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## **DOCTOR OF PHILOSOPHY**

**risk-e The risk management pathway, an e-learning tool for healthcare professionals.**

Minas, Christos

*Award date:*  
2008

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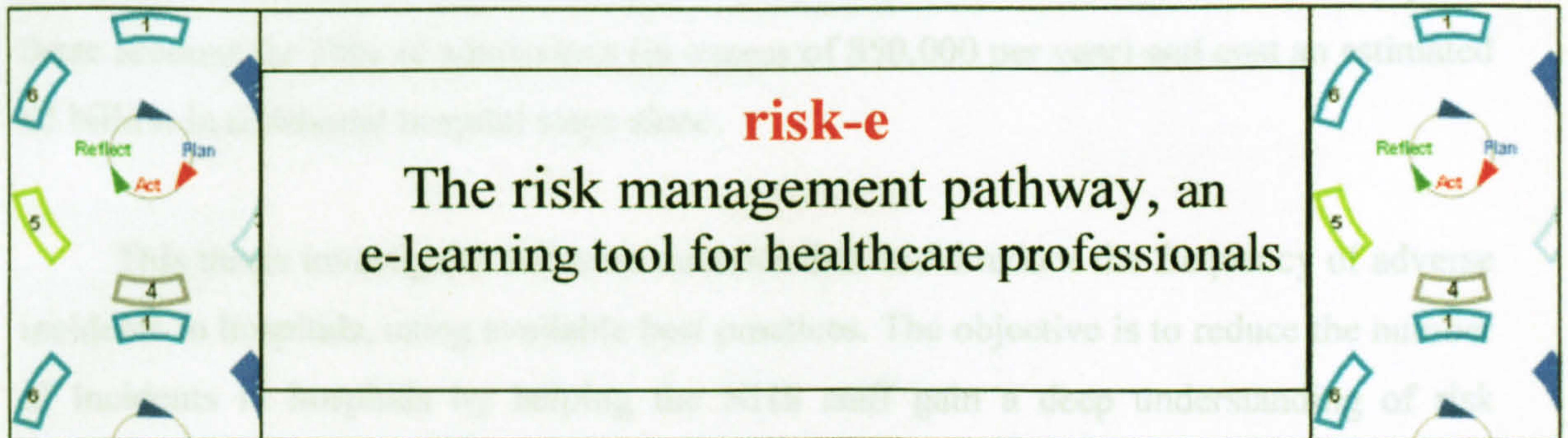
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Thesis submitted to the Bangor University  
 in Candidature for the degree of Doctor of Philosophy

2008



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## **Abstract**

Annual NHS clinical negligence expenditure is rising every year. The overarching NHS clinical governance strategy aims at a reduction in adverse incidents in the health service. However, adverse incidents in the health service continue to rise and in NHS hospitals these account for 10% of admissions (in excess of 850,000 per year) and cost an estimated £2 billion in additional hospital stays alone.

This thesis investigates software methods that could reduce the frequency of adverse incidents in hospitals, using available best practices. The objective is to reduce the number of incidents in hospitals by helping the NHS staff gain a deep understanding of risk management with minimal distraction from their daily duties.

The solution is an e-learning tool which combines web based e-learning and database management functionality. It provides the users with risk management educational material and appropriate database tools in order to be able to build up a risk action plans database based on their job experience and those educational materials. The software application has been developed based on a development methodology and a customized software development life cycle model.

The research addressed the complexity and multidimensional nature of the risk management e-learning development approach in the health care environment. Throughout the research a deeper understanding of variety of concepts and aspects in different fields has been gained and the appropriate educational platform and pedagogy for the system has been identified.

## **Acknowledgment**

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## ***Chapter 1***

### **Introduction**

#### **1.1 The NHS & Risk**

The NHS is a massive organization, which employs nearly one million staff. The aim of the NHS was to promote “the establishment of a comprehensive health service designed to secure improvement in the physical and mental health of the people of England and Wales and the prevention, diagnosis and treatment of illness” (1946 NHS Act).

Human error is a very serious issue in some cases for any organization because it can have impact on many different areas in the organization. Unfortunately in the NHS human error can have direct impact to patient’s health and in some cases can cause death. There are thousands of cases nationally related with accidents in NHS caused from human error based on information recorded at the National Audit Office (NAO) and as seen by the growth of a patient’s litigation action against the NHS. This is one of the biggest issues in the NHS because it damages its reputation and it also costs millions of pounds every year.

Five percent of the general population reports suffering some injury or other adverse effects of medical care based on the last figures of NAO. Furthermore, annual NHS clinical negligence expenditure was just £1 million in 1974-75 (£6.33 million at 2002 prices). This figure rose to £446 million in 2001-02 only in England. The NHS Litigation Authority, responsible for handling negligence claims made against NHS bodies in England, dealt with nearly 7,000 claims for clinical negligence in 2002/2003, just under seven percent relating to episodes of care that took place prior to 1995. Similar is the situation with the NHS in Wales.

Based on the statistical figures from Welsh Risk Pool (WRP), the annual cost of clinical negligence to the NHS in Wales is considerable and rising, reducing the funds available for patient care. Adverse incidents in the health service continue to rise and in NHS hospitals these account for 10% of admissions (in excess of £850000 per year) and

cost an estimated £2 billion in additional hospital stays alone. In 1999-2000 total cash payments made by the NHS in Wales on clinical negligence cases were £26.9 million, an increase of 42 percent compared with the previous year. During 2001-02, the NHS in Wales paid out for clinical negligence and personal injury amounting to some £18.6 million in respect of 136 cases, a rise of £8.2 million from the £10.4 million paid out in 2000-01 (WRP, 2004).

Escalating costs of litigation in Wales cost £25 million in 2003/4 (WRP, 2004) £37 millions in 2004/5 and £42 millions in 2005/6, and are predicated to increase over the coming years. There has also been concern at the scale of the current and likely future costs of settling clinical negligence claims and the time taken to resolve them.

The NHS in Wales recognises that more needs to be done to prevent clinical negligence costs continuing to rise. The reasons behind the negligent incidents are often complex and difficult to determine, National Audit Office Wales analysis of a sample of cases suggested that errors arising from a breakdown in administrative, rather than clinical, procedures were at least contributory factors beneath a good proportion of cases of negligence (Bourn, 2001). It was argued that there are a number of ways to overcome human error and the importance of constant evaluation of tasks to identify and manage risks. There are recent initiatives to reduce the risk of clinical negligence arising in the first place.

In 1995 clinical risk management was an essential prerequisite for each health authority and NHS Trust to adopt in order to reduce the incidents in the hospitals. The introduction of risk management standards by the Welsh Risk Pool, together with motivation for trusts to comply with them, is a useful mechanism for trusts to organize better procedures in order to minimize the potential negligent incidents. The Welsh Risk Pool introduces an effective risk management system through the application of risk management standards and the settlement of legal claims. Also, the results of independent assessments of trusts' compliance with the risk management standards in 2000 show that there remain considerable scope for further improvement. Only five of the 15 trusts

achieved the benchmark of at least 75% compliance (Bourn, 2001). The National Audit Office Wales also found that the three standards correspond to the non-clinical errors and with lowest compliance across Wales can significantly contribute to incidents of clinical negligence. Furthermore, one of the most important risk management standards is that trusts should have incident reporting systems. Such systems are keys to gathering evidence about clinical error, in such a way that causes can be tackled. Progress by trusts in implementing adverse clinical incident reporting systems has been slow. Some Trusts, not only in Wales but nationally, are using IT technology in order to cover that gap and are using risk management IT software systems such as DATIX or Safeguard. Finally, each NHS Trust is paying a reasonable amount of money every year in order to educate its employees on risk management subject and the risk management software system. Based on the WRP findings there is no specific, accredited bespoke provision of training in health care risk management, apart from that delivered by independent consultants which is expensive to purchase. Furthermore, it is not provided through the medium of IT (which would allow for reduced time away from the workplace) and is not delivered through a guaranteed educational quality assurance accreditation framework. Therefore, the uptake of this type of training is intermittent due to constraints of time, expense and lack of accreditation.

