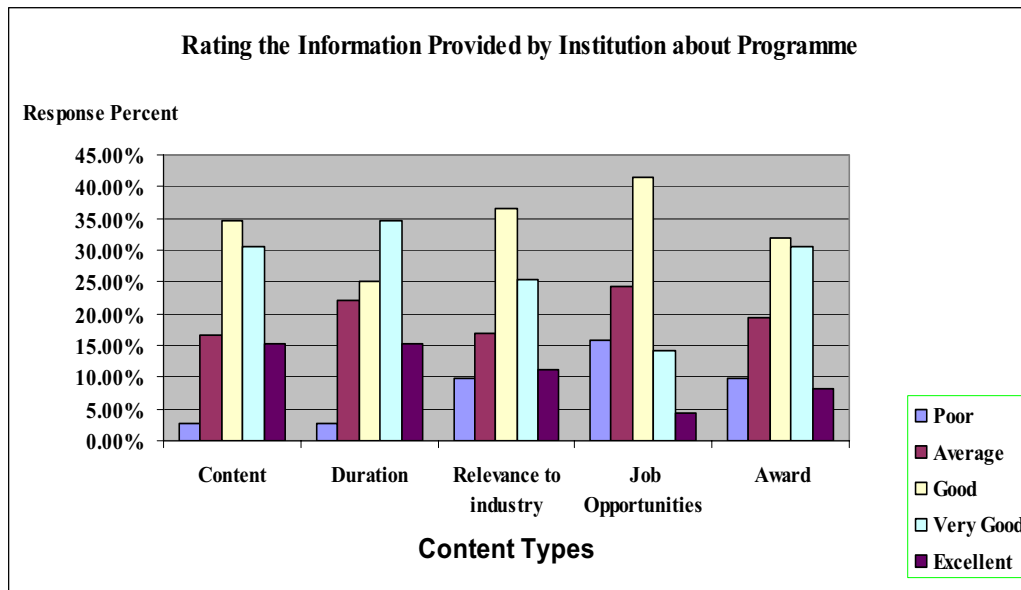
**Figure 24: Rating the Information Provided by Institutions about Programmes**

The results of these feedback showed that content and duration of programmes tied with an excellent mark of 15.30% and that job opportunities had the lowest rank in being excellent at 4.30%.

**Remarks**

By students ranking content and duration as excellent, the researcher made a decision to include these two as part of the comparison criteria. A comment field was available and some of the comments made were very interesting. The purpose of the comment box was to find out how students felt about the whole structure of the programmes they were studying. This would allow the researcher feedback on programmes taught and then try and solve the gap analysis issues. Following is a list of comments from students:

- *Sorry, but I find this question a little ambiguous or confusing.*
- *N/A*
- *It's a new field so connection to industry is a challenge. However, I think this should be pointed out. Debatable to say course produces "industry ready graduates" when no real KM industry.*
- *Content not really provided by institution, but by staff in dept.*
- *it's not really a programme, just a PhD by research, no programme behind it*

- *DIT is quite responsive to changing programmes from current students. After award feedback is quite important. Not enough information was given about the dissertation just before it commenced. The delay is assigning supervisors makes June an unproductive month so that end of May should really see the assigning of supervisor rather than mid June. This assists in the refining of the proposal. Also the dissertation talk needs to be improved. A past student should be the one to advise students for the most part, rather than course co-ordinator in order to orient the students on the importance of following the marking guide sheet, so that students are aware of the time shortness and enormity of the task they are about to undertake. For example, that surveys must be academically appropriately designed and that the onus is not on supervisor but on student to liaise with supervisor for guidance.*

- *Course descriptions are high on rhetoric but vague on detail. Probably written before lectures were finalised.*

- *I am not exaggerating, it's a fact. Please get a list of current/past students and ask them what they are doing. There are loads and loads of PhD who are still waiting to get their PhD finished. Lazy supervisors!*

**Interesting Discovery**

From the comments, some students felt that content was not provided by the institutions. This is important for Knowledge Model because by providing content information in a visual map, a student would know what was contained in each programme in advance. This would also allow the research perform a gap analysis thus the importance of marketing intelligence.

**Q9**

This type of question allowed students to provide their own opinions, on additional information that could be provided about their programmes of study. The comments were wide and varied; following is a list of these comments; these results are presented in **table 8 below**

1) The whole Course Structure of the Modules!
2) Some module should be included to suit the current demand, especially in management and network.
3) Experience of the lecturers.
4) I found the information provided quite comprehensive, but an overview of current research in the area would be interesting.
5) Use of diagrams or flowcharts to outline content, lecture schedule, etc, where assessments will be required, value/percentages of each assessment stage (in context of overall year).
6) A bit more honesty about the actual competence of the organisers.
7) My course was the first year it ran, so bit difficult to offer more info. Perhaps more information with KM in general, but that comes out during the year.
8) Information about the assessment process
9) Feedback from Alumni in terms of applicability of course
10) there was very little information provided by the dept
11) Not a lot. There was a website set up. I was able to get information on all subjects, projects, lecturers and facilities there. I was also able to contact people involved in the course, including the head of the course, and was given immediate responses each time.
12) That it is not necessary to be proficient in IT prior to enrolling.
13) Skill set needed eg web design skills etc
14) Amount of coursework, and previous experience of students as to how this coursework/if the coursework was of relevance to them

posts MSc qualification.

15) More info about assignments

16) None

17) any would be additional

18) it is a PhD. by research so I am not sure if any more information can be provided

19) Tell students that prior programming knowledge would help.

20) Information on the Dissertation, the process, and its importance in the overall award grade.

21) Advertisement had enough.

22) What organisations are doing in relation to knowledge management and how the course would help to advance your career within these organisations?

23) Details in advance of lecture topics.

24) The availability of modules being offered

25) Nothing

26) Industry attached research.

27) Level of skill needed to complete the course. A lot of programming was used in this course and half my class had no prior knowledge of programming.

28) Possibility that elective modules may not be available

29) A more in-depth list of the topics being covered in each module rather than a general description

30) n/a

31) Design

32) Detailed information about the modules

33) Msc knowledge management is a dynamic study relevant to present and future organisational management.

34) None

35) More information about career opportunities

36) hours for attendance, even more detail on content i.e. not just title of course but rather info on actual software and skills you will learn

| | |
|---|---|
| *37)* | Explicit information about the process of getting publications, going to conferences, explicit encouragement of collaborations, outline of what is expected from a thesis, closer supervision of PhD students by the department, explicit detailed and simple information about funding, funding sources, opportunities and availability and duration of funding. |

**Table 8: Opinions from Students on Additional Information for Programmes**

From the feedback on question 9 above, some of their comments had relevance on the knowledge model. Students felt that use of diagram would provide a clear picture of the programme structure e.g. comment number 5 stated *'Use of diagrams or flowcharts to outline content, lecture schedule, etc, where assessments will be required, value/percentages of each assessment stage (in context of overall year).'* This had relevance because the knowledge model being implemented was in form of a visual map.

**Justification**

This justified that if a visual map was build providing information on programme content it would be a very important tool. Also many comments was on information which was provided on the courses was limited. Thus in the researchers opinion, these meant having a visual map which provided information to students meant a lot.

**Q10**

This was an opinion type of question, where surveyees were required to provide their own opinion on what advice they would tell prospective students to encourage them to the program. The list below was comments which were received.

1) flexible, modularized type of study

2) Relevance to present-day life - use of technologies. Applicability of study to teaching profession - awareness of technologies used by primary/post-primary students. Cost of course - possibly one of the cheapest masters in the country from the most reputable 3rd level institution in the country. (Location of Trinity was very important for me - I feel most other colleges are more difficult to get to (i.e. unless you live nearby). P.S. Rem part-time course.

3) The majority of lecturers were excellent and the course is very interesting.

4) It is worthy doing it!

5) To work hard on the assignment, because the exam is just 2 hours...

6) Industrial relevant course.

7) While the course naturally focuses on the areas surrounding KM, the background subjects e.g. Ent. Systems provide a great foundation or refresher for students not directly associated with computer sciences.

8) I would with caveats, it would greatly depend on the person's current experience in their role, I am relatively new to my job, therefore I got a lot out of it, and someone with more experience would get a lot less in my opinion.

9) I would strongly discourage them.

10) Maybe. I'd be very clear that it's a new industry and there is no

direct employment. For non-IT people, I'd tell them it's quite IT-based. And for people already in IT, I would tell them that KM isn't all about "IT" nor is this course.

11) The course content is superb

12) The team-based approach to course work. The real-world experience and life experience of the lecturers

13) its not to difficult, just time consuming

14) pick your supervisor carefully, because a good supervisor makes the work very enjoyable

15) If they had a real interest in getting into the video game industry and are willing to put in a hard years worth of work I would give them strong encouragement.

16) YES

17) The interdisciplinary background of students enhances the learning experience.

18) if you have any interest in using technology in the educational field it will give you a good grasp of what's out there (i.e. best practice etc) and improve your skills this course certainly will be for you

19) If they're looking for a practical course, do it. If they're looking for more theory, don't.

20) learn Dream weaver first

21) study hard and give yourself plenty of time

22) they do good research

23) If they have an interest in multimedia then this course is very interesting. It covers all areas of interactive media.

24) For full time people: If they are non-IT people I would advise them to get the most out of this course. If they are IT people then I would advise them to do a business program instead as this would be more helpful to their career. For part time students doing these modules would be better as evening subjects who are non-IT or IT people. Multi-discipline is better than specialisation as industry changes and flexibility is needed.

25) Research is for those who can dedicate to it.

26) I think the best part of the program was meeting class colleagues and lecturers who come from different backgrounds and have different experiences. - The social networking aspect and the other things you learn. This could probably be applied to any course.

27) Would recommend

28) the course is much more research based as you learn how to write even papers from the start

29) Not to do PhD under lazy guide/ supervisor. Get an active one who finishes one's PhD in 4 to 5 years.

30) Very interesting course and you learn a lot, but you have to have previous knowledge of programming languages.

31) Good all round knowledge so that should be able to design and deliver KM/KB systems.

32) Attend all available extra courses open to post grad students.

33) It is a very interesting Programme, which appears to have a major part in businesses with more attention being given to it daily

34) it was a very enjoyable course, it was a course at the cutting edge of industry, very relevant to industries and how they work

35) If interested in this field, this programme of study will dramatically increase your job opportunities

36) It's interesting

37) A programme well structured and managed by experience lecturers who expose student to latest information and skills necessary in today organisation.

38) Broad range of topics , from technical to theoretical some interesting theory

39) I would tell them the level of teaching in this course is very good.

40) Ask lots of questions of your supervisor and the department head or postgrad head.

41) Yes

**Table 9:  Advice Current Students would tell Prospective Students**

**Justification**

From the feed back on advice to other students, some of the feedbacks were used in evaluating the knowledge model. For example what programmes the course coordinators should consider introducing in the institutions? The researcher discovered insight information which was important for marketing intelligence especially in academic institutions, by marketing their programmes, they would attract more students into these programmes or introduce new programmes in their institutions.

**Q11**

Students were required to List; at most, 3 subjects that you wish had been included in your MSc Programme. Table contains their responses

1) 1. More programming 2. Basic of algorithms 3. more labs v lectures
2) Because of the varied backgrounds people were coming from and taking this into account, there is nothing I would add to this course.
3) Overview of Irish Health Service and how hospitals are run. Health Economics
4) Programming e.g. Java, C++ Information Retrieval Software Engineering e.g. Advanced
5) More SQL .NET
6) Computer networking E-Business Business Management
7) information applicable to Irish industry more field trips centres of excellence
8) Psychology.
9) Not doing MSc.
10) Something around cooperate and invidual motivation in taking on or using a KMS.

11) (1) Worked Methodologies for best practice in IT, such as Prince II, ITIL etc. (2) Planning and Organisation Methods. I haven't got a 3rd, the content was quite good.

12) database applications SQL

13) I'm not doing MSc.

14) Organizational Behaviour Communications Business strategy Change Management

15) nothing left out of my course

16) Project Management People Management element Presentation Skills

17) Networking Artificial Intelligence Ethical Hacking

18) Industry case studies

19) none come to mind

20) HCI

21) n/a

22) 3d Modelling/Animation.

23) GIS

24) A.I, Animation, Graphic design

25) Advanced Data Structure and Algorithms Advanced Operating Systems Game Programming

26) cant think of anything else

27) Educational Theory expanded. Use of Web 2.0 technologies and their impact.

28) Nothing extra l

29) no opinion

30) philosophy of thought

31) Ethics

32) –

33) Industry based programming practices subject.

34) I am happy with the content as it is.

35) You mean in the first part of PhD? some courses would be have been good related to the field of research, e.g. computer graphics, statistics, computer vision

36) na

37) It is a research programme, if I like something relevant I may include it.

38) introductory programming web design multiple os basics

39) Studying for a PhD. I took a course in statistics but additional courses on paper writing and research methodologies would have been useful

40) not doing a msc

41) Semantic Web and Ontology

42) .net

43) Animation and image processing

44) Accounting, Orientation (Use of time, researching for subjects, undertaking industry certifications, dealing with stress and use of facilities on-campus).

45) None

46) Org Culture

47) Dimensional modelling, data reporting, ETL

48) IT Security policies in the workplace. System administrator and IT staff roles within the workplace

49) Machine Learning, More technically oriented modules.

50) KM, Knowledge Representation, Business System Intelligence

51) More Advanced databases

52) Advanced 3D programming

53) Collaboration Management Technology Tools for KM More Business Intelligence

54) Collaboration Management Technology Tools for KM More Business Intelligence

55) Relevant Cognitive Psychology Relevant Sociology

56) Artificial Intelligence Cloud Computing Green Computing

57) Animation. This course was dropped at the start of the year. Introduction to programming would have been very helpful

58) Customer Analytics / Marketing (a very big use for BI).

59) Thesis Writing skills, How to extract the correct information you

need from papers

60) C language, Java, one foreign language

61) Marketing

62) 1. study of an actual knowledge management tool, e.g. CRM, or SharePoint

63) Animation (FULL MODULE)

64) 3D Animation, 2D Animation, Post Production Effects

65) Web2.0 Social Networking

66) Organisational Management studies

67) database design; web application design using frameworks; introduction to programming

68) dedicated data mining module

69) Development for Mobile platforms (the course focused more on telecommunications infrastructure, which I don't think it's that useful in our case)

70) Photoshop, illustrator, after affects for video

71) sdfsd

72) Business, Web Development

**Table 10:  At Most 3 Subjects each Student wished to be included in MSc. Programme**

The response to programmes students wished to be included in the programmes they were studying involved letting the management team of the institutions know that more subjects were required.  These would have impact on the implementation of the knowledge model because for future work more information would have to be added into these models

**Q12**

This was an open minded type of question, it required students to provide information on; if they were given an opportunity to change one thing related to their experience with the MSc program which would have made it more successful or fulfilling, what it would be. Wide varieties of comments were received; Table below contains a list of their opinions

1) Increase number of labs v theory. focus more on practical skills (see similar MSc or post Grad Dip in DIT)

2) Coming for a non-techie background, I was confronted with lots of tech problems with my laptop. It should be made clear to students that help is there.

3) Some of the modules which were very basic should have been optional, depending on the student's background.

4) The months the Dissertation is done. Instead of doing it in the summer to do it.

5) Project should be Industrial connected

6) A student should have project idea from the beginning of the second semester so that all exercises and class works for Research & Methods module could reflect their projects. I think this will be more useful during dissertation, because all the material used during class could also be applied in their dissertation.

7) Through projects make better use of the student's knowledge and experience.

8) Any of the following... (1) I would have liked less self-promotion on the part of the institute. I knew its reputation already. (2) I would have liked far more effective and efficient administration of the course, it was very poor. (Lecture notes were not available in advance, schedules were mixed up, and even one part of an exam paper was not delivered until 30min into the exam!) (3) It is marketed as a taught masters but a significant amount of lecture time was given to workshops. This should be emphasized on the website detailing the course so I as a potential student no in

advance. (I would probably have still done the course )

9) Nothing. You get out what you put in! :)

10) some participants attended very poorly and there was group so poor attendance made it difficult for others

11) More resource to be made available to the administration of the course. As a part-time course it is most important that course work co-ordination and feedback be given promptly.

12) better administration, handouts emailed before the class, not after

13) n/a

14) Not being the first year to be in the program. We were the ones that had to face any of the problems that arose. Other than that, nothing.

15) Don't know yet

16) None

17) cant think f any

18) I would have started my assignments earlier!!

19) Knowing Dream weaver beforehand

20) no opinion

21) Supervision standards would be nice. As it stands now, the experience we have depends a lot on our particular supervisors. Some do a great job; others are not as skilled at that part of their job. Having a clear, written standard of what a supervisor's precise role should be would be nice.

22) You still mean the first part of PhD? some course would have been good, furthermore more invited talks from good researchers and a weekly forum for discussions and talks

23) Getting our supervisors earlier. More information on what is considered appropriate for a master's project.

24) Dissertation, I would have spoke much more with my supervisor about it and would have liked my supervisor to have met up in person. Supervision by email does not have the same impact on the student. It encourages the student to be lazy. At the minimum supervision by phone and email combination at an appointed time

is important if face-to-face is not possible every week. Email Supervision on its own is wholly insufficient.