Consequently, there remains scope for reducing the number of incidents in the hospitals in order to improve clinical care - and thus potentially reduce negligent incidents - through learning from experience. Furthermore, as a result of the government push for quality, risk management has been high on the NHS agenda since 1997. Tragic events in the NHS, where patients have been harmed and NHS have failed to learn from their mistakes (HMSO, 2001, Department of Health, 2000), have also ensured that risk management remains high in the agenda. Escalating costs of litigation in NHS over the last years are predicated to increase over the coming years and this has also prompted high level intervention.

## 1.2 The challenge and potential solution

At the moment, education and training for staff in NHS in Wales is provided by external consultants (which are costly) on an ad hoc basis with no strategic quality assured provision available. The risk management IT software systems currently used in NHS have reporting abilities rather than teaching abilities. It helps the NHS staff to transform the paper work into electronic form without helping them to really learn and understand how to manage the risks in their environments.

The Welsh Risk Pool (WRP) is a health risk pooling organisation with two main responsibilities. First a re-imburement function for compensatory claims against Welsh NHS Authorities/Trusts. This includes claims for clinical negligence, staff injury and other general risk. Second, a regulatory function to promote and maintain high quality risk management, using audit to measure compliance with WRP standards. WRP does not teach NHS staff how to manage risks in hospitals, but it provides guidelines on how to manage risks in the hospitals. Hence, NHS staff does not receive education on risk management and they do not develop the ability to make the correct decision about crucial risk management subjects in their working environment.

Obviously the lack of risk management knowledge is the main reason causing incidents in hospitals, and costs a lot of money and damage to NHS reputation. NHS and WRP have to find a cheap, attractive and effective way to provide NHS staff with risk management knowledge without adding extra work for them.

There is common agreement that companies and organisations in any sector are facing an increasingly competitive and dynamic business environment in which speed, information, knowledge and skills are seen as necessary elements of success (Bates 1995, Bastiaens and Martens 2000, Rosenberg 2001). Knowledge is seen as the most important success factor for the organisations. The significance of technologies during the industrial revolution, knowledge creation, knowledge management, and organizational innovations plays essential role as well in the future's businesses (Drucker, 1993).



Main part of an organisation power is the workforce. Skills and knowledge are essential elements of powerful workforce. Organisations spend a lot of money for their employees training and education in order to increase the workforce skills and knowledge level. Training and learning are essential ingredients for the management of this power from the organisation as it can improve employee's performance and corporate (Bates 1995; Marquardt and Kearsley 1999). Additionally, the individual employee's career competition in the organisations, targeting higher income, makes education and training more attractive or in some cases necessary in order to gain the needed knowledge and skills that will help the employee to reach the target (Brown 2001, Urdan & Weggen 2000, Rosenberg 2001).

The new technological innovations, especially in IT sector, helped many traditional services such as commerce, learning, shopping, etc to be transformed successfully into online services. Finally the development of the internet made the world a global neighbourhood in which anyone can instantly communicate with those from another country and that helped the evolution of methods that delivers learning and knowledge (Tipton 2005, Bastiaens and Martens 2000).

Thus, for WRP and NHS to solve the risk management issue, it may be necessary to shift away from the traditional ways of workforce training towards new approaches that better facilitate quick and effective learning with low cost. One approach that can be taken into consideration is the e-learning approach. In these years many organizations choose to use e-learning for the training of their workforce or for knowledge creation and dissemination. Many writers who are studying training and development suggested e-learning as an effective approach of workforce training and educating and they are exploring the benefits of it (Koprowski 2000, Chapnick 2000, Hartley 2000, Lim 2001, Salmon 2000, Hefzallah 2004, Urdan & Weggen 2000, Rosenberg 2001, Oliver & Herrington 2001).

The education and research literature contains a plethora of papers and studies (Fenn 2002; Fenn & Rickman 2001; Fenn et al. 2000; Towse et al. 2003, Pleasence et al. 2003) concerned with medical negligence and risk management in NHS. Many of these papers and studies provide helpful information and guidelines regarding many aspects in this field.

Although useful, there is no clear evidence of any effective solution which can help NHS to reduce the number of accidents in the hospitals. However, all of them highlight the importance of this issue and the needs of finding a successful solution.

The thesis aim is to contribute to actions designed to redress the rising cost of litigation and other financial compensation as a result of inadequate consideration of risk in NHS in Wales. This study will investigate a new software solution for the above problem.

### **1.3 Research questions**

The problem statement highlights a set of serious challenges in the field of medical negligence and risk management in the healthcare environment. Subsequently, these are formulated into four principal research questions that will be addressed in this dissertation.

- a. What solution, including risk management concept, will be the most appropriate and advantageous for the NHS to reduce the frequency of adverse incidents in hospitals?
- b. How can NHS staff gain deep learning about risk management with minimal distraction from their daily duties?
- c. What educational platform is required in order to provide education to healthcare professionals?
- d. What is the best pedagogical approach for teaching healthcare professionals in order to import deep knowledge about risk management?

### 1.3.1 Research goals

As highlighted the NHS are already using Technological solutions in many aspects of management. Furthermore with the government pushing research councils and encouraging researchers to investigate and develop Digital Economy solutions it seems appropriate and relevant to look to a software solution.

The overarching NHS clinical governance strategy aims at a reduction in adverse incidents in the health service. The reporting of adverse incidents and subsequent management is often constrained by a blame culture, the effect of which is to impede organisational progress towards active learning from clinical accidents. As highlighted, there is no specific, accredited, bespoke provision of training in health care risk management, apart from that delivered by independent consultants which it is not provided through the medium of IT which would allow for reduced time away from the workplace. Therefore, the uptake of this type of training is intermittent due to constraints of time, expense and lack of accreditation.

Consequently the main goal of this dissertation is to investigate and develop a software system that will address these challenges and help to reduce the number of adverse incidents in hospitals. The specific research goals of this dissertation are as follows:

- a. Develop a unique e-learning platform for healthcare professionals, which integrate with their daily work duties.
- b. The user of the system will be able to learn about risk management and apply warnings to real-time situations in their healthcare environment.
- c. The user of the system will be able to share experience and knowledge through the system with other users globally.
- d. Identify a pedagogy which will help the healthcare professionals to import deep knowledge about risk management.
- e. Identify and use best practices in e-Learning design and development

## **1.4 Contributions & Progression of the Work**

This thesis makes several contributions. (1) substantial background and related work material, pertaining to NHS and e-learning, (2) an e-pathway was developed, suitable for risk analysis for the NHS; (3) Detailed requirements for an e-learning risk management system were produced; (4) a prototype implementation was ideated, developed and implemented; and (5) a pilot implementation was created and evaluated.

The progression of the thesis was to follow a two stage process. In the first stage a prototype was designed, tested and evaluated (this is described in chapters 5, 6 and 7). In the second stage a pilot tool was developed. The prototype influenced and directed the development of the pilot application. Consequently, the overarching structure of the thesis is that chapters 2 and 3 provide background and related work; chapter 4 describes the software development and research methodology; chapters 5, 6 and 7 describe the prototype, chapter 8 the pilot application and chapter 9 concludes.

## **1.5 Dissertation structure**

The document is presented in eight further chapters. A reference section and an appendix session of the extra materials are also included at the end of the Thesis.

### **Chapter 2: Background**

This chapter presents background information, which is of direct relevant to this thesis. It provides comprehensive review of a particular body or bodies of literature relating to a subject or topic in a field in which this thesis is researching. This chapter provides information about the NHS and the impact of the serious issue of medical errors in the organisation. Furthermore, it identifies and explores the most significant solutions that have been applied in order to solve this serious issue. These solutions are the NHS investment on risk management software applications, the establishment of risk management in NHS and the creation of the Welsh Risk Pool organisation.

**Chapter 3: Background & Related Work -- E-learning**

This chapter investigates e-learning principles and technologies. Principally it contains two parts: a section on e-learning technologies that investigates various technologies from a broad perspective; and specifically investigates various Virtual Learning Environments (VEL's)

**Chapter 4: Software Development & Research methodology**

The chapter introduces the software system development methodology for this study and the software development life cycle (SDLC) model, which is identified for this development. It also outlines the research methodology chosen for the study which is used during the software development life cycle stages in order valuable in information to be collected.

**Chapter 5: Prototype Model Requirements**

The chapter lists the functional and non-functional requirements for the prototype model of the “risk-e” software application. The chapter explains how the system should react to particular inputs and how the system should behave in particular situations. The requirements have been gathered from potential customers by applying the chosen research methodology.

**Chapter 6: Prototype Implementation**

The chapter explains the design and the implementation prototype model and shows how the requirements are transformed through the software development life cycle into a software application. Best practises in e-learning design and development has been identified and applied on the system development. Pedagogy, HCI and design guidelines are drove the design of the system which is represented with UML diagrammatic notation. Finally, the chapter gives an overview of the look and feel of the system.

**Chapter 7: Prototype Testing and Evaluation**

This chapter describes the process of testing the functionality and correctness of the prototype model. It will also evaluate an attribute or capability of a program or system and

will determine if it meets its required results (customer's requirement). The implementation of the pilot model will be based on the findings of the evaluation of the prototype.

### **Chapter 8: Pilot Model Development**

This chapter discusses, explores and explains the pilot model development life cycle of the "risk-e" system. Pilot model is the new version of the "risk-e" software application after the prototype model. The pilot model development life cycle is based on the prototype model life cycle outcomes and it is tested in more realistic environment. The chapter lists the requirements of the system and discusses the design which is transformed into a software application. It also provides an overview of the look and feel of the system and analyses the results of the system's testing and evaluation.

### **Chapter 9: Summary - Conclusions**

This chapter presents the final conclusions from the study. The chapter commences with a discussion of the implications of the findings. Methodological and conceptual limitations of the study will then be outlined. This is followed by recommendations for future implementation, future research and an overall conclusion of the study.

## **1.5 Contributions**

A substantial part of the body of this thesis is made up of the first draft of a series of six papers, which have subsequently been submitted and presented as publication papers to international conferences. The co-authors are informed and hereby agree to that the author's contributions to the publications listed below will be used in this thesis for the PhD degree at University of Wales Bangor.

“Developing the learning organization through learning communities: the risk-e project”  
D. Jones, E. Bartholomew & C.Minas, annual all Wales Colloquium, Gregynog, Wales,  
UK, 2005

Author contribution to this paper has been 20%

“Introduction to risk management e-learning web-based tool for healthcare professionals”  
C. Minas, IASTED International Conference on Web-based Education, Puerto Vallarta,  
Mexico, 2006

Author contribution to this paper has been 100%

“risk-e: Learning elites and change agents in the NHS”. D. Jones, E. Dickinson, R.  
Edwards & C. Minas, International Research Conference Spring 2006, Risk Management  
Research & Practice: An Educational Perspective, Wales, UK.

Author contribution to this paper has been 25%

“Developing risk management software”. C. Minas, International Research Conference  
Spring 2006, Risk Management Research & Practice: An Educational Perspective, Wales,  
UK.

Author contribution to this paper has been 100%

“The risk management pathway: a web-based e-learning tool for healthcare professionals”.  
C. Minas & R. Edwards, 1<sup>st</sup> Nurse Education International Conference,; Developing  
collaborative practice in health and social care education, 2006, Vancouver, Canada.

Author contribution to this paper has been 60%

“The risk-e online collaborative learning platform”. R. Edwards & C. Minas, 1<sup>st</sup> Nurse  
Education International Conference, Developing collaborative practice in health and social  
care education, 2006, Vancouver, Canada.

Author contribution to this paper has been 40%

## ***Chapter 2***

### **Background & Related Work – the NHS**

#### **2.1 Objectives of this chapter**

Assessing risks and mitigating against those risks is an important concern for many large organizations. Risks occur at different levels of an organization, from grandeur decisions of the upper managers to day-to-day running decisions of the shop-floor workers. Because this thesis is investigating the concept of using an e-learning strategy to mitigate risk applied to the NHS, two principle areas require research: the NHS and e-learning. Thus this chapter provides background information about the NHS in order to highlight the size of the organisation, its history and its importance for the nation, and the impact of the serious issue of medical errors in the organisation. It covers aspects about the huge NHS investment on IT software systems for general purposes or specifically for risk management. It provides general information about risk management software systems and side effects and how these systems helped to reduce accidents in the NHS. Furthermore, it explains the role of risk management in the NHS and it evaluates the risk management strategy of NHS Trusts. Finally, it explains the role of WRP in NHS in Wales and the contribution of WRP actions to the fight against that important issue of accidents in the NHS.

#### **2.2 NHS**

##### **2.2.1 Overview**

The National Health Service or NHS, as it is more commonly known, was set up on July 5 1948 to provide healthcare for all citizens, based on need, not the ability to pay.

*“The NHS is a massive organization which employs nearly one million staff, often said in the days of the Soviet Union to rival the Red Army as the largest employer in Europe. As a pharmacist you will be one of those employees so it is important to understand how the NHS is organized.”*

Stephen Curtis (1999)



The NHS is a publicly funded health care system, with an anticipated expenditure of £76,144m in 2005/2006 that is raised through general taxation. The NHS is accountable to Parliament, and this accountability is exercised through the Secretary of State for Health and supporting Ministers.

The services provided are administered in three groups: general practitioner and dental services, hospital and specialist services, and local health authority services. General practitioners (GP), family practitioners or family physicians are medical doctors who give primary care to a group of people who register with them. GPs may perform minor surgery and/or obstetrics. GPs, as the dentists, operate in their own practices but are paid by the government like normal doctors, who are working in the hospitals. Their services are organized locally by an executive council. Hospital and specialist services are provided by professionals on government salaries working in government-owned hospitals and other facilities that are under the direction of regional authorities called hospital boards. Local health authority services provide maternity and child welfare, post-hospital care, home nursing, immunization, ambulance service, and various other preventive and educational services.

The NHS is funded by the taxpayer and managed by the Department of Health, which sets overall policy on health issues. It is the responsibility of the Department of Health to provide health services to the general public through the NHS. Smaller contributions are coming to support the NHS from local taxes, payroll contributions, and patient fees. The majority of NHS services are provided free of charge to the patient. The service has managed to provide generally high levels of health care while keeping costs relatively low, but the system has come under increasing financial strain because the growth of medical technology tended to make hospital stays progressively more expensive (Britannica, 2004).

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Please refer to original text to see this material.

needed. The NHS was to be funded out of general taxation and was to be based on the following principles:

- Free at the point of delivery
- Comprehensive
- Equity
- Equality

The aim of the NHS was to promote “the establishment of a comprehensive health service designed to secure improvement in the physical and mental health of the people of England and Wales and the prevention, diagnosis and treatment of illness” (1946 NHS Act).

Since 1948 the NHS has seen many changes both in the delivery of healthcare services and in the ways in which those services are structured and organized. Very significant changes occurred on each past decade from the growth period of the 1960s to the constraints of the 1970s and 80s right up to the current organizational and structural arrangements which shape NHS Wales today. More information about those changes on each past decade could be found on NHS official web site.

### **2.2.3 NHS in Wales**

Three million people live in Wales and use the services of the NHS. Based on statistical figures, Wales has some of the highest rates of cancer and heart disease and has a high proportion of elderly people, which makes the NHS services very important here. Furthermore, the delivery of health services in Wales also has to take into account the mix of countryside, city and valley areas that exist across the country, which makes the delivery of health services more difficult.

For the last 30 years Wales has a different policy from England and Scotland but these powers have been significantly advanced by the advent of devolution. The Government of Wales Act of 1998 gave authority and powers over a number of areas including education, agriculture, social services, local government and health services to the National Assembly for Wales. The first elections to the Assembly took place in 1999 and from this the Welsh Assembly Government was formed (NHS, 2005).

The Minister for Health and Social Services is one of the most important people within the Welsh Assembly Government, who holds main responsibilities for both health and social care. The Health and Social Services Committee, which is composed of assembly members from all of the political parties, contributes to the development and examination of health and social care policy. Civil servants including those with professional backgrounds provide support to the Minister and the government in formulating and implementing health and social care policy.

### **Wales NHS Structure**

The NHS structure is too complicated, not only in Wales but generally, as the NHS is a huge organization with millions of employees and millions of roles and responsibilities. The main structure of NHS in Wales is described on the official web site and it tries to draw a basic picture. The important structures and procedures for the Assembly are laid down in the Government of Wales Act of 1998. The more detailed processes are set out in the Assembly Standing Orders. The Assembly is chaired by the Presiding Office who is the equivalent of the Speaker in the House of Commons and who is elected by the whole Assembly.