25) Maybe I would like to work harder on my MSc Project

26) Group projects can be frustrating and difficult for a part-time student

27) To be able to spend more time out of the classroom with students and staff, as you fell they have a lot to offer but just no time or opportunity to do so.

28) Better lecturers

29) The time that masters students are given for the exams are not enough. In order to do well at least 3 hours are enough and not 2 hours like undergraduate students.

30) Reduce the fees

31) I would have liked to have known I needed to know programming languages

32) Easier method of acquiring subject matter from WebCT. Seemed to spend a lot of time downloading, renaming, and organising files!

33) Nothing

34) a few lecturers

35) n/a

36) More choice of modules

37) More emphasis on design

38) Collaboration within the program is poor

39) None

40) A talk from a knowledge management practitioner in industry would have been helpful - I may have missed it though.

41) I would have changed the lectures for Mobile Computing and Flash (semester 1 - Basic)

42) less stress and deadlines, instead more time to learn

43) asfdasdf

**Table 11:  One thing Students Wished to Change on Programmes**

**Justification**

Students felt they would have changed the way modules were being offered, the cost of education in postgraduate programmes, more choice of modules and also the fact that some stated that lecture notes were not presented properly or were missing. This provided the bases of the visual map and proved that these map would have impact on these students since it will provide a clear picture on what was being offered before they started the programmes.

**Part B:    Response Percent from Heads of Department and Course Coordinators of computer science postgraduate programmes**

Part B below introduces the results of the survey to the heads of department and course coordinators.  The results and analysis are divided into five parts, namely:

- Part A: Postgraduate Computer Science Programmes in Ireland Questions
- Part B:  Marketing Intelligence and Academic Institutions Questions
- Part C:  Research about Other Institutions Questions
- Part D:  Knowledge Model Questions
- Part E:  Gap Analysis Questions

**Part A: Postgraduate Computer Science Programmes in Ireland Questions**

**Q1**

The following results represents information on which institutions course coordinators and heads of department worked in.

| Name of Institution | Response Percent (%) | Response Count |
|---|---|---|
| Dublin Institute of Technology (DIT) | 25.00 | 3 |
| Trinity College (TCD) | 16.70 | 2 |
| Letterkenny Institute of Technology (LYIT) | 8.30 | 1 |
| Dublin City University (DCU) | 8.30 | 1 |
| University College Cork (UCC) | 8.30 | 1 |
| University of Limerick (UC) | 8.30 | 1 |
| University of Limerick (UL) | 8.30 | 1 |
| National University of Ireland Galway (NUIG) | 2.29 | 2 |
| Queens University Belfast (QUB) | 8.30 | 1 |
| Other | 0.00 | 0 |

**Table 12: Institutions in which Course Coordinators and Heads of Department Worked**

**Figure 25** in next page contains graphical representation of the response on which institutions the heads of department and course coordinators worked
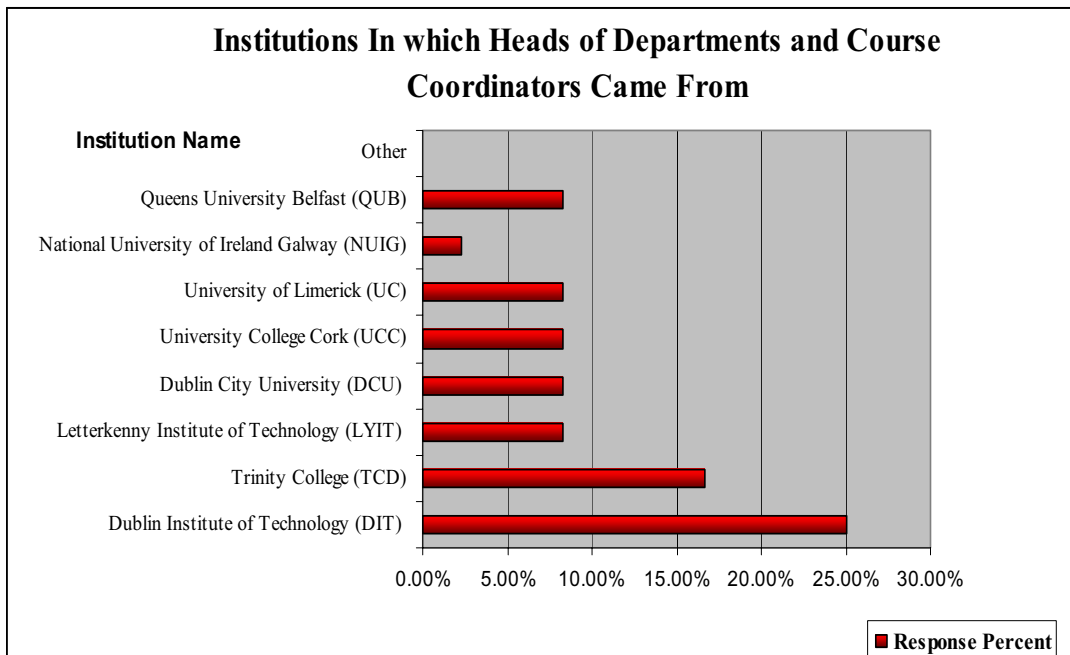
**Figure 25:  Institutions in which Course Coordinators and Heads of Department Worked**

From the results, DIT had very good response and this was important because the Knowledge Model was intended to assist the DIT course coordinators in obtaining information on what other institutions did and also acknowledge the importance of the knowledge model once it was implemented.

**Interesting Observation**

At least one course coordinator from each of the eight institutions chosen during the knowledge audit on postgraduate education in Ireland in chapter 4, responded to the survey.  This was important because it showed they were really interested in information on the knowledge model would contain

**Q2**

This type of question was intended to find out what the role they held in the institutions. A total of 15 respond count was received.

| Institution | Response Percent (%) | Response Count |
|---|---|---|
| Head of school | 6.70 | 1 |
| Head of department | 13.30 | 2 |
| Programme Co-ordinator | 46.70 | 7 |
| Director of Graduate Studies | 6.70 | 1 |
| Lecture | 20.0 | 3 |
| Other (Director of Education) | 6.70 | 1 |

**Table 13: Roles Held by Audiences who responded to the Survey**

Following is a graphical representation of the roles held by audiences who responded to the survey:
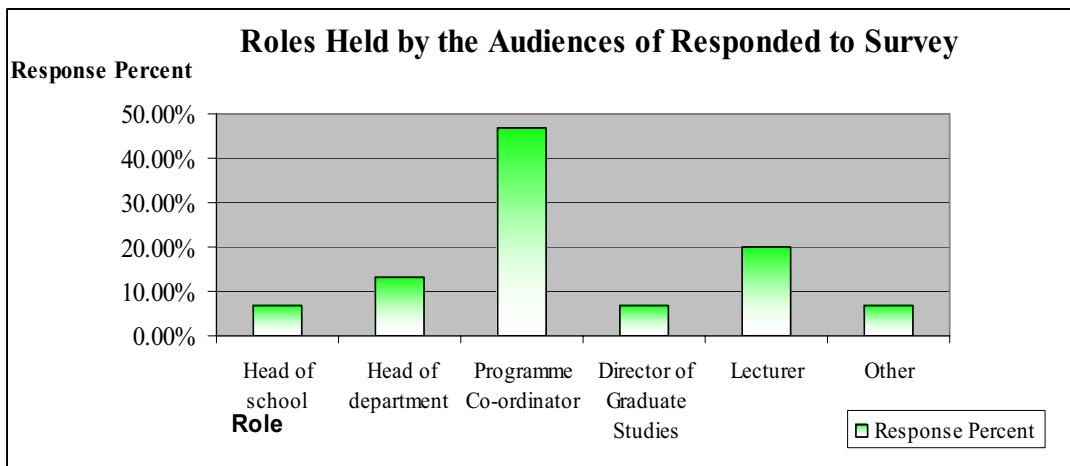


**Figure 26: Roles Held by Audiences who responded to the Survey**

**Interesting Discovery:** Some of them held two roles because the total responses was from 12 heads of department and course coordinators for the overall survey, so some must have held two posts.

**Opinion**

The response was from very senior people in the academic institutions. This was very important because it presented a clear view to the researcher that the visual map once implemented would be accepted.

**Q3**

The results on types of postgraduate programmes in computer science available in different institutions. From the results the taught masters and research masters had the highest responds. This was important because the knowledge model to be implemented would contain information on taught masters, so the right audiences were targeted correctly.

|  | **Response Percent** | **Response Count** |
|---|---|---|
| MSc Taught | 100.00% | 12 |
| MSc Research | 100.00% | 12 |
| Postgraduate Diploma | 83.30% | 10 |
| PhD Professional | 0.00% | 0 |
| PhD Research | 91.70% | 11 |
| Other | 9.09% | 2 |

**Table 14: Types of Postgraduate Computer Science Programmes in Each Institution**

Graphical representation on types of postgraduate computer science programmes in each institution is presented in **Figure 27** below
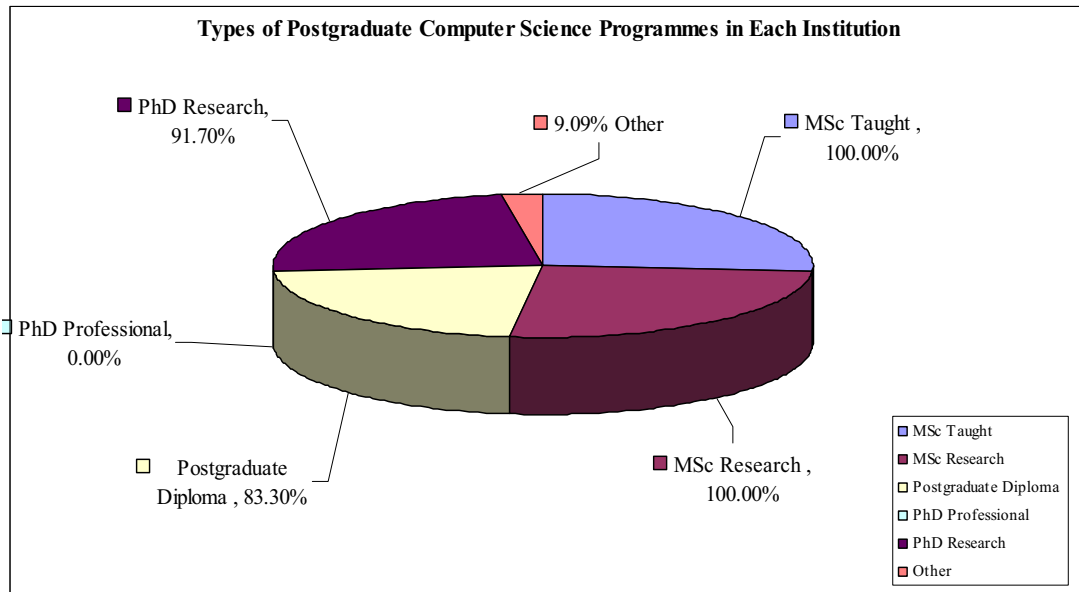
**Figure 27: Types of Postgraduate Computer Science Programmes in Each Institution**

## Concluding Remarks

It was important to target the right audience, for the success of the whole project

## Q4

For each of the following programmes in computer science that you offer, which audiences do you target? This question was aimed at obtaining feedback on types of audiences' target. This was important because the survey proved to have been sent to the right audiences thus correct feedback on the information for building the knowledge model.

**Table 15 below** contains graphical representation of these responds

|  | New Graduates | Mature Students | Those in Employment | Response Count |
|---|---|---|---|---|
| MSc Taught | 100.00% | 75.00% | 91.70% | 12 |
| MSc by Research | 100.00% | 75.00% | 66.70% | 12 |
| Postgraduate Diploma | 100.00% | 77.80% | 77.80% | 9 |
| PhD Professional | 0.00% | 0.00% | 0.00% | 0 |
| PhD Research | 100.00% | 80.00% | 63.60% | 11 |
| Other | 0.00% | 0.00% | 0.00% | 0 |

**Table 15: Audiences Targeted for each of the Programmes offered**
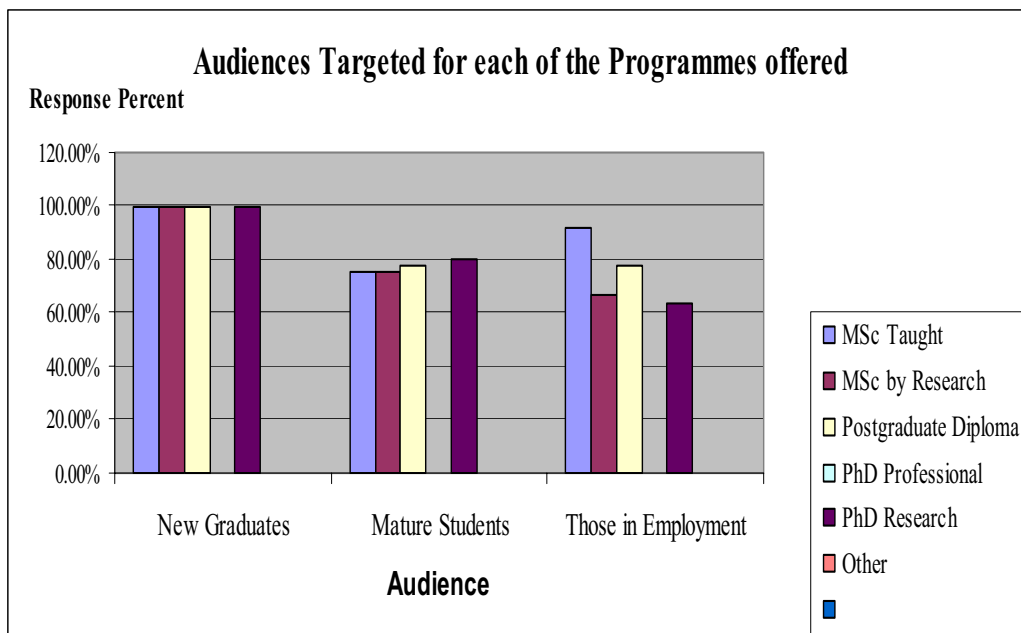
**Q5** For each of the following programmes in computer science that you offer, which is the **MAIN** audience you target? The response to this questions required identification of the main audience required. Results of the responses is provided in figure

| | New Graduates | Mature Students | Those in Employment | N/A | Rating Average | Response Count |
|---|---|---|---|---|---|---|
| MSc Taught | 58.30% | 8.30% | 25.00% | 8.30% | 1.64 | 12 |
| MSc by Research | 91.70% | 0.00% | 0.00% | 8.30% | 1 | 12 |
| Postgraduate Diploma | 50.00% | 10.00% | 30.00% | 10.00% | 1.78 | 10 |
| PhD Professional | 50.00% | 0.00% | 0.00% | 50.00% | 1 | 2 |
| PhD Research | 90.00% | 0.00% | 0.00% | 10.00% | 1 | 10 |

**Table 16: Main Audience Target for Each Programme**

The graphical representation of these results is presented in **Figure 28 below**
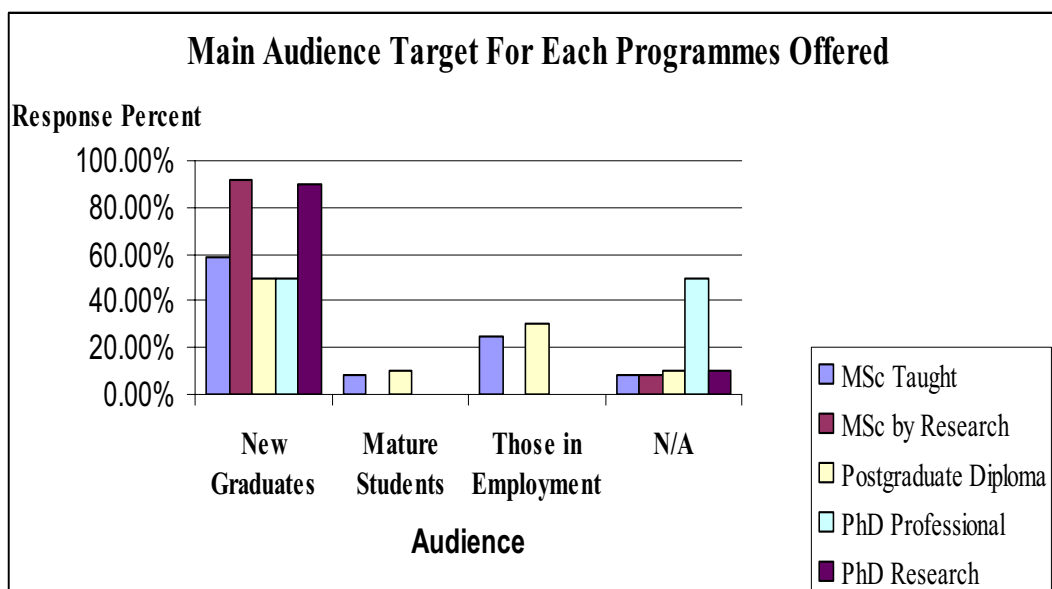


**Figure 28: Main Audience Targeted for each Programme Offered**

**Concluding Remarks:**

New graduates were the main targeted audiences. This proves that marketing intelligence being conducted by the researcher in this thesis plays a very important role because by marketing these programmes more students would be attracted to them and enrol.