The 60 members of the Assembly delegate their executive powers to making and implementing of decisions and laws to the First Minister who is elected by the whole Assembly and therefore usually represents the largest political party. The First Minister in turn delegates responsibility for delivering the executive functions to a number of Assembly Ministers and together they form the Assembly Cabinet. There is a specific Minister for Health and Social Services (NHS, 2005).

Assembly members from all parties are able to express their opinions as to how each of the areas of responsibility of the Assembly should be dealt with by the executive. They do this mostly through Subject Committees which develop policies and examine what the Assembly does. Members are elected to serve on Subject Committees so that the balance of political groups in the Assembly is reflected, as far as practicable, in the membership of the committee. There is a Committee for Health and Social Services (NHS, 2005).

The powers of the assembly have recently been reviewed by the Richard Commission. Appointed by the First Minister of the National Assembly for Wales the commission reviewed:

- The scope of the Assembly's powers; whether they are adequate to meet the needs of Wales
- The number of elected Assembly members and their method of election

### **Wales NHS Staff**

The NHS in Wales employs some 90,000 staff which makes it a huge employer in Wales. The NHS is a labour intensive service and its pay bill accounts for at least 75% of its total annual cost. NHS Staff are drawn from many professions and occupational groups and work in a variety of settings across Wales. In addition to staff employed directly by the NHS there are contractor professions including dentists, opticians, pharmacists and nearly 2,000 General Practitioners (GPs) who predominantly work in primary care settings.

### **Wales NHS Trusts**

There are about 400 NHS trusts in the UK and these are responsible for the management of hospital services, community health services, and ancillary services such as ambulances. There are 14 NHS Trusts in Wales, including one all-Wales Ambulance Trust. Between them, the Trusts manage 135 hospitals and some 15,000 beds. Half a million people - a sixth of the population - will have a hospital stay in any given year (Mason, 1999).

## **2.3 Medical Errors**

### **2.3.1 Human error**

Reason (2000) stated that there is a common view that error is a result of 'aberrant mental processes such as forgetfulness, inattention, poor motivation, carelessness, negligence and recklessness'. Therefore the human becomes the risk and is blamed for adverse incidents.

Heinrichs' study (1941) of 75000 insurance claims as a result of accidents, found 5 factors in the accident sequence:

- 1 Ancestry and social environment
- 2 Fault of person
- 3 Unsafe act and/or unsafe mechanical or physical hazard
- 4 Accident
- 5 Injury

This is a hierarchy whereby one leads to another until accident occurs. Injury results from an accident, which results from an unsafe act or physical hazard, which comes about as a result of a fault by a person, who is shaped by social environment and ancestry. Heinrich felt the key was number 3 from the above list and the main element of this was unsafe acts.

Culvenor (1997) in his literature review identified that early risk managers held the belief that if human mistakes could be reduced then no adverse incidents would occur. Therefore risk management methods were an attempt to change a person's behavior. Glendon and McKenna (1995) supported this, looked at human error and stated that in some cases trial and error is fine – in other, where for example we are in charge of another person's life or wellbeing, it seems unreasonable to learn by trial and error.

As the majority of accidents are explained by human error this becomes a convenient label to explain and in a way justify mistakes. It was argued that there are a number of ways to overcome human error and the importance of constant evaluation of tasks to identify and manage risks.

### 2.3.2 Medical Errors in NHS

***“A patient safety incident is defined as: 'any event or circumstance arising during NHS funded care that could have or did lead to unintended or unexpected harm, loss or damage to one or more patients”***

Knox (2001)

The vast majority of NHS care is safe, but mistakes do happen, sometimes with tragic consequences.

***“Medical errors ‘kill thousands’”***

18/04/2000, [bbc.co.uk](http://bbc.co.uk)

***“Teenager given wrong drug dies”***

01/02/01, [Guardian](http://Guardian)

***“Cancer boy dies after blunder over injection”***

03/02/01, [Daily Mail](http://Daily Mail)

***“Injured nurse wins £414,000 damages”***

17/10/02, [Guardian](http://Guardian)

***“£20 million for dancer paralysed in childbirth”***

15/10/02, [Telegraph](http://Telegraph)

***“Brain damaged girl gets £3.2m”***

19/02/2004, [bbc.co.uk](http://bbc.co.uk)

***“Over 2,000 ‘die from NHS errors’”***

03/11/2005, [bbc.co.uk](http://bbc.co.uk)

***“Blunders by NHS kill thousands of patients each year”***

by Beezy Marsh and Tom Harper 28/08/2006, [telegraph.co.uk](http://telegraph.co.uk)

***“Dad dies after doctors miss cancer 37 times”***

by JAYA NARAIN, 14/04/2006, [Daily Mail](http://Daily Mail).

***“Teenager who was given massive radiation overdoses dies”***

by BETH HALE, 19/10/2006, [Daily Mail](http://Daily Mail).

Many similar articles are published every year based on many accidents that occur in hospitals. Those articles describe medical errors in hospitals, which in many cases have fatal results and every time, every year those articles try to remind us of the major problem of accidents in hospitals. A big list of Systematic mistakes in the Health Service that is published from many different sources can be found on the Campaign for Health Service Democracy web site (Williams, 2005).

Some medical errors are very simple but some others are very serious mistakes. Of course the result of an error is mixed, even for a very simple medical error the result can be fatal, as for a very serious medical error the results cannot be fatal. One patient died after

air was allowed to enter a vein through a drip, one had forceps left inside, another received the wrong set of lungs during a transplant, while a man had the wrong testicle removed and a woman underwent an unnecessary hysterectomy. That kind of medical error shows clearly that the system is not working properly and wrong information is transmitted.

Furthermore a medical error can affect many people at the same time, even NHS staff. A few years ago it was reported that more than a 1,000 patients may have been wrongly diagnosed with heart problems after a technician at a hospital in Bury, Lancashire, misinterpreted ultra-sound tests. Also a consultant radiologist at Trafford General Hospital in Manchester was reported to have mistakenly given 22 breast cancer sufferers the all-clear.

### **2.3.3 Most Common Error**

According to NPSA the most common error in primary care (50% of cases) was a failure or delay in diagnosis. Other common errors included medication prescription errors, failure or delay in referral, and failure to warn of, or recognize, side-effects of medication (each around five per cent). Not all of these errors result in serious harm. However, 21% of the outcome of these errors in primary care was the death of the patient and other outcomes included deterioration in clinical condition (6%) and unnecessary pain (4%).

In another UK study in 2003, 101 events were used from Rubin et al (2003) in order to create an initial error classification. 940 errors were recorded in a single two week period from 10 practices. The overall error rate was 7.5% (75.6 per 1000 appointments). The errors were classified into six categories; 42% (397/940) were related to prescriptions, 30% (282/940) were related to communication errors, 6% (22/397) were related to medication errors and 3% (24/940) were related to clinical errors (Rubin G et al., 2003).

### **2.3.4 Medical Errors with numbers**

*“The most recent survey of NHS standards shows that there are now almost one million incidents and lapses in hospital care annually.”*

Daily Mail on 07/02/2006



According to the National Audit Office, there are around 2,000 avoidable deaths every year in the NHS, while another 5,000 patients die annually from infections acquired in hospital. This may be a conservative estimate. An official report last year said that up to 34,000 patients a year may die because of medical mistakes.

The editor of the BMJ, Dr Richard Smith told BBC Radio 4's Today programme: "Probably 20-30,000 people a year in Britain die of medical errors but then of course many more will be injured and suffer other consequences."

Thousands of patients are dying needlessly every year because of blunders by NHS staff, a report that a Government watchdog has revealed. A total of 2,159 people died after serious lapses in care by hospitals, family doctors' surgeries, ambulance trusts, and in community and mental health care last year. A further 4,529 patients suffered severe harm because of avoidable mistakes, the National Patient Safety Agency (NPSA) said.

*"The system of recording serious incidents involving patient safety started after a study in England found the NHS was poor at learning lessons when mistakes were made."*

"Patient death figures released", [bbc.co.uk](http://bbc.co.uk), 31/04/2005

*"We can only prevent these problems if we learn..."*

NHS National Patient Safety Agency

Annual NHS clinical negligence expenditure rose from £1 million in 1974/75 (£6.33 million at 2002 prices) to £446 million in 2001/02. The following table illustrates the estimated cost of accidents in the NHS over the last decade. Available information has been collected from very accurate sources such as NHS, WRP, NHLS, NAO, BBC, National Statistics, etc but none of them can calculate the yearly cost of accidents in the NHS with 100% accuracy.

Year	NHS England		NHS Wales	
	Paid out	Legal bill	Paid out	Legal bill
1996-97	£235m	-	-	-
1997-98	£144m	£1.3bn	£11m	-
1998-99	£130m	£2.3bn	£24m	-
1999-00	£373m	£3.2bn	£26.9m	-
2000-01	£415m	£3.9bn	£10.4m	£40.9m
2001-02	£446m	£4.4bn	£18.6m	£92m
2002-03	£446m	£5.25bn	£23m	£78m
2003-04	£423m	-	£25m	-
2004-05	£503m	£8bn	£37m	£145m
2005-06	£560m	£21bn	£42m	-

Table 1: NHS (England – Wales) Cost of Accidents 1996-2006

## 2.4 Risk Management in NHS

### 2.4.1 Risk

Risk, generally defined in terms, is something uncertain and uncertainty carries some adverse effects. In other words, risk is made up of probability of occurrence (uncertainty) and severity of consequence (adverse effects). Science and the Determination of Safety defines risk as "*A measure of the probability and severity of adverse effects*"

The term "Risk" has been used in many different applications. It can be applied to safety and it can also be applied to business investment (business risk, project risk etc.). Risk normally refers to something that is "uncertain"; and that uncertainty normally carries a loss or adverse effect. However, in the context of health and safety management, the meaning of "risk" mainly refers to risk of having accidents, risk of having harms.

*“Risk is a concept that denotes a potential negative impact to an asset or some characteristic of value that may arise from some present process or future event.”*

Wikipedia – “risk”, The free encyclopedia, 2007

Risk is present in any organization in relation to its service and business activities, people, management and support systems, buildings, equipment and supplies. Within the NHS risk generally has been identified as: "*anything that could prevent the organization from meeting its objectives*" and more specific as "*a risk is the probability or likelihood that harm may occur, coupled with the consequences of that harm*". In NHS risk can be

associated with people (patients, visitors and staff), buildings and estates, equipment and consumables, systems and management. Another more general term of risk has been given in the Australian Standard about Risk Management used by NHS:

*“risk is the chance of something happening that will have an impact on objectives. It is measured in terms of consequence and likelihood.”*

AS/NZS 4360:1999 Risk Management (The Standard)

### **2.4.2 Risk Management**

Risk management is the term to describe a process which is concerned with the identification, understanding, evaluation, control and minimization of risks in any organization in any sector. This process includes management plans, strategies and techniques that can be used for the above purposes. Risk management is also very important for NHS as it is a process that helps to reduce accidents in hospitals and it has significant impact on the NHS over the last years.

*“Risk management is the culture, processes and structures that are directed towards the effective management of potential opportunities and adverse effects.”*

AS/NZS 4360:1999 Risk Management (The Standard)

*“Risk management is the term applied to a logical and systematic method of establishing the context , identifying , analysing , evaluating, treating, monitoring and communicating risks associated with any activity, function or process in a way that will enable organisations to minimise losses and maximise opportunities. Risk is as much about identifying opportunities as avoiding of mitigating losses.”*

AS/NZS 4360:1999 Risk Management (The Standard)

### **2.4.3 NHS Trust Risk Management Strategy**

Based on the statistics and the daily evidence of accidents in NHS it is obvious that lessons are not always learned from incidents in hospitals. This means that the same mistakes are made more than once. These mistakes can cause unnecessary injury to patients, financial cost to the Trust and damage the Trust reputation. There has been recognition at a national level that Trusts should have systems in place to learn from incidents or potential incidents.

There are a number of external assessment schemes, including controls assurance, WRP, which require hospitals to put in place robust systems to deal with risks.

The NHS recognizes that identifying risks and managing these well provides the ability to improve patient care and especially avoid accidents in Trusts. The NHS is trying hard in the last years to place a system, a set of procedures and activities, which will help NHS to identify and manage risk inside the Trusts. The NHS also recognizes it is vital to develop systems and procedures, which identify and minimize risks to patients, visitors, staff and others, if it is to achieve its commitment to providing high quality care.

Based on all the above each Trust in NHS is responsible to develop a Risk Management Strategy, which will be continuously developed and it will delegate tasks and responsibilities to all people in the Trust, as anyone is responsible for risks. This strategy will also be developed as risk management becomes a more central part of the way hospitals work.

The aim of the Trust's risk management strategy is to develop and maintain a clear and effective structure of responsibility and accountability across the whole Trust, together with clear systems for identifying and managing risks. So that all Trust employees will be able to play their part in dealing with risk, leading to measurable improvements in patient and staff safety.

The evaluation of risk management strategy in NHS will give the opportunity to better understand how NHS is trying to deal with the problem of the high number of accidents in hospitals. In order to evaluate the Risk Management Strategy in NHS Trusts, 20 Risk Management Strategies from 20 different Trusts in Wales and 20 Risk Management Strategies from 20 different Trusts in England & Scotland were chosen randomly (Table 2). Based on each of their "risk management strategy and policy" document, all the most important and common elements were collected, in order to understand the core of risk management strategy in NHS.

Trusts in England and Scotland	Trusts In Wales
Bedfordshire Bristol North NHS Trust Buckinghamshire and Oxfordshire Central Manchester Derby Nottingham City Dudley East Kent East Leads East Somerset Eastern Birmingham Greater Glasgow Luton and Dunstable Newcastle, North Tyneside and Northumberland Mental Health NHS Trust North Sheffield Orkney NHS South Birmingham South Devon South Western Staffordshire Surrey and Sussex Telford and Wrekin Torbay NHS Trust York Trust Wrightington, Wigan and Leigh NHS Trust	Bridgend Cardiff Ceredigion and Mid Wales NHS Trust Conwy Denbighshire Trust Erewash Flintshire Heath Port Talbot Lincolnshire NHS Trust Monmouthshire Newport North Glamorgan Trust Pontypridd and Rhondda Powys Rhondda Cynon Taff Swansea Vale of Glamorgan Worcestershire Partnership Trust Wrexham

Table 2: List of NHS Trusts

#### 2.4.4 Responsibilities

All employees in the Trust are responsible for the risks in their organization. They have the responsibility to be aware of and apply risk management principles in their working environment. They should be aware that they are working in accordance with all Trust risk management policies and procedures. They should also be aware of and discharge their duty under legislation to take reasonable care for their own safety and the safety of all others who may be affected by the Trust's business. Furthermore they should comply with the standards of any relevant professional bodies.

Each trust is responsible to develop its own risk management strategy and to create its own organizational structure that supports that strategy. Based on the evaluation of 40 different Trust organization structures that has been included in Trust risk management strategy documentation, common roles with important responsibilities were found.

**The Board**

The Board manages the Trust's affairs efficiently and effectively through the implementation of internal controls to manage risks. The Board's main responsibility is to ensure high quality patient care. The members of the board should monitor and review the effectiveness of internal controls such as financial, organizational clinical and non-clinical. They also monitor the performance and ensure objectives are achieved.

**The Chief Executive**

The Chief Executive leads the department, in delivering strategies and managing operational delivery. The Chief Executive has also executive responsibility for ensuring effective systems of risk management, controls assurance and internal controls are in place.

**All Clinical and Executive Directors**

The Clinical and Executive Directors are responsible for leading or delegating leadership responsibility for risk management to key staff within their department. They will ensure systematic identification and assessment of risks, documentation of the directorate risk register and action plans, and linking to Trust monitoring and advisory services, including the Director Management Team and the Governance Committee. There are also individual directors in different posts such as medical director, director of nursing and governance, director of community care, director of finance, director of facilities, director of personnel, director of specialist services etc, based on the structure and strategy of the Trust. All directors and heads of departments are playing their individual role within their directorates or departments in accordance with the risk management strategy of the Trust. They have specific responsibility for managing risk.

**Risk Manager**

The Risk Manager is a person with excellent knowledge and long experience about risk management. He/she is responsible for providing advice on and facilitating the effective management of risks. The Risk Manager responsibilities include establishing risk management systems and processes but also their maintenance.

## **Committees**

There are also many different committees in the Trust structure that support the Trust's risk management strategy and they also play an important role with important responsibilities on specific areas of risk management.