**Q6**. For each programme type offered, what is minimum entry requirement? The results of these questions are presented in table below. These was important because one of the criteria for comparison in the final model was looking at different institutions and the minimum entry required into the programmes they offered.

| | First Class Honours (1.1) | Second Class Honours Upper Division (2:1) | Second Class Honours Lower Division (2:2) | Pass | Work Experience in related subject | Response Count |
|---|---|---|---|---|---|---|
| MSc Taught | 0.00% | 16.70% | 83.30% | 0.00% | 8.30% | 12 |
| MSc by Research | 0.00% | 66.70% | 33.30% | 0.00% | 0.00% | 12 |
| Postgraduate Diploma | 0.00% | 10.00% | 50.00% | 30.00% | 20.00% | 10 |
| PhD Professional | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0 |
| PhD Research | 0.00% | 66.70% | 33.30% | 0.00% | 0.00% | 12 |
| Other | | | | | | |

**Table 17: Minimum Entry Requirements for each of Programmes Offered**

A graphical representation of these results is presented in **Figure 29 below**
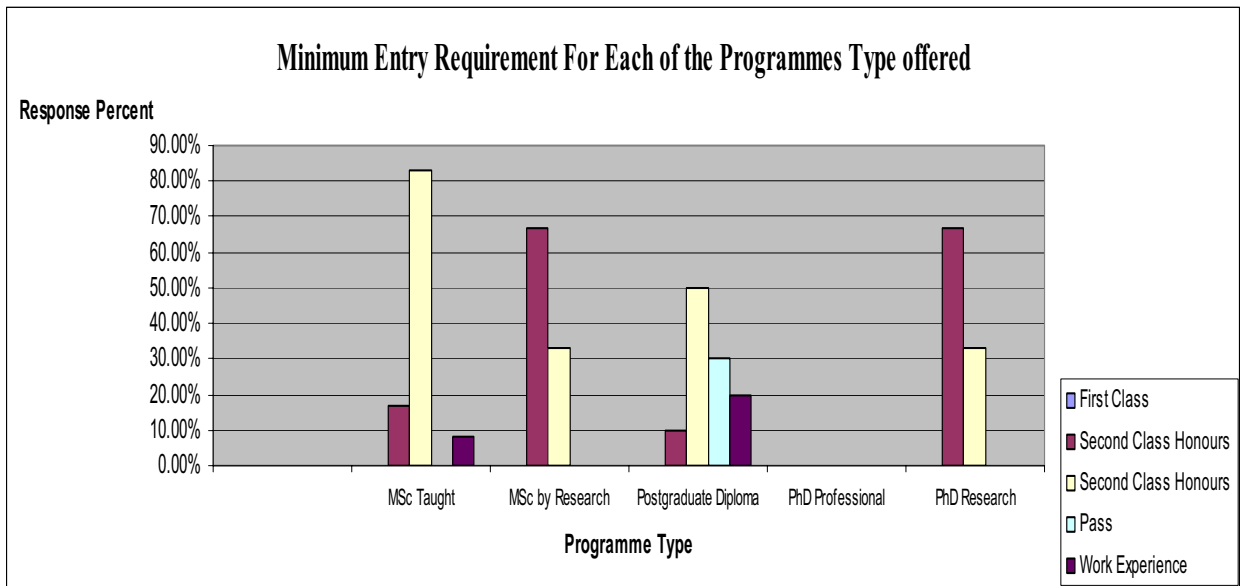
**Figure 29: Minimum Entry Requirement for each of Programme Type Offered**

**Observations**

These showed that minimum entry required of an undergraduate Hons of second class lower division was the highest. That meant that by providing these results in marketing analysis students would work hard to obtain the required grades for entry into these programmes.

**Q. 7** for each of these programmes how they are typically offered?

This question targeted a feedback back on the mode of study available for each of the programmes offered. This information was important to because a comparison criteria on how each of these programmes were offered was to be used in final model.

| | Fulltime | Part-time | Both Fulltime and Part-time | Rating Average | Response Count |
|---|---|---|---|---|---|
| MSc Taught | 33.30% | 0.00% | 66.70% | 2.33 | 12 |
| MSc by Research | 50.00% | 0.00% | 50.00% | 2 | 12 |
| Postgraduate Diploma | 44.40% | 0.00% | 55.60% | 2.11 | 9 |
| PhD Professional | 0.00% | 0.00% | 0.00% | 0 | 0 |
| PhD Research | 41.70% | 0.00% | 58.30% | 2.17 | 12 |

**Table 18: Results on how each of the Programmes are Offered**

Following is a graphical representation on how each of the programmes are offered, **Figure 30 below** contains the results
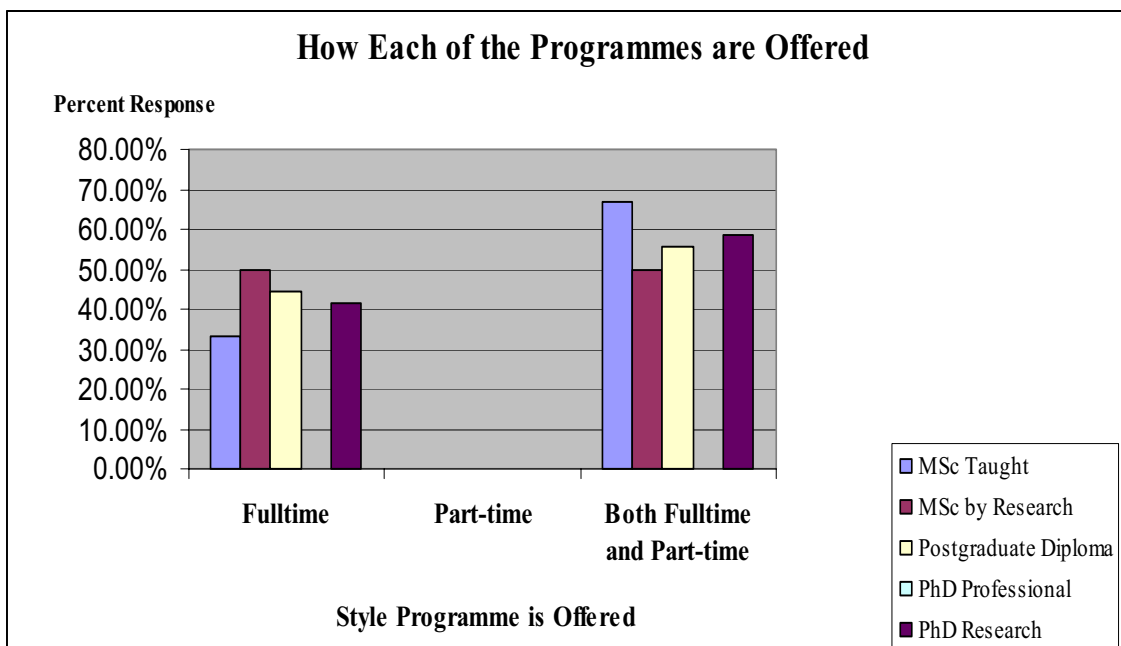


**Figure 30: How each of the Programmes are Offered**

**Q 8**

This question required the course coordinators and heads of department to indicate areas covered for each of the programmes they offered

| | Distributed Systems | Health Care | Information Technology | Knowledge Management | Multimedia |
|---|---|---|---|---|---|
| | | | | | |
| MSc Taught | 41.7 | 16.70% | 75.00% | 41.70% | 58.30% |
| MSc by Research | 90.9 | 36.40% | 72.70% | 45.50% | 63.60% |
| Postgraduate Diploma | 22.2 | 22.20% | 77.80% | 33.30% | 0.00% |
| PhD Professional | 0 | 0.00% | 0.00% | 0.00% | 63.60% |
| PhD Research | 81.8 | 45.50% | 72.70% | 63.60% | 60.00% |

| Security | Software Engineering | Ubiquitous Computing | Other | Response |
|---|---|---|---|---|
| | | | | |
| 33.30% | 33.30% | 33.30% | 33.30% | 12 |
| 63.60% | 63.60% | 45.50% | 27.30% | 11 |
| 22.20% | 22.20% | 11.10% | 22.20% | 9 |
| 0.00% | 0.00% | 0.00% | 0.00% | 0 |
| 54.50% | 54.50% | 63.60% | 36.40% | 11 |

**Table 19:  Areas covered for each Type of Programme Offered**

A graphical representation of these results is provided in **figure 31** below
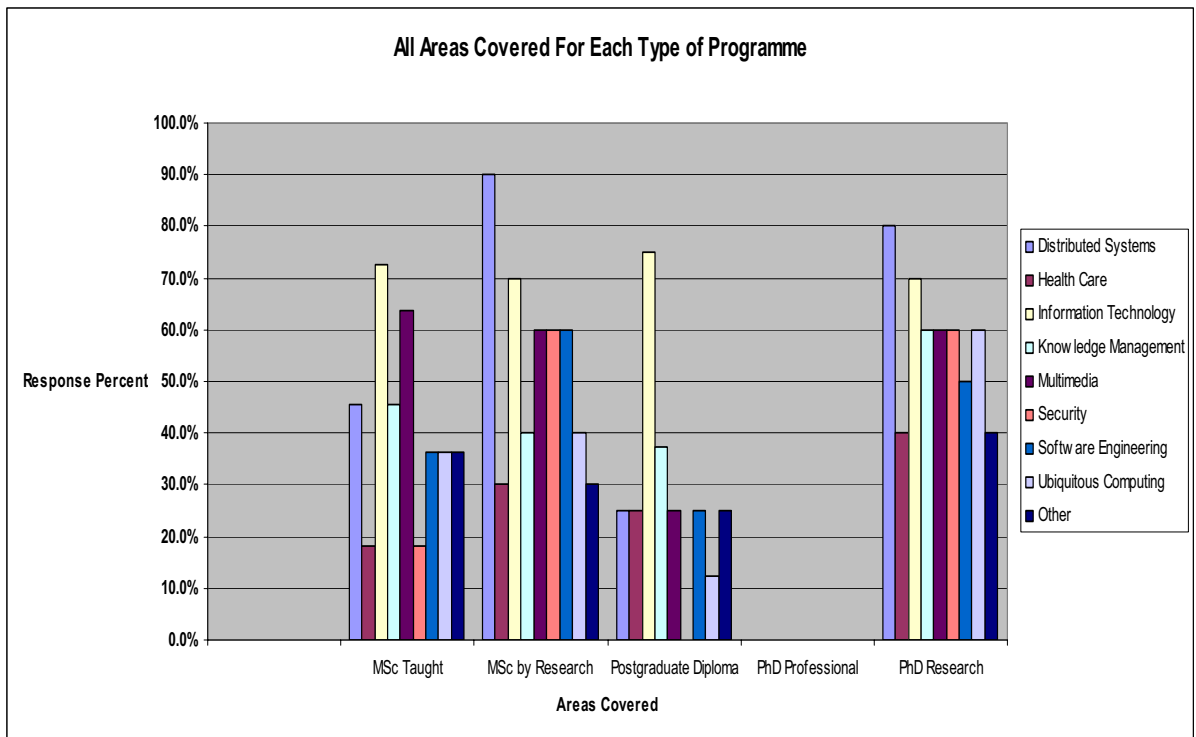


**Figure 31:  Areas covered by Each Type of Programme Offered**

The results of their responds on areas covered provided an overview of which were the main areas covered. This was important to the knowledge model because the course content was one of the comparisons criteria being used for evaluation of comparisons between course contents and areas they covered.

**Q9**

On your taught programmes do you offer any exemptions from modules? The results showed that majority responded with a no. Due to these responses it was decided to include this information in the final model on whether they were any exemptions, during comparisons this would be used to investigate which institutions offered exemptions.

|  | Response Percent | Response Count |
|---|---|---|
| **Yes** | 16.70% | 2 |
| **No** | 83.30% | 10 |
| **N/A** | 0.00% | 0 |
|  |  |  |

**Table 20: Response Percent to Whether Exemptions were offered on Taught Programmes**

Graphical representation of this information is provided in **figure 32** below
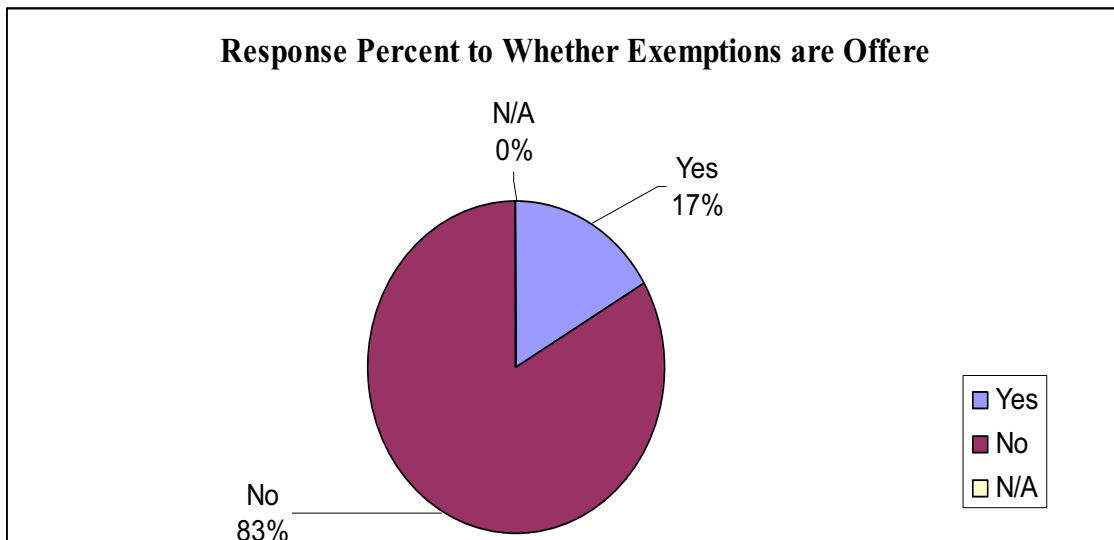
**Figure 32:  Response Percent to Whether Exemptions were offered on Taught Programmes**

**Part B:  Marketing Intelligence and Academic Institutions Questions**

**Q1**

**Which of these resources do you use in marketing your programmes?**

| Resources | 1st | 2nd | 3rd | 4th | 5th |
|---|---|---|---|---|---|
| Web | 75.00% | 8.30% | 16.70% | 0.00% | 0.00% |
| Newspaper | 0.00% | 50.00% | 16.70% | 25.00% | 8.30% |
| Recruitment Fairs | 10.00% | 30.00% | 30.00% | 20.00% | 10.00% |
| Other Students | 0.00% | 18.20% | 27.30% | 36.40% | 18.20% |
| Relationships with Industry | 9.10% | 0.00% | 18.20% | 18.20% | 54.50% |

| Rating Average | Response Count |
|---|---|
| 1.42 | 12 |
| 2.92 | 12 |
| 2.9 | 10 |
| 3.55 | 11 |
| 4.09 | 11 |

**Table 21: Resources Used in Marketing the Products**

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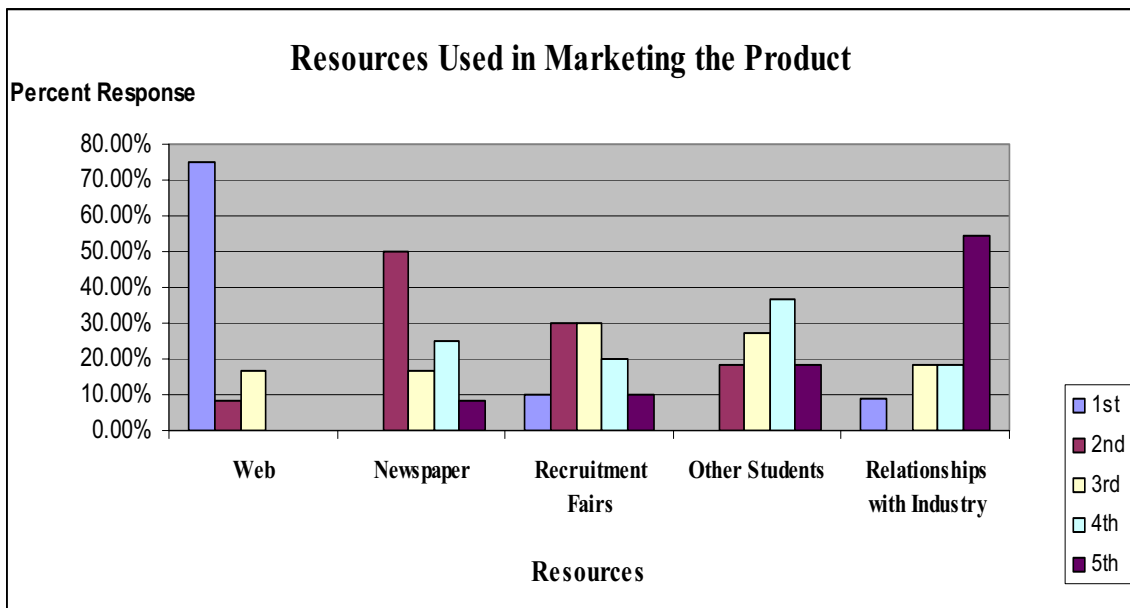
**Figure 33 : Resources Used in Marketing the Products**

**Q2**

**Please rank each of the following in terms of their effectiveness as a recruitment mechanism.**

| Resources | Most Effective | Effective | Poor | N/A | Rating Average | Response Count |
|---|---|---|---|---|---|---|
| Web | 72.70% | 0.00% | 9.10% | 18.20% | 1.22 | 11 |
| Newspaper | 9.10% | 54.50% | 27.30% | 9.10% | 2.2 | 11 |
| Recruitment Fairs | 0.00% | 40.00% | 30.30% | 30.00% | 2.43 | 10 |
| Other Students | 30.00% | 50.00% | 10.00% | 10.00% | 1.78 | 10 |
| Relationships with Industry | 0.00% | 60.00% | 30.00% | 10.00% | 2.33 | 10 |

**Table 22:  Ranked in Terms of their Effectiveness as a Recruitment Mechanism**
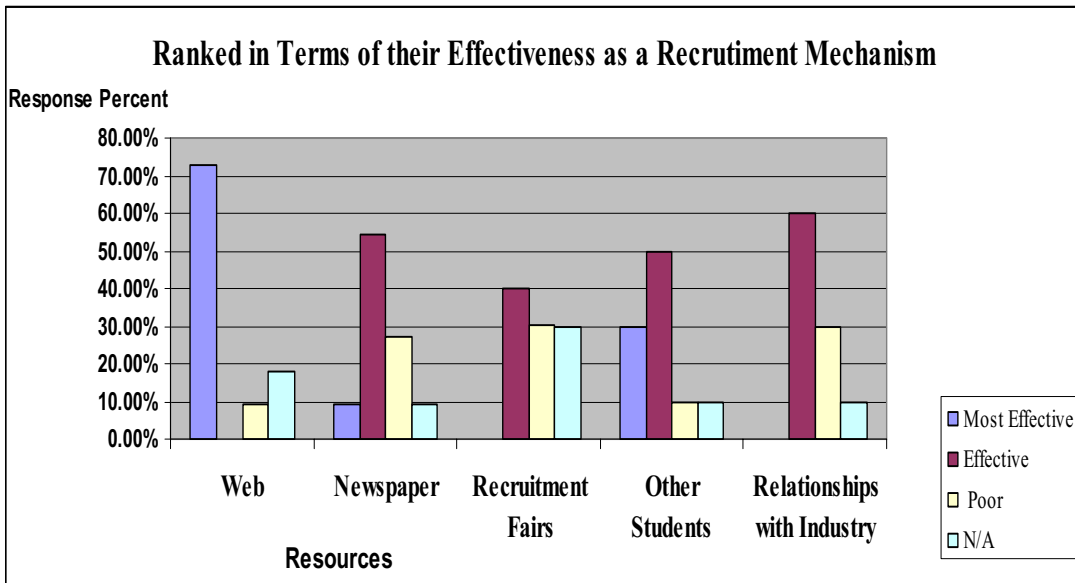
**Figure 34: Ranked in Terms of their Effectiveness as a Recruitment Mechanism**


**Q 3**

**Do you, in your role, research what other institutions do?**

|  | **Response Percent** | **Response Count** |
|---|---|---|
| Yes | 50.00% | 6 |
| No | 50.00% | 6 |

**Table 23: Response on Whether Course Coordinators and Heads of Dept. Research what other institutions do**
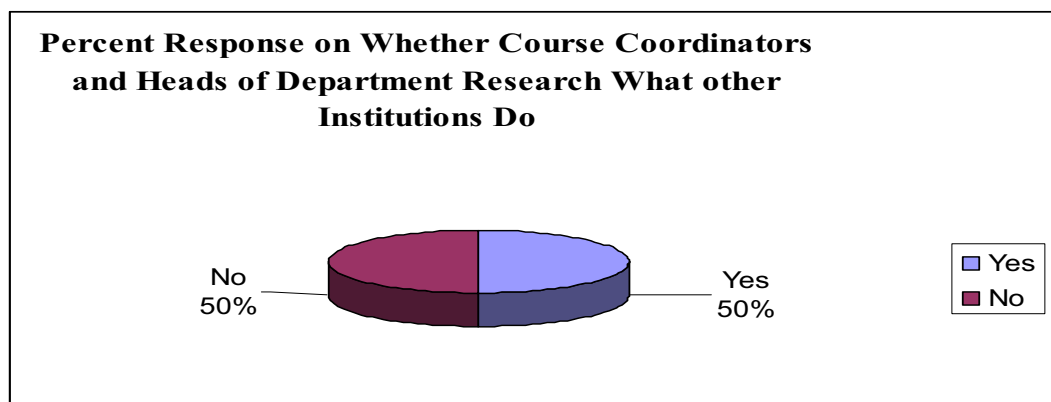


**Figure 35: Response on Whether Course Coordinators and Heads of Dept. Research what other institutions do**

**Part C:  Research about Other Institutions Questions**

**Q1**

**For each of the following please indicate their usefulness to you as a source of information on programmes in other institutions?**

| Resources | Most Useful | Sometimes Useful | Occasionally Useful | Never Useful |
|---|---|---|---|---|
| Web | 66.70% | 33.30% | 0.00% | 0.00% |
| Newspapers | 16.70% | 33.30% | 50.00% | 0.00% |
| Colleagues | 16.70% | 83.30% | 0.00% | 0.00% |
| Recruitment Fairs | 0.00% | 60.00% | 20.00% | 20.00% |
| Students (Past/Present) | 0.00% | 66.70% | 33.30% | 0.00% |
| Interaction with Industry | 0.00% | 66.70% | 16.70% | 16.70% |

| Rating Average | Response Count |
|---|---|
| 1.33 | 6 |
| 2.33 | 6 |
| 1.83 | 6 |
| 2.6 | 5 |
| 2.33 | 6 |
| 2.5 | 6 |

**Table 24:  Usefulness of the Resources as a Source of Information on Programmes in Other Institutions**
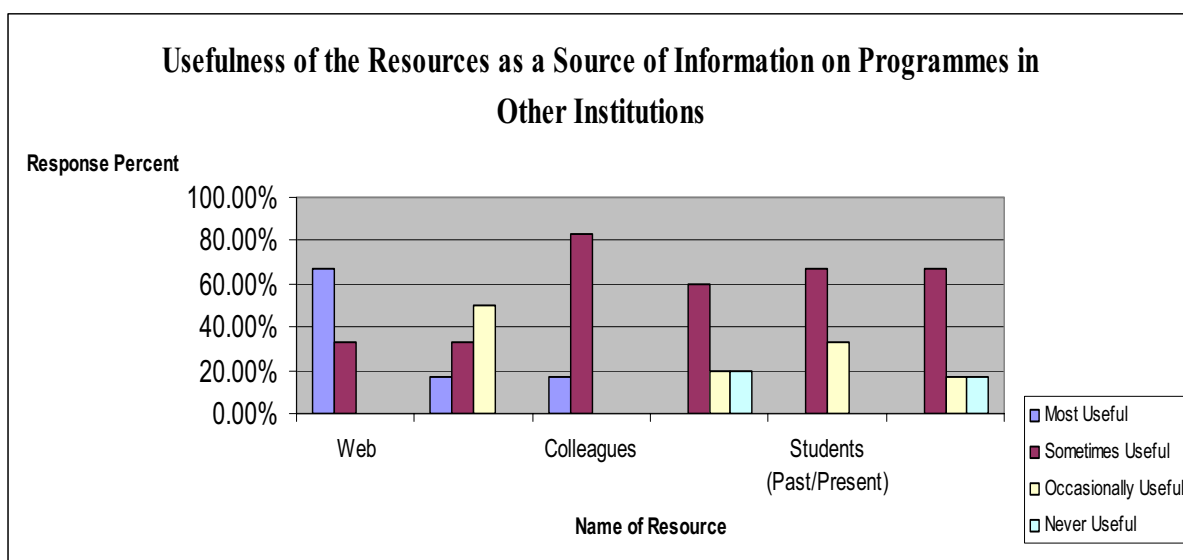
**Figure 36:  Usefulness of the Resources as a Source of Information on Programmes in Other Institutions**

**Q2**

**When comparing programmes in your institutions, what factors influence the comparison?**

|  | **Strongly Influences** | **Some Influence** | **Little/No Influence** | **N/A** |
|---|---|---|---|---|
| Content | 66.70% | 33.30% | 0.00% | 0.00% |
| Fees | 16.70% | 33.30% | 50.00% | 0.00% |
| Entry Requirements | 0.00% | 50.00% | 50.00% | 0.00% |
| Exemptions | 0.00% | 0.00% | 83.30% | 16.70% |
| Duration | 16.70% | 83.30% | 0.00% | 0.00% |
| Industry sponsorship | 0.00% | 16.70% | 66.70% | 16.70% |
|  |  |  |  |  |

| **Rating Average** | **Response Count** |
|---|---|
| 1.33 | 6 |
| 2.33 | 6 |
| 2.5 | 6 |
| 3 | 6 |
| 1.83 | 6 |
| 2.8 | 6 |
|  |  |

**Table 25:  Factors that influence Comparisons when Comparing Programmes in Institutions**

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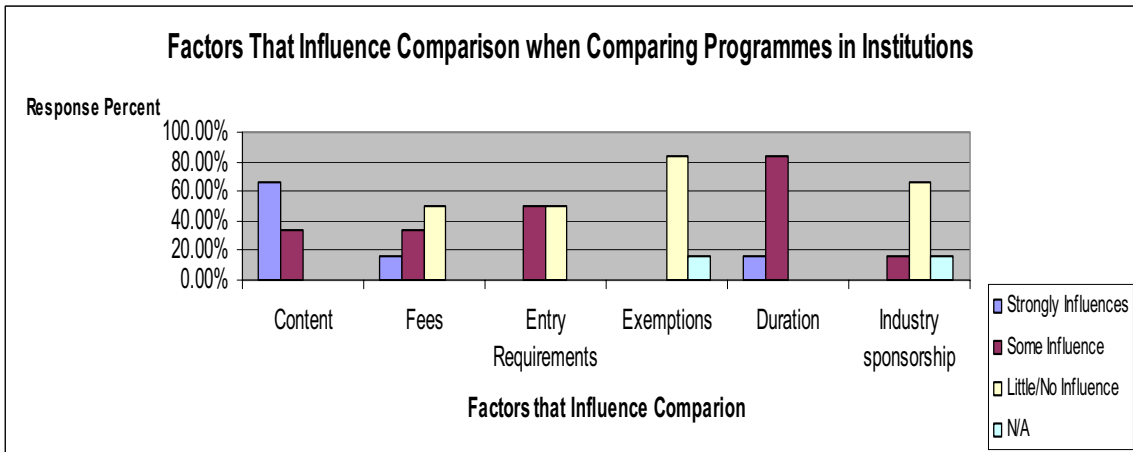
**Figure 37: Factors that influence Comparisons when Comparing Programmes in Institutions**

**Q3**

**Would you use a resource that could provide summary information about other higher education institutions programmes and notify you of changes?**

|  | **Response Percent** | **Response Count** |
|---|---|---|
| Yes | 100.00% | **6** |
| No | 0.00% | 0 |
|  |  |  |

**Table 26: Response on whether they would use a resource that would provide a summary about other institutions**

**Response Percent on Whether the Heads of Department and Course Coordinators would use a Resource that would provide a Summary Information about other Higher Education Institutions Programme**

0%

100%

Yes
No
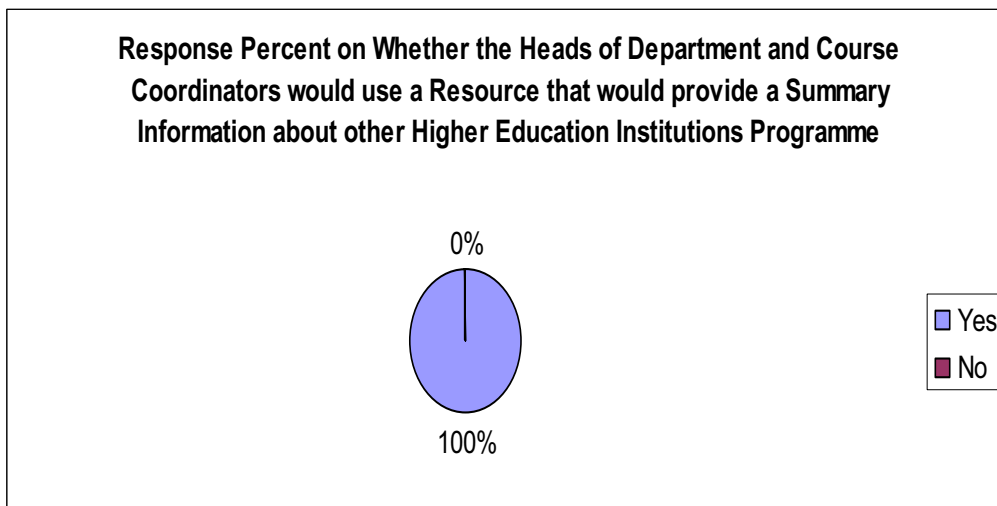
**Figure 38: Response on whether they would use a resource that would provide a summary about other institutions**

## Part D: Knowledge Model Questions

1. **Would a visual map of your programme showing structure, content, duration, cost etc are useful?**

|  | Response Percent | Response Count |
|---|---|---|
| Yes | 81.80% | 9 |
| No | 18.20% | 2 |

**Table 27: Response on whether a visual map would be useful**
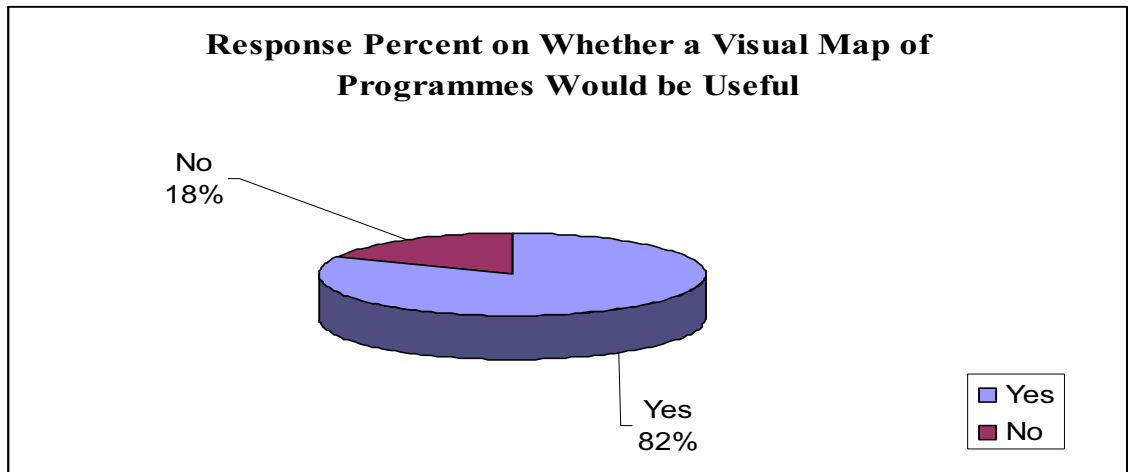
**Figure 39: Response on whether a visual map would be useful**


**Q2**

**What factors would you consider when evaluating such a map?**

| Factors | Very Important | Importa | Little/No Importance | Rating Average | Response Count |
|---|---|---|---|---|---|
| Nature and content of information | 63.60% | 18.20% | 18.20% | 1.55 | 11 |
| Ease of use | 45.50% | 45.50% | 9.10% | 1.63 | 11 |
| Ability to perform information Query | 20.00% | 70.00% | 10.00% | 1.9 | 10 |
| Ability to perform simple updates | 20.00% | 70.00% | 10.00% | 1.9 | 10 |
| Automatic updates to map | 40.00% | 40.00% | 20.00% | 1.8 | 10 |

**Table 28 : Factors considered when Evaluating the Map**
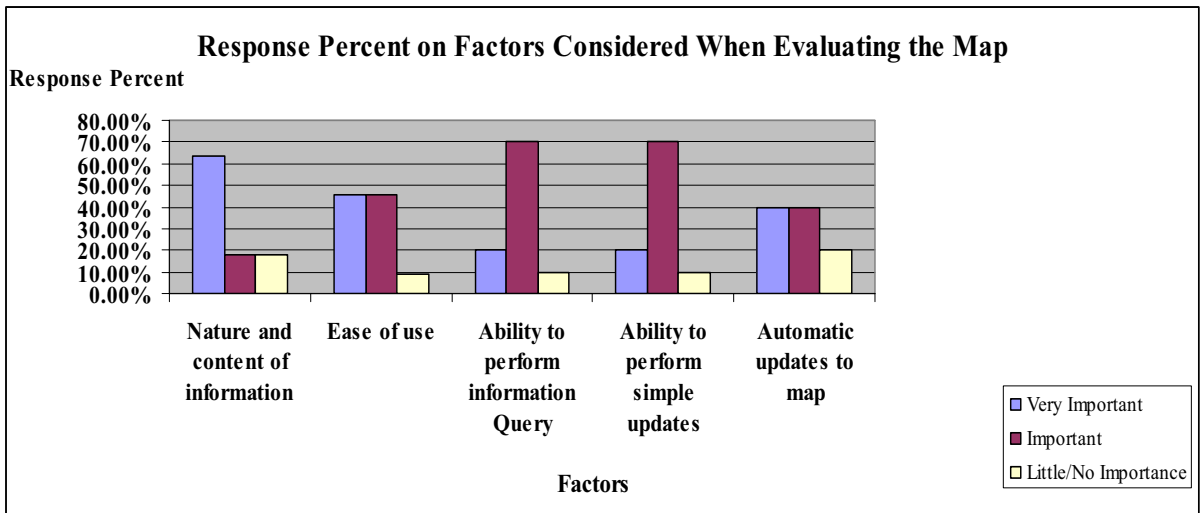
**Table 29: Factors considered when evaluating the Map**