### **Risk Management Committee**

The Risk Management Committees' responsibility is to develop and ensure the maintenance of a strategic risk management system. It will coordinate and categorize organizational, commissioning, clinical and non-clinical risk and report to the Board. The Risk Management Committee will ensure that procedures are in place in order for the risk management strategy to be applied effectively.

### **Clinical Governance Committee**

The Clinical Governance Committees' main responsibility is to provide assurance of effective clinical governance. Clinical Governance Committee should be assured that the Trust has appropriate procedures in place for effective internal review and management of clinical governance. Furthermore, it is responsible for clinical aspects of risk, complaints and critical adverse events.

### **Audit Committee**

The Audit Committee is responsible to provide the Board with an assurance that the systems are in place for risk management and are operating efficiently and effectively. The Committee will also provide an objective review of the Trust's corporate governance responsibilities, financial systems, financial information used by the Trust and compliance with law, guidance and codes of conduct.

## **2.4.5 Risk Management Process**

Risk management is a complex process, where appropriate aspects are carried out by a team of experts. It is an iterative process of continual improvement. The steps of the risk management process are shown in the figure below.

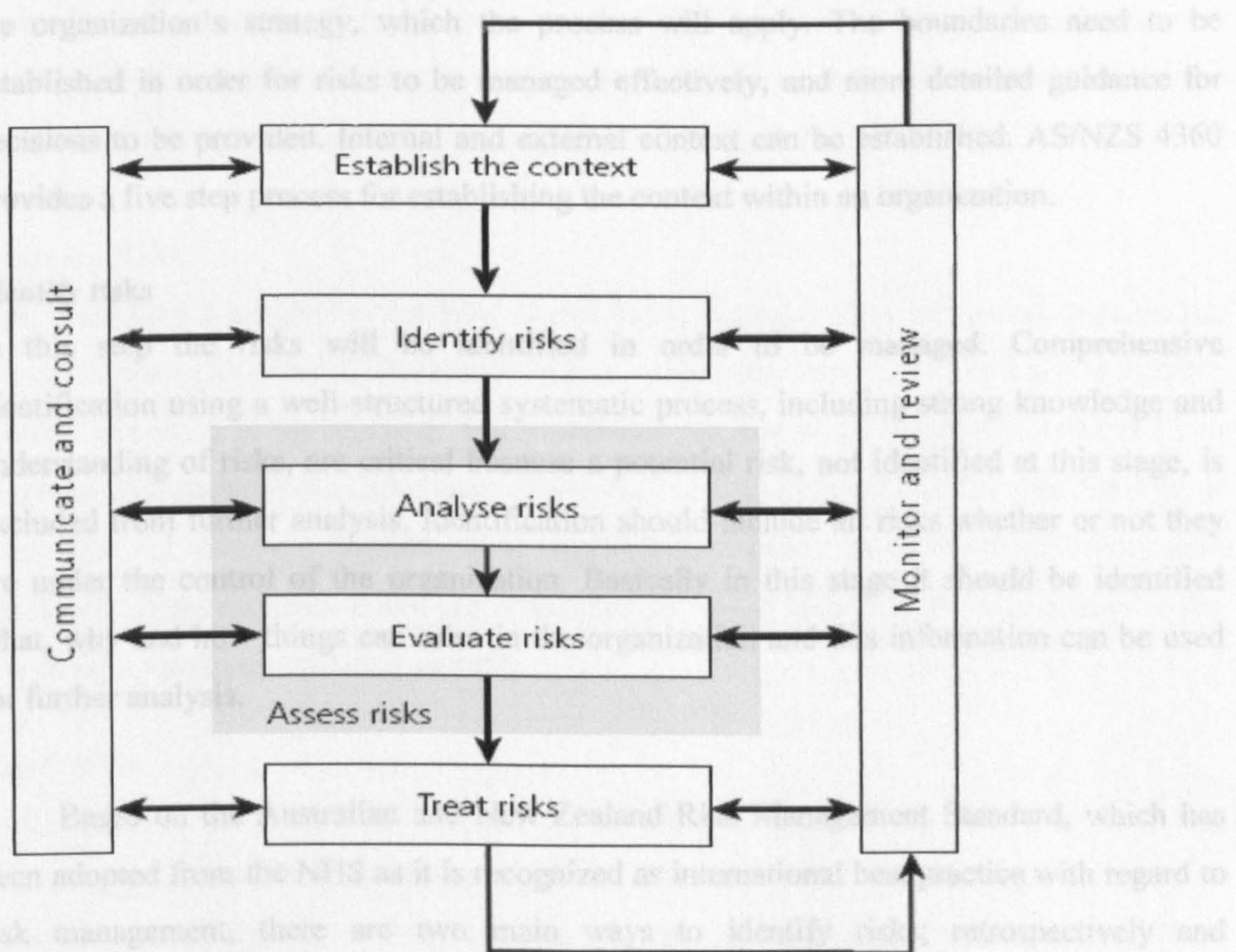


Figure 2: Risk Management process

Risk management process consists of 5 main steps, which are passing information to “Communicate & consult” and “Monitor & review” sets of activities. It is also another way to link these steps together. “Communicate & consult” is one of the most important aspects of risk management and for this reason it is integral to the entire risk management process. It aims to identify who should be involved in the whole risk assessment. “Monitor & review” is equally important and integral to the entire risk management process. The risk management board must monitor risks and review the effectiveness of the treatment plan and strategies. Risks need to be monitored periodically to ensure changing circumstances do not alter the risk priorities. The risk management plan should also be reviewed annually. The main elements of risk management process are:

#### Establish the context

Risk management process starts with “establish the context” step. Each organization considers that risk management process has to establish some boundaries within, based on



the organization's strategy, which the process will apply. The boundaries need to be established in order for risks to be managed effectively, and more detailed guidance for decisions to be provided. Internal and external context can be established. AS/NZS 4360 provides a five step process for establishing the context within an organization.

### **Identify risks**

In this step the risks will be identified in order to be managed. Comprehensive identification using a well-structured systematic process, including strong knowledge and understanding of risks, are critical because a potential risk, not identified at this stage, is excluded from further analysis. Identification should include all risks whether or not they are under the control of the organization. Basically in this stage it should be identified what, why and how things can arise in the organization and this information can be used for further analysis.

Based on the Australian and New Zealand Risk Management Standard, which has been adopted from the NHS as it is recognized as international best practice with regard to risk management, there are two main ways to identify risks; retrospectively and prospectively. Retrospective risks are those that have previously occurred, such as accidents or incidents. It is the easiest and most common way to identify risks. Prospective risks are often harder to be identified. These are things that have not yet happened but might happen sometime in the future. SWOT analysis is recommended as a risk identification tool.

### **Analyze risks**

In this step the risks are prioritized based on their level. The level of each risk is calculated based on the risk consequences and likelihood. The minor acceptable risks will be separated from the major risks. In this step the proper data will also be collected and provided; this data will be used in the risk evaluation and treatment. Risk analysis involves consideration of the sources of risk, their consequences and the likelihood that those consequences may occur. Factors, which affect consequences and likelihood, may be identified. Risk is analyzed by combining estimates of consequences and likelihood in the context of existing control measures. Australian and New Zealand Risk Management

Standard recommends 3 types of risk analysis; qualitative, semi-quantitative and quantitative. More information regarding the types of risk analysis can be found within the Australian and New Zealand Risk Management Standard (HB 4360:2004).

### **Evaluate risks**

Risk evaluation is comparing the level of risk found during the analysis process against the pre-established risk criteria. The results of the comparison show if the risks are acceptable or need treatment. If the levels of risk established are low or tolerable, then risks fall into an acceptable category and treatment is not required. If risks do not fall into the low or acceptable risk category, they should be treated with a different way in order to reduce the likelihood of the occurrence and the consequences which help the risk to be placed in the low or acceptable risk category as well.

### **Treat risks**

Risk treatment is identifying options for treating or controlling risk, preparing risk treatment plans and implementing them in order to lower the risk into the low or acceptable risk category. In order to lower the risk into this category its level should be reduced by reducing or eliminate negative consequences, or reducing the likelihood of the adverse occurrence.