**Q 3**

**Would you be interested in receiving information showing gap analysis between your programme and other programmes?**

|  | Response Percent | Response Count |
|---|---|---|
| Yes | 63.60% | 7 |
| No | 36.40% | 4 |

**Table 30: Receiving Information on Gap Analysis between Programmes**
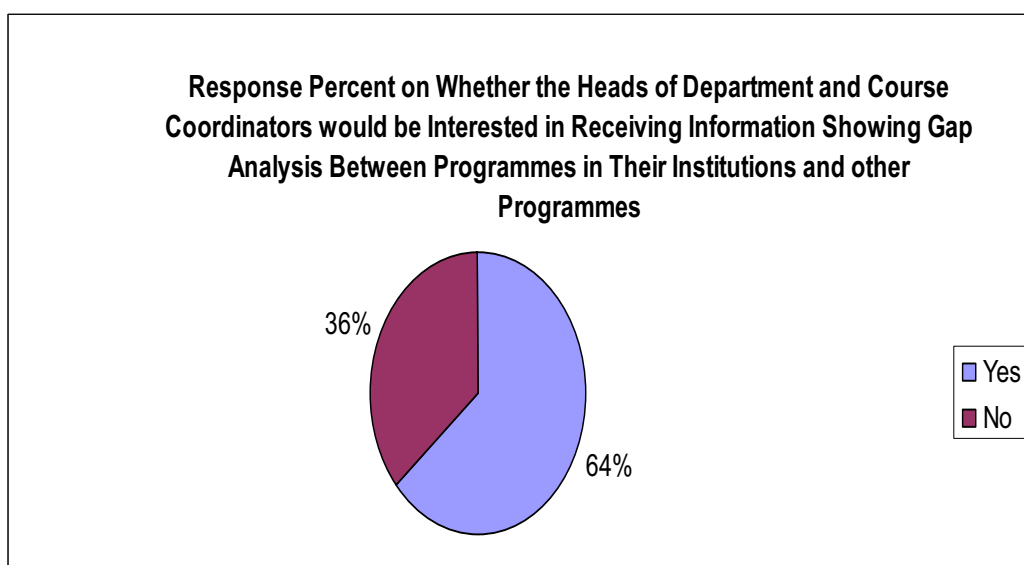


**Figure 40: Receiving Information on Gap Analysis between Programmes**

**Part E: Gap Analysis Questions**

**Q1**

**Please rank the usefulness of the following mechanisms for delivering gap analysis information?**

| | Very Useful | Useful | Not Sure | Not At All Useful |
|---|---|---|---|---|
| Email Digest | 42.90% | 57.10% | 0.00% | 0.00% |
| Pod Adcasts / IP Web Ad casts | 0.00% | 0.00% | 28.60% | 71.40% |
| Digital TV course ads | 0.00% | 0.00% | 42.90% | 57.10% |
| Websites | 57.10% | 28.60% | 14.30% | 0.00% |
| Moodle Ads | 0.00% | 14.30% | 14.30% | 71.40% |
| RSS Feeds | 28.60% | 14.30% | 14.30% | 42.90% |
| Education Blogs | 0.00% | 14.30% | 28.60% | 57.10% |

| Average Rating | Response Count |
|---|---|
| 1.57 | 8 |
| 3.71 | 8 |
| 3.57 | 8 |
| 1.57 | 8 |
| 3.57 | 8 |
| 2.71 | 8 |
| 3.43 | 8 |

**Table 31: Mechanisms for Delivering Gap Analysis ranked on Usefulness**
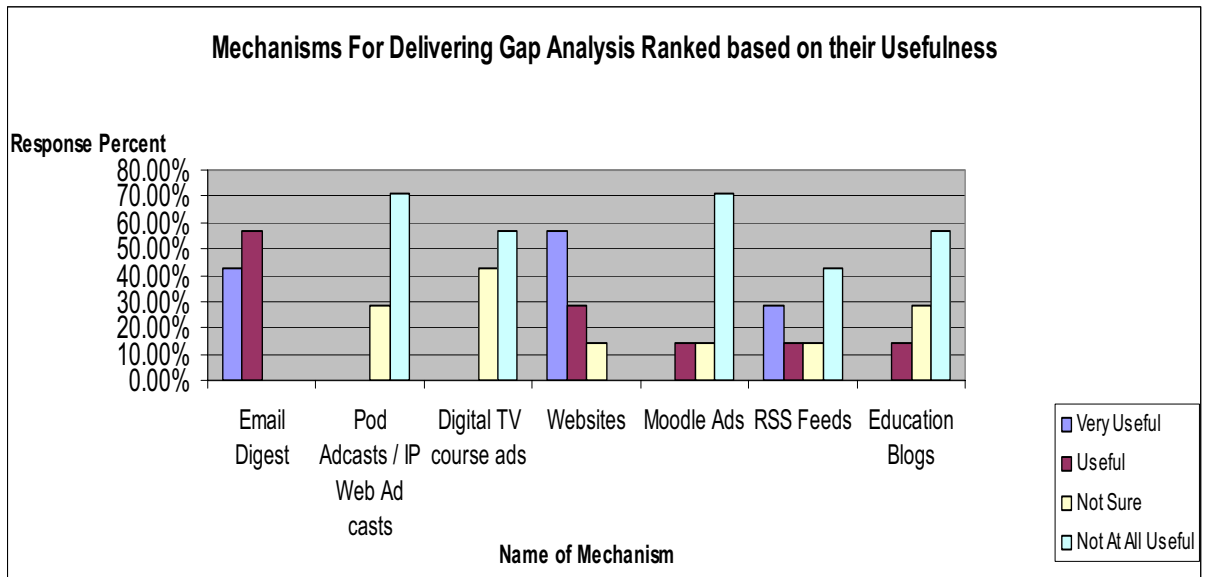
**Figure 41: Mechanisms for Delivering Gap Analysis ranked on Usefulness**

1. **Would you be willing to evaluate a demonstration of a visual map and gap analysis of a postgraduate programme?**

|  | Response Percent | Response Count |
|---|---|---|
| Yes | 37.70% | 3 |
| No | 62.50% | 5 |
|  |  |  |

**Table 32: Willingness to Evaluation a Demonstration on the Visual Map**
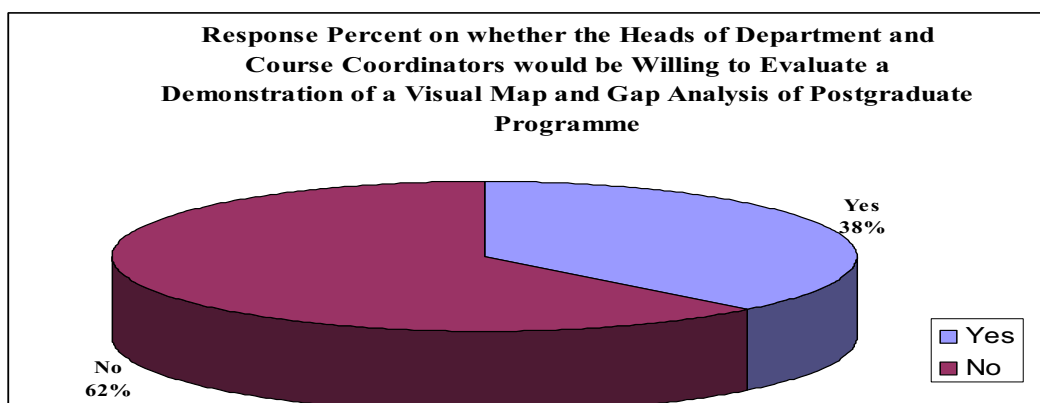


**Figure 42: Willingness to Evaluation a Demonstration on the Visual Map**

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## *Conclusion*

This chapter looked into why Knowledge Audit of Marketing Postgraduate Computer Science Programmes in Ireland was important before implementing a knowledge model.

It also introduced the types of Postgraduate Education in Ireland, focused more on why postgraduate is important and the role of Postgraduate Education Computer Science Education. The diversity of these programmes. Emphasis was more on the competitive situations institutes are in and the need for marketing intelligence.

Review of online material provided by the institutions was conducted to find out how much information was out there.

The next stage involved the introduction of the methodology used. The sources of information were discussed in detail and it was found out that the web was the main sources of information.

A Preliminary Knowledge Model was implemented, these was derived by auditing the existing information from the college websites and then refining to obtain the main information which would be used in the final knowledge model

Finally primary survey was conducted; these looked into the types of audiences targeted for the thesis, the survey questions which were presented in a questionnaire format, the survey design and types of questions asked and finally the results from feedback by the audience's target. Then the analysis of this feedback was conducted.

**Concluding Remarks**

Due to the number of surveys send out there, the information collected was huge. This provided a clear picture after analysis on what information should and shouldn't be included in the final knowledge model. Also due to time limit and amount of analysis required, some results were provided without a brief

description. The survey results involved analysis them using both graphical formats for comparison purpose and table format. This meant double work for the researcher, but at the end very promising results were received and this lend to the next chapter of process involved in implementing the actual knowledge model.

**Chapter 6** below discusses these processes:

# 6 USING XTM TO SUPPORT MARKETING INTELLIGENCE OF POSTGRADUATE CS PROGRAMMES IN IRELAND

## *Introduction*

This chapter introduces the use of XTM to support marketing intelligence of postgraduate computer science programmes in Ireland. Topic maps enable knowledge structures to be codified and linked with information resources. The chapter starts by introducing describing the process used to create the map. It then moves on to describe tools which could be used to develop an XTM map, justifying the selection of the tool used. The chapter finishes by presenting the XTM developed and discusses the feedback on the map.

## *Requirements*

Requirements should influence all further design decisions. There are different types of requirements, for example user requirements, functional requirements, design requirements, functional requirements, design requirements, system requirements, performance requirements as well as budget, time, and human resources. Especially the user requirements should be taken very seriously. All collected requirements should be listed in a document. A priority assigned to each requirement helps to distinguish important from unimportant ones.

### *Process of Creating Topic Map*

There are three possibilities for the creation of topic maps: manually, automatically or a mixture of both (ISO, Geneva 2000). There are also two different layers in a topic map: the instances and the classes. Classes are created in the design phase, and both phases could make use of different creation techniques (ISO, Geneva 2000). The main differences between classes, instances and class-instances are:

- **Class:** The core concept of class; the role of class as played by one of the members of a class-instance association.
- **Instance:** The core concept of instance; the role of instance as played by one of the members of a class-instance association.
- **Class-Instance:** Class-instance is a class of association that expresses class-instance relationships between topics that play the roles of class and instance respectively. The subjects "class-instance", "class", and "instance" are all defined.

The process of developing a map shares many similarities with the process of database development. Defining the scope of the topic map being created is important. The scope concepts allows modelling different views on the topic map and provides the ability to filter, hide, parts of it. Views could model user interests, languages, access rights etc. They can be considered from the beginning or added later. It is important to investigate whether the designer will need a multi-lingual topic map. Multi lingual names of topics are typically modelled with scope. The OASIS Technical Committee Published Subjects for Geography and Languages (Rath 2003) provides a set of published subjects for all major languages, which can be used.

The process adopted to create the topic map described in this dissertation is the s process developed by Park and Hunting (Park & Hunting 2003). The phases are:

- Phase 1: Setting the Objectives
- Phase 2: Analysis: Consisting of General design, Use of Scope, Topic Map Population, Editorial Issues, Not reinventing the wheel and Brainstorming
- Phase 3: Design Phase
- Phase 4: Creating the Designed Map
- Phase 5: Testing

- Phase 6: Documentation.

The process works by first setting up the objectives of the aims as to why the topic map is being created. Once the objectives have been set an analysis is conducted which consists of the general design, the scope of the problem and the topic population information, and also whether there are any editorial issues. Once the analysis has been conducted the design phase is implemented which leads to creating the designed map and once this map has been created the testing and evaluation of this map is conducted. During all this process documentation is conducted as the knowledge model is being developed

 These processes are discussed in detail in the following subsections

### *7.2.1 Phase 1: Objectives*

This phase is perhaps the most important if the map is to be truly useful. As with any development project if the objectives of the final produce are not fully understood, the usefulness will be limited. It is therefore important to state the objectives clearly. Park and Hunting identify (Park & Hunting 2003) that these could be achieved by:

1. Defining the application domain: what will be covered by the topic map;
2. Defining the functional requirements: Who will use the topic map and for which purposes;
3. Defining the schema: What kinds of subjects will be covered and how will they be related; what the topic map should look like;
4. Selecting tools and implementing application: Which software and architecture to use to implement the application;
5. Populating the topic map: Generate instances automatically or manually; Verify if the populated topic map satisfy the user requirements, does the schema require improvement;
6. Maintain the topic map and its application: What has to be done to keep the application running and topic map up-to-date

**Phase 2:  Analysis Phase**

The analysis phase ensures that the project results in a topic map solution, which really solves the initial problem and not something else, clearly meeting the objectives defined by phase 1. Requirements should influence all further design decisions.  There are different types of requirements, for example user requirements, functional requirements, design requirements, functional requirements, design requirements, system requirements, performance requirements as well as budget, time, and human resources.  Especially the user requirements should be taken very seriously.

The first steps involved in the analysis phase as identified by Pary and Hunting (Park & Hunting 2003) is the requirements analysis.  Listing the various requirements the topic map application has to fulfil and assign priorities:  by considering user requirements, functional requirements, design requirements, functional requirements, design requirements, system requirements, performance requirements as well as budget, time, and human resources. The following is a list of questions which can be used as a guide through the analysis phase and form a 'checklist' for completeness. They also help to structure the requirements.   All collected requirements should be listed in a document.  A priority assigned to each requirement helps to distinguish important from unimportant ones.

### 7.2.3 Requirements Analysis

A set of categorized questions used to assist in addressing the requirements was set up. These involved

    a. *Where the boundaries of the application domain:*  This question was critical because width and depth of the 'knowledge' captured in the topic map had to be limited to become manageable.

    b. *Who the users of the knowledge model were and what were there expectations?*

c. *Whether the topology of the topic map was to be restricted? :* Decision to restrict the number of tree hierarchies to avoid too detailed classification was made. This was because the amount of information collected regarding the postgraduate programmes was huge so information had to be refined

An additional aspect of the requirements analysis concerned the requirement of topic map population, following questions were derived to try and assist in answering this questions:

a. *What was the topic map population going to look like? :* Decision was made to use a tool which could automatically generate the topic map.

b. *Whether there was need to Do deal with legacy data? :* Legacy data meant already existing taxonomies, thesauri, ontologies, which could be migrated to or converted into a topic map. These was a new knowledge model so no existing knowledge model was available.

c. *Considering an automatic occurrence creation/maintenance by a categorization/classification tool.* This was important because data was not extracted but put manually by the researcher

### *7.2.4 Do not reinvent the wheel*

Humans have been ordering, classifying and grouping information for generations. Topic maps are quite often built over existing resources and repositories or are used to migrate from a legacy system to a topic map application. In the case of the knowledge model it was created from scratch because no other model of the same nature existed before. The structures of the resources, repositories, or legacy systems should be investigated to see if they can be re-used in the topic map schema. Following are some of these structures:

- Ontology;
- Subject categorisation, subject classification, taxonomy;
- Metadata vocabulary;
- Table of contents, index, glossary, thesaurus, data dictionary;
- Document structures ( DTD, XML Schema);
- Link structures. Many of the organizations do not have link structures

### *7.2.5 Brainstorming*

Because topics computerise the relevant subjects of the application domain, brainstorming of these subjects is the starting point. Just list anything regardless of what it might finally become a class, a topic, an association, an occurrence, or a theme. Think about the different angles, views from which users will look at the topic map. Be creative, but have the topic user in mind.

## *7.3 Design Phase*

The design phase now organises and defines the classes more thoroughly. Every class should be defined as a template (including constraints). It is this collection of templates that forms the schema for our topic map. Even if TMCL is not standardised, templates and constraints help to achieve a clearer design and better documentation. To express constrains, straight text or some form of business rule notation could be used. The critical thing is that you clearly precisely identify the constraints that must operate for this topic map.

- Topic Classes: Distinguish between resource, topic instance, and topic class. Here is a rules-of-thumb: Only resources reified as topics can have characteristics, e.g. has a name, have an occurrence, or be associated with other topics. If a resource does not need to have names, occurrences or be associated with other topics, the resources will probably be 'only' an occurrence, but not a topic. The topic template constrains the properties of the instances: for example

i. Number of names(s) in scopes;

ii. Occurrence class(s) in scope(s) and their cardinality;

iii. Association role(s) the instances play association of certain class;

iv. Distinguish between optional, must and must not constraints.

For example, in DIT Knowledge Model

Constraints of topic class *"Computer Science Postgraduate Programmes" would be: one name in each of the scopes, "DIT SOC", 'TRINITY', 'DCU' and 'UCC', one or more "map"* occurrence in scope

- Occurrence classes: Check available resources and their semantics for the application domain to identify occurrences and their classes. Look at every topic and association class and figure out, from the user's perspective,

meaningful occurrence classes. The occurrence template constraints the use of the occurrence class instances by: topic class (s) instances of current occurrence class are assigned top; scope(s); number of name(s) in scopes(s); distinguish between optional, must, and must not constraints. For example in DIT Knowledge Model,

- Association classes: Look at all topic classes and their possible combinations to figure out the meaningful association classes. Detailed topic classes can sometimes be expressed as general topic class plus an association. Following were kept in mind during when inventing process of the topic classes: naming of association class: Should be a noun expressing the relationship; e.g. "DIT SOC Location". Naming of association role; should be a noun, which might be a subclass or super class of that topic class the role players are instances of; e.g. "TRINITY" (super class of "Contact Address (Trinity)". The association template constraints the use of association class instances: scope(s);, association role(s) and their cardinality; combination of topic class(s) to play the role(s); arc labels; number of name(s) in scope(s);

- Scope Sets: Scope sets express the validity, applicability of topic characteristics names, occurrences, and associations. Scope is used to define various views on the topic map. Scope sets have an impact on name-based merging of topic maps by providing name spaces. Analyse the needed views and merging name spaces to identify the scoping topics. Scoping topics normally should be instances of classes and not just 'classless' topics. The scoping topic template constraints the use of scoping topic: topic (s) to which instance characteristics the scoping topic might be assigned to; occurrence class(s) to which instances the scoping topic might assigned to;

- Class hierarchies: Class hierarchies are an essential part of ontology. They model taxonomy and are the foundation for compact topic maps, influencing, and powerful searching.

- If you want to prepare your topic map for proper merging with other maps you should establish the subject identity of the topics, you could either refer to addressable subjects of application domain or you have to use subject identifier for non addressable subjects. It is important to consider existing vocabularies e.g. from ISO as a basis.

- Properties: Topics might carry properties-value pairs, which are modelled as resource data occurrences. The occurrence class is the property and the resource data string is the value.

## *7.4 Phase 4: Creating the designed map*

The above section has been describing the process involved in design the topic map. This section introduces the process the researcher undertook to design the DIT Knowledge Map and DIT and other Institution. Three techniques normally are adopted,

- which involved; Writing XTM (or HYTM) code in an ASCII editor or
- XML editor; Writing a topic map pseudo code, which is transformed to XTM automatically and finally
- Using topic map software, which provides an authoring user interface.

The third technique was adopted when creating the DIT Knowledge Model Topic Map. This was because interface of topic map software hides the complexity of the syntax, the id handling, and the proper interlinking of the topics from user. The topic map authoring interfaces used was free open source software called Ontopia Omnigator, which came with a web-based and a java-based authoring interface and provided a free evaluation license.

## *7.5 Phase 5: Testing*

Testing is a key part of successful topic map design and should be taken very seriously. The designer performed first tests and created the obvious topics, associations, occurrence, and assigned the scope sets to the topic characteristics. Navigate the topic map and went through the following checklist:

i. *Does everything 'make sense'?*

ii. *Is something missing? Is something in the map, which should not be in there?*

iii. *Is the granularity okay?*

iv. *Are there constraints okay" are they too restrictive or too weak?*

v. *Are names consistent? Do you find only singular or only plural names?*

vi. *Check for classes with only one subclass or more than twelve subclasses. Both might lead to modelling probems.*

After the designer finished the checks and improved the topic map according to the results, users were involved in evaluating and testing, the main reason was to find out whether they were confused or happy? And also whether every expected traversal path was realised? Or they found what they were looking for? Besides user testing, is essential as it has direct impact on the acceptance of the map. Other tests performed consisted of:

- Consistency testing, which looked into whether all constraints were fulfilled

- Statistical test: This involved checking what the number of topics were in total, associations, and occurrences in each or specific classes, how many and which roles topics played in associations and how long were the association chains on average, maximum, within certain classes, or class combinations , or any classes

- Functional testing: these involved looking into the functional requirements fulfilled.

These test methods should be applied to a topic map from time to time ensuring that it keeps its quality even when its size grows.

## 7.6 Phase 6: Documentation

Software documentation must usually fit different kinds of reader. The topic map designer maintaining the map needs different documentation as the author or the user. Documentation consists of manuals for the different audiences, each written and maintained separately from the topic map. The approach taken is assigning the necessary pieces of documentation as occurrences to the classes and instances, needing to be documented. The occurrence classes can model the kinds of documentation e.g description, editorial guideline, and help text. Scopes assigned to the occurrence can express the target audience e.g. designers or author or user and their language. It is the

task of the topic map software to display the documentation to the right user in the right language.

## 7.7 Tools to support XTM creation

The purpose for reviewing ontology building tools is to determine the toolkit most suitable for ontology creation, editing, and mind/concept mapping from the view points of Information Architects (IAs) who play a significant role in designing knowledge management systems.

The designer looked into different types of tools in order to choose which tool was best for the task. Following is a list of these tools:

- **Wandora**: Wandora is a general purpose knowledge extraction, management and publishing application based on topic maps. Wandora has been designed to enable easy aggregation, management and publishing of data and features rich data extraction, import and export capabilities. The designer was free to use Wandora in personal and non-commercial projects.

- **Ontopia:** Ontopia was available for free and was limited to 5000 topics, associations and occurrences. This was a good feature because it allowed enough capability of building topic maps for this project. It also allowed the user to navigate topic maps in a generic interface which would allow the designer to quickly test the topic maps.

- **Perl TM** Perl extensions for Topic Maps: With it the designer can manipulate Topic Maps via an API, navigate through TMs via a TMDM-like API, read AsTMa 1.x and 2.x resources, create virtualized topic maps, use a topic map backend store, query topic maps via TMQL".

- **SemanText**: This is a prototype application developed to demonstrate how the topic map standard (ISO/IEC 13250:2000) can be used to represent semantic networks. Semantic networks are a building block for artificial intelligence applications such as inference engines and expert systems. SemanText builds a knowledge base, in the form of a semantic network, from the topic map. New information can be added to the knowledge base and topic map automatically

when the user defines rules which are used to infer new knowledge. All of this is done using constructs defined in the topic map standard.

After looking at the tools a decision to use Ontopia was reached based on the features it stated it provides. A brief description of the tool is provided below;

The Omnigator is an application that lets user load and browse any topic map, including their own, using a standard web browser. The name is a contraction of "omnivorous navigator", and was chosen to underline the application's principal design goal, which is to be able to make sense of *any* conforming topic map. The Omnigator is intended as a teaching aid, to help you understand topic map concepts, and as an aid in developing your own topic maps. It is built using the Ontopia Knowledge Suite (OKS). The following is a print screen of the architecture for the ominigator
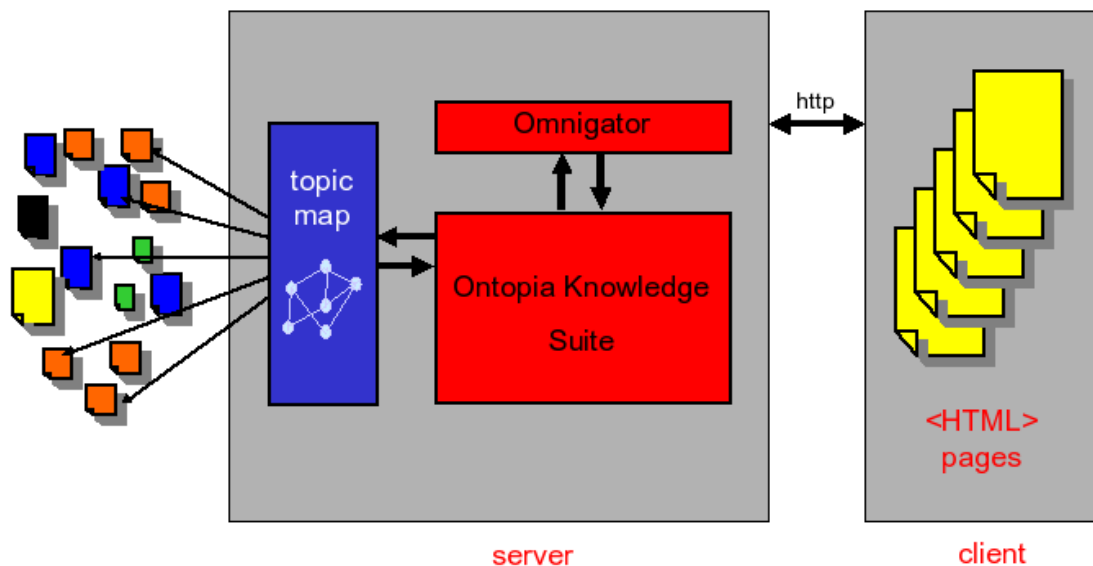


**Figure 43: The Omnigator Architecture**

The tool is ready to use and the designer just is required to read the tutorial book and then start creating the maps.

## 7.8 Prototype XTMs

A prototype is used as part of the product design process to allow engineers and designers the ability to explore design alternatives, test theories and confirm performance prior to starting production of a new product. Engineers use their experience to tailor the prototype according to the specific unknowns still present in the intended design. The DIT prototype was tailored to meet the requirements of the intended audiences. The following prototype was extracted from the XTM prototype of the Knowledge Model which was created for DIT and DIT and TCD. A full prototype of the knowledge model is to be found on **Appendix A**

```xml
<?xml version="1.0" encoding="utf-8"
standalone="yes"?><topicMapxmlns="http://www.topicmaps.org/xtm/1.0/"xmlns:xlin
k="http://www.w3.org/1999/xlink" id="reified-id204">
<topic id="id207">
  <instanceOf>
   <topicRef xlink:href="#id14"></topicRef>
  </instanceOf>
  <baseName>
   <baseNameString>CS PG EDUCATION</baseNameString>
  </baseName>
  <occurrence>
   <instanceOf>
    <topicRef xlink:href="#id81"></topicRef>
   </instanceOf>
   <scope>
    <topicRef xlink:href="#id103"></topicRef>
   </scope>
   <resourceData>000000001</resourceData>
  </occurrence>
 </topic>
```

## 7.8.1 XTM for DIT

XTM for DIT was present in a Hierarchy style of Concept Maps. Screen Shots have been taken for the purpose of demonstration, to see how the nodes expand. Following is a screen shot of topic types and how they expand through use of drill – down style.

**Figure 44** shows the results of the drill down
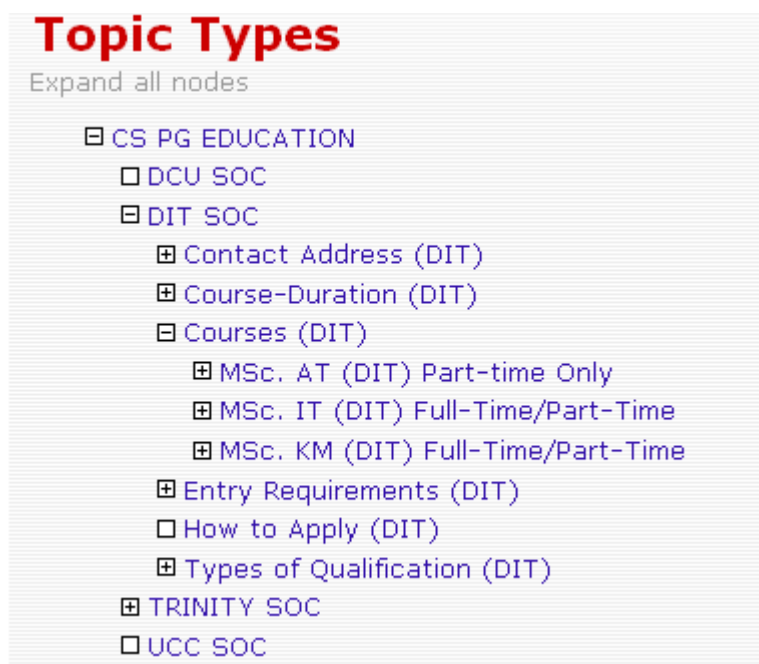


**Figure 44:  DIT Programme Information in Drill-Down Format**

From the above expanded nodes, following is a full screen shot as viewed in vizigator Computer Science Postgraduate Education (CS PG Education) is the super type of DIT SOC, TRNITY, UCC SOC and DCU SOC
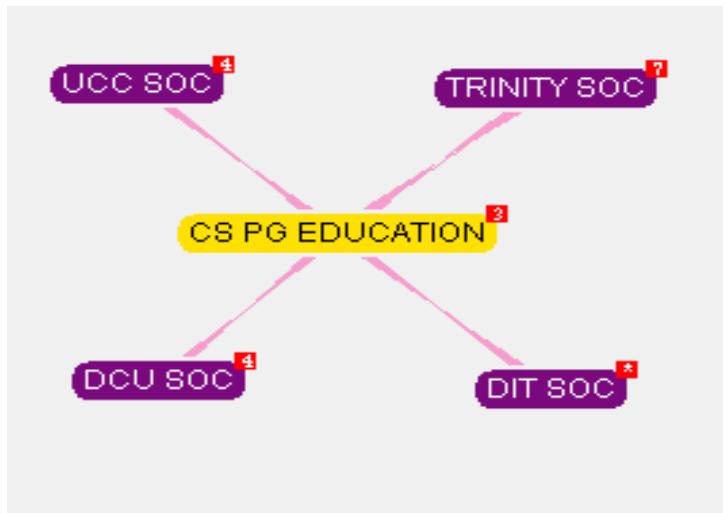
**Figure 45: Topic Map for Institutions Offering Computer Science Postgraduate Progrmmes**

The following screen short in **Figure 46** shows the topic map of DIT SOC and schools information and details of programme offered in DIT SOC; types of Qualification, How to apply, and contact address, etc
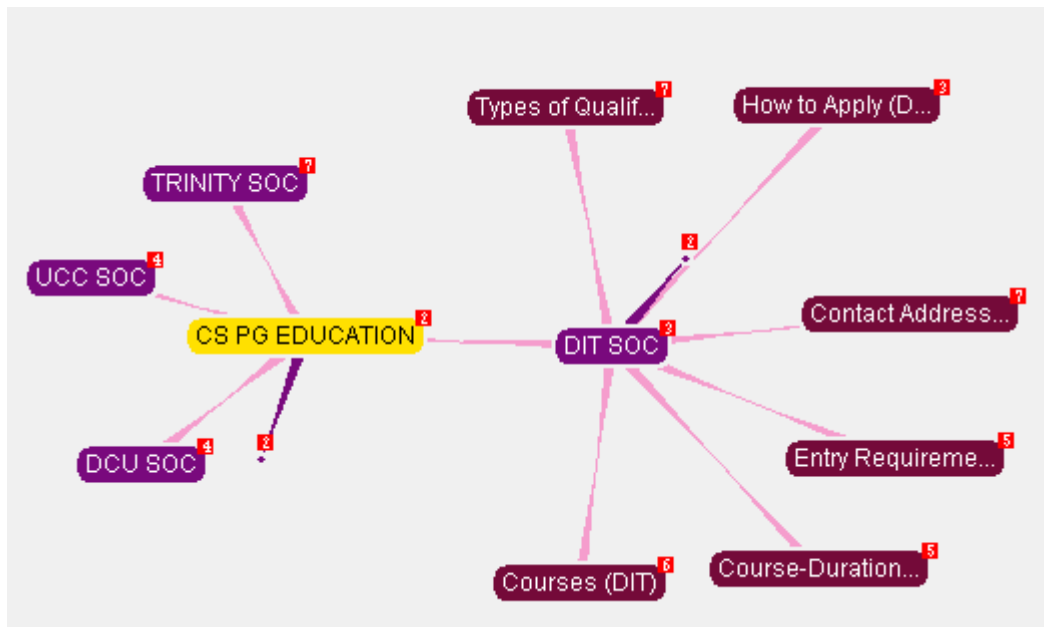