#### **2.4.6 Risk Assessment Tool**

Having identified the risks in the previous stage of the risk management process, it is necessary to assess and prioritize the risks. The assessment of risk could be based on two factors:

- i) The estimated **likelihood** or likely frequency of an adverse event happening
- ii) The estimated **severity** of the most probable consequence of the event happening

In order to indicate the estimated levels of risk, most of the Trusts adopted and added in their risk management strategy a scoring system based on the Australian Standard matrix (AS/NZS 4360:1999). Based on that standard the score ratings can be given for the

frequency of an event and the severity of the outcome. Then by multiplying the two scores, a rate for the level of risk is produced.

Risk factor= Consequences x Likelihood

All risks will be assessed against the agreed matrix to ensure consistency in the risks profiling across the organization. Risk Factor will be used to determine the quantifiable risk level. A risk factor can be determined ranging from 1 (low severity and likelihood rare) to 25 (almost certain to happen with catastrophic consequences).

The likelihood is to be scored on a scale of 1-5 in accordance with the following grid. The severity of consequence is to be scored on a scale of 1-5 in accordance with the following grid.

Likelihood	Consequence					Very Low
	1	2	3	4	5	
1	1	2	3	4	5	Low
2	2	4	6	8	10	
3	3	6	9	12	15	Moderate
4	4	8	12	16	20	
5	5	10	15	20	25	High

Table 3: Risk Classification matrix  
(source: Health Care Standards Unit, 2004)

#### Likelihood Table

Level	Descriptor	Description
1	Rare	Event could occur but in exceptional circumstances
2	Unlikely	Event could occur at some time
3	Possible	Event might occur at some time
4	Likely	Event will probably occur in most circumstances
5	Certain	Event is expected to occur in most circumstances

Table 4: Likelihood Table  
(source: Health Care Standards Unit, 2004)

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## 2.5 Welsh Risk Pool

The Welsh Risk Pool (WRP) is a health risk pooling organization with two main responsibilities. Firstly a re-embursement function for compensatory claims against Welsh NHS Authorities/Trusts. This includes claims for clinical negligence, staff injury and other general risk. Secondly, a regulatory function to promote and maintain high quality risk management using audit to measure compliance with WRP standards.

WRP is working as a mutual self-insurance scheme designed to cover NHS bodies in Wales. Membership is not essential but most of the Trusts and Health Authorities in Wales are currently WRP members. WRP offers a scheme that covers clinical and non-clinical risk issues such as staff injuries and physical assets. NHSLA plays the same role with similar responsibilities with WRP but it is designed to cover NHS bodies in England.

At this point it should be cleared that WRP does not manage claims for its member, the NHS Trust. This task is undertaken by the claims managers within each Trust and Health Authority in conjunction with legal representation (either contracted solicitors or Welsh Health Legal Services).

The most important responsibility of Welsh Risk Pool is to assist Welsh NHS Trusts and Local Health Boards (LHBs) with the introduction of effective risk management systems, through the application of risk management standards and the settlement of legal claims. WRP is playing a leading role in promoting effective risk management across NHS in Wales. A number of risk management standards are being developed specifically for the health authorities. The risk management standards combine clinical aspects like clinical audit and non clinical aspects, based on controls assurance standards. WRP has established a Risk Manager Network to disseminate best practice between the Welsh NHS Trusts. Members of the WRP scheme have to be assessed annually against a range of the standards in order for the safety of patients, visitors and staff to be improved. WRP has developed an assessment process, which is applied from a team of assessors in each WRP member. The current standards have incorporated the Controls Assurance project. The number will increase as new standards are developed,

thus ensuring that health organisations in Wales have only one set of comprehensive standards.

### **2.5.1 Assessment Process**

The external review undertaken by the WRP assessors concentrates on the principle areas of risk within the organization. The annual external assessment of Trusts is based on those standards selected for review by the WRP (currently standards 1 to 22). A compliance score of 75% (collectively) is the present level (this may change over time) of achievement that Trusts must attain to obtain a reduction in excess level of £5,000. In subsequent years the review may incorporate further standards as required.

WRP are spending around 5 days in order to complete the assessment process for one Trust. The assessment is undertaken at the Trusts' site. The assessors have to review the documentation (portfolio with evidences and reports) and they have to interview key staff of the Trust. The assessment is principally concerned with ensuring that processes are in place to manage risk.

At the end of the assessment visit WRP is sending a report to the Trust, which highlights the criteria where further work is needed to attain compliance. The report also comments on areas of good practice as a positive feedback, which will motivate people to continue improve safety in the Trust and to keep them on the correct track. The report of each Trust is not available to other organizations from WRP.

Additionally to the above assessment process performed by WRP assessors, the health bodies are expected to self-assess against all Welsh Risk Management standards on an annual basis and it is beneficial before the WRP assessment visit. The results of the self-assessment and action plans are reported to the National Assembly for Wales.

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WRP observed, based on the assessments over the last years, that risk management education or practice is missing from NHS. Furthermore, WRP believes that this is one of the main reasons for the high number of accidents in the hospitals.

## **2.6 IT in NHS**

NHS invested and still is investing reasonable amount of money on new IT systems. As an example the final cost of electronic health record computer software system could rise to between £18.6bn and £31bn, when the declared cost was £6.2bn (BBC News – Warning of Major NHS IT overspend, 2004). NHS also invested on risk management software systems such as DATIX and Safeguard System. Unfortunately, for security reasons only NHS staff with specific permission have access to these software system and the evaluation their functionality was difficult from people outside NHS. The evaluation of DATIX and Safeguard systems has been performed based on information about their functionality that has been collected from their web sites and comments from key NHS staff, who used the software applications before.

### **2.6.1 DATIX Software**

#### **Overview**

DATIX is a software system for Staff and Patient Safety in Healthcare, used by more than 75% of the NHS as well as private healthcare providers. DATIX was founded by Brian Capstick, one of the UK's leading healthcare lawyers acting for hospitals and so has benefited from over twenty years' experience of defending more than 20,000 claims arising from staff and patient safety incidents. DATIX is a healthcare risk management software to create a comprehensive picture of organization's risks by integrating information from patient safety incidents with complaints, claims, PALS and Health & Safety incidents that affect staff and visitors as well as patients. The system allows these risks to be prioritized and the Board to be fully assured that the Trust's principal risks are adequately controlled.



## **DATIX Main Facilities**

DATIX provides the users with a huge range of useful facilities which have been built day by day during the last years. An overview of the most important and useful facilities of DATIX system as described on the official web site are:

### **Safety Alerts**

The DATIX Safety Alerts module allows users to manage the dissemination of safety information within their organization, collating responses from their staff and producing performance reports to inform the organization Board.

### **Incidents Reporting**

DATIX enables the collection and analysis of data in a meaningful and easy to understand format based on a coding system for clinical and non-clinical adverse events.

### **Risk Register and Assurance Framework**

DATIX Risk Register Assurance Framework is the most important facility of the system which is direct related with risk management. The facility enables users to identify and prioritize the risks in their organization. The Board has also access to the system and the Board members can be fully aware about the Trust's risks and they can be assured of the risks control.

The DATIX risk register records not only "reactive" risks, identified from incidents, complaints, claims and PALS, but also "proactive" risks, which have come from other sources. Information about risk assessments can be entered at all levels by NHS staff, even using DATIXWeb. Risk registers can be maintained for a hospital, directorate or even ward, feeding upwards to the Trust risk register.

### **Standards**

DATIX Standards software is part of DATIX Risk Management, which means the users can benefit by linking standards with the reporting of incidents, complaints or claims. This will allow the users to see where improved compliance with standards could reduce the number of staff and patient safety incidents. Standards can also be linked to the Risk

Register and Assurance Framework, enabling users to assess the risks associated with failure to comply. Furthermore, DATIX Standards software enables the Trust to manage compliance with healthcare standards. Users can record and retrieve the evidence their required to support inspections and their declaration of compliance with Standards for Better Health.

### **Complaints**

This feature of the DATIX system provides users with the appropriate tools in order to help them to manage and monitor the complaints process from initial receipt stage to conclusion or review stage. It is also ensuring them that they will meet targets by automatically generating acknowledgement and final reply letters when they are due. Furthermore, it includes a wide range of standard reports, which helps users to analyse the complaints and report on their performance. Finally, the DATIX system keeps records about the members of the staff and it is able to provide information where the same member of staff has been involved in multiple complaints. This ability is very useful to the managers and according to the Training Records tool they can see where additional training may be required.