**Figure 46: Topic Map for DIT School of Computing**

This print screen in **Figure 47** presents more detailed information about DIT. Each root node contains a visual map which provides more detailed information from the previous one
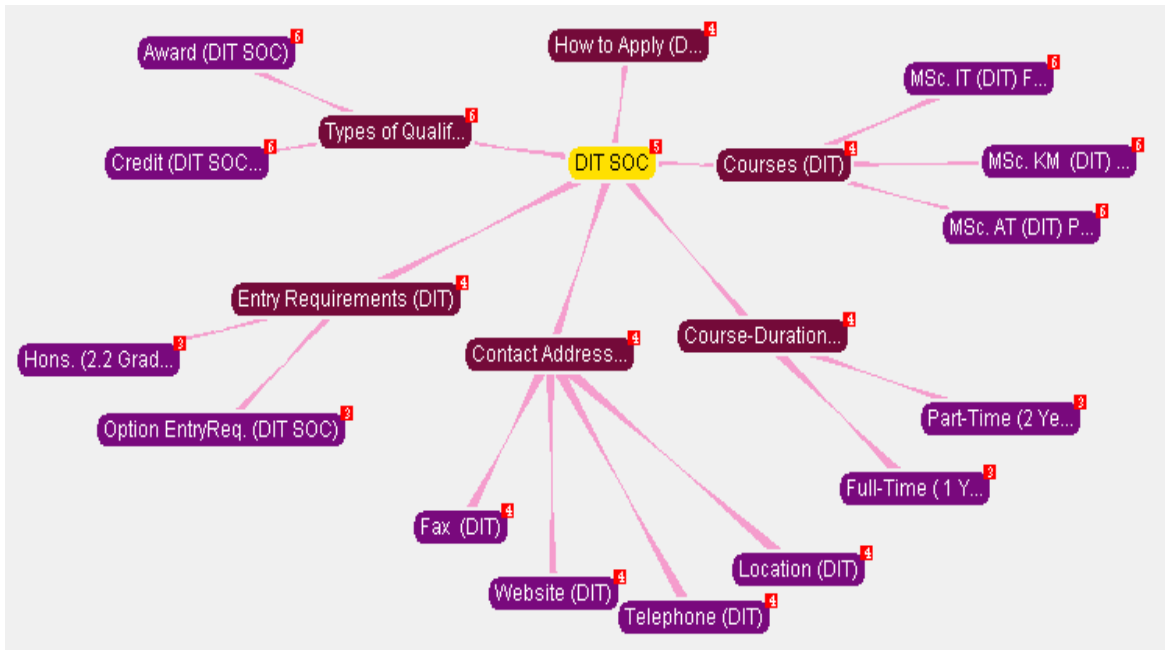


**Figure 47: More Detailed Topic Map about DIT SOC**

**Figure 48** contains the Screen shot of courses in DIT
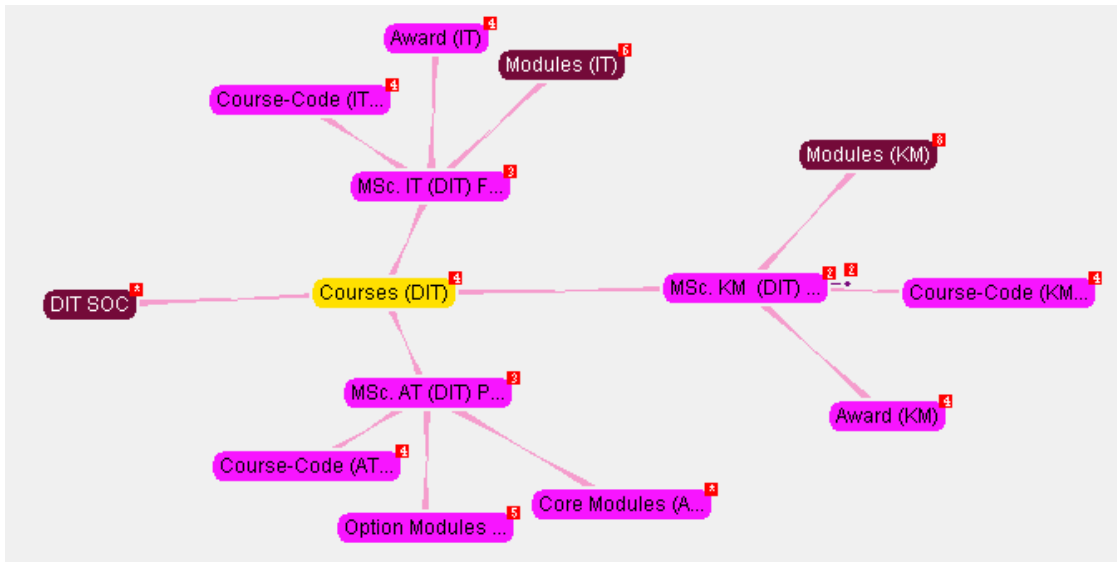


**Figure 48: Topic Map on Courses Offered in DIT**

A complete set of Screen Shots is in **Appendix B**

**Justification**

From the above screen shot presents a quick and clear visualization of the topic maps used in completing the DIT Knowledge Model. It is very interesting to see the power of visual map in presenting information. For example the courses offered in DIT school of computing can be visualized very quickly thus the advantage of visual maps compared to the web.

### *7.8.2 XTM for Trinity College Dublin*

Topic Types: Following **Figure 49** is screen shot of the expanded nodes of Trinity College



**Figure 49: Trinity College Dublin, Drill-Down Information**

When viewed using the vizigator, following is the screen shots (**Figure 50**) of Trinity College Topic maps were obtained
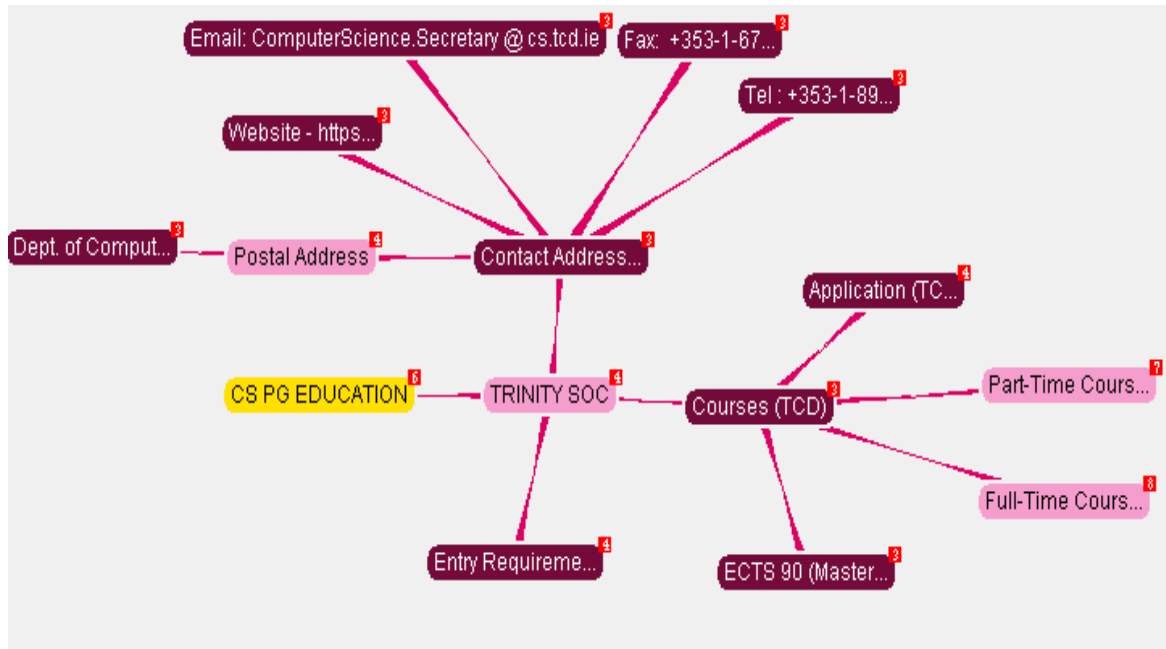


**Figure 50:  Topic Map of Trinity College**

The screen shot of the courses offered in **Trinity College** are shown in figure 51
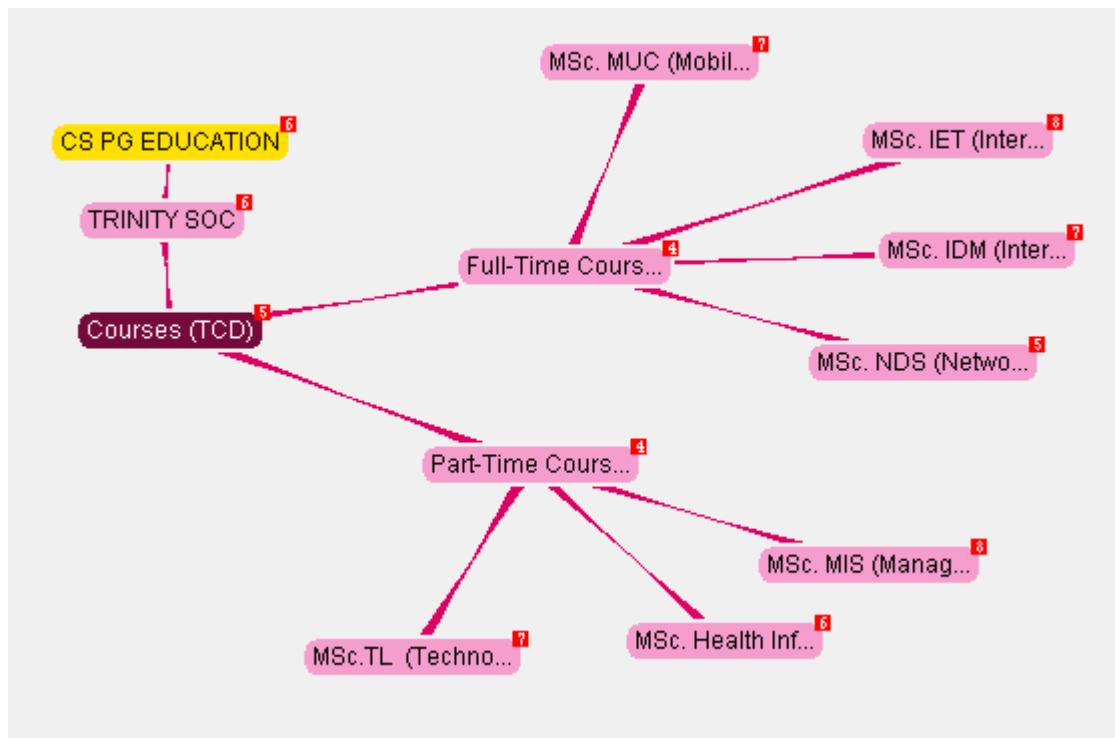
**Figure 51:  Topic Map of Courses Offered in Trinity**

The full Screen Shots of Trinity College Topic Maps are in **Appendix B**

The following screen shot **Figure 52** shows how the final visual map looks for all the information entered for the two colleges



**Figure 52: Complete Visual Map of Programmes in Trinity and in DIT**

The visual map can be used for drill down and comparisons of different in formations. For example Comparison of the final knowledge model developed for DIT and DIT and Trinity College Dublin involved; content, modules, cost and entry requirements. Comparison criteria was developed which enable the users to compare information between the two colleges though visualization. For example comparison of modules offered in DIT and Modules offered in Trinity showed the following results:
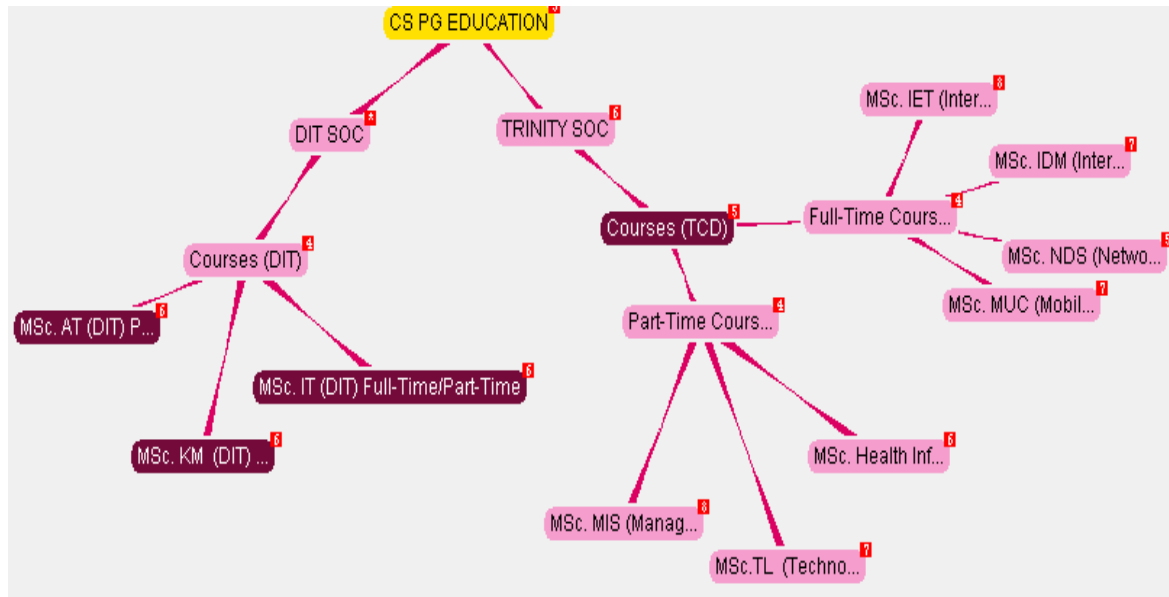


**Figure 53: Comparisons of Courses offered in DIT and Courses in Trinity**

## 7.9 Testing and Evaluation

The last phase of development is the testing phase. While the design phase takes into account various design or HCI principles such as those described by Nielson; e.g. provide consistency, error prevention and error detection. The testing phase evaluates the working prototype to ensure that it not only adhere to such principles but is also easy to use and user friendly. There are three main general approaches to testing: black box testing, white box testing and functional testing.

- **Black Box testing** is a software testing technique where the tester does not know the internal workings of the item being tested. For example, in a black box test on software design the tester only knows the inputs and what the expected outcomes should be and not how the program arrives at those outputs.

The tester does not ever examine the programming code and does not need any further knowledge of the program other than its specifications.

- **White box testing** also known as glass box, structural, clear box and open box testing is software-testing technique whereby explicit knowledge of the internal workings of the item being tested is used to select the test data. Unlike black box testing, white box testing uses specific knowledge of programming code to examine outputs. The test is accurate only if the tester knows what the program is supposed to do.

- **Functional testing** covers how well the system executes the functions it is supposed to execute, including user commands, data manipulation, searches and business processes, user screens, and integrations. Functional testing covers the obvious surface type of functions, as well as the back-end operations (such as security and how upgrades affect the system).

During this project both White Box testing and Functional testing throughout the development of the prototype. This was to ensure that the code adhered to the XTM rules. An iterative approach to development was adopted where the map was developed in phases, evaluated and then reflected upon to find out if the design can be corrected or improved.

The final user evaluation of the prototype concentrated mainly on collecting the views of those primarily involved in creating material for marketing programmes and those primarily involved in consuming the marketing material created. Therefore in the evaluation three programme co-ordinators and give current postgraduate students were shown a demonstration in one to one sessions and interviewed to collect their feedback.

A structured interview was conducted in order to evaluate whether the model will be accepted as having met the standards required for XTM Topic Maps and also to test whether if was functioning fully and contained update information of postgraduate computer science programmes offered both in DIT and Trinity College Dublin.

During the interviews, a demonstration of the XTM for DIT and XTM for Trinity was done; these involved a full demonstration of the functions of the Topic Maps created. After the demonstration, the designer asked the following questions:

- *What they thought about visual representation?*
- *Whether they thought the XTM for DIT and that for Trinity would benefit the students*
- *Was there anything they would have expected to see that was missing in the visual map*
- *Whether they thought in future visual maps would replace the web information.*

These questions were aimed at finding out whether the knowledge model would be accepted by the users and evaluating whether it provided complete update of the programmes offered in these two institutions.

### 7.9.1 Feedback from Students and Course Coordinators/Heads of Dept

The majority of students felt that the visual map presented a very clear picture of the programmes finding it user friendly as long as they knew how to navigate the maps. The level of detail made the limited the usefulness as the visual became more complicated as the levels expanded making navigation and understanding more difficult. However they reported as the Ontopia tool was used to demonstrate the maps, the students found this interface quite complicated since they had no exposure to it previously and therefore would need sometime learning how to use it before being able to fully exploit the model.

**Feedback from Course Coordinators and Heads of Dept**

The XTM DIT and that for Trinity to three programme co-within the DIT. One programme coordinators stated the researcher should make the tool available on the website, since he felt it would benefit people a lot. Another felt that perhaps it couldn't since users are used to the way in which the content is currently presented and would not find this new navigation particularly easy. The content of the map was considered comprehensive, covering all the required content and presenting it in a more user friendly way. Some omissions in the model were noted for example a time table element. This is an interesting comment since it extends the usefulness of the XTM interface beyond the marketing element to prospective students into an information

resource for current students. Interestingly, different to the students one co-ordinator recommended purchasing a full version of the tool since it would be useful for use in teaching students and by students completing projects.

**Summary of Findings**

From the interviews conducted, the designer was satisfied that the users of the tool would be satisfied with the information which was presented and that the prototype implemented was working perfectly.

## 7.10 Conclusion

This chapter looked into use of XTM to Support Marketing Intelligence of Postgraduate Computer Science Programmes in Ireland. A full prototype of XTM for DIT and Trinity College Was developed and tested to make sure it functioned properly. In conclusion this developer believes that the results of the evaluation development, implementation and testing phase produced a robust "simple" user friendly and easy to use DIT Knowledge Model and DIT and Trinity Knowledge Models. There are possibilities of exporting the visual map and using it as a dynamic map.

# 8. CONCLUSION

This chapter provides a summary of the whole dissertation, the research definition and research overview; it also looks into contributions of dissertation to the body of knowledge and also discusses comparisons, evaluations and limitations of the whole dissertation and also provides recommendation for future work.

## 8.1 Research Definition & Research Overview

The aim of the project described in this dissertation was to investigate the usefulness of a knowledge model created using XML topic maps of postgraduate computers science programmes in Ireland to support marketing intelligence Dublin Institute of Technology (DIT). The researched involved:

- Conducting a literature review on marketing intelligence, postgraduate computer science degrees, and use of xml topic maps to build a knowledge model.
- Assessing the usefulness of marketing intelligence as knowledge management activity for postgraduate education in Ireland.
- Conducting a knowledge audit of existing marketing material of postgraduate degrees in computer science in a number of academic institutes and through a survey of the principle stakeholders involved in this area: the management of programmes and postgraduate students.
- Conducting both primary and secondary survey to gather information for providing guidelines in implementing the knowledge model.
- Designing, analysing and implementing a knowledge model for DIT and other institutions.
- Expressing the knowledge model for DIT and other institutions in an XTM representation and visual expression of this representation.
- Assessing the usefulness of these models and visual representation for the purpose of marketing intelligence.

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## 8.2 Contributions to the Body of Knowledge

This chapter first dealt with overall project background which covered the introduction of what was involved with the thesis

This chapter introduced knowledge management. It was concluded that Knowledge management had been burgeoning in importance during the last one and half decades. Both profit making and non-profit making organizations have had to and continue to embrace and practice knowledge management. Knowledge capture, knowledge integration and knowledge delivery are the essential parts of dynamic knowledge management (Becerra-Fernandez, Gonzalez & Sabherwal 2004). As such, marketing intelligence can be seen as a knowledge management activity. This dissertation has introduced the impacts knowledge management has both in organizations and to people in the academic institutions. Through computing for knowledge management, the success of this dissertation is shown clearly, the researcher required knowledge in order to complete the dissertation, by conducting literature review on the subject area, it has added to the body of knowledge.

The next chapter dealt with marketing intelligence. After looking into marketing intelligence, the researcher concluded Marketing intelligence was a future-oriented activity that helps an organization copes in its market, in. It included all ways an organization acquires and uses information. Marketing intelligence comprised of all kinds of information on the market and marketing research; the collection and analysis of internal data, competitive analysis; analysis and reverse engineering of competitor's products; understanding how and where to add value for customers; and the process of synthesizing large amounts of informally gathered information about the industry and business environment. While marketing and marketing intelligence are widely used in business, they are less used in non-business organisations such as academic institutes. Yet academic institutes now find themselves in a very competitive market place, competing

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for students from their traditional audiences and forced to seek out new audiences for their programmes. Marketing intelligence was therefore very relevant to academic institutes, thus the role it has played in the final results of this dissertation. All the tasks involved in this dissertation required an analysis of marketing intelligence of one sort or another.

The next chapter dealt with knowledge mapping, an overview of knowledge mapping was discussed with introduced the key concepts and then the process involved in creating knowledge maps was discussed in detail. Comparisons of Concept maps versus topic maps were performed and finally a investigation of topic maps and XML topic maps was done to try and find out their relationships. The researcher concluded that by specifying, designing and implementing a knowledge model for DIT and comparing it with other Institutions, it fulfilled the requirements of this dissertation.

The next chapter dealt with Knowledge Audit of Marketing Postgraduate Computer Science Programmes in Ireland.

This chapter dealt with Using XTM to Support Marketing Intelligence of Postgraduate CS Programmes in Ireland and also included sections on all the process involved in implanting the final knowledge model for DIT and Trinity.

**Remarks by Researcher**

By implementing the DIT knowledge model and DIT and Trinity Knowledge Model, the researcher has contributed to the body of knowledge. Knowledge management has enabled the success of the dissertation and computing for knowledge management has a great impact in the role it plays in academic institutions globally.

Contributions to the body of knowledge by the project described in this dissertation include a literature review which covered typical issues in knowledge management

including the difference between knowledge and information management, knowledge society, knowledge economy, intellectual capital, knowledge workers, the concept of organizational learning, assessment, valuation and measurement of knowledge-based assets, tools of knowledge management, etc.

The researcher conducted Literature Review on Marketing Intelligence, Postgraduate Computer Science Degrees, and Use of XML Topic Maps to build a Knowledge Model. Literature was reviewed from journals, both electronic and hard copies, conference papers, research publications and international organizations' official publications, such as the IEEE, ACM and books. The researcher made every effort to use the latest publications on several aspects in Marketing Intelligence and Knowledge Modelling. The major source of the latest publications in Marketing Intelligence was the Internet. Some specific databases were consulted to provide the required information. Among the databases/hosts/websites consulted and searched were: Emerald Insight services, EBSCO host databases, Science Direct databases, Communication of Association for Information Systems databases and JSTOR Business Collection databases. Websites of individual organizations like the Dublin Institute of Technology (DIT), Trinity College Dublin, Letterkenny Institute of Technology (LYIT), University College Dublin (DCU), University College Cork (UCC), University of Limerick (UC), National University of Ireland Galway (NUIG) and Queens University Belfast (QUB) were also searched.

An assessment of the usefulness of Marketing Intelligence as Knowledge Management activity for Postgraduate Education in Ireland: Academic verses Business Marketing Intelligence as Knowledge Management Activity was conducted and researcher investigated how marketing intelligence can help in introducing competitive advantage of academic institutions in Ireland

Knowledge auditing of existing online Marketing Material of Postgraduate Degrees in Computer Science was conducted which exposed that as models which shows structure and content, which facilitates querying.

A survey research method was adopted for the purpose of collecting data for this thesis. The researcher scanned through several relevant documents that the institutions availed for additional information and also unobtrusively observed the behaviour of the respondents and used the findings to Survey those who are recipients and creators of Marketing Intelligence to access what use , what type etc.

Used finding of Literature Review, Survey, Audit and User Survey to derive Knowledge Model for Marketing Intelligence in Postgraduate Computer Science Degrees.

Expressed models in computer process able form using XTM which can be used for Querying and visualisation.

The literature review survey of Marketing Intelligence provided a clear picture of Marketing Intelligence Postgraduate Education from 8 different institutions located in the Republic of Ireland

The researcher developed a knowledge model that expressed as a searchable visual model of two institutes to facilitate comparison. The knowledge model was also exported to be used on Websites by current postgraduate students undertaking computer science, graduating classes of computer science undergraduate degrees and Heads of Department and Programme coordinators of different institutions.

The visual map developed was expanded and altered using tools such as Ontopia omnigator, because XTM Standards used in Java Programmes for Querying and Updating.

### 8.3 Comparison, Evaluation and Limitation

The whole project has been a success and fulfils the targets it was set to do in the project scope. Use of XML Topic Maps to develop a knowledge model has led into a greater impact the knowledge model has had on its users. Since the XML Topic Maps developed for DIT and Trinity were ontology-driven topic maps, they had advantage over the ordinary topic maps:

➢ The ontology-driven topic maps approach offers several major advantages. An ontology-driven topic map is desirable for its maintainability.

➢ Producing the ontology first from which to generate the topic map separates the ontological design from the XTM implementation details.

➢ As the XTM specification evolves, its naturally needs to change in order to fulfil purposes other than those strictly relevant to knowledge representation. As versioning of the specification occurs, if the ontology for a given topic map remains unchanged, then only the mapping from the ontology language to the XTM specification needs to be updated.

➢ Updating such a mapping for a given knowledge representation language relative to the new XTM version is preferable to updating all topic maps.

➢ Separating the ontology from the topic map enables conceptual changes to be explicitly recorded apart from all other changes, in this case the ontology-driven topic maps approach offers the advantage of a typical loose coupling approach.

➢ The ontology-driven topic maps approach makes available the use of numerous existing ontologies. Ontologies are the results of significant investment, as are topic maps.

The evaluation of the developed topic from different audiences who were interviews produced very interesting results, from the management perspective; they felt the DIT Knowledge Model of DIT and DIT and Trinity was very important especially in comparing different programmes between the two institutions. The information in this knowledge model was up to date and very relevant for them. From a student perspective, they thought it involved a lot of work and felt that the information contained in the model was clearly presented by using the visual map vizigator in ontopia.

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Overall, the dissertation has been a success and a lot of work has taken place. The final knowledge model developed fulfils the purpose of marketing intelligence and analysis.

The main limitations of this project have been time factor. The dissertation involved a lot of knowledge auditing and research on the subject area. Due to the short time available for the dissertation deadline, the researcher had to reduce the amount of data collected from the third level institutions. Due to time limit the only a knowledge model for two institutions was developed, the Dublin Institute of Technology and Trinity College Dublin.

The primary survey conducted for the graduating class of undergraduate computer science degree in DIT was only completed by three students, this was due to the fact that many students had already finished college and probably travelled by the time the survey questionnaire was released.

## 8.4 Future Work & Research

The researcher strongly recommends future work on this thesis be performed because:

Extend the work to cover all types of Postgraduate and undergraduate Education. By extending the work to cover all types of postgraduate and undergraduate education current and future students would benefit from the information presented.

Investigate the effect of replacing Web Information with the Visual. Point out differences between current structure and visual. It would be important to find out whether it would be possible to replace the web. One of the feedbacks provided from the evaluation chapter on the visual map was that audiences felt that the visual map could indeed replace the web.

Develop User Interface for XTM Creation which hides complexity. At the moment the tool which was used although was chosen to be the best tool did not have a user interface which hides the complexity of the maps. This interface was designed for designer, so this would be important.

Develop a tool that allows Editing Information through the Visual. At the moment, there are no known tools that allow editing of information through the visual map. One of the audiences interviewed comment that it would be important to edit information on the visual map directly without going back to the description sections.

Extend the work of Marketing Intelligence in another type of organization. The organization in which this thesis was conducted was academic, so it would be important to extend it to other types of organizations like the financial organizations or supermarkets. This would allow comparisons on wide areas.

Finally it would be important to expand the topic types implemented to include time table scheduling and student and lecture information. This feature were skipped during the implementation of the knowledge model due to time factor but some of the audiences who evaluated the knowledge model wanted to see this information included in the model.

## 8.5 Conclusion

This project highlighted the applicability and usefulness of developing a knowledge model for the purposes of marketing intelligence in postgraduate education in Ireland. It used XTM to express models built as a results of a knowledge audit of three of the a major academic institutes in Ireland and evaluated its usefulness to both those involved in creating the marketing information and those consuming that information

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# APPENDIX A:  KNOWLEDGE MODEL  PROTOTYPES

# DIT AND TRINITY COLLEGE DUBLIN  *DUE TO THE HUGE SIZE OF THE PROTOTYPE PRODUCED, IT IS ATTACHED AN XTM FILE. UNDER THE NAME (DITKNOWLEDGEMODEL(4))*

# APPENDIX B: SCREEN SHOTS OF KNOWLEDGE MODEL FOR DIT AND TRINITY

# APPENDIX C:  SURVEY QUESTIONS

**Questions to Current Postgraduate Computer Science Students**

1. *What programme level are you studying at?*
2. *What is the title of your programme of study?*
3. *What third level institution are you studying at?*
4. *Are you studying fulltime or part-time?*
5. *Rate the following in terms of their influence on your choice to study at postgraduate level.*
6. *Rank the following in terms how they influenced your choice of programme of study.*
7. *How would you rank the following as sources of information when researching programmes to study?*
8. *How would you rate the information provided by your institution about the programme you are studying?*
9. *In your opinion, what additional information could be provided about your programme of study?*
10. *Having experienced your programme of study, what would you tell prospective students to encourage them to do the program?*
11. *List, at most, 3 subjects that you wish had been included in your MSc programme.*
12. *If you could change one thing related to your experience with the MSc program that would have made it more successful or fulfilling, what would it be?*

**b)  Questions to Heads of Department and Course Coordinators**

The survey questions were divided into five parts, namely:

- Part A: Postgraduate Computer Science Programmes in Ireland Questions
- Part B:  Marketing Intelligence and Academic Institutions Questions
- Part C:  Research about Other Institutions Questions
- Part D:  Knowledge Model Questions
- Part E:  Gap Analysis Questions

**Part A: Postgraduate Computer Science Programmes in Ireland Questions**

1. *Which higher education institution do you work in?*
2. *What is your role in this institution?*
3. *What types of postgraduate programme in computer science are available in your institution?*
4. *For each of the following programmes in computer science that you offer, which audiences do you target?*
5. *For each of the following programmes in computer science that you offer, which is the MAIN audience you target?*
6. *For each programme type offered, what is minimum entry requirement?*
7. *For each of these programmes how are they typically offered?*
8. *For each type of programme please indicate all areas covered?*
9. *On your taught programmes do you offer any exemptions from modules?*

**Part B: Marketing Intelligence and Academic Institutions Questions**

1. *Which of these resources do you use in marketing your programmes?*
2. *Please rank each of the following in terms of their effectiveness as a recruitment mechanism.*
3. *Do you, in your role, research what other institutions do?*

**Part C: Research about Other Institutions Questions**

1. *For each of the following please indicate their usefulness to you as a source of information on programmes in other institutions?*
2. *When comparing programmes in your institutions, what factors influence the comparison?*
3. *Would you use a resource that could provide summary information about other higher education institutions programmes and notify you of changes?*

**Part D: Knowledge Model Questions**

1. *Would a visual map of your programme showing structure, content, duration, cost etc be useful?*

2. *What factors would you consider when evaluating such a map?*

3. *Would you be interested in receiving information showing gap analysis between your programme and other programmes?*


**Part E:  Gap Analysis Questions**

1. *Please rank the usefulness of the following mechanisms for delivering gap analysis information?*

2. *Would you be willing to evaluate a demonstration of a visual map and gap analysis of a postgraduate programme?*


**c)  Survey Questions to Undergraduate Computer Science graduating classes**

1. *What programme level are you interested in joining*

2. *What other postgraduate programmes did you previously consider?*

3. *What third level institution have you just graduated from?*

4. *Are you planning to register for fulltime or part-time computer science postgraduate course?*

5. *Rate the following in terms of their influence on your choice to study at postgraduate level.*

6. *Rank the following in terms how they would influence your choice of programme of study.*

7. *How would you rank the following as sources of information when researching programmes to study?*

8. *How would you rate the information provided by your institution about the programme you are studying? Please rank and comment on the information provided.*

9. *What was the main deciding factor which influenced your choice of programme and Institution?*

10. *List, at most, 3 subjects that you wish to be included in the MSc programme you are about to start.*

# APPENDIX D: EMAILS SEND TO STUDENTS

Wordings used while distributing students' surveys:

*From: Catherine Mulwa*

*To: Postgraduate Computer Science Students*

*Date: 22nd March 2008*

*Dear students,*

*I am a postgraduate student in the Faculty of Science, School of Computing at the Dublin Institute of Technology. I am conducting a survey which is part of research I am undertaking to complete an MSc degree.*

*The aim of this survey is to collect information from Heads of Departments and Course Co-coordinators and Students, which will be used to create a knowledge model of postgraduate computer science degrees for the purpose of marketing intelligence. The survey is presented in form of a questionnaire which is online at the moment. The questionnaire is very short and brief and will only take very short of your time to go through it.*

*I would appreciate if you could go through it and provide me with your feedback. Please attached find a link to the survey itself.*

*http://www.surveymonkey.com/s.aspx?sm=TbE6X9BGNS5za8xIMcEGM Q_3d_3d*

*Best Regards,*
*Catherine Mulwa*

Wordings used while distributing course coordinators and heads of department surveys. The style was structured to address each of them individually. For example an email sent to Reinhard Schaler of university of limerick had these wordings

*From:  Catherine Mulwa*

*To:  Course Director*

*Date: 22ⁿᵈ July 2008*


*Dear Reinhard Schaler,*


*I am a postgraduate student in the Faculty of Science, School of     Computing at the Dublin Institute of Technology.   I am conducting a    survey    which   is part of research I am undertaking to complete a  MSc        degree.*

*The   aim   of   this   survey   is   to   collect   information   from   Heads   of Departments and Course Co-coordinators and Students, which will be       used to create a knowledge model of postgraduate computer science      degrees  for the purpose of marketing intelligence.  The survey is          presented  in  form of a questionnaire which is online at the moment.  The         questionnaire     is very     short and brief and will only take very short of       your   time   to   go through it.*

*I   would   appreciate   if   you   could   go   through   it   and   provide   me   with   your feedback.  Please attached find a link to the survey itself.*

*http://www.surveymonkey.com/s.aspx?sm=fH19y1mqCtZyod3w2i8xnA_ 3d_3d*

*Best Regards,*

*Catherine Mulwa*

*NB:   Please   Reinhard   Schaler,    I   am   also   conducting   a   survey   on   the postgraduate computer science students.  Is it possible to pass the   information to your students?  If yes, Please find a link to the survey     addressed   to   the students.*

*http://www.surveymonkey.com/s.aspx?sm=TbE6X9BGNS5za8xIMcEGM*

*Q_3d_3d*