### **(PALS) Patient Advice and Liaison Service**

All NHS Trusts and PCTs have a statutory duty to monitor and improve quality of healthcare. With DATIX PALS managers can provide a comprehensive monitoring service and pinpoint areas where improvements are needed. Information from the Patient Advice and Liaison Service may be combined with Risk Management data from other DATIX modules (DATIX, 2005).

### **Claims**

DATIX Claims Management provides information users need to manage their legal caseload. It meets the reporting requirements of the NHSLA and is regularly reviewed to ensure its continuing compliance. DATIX provides a comprehensive suite of reports that enables managers to keep their Board and Directorates up to date with their liabilities.

### **Inquest Management**

The DATIX Inquest Management module gives all the tools the managers need to help manage the inquests in which their Trust is involved. DATIX records all the personnel involved in the inquest, including the coroner and coroner's officer, the pathologist and any staff at the Trust.

### **Training Records**

Workforce is the power and the key to success for each organisation. DATIX Training allows HR to create a skills profile of the staff. Managers can see what training the staff has received, while keeping track of those who have missed sessions or require retraining. The software provides the ability of training scheduling for specific members of staff or groups of staff of particular grades or at certain locations. The system will also identify where a member of staff lacks a required skill and can automatically inform the manager or schedule their attendance on a course. The DATIX Training module is fully integrated with the other modules of DATIX Risk Management software in order to exchange information. So, if a member of staff is involved in an incident, it will be possible to see at a glance if the lack of a skill or failure to attend a course could have been a contributory factor. Furthermore a member of staff could be scheduled to attend a relevant training course in order to cover the gap of knowledge, which probably causes the member's involvement in the incident.

### **Datix Common Classification System (CCS)**

This is a useful and powerful sub-system that DATIX provides to the users (NHS staff). This sub-system provides 3 main facilities:

#### Classification of safety Incidents

This is a sophisticated module of the Datix Common Classification System (CCS). It helps users to identify failures that are remediable at the level of healthcare system from the evidence of incidents accumulating in the database. The CCS comes fully integrated with the coding system (or taxonomy) developed by the National Patient Safety Agency

for the UK's National Reporting and Learning System (NRLS), but includes three important extensions (DATIX, 2005).

### Patient safety

The patient safety module of the system provides users with a variety of different tools in order to help them to improve the patient safety. One component of the systems helps NHS staff to identify, based on the evidence, the diagnoses and clinical procedures which commonly give rise to serious patient safety incidents. These are often in obstetrics, accident and emergency medicine or surgery. Another component of the system helps users to classify the more common clinical errors, such as delays in diagnosis or unintended damage to structures during surgery. The system is linked with a database of more than 20,000 clinical negligence claims and may be used to classify and learn from litigation claims as well as incidents.

### Correctable causes of safety incidents

This is another important module of the CCS, which provides the user with a screening tool for the "correctable" causes of serious safety incidents. These are failures in the processes for the delivery of healthcare which can be remedied by action of the proper people at local level. The screening test option can be rapidly applied incident by incident and provides a valuable aid to causal analysis. The identification of remediable causes in this way is essential if incident reporting is going to point the way to action that may be taken at local or national level to improve the safety record. The accuracy of the recommendations will affect the system's reputation but it can also cause fatal problems to the NHS (DATIX, 2005).

### **Staff Health and Safety**

Health and Safety is a very important subject for the staff protection of each organisation. The Correctable Causes of Safety Incidents tool covers health and safety incidents that affect staff and in some cases patients in primary and secondary healthcare.

## **DATIXWeb**

DATIXWeb is another version of DATIX software system which can run online via an internet browser. So, the DATIX system will be available to the users through intranet or internet. This version of DATIX launch to the market at beginning of 2007 and for this reason it provides the users with only the following limited facilities in comparison with the main standalone version.

Web-based Incident Management; DATIXWeb allows users to report incidents directly to the system by using a web based facility, which is running through the Trust intranet. The incident's details will be e-mailed automatically to the appropriate manager, who can complete the details of the investigation online and also run analyses on incidents.

Web-based Risk Register and Standards; A very useful and powerful facility of the system is the online availability as optional components of the DATIX Risk Register and DATIX Standards. Staff can complete risk assessments and departments can manage their own risk registers online using the Trust intranet. Criteria within standards can be assigned to different staff members to own and action plans can be created.

Web-based Reports; DATIXWeb also provides the facility for each department to produce as easy and as fast as possible its own reports via the intranet. Reports can be produced in two formats; statistical and graphical.

### **2.6.2 Safeguard System from Ulysses**

#### **Overview**

Over the last years, Ulysses has aimed to develop a powerful risk management software for healthcare professionals. Safeguard is a fully integrated Risk Management System providing organizational, departmental and ward based statistics across all areas, plus detailed analysis and tracking of patient and staff involvement in events. It combines different smaller management systems in order to provide healthcare professionals with a variety of proper tools to manage different issues in NHS.

Data can be entered using the Organization's intranet through simple-to-use web forms. Records are submitted to a holding file before being merged into the live System. Those are two of the main advantages of the system.

Safeguard tracks people's involvement in multiple cases across all systems, examining their role in the event. Safeguard can identify people with similar demographic information, and merge any duplicate or related information to give a complete picture of their involvement in incidents, complaints, legal cases, PALS enquiries and requests for information (FOI).

Safeguard combines many smaller systems in one environment in order to help users to manage their work better. Those systems are:

- Risk
- Incident
- Complaints
- Litigation
- PALS
- Request for Information
- Training
- Occupational Health

### **Risk**

Safeguard provides users with the risk management module, which helps Trusts demonstrate their compliance to all Government led standards and incorporates them into the Trust's Assurance Framework where appropriate. The system compliance to Standards and Assurance Framework links into the standard functions of Risk Management in healthcare. This includes risk registers and assessments, clinical and non-clinical incidents, legal claims and other complaints and PALS queries.

A very useful tool of Safeguard Risk is the Risk Register. Similar to the DATIX "Risk Register and Assurance Framework", the Risk tool helps NHS staff to identify risks and manage them on a day to day basis. Directorates and departments have their "view" of the register and manage their own risks and action plans. However, where the risk cannot be managed at that level, the system provides a "taxonomy" tool where the risk can be

flagged as a corporate risk and managed by the Trust Board. The Risk Register is collecting information from the Incident module, the Complaint module and the Litigation module.

Whilst each directorate or department prioritizes and manages their own risks, the Risk Manager has the “Trustwide” view of the Register. This enables users to see the potential problems building up through the Trust through their frequency or severity across all departments. Such Risks can be reprioritized or managed at a higher level if required.

### **Incident**

Another module of the Safeguard system is about incidents. The Incident module provides healthcare professionals with a variety of tools in order to manage incidents in their organization. Within one database, the system collects and reports trends in all types of incidents including the following: Clinical and Non-Clinical Incidents; Adverse Outcomes; Accidents; Near Misses; Violence and Aggression; and all Health, Safety and Security Incidents involving Patients, Staff and the General Public. The module also identifies events of high risk using recognized risk assessment methods and transfers them to the Risk Register. This provides effective information for the management of risks within the Organization. Furthermore, it tracks investigations, other actions or events, identifying the member of staff responsible, with target and completion dates. Finally, it stores and links supporting evidence in any format to the incident record.

### **Complaints**

The Complaints Management module leads the user through the complaints process from receipt to resolution. This module tracks all events and communications between the patient and the Trust promoting effective controls assurance. It manages the administration of the NHS complaints legislation, leaving the Complaints Department time to deal with patients rather than paper-work, providing pertinent and up-to-date information. It tracks investigations and other actions or events identifying the member of staff responsible, with target and completion dates.

Based on the above actions it brings forward unacknowledged complaints and unresolved issues helping staff meet deadlines. It also categorizes complaints by the problem raised, associated with the department, directorate, specialty, service and profession within the organization.

Complaint management module can cross and link together information in order to give a wider picture of complex situations, which involves more than one complaint made from one or more complainants and one or more members of staff are responsible for. Moreover, similar to the Incident module, it identifies complaints of high risk using recognized risk assessment methods and transfers them to the Risk Register. This provides effective information for risk management within the organization.

### **Litigation**

The Litigation module manages legal cases from start to finish. It is tracking events, stages, communication, and issuing reminders to ensure each stage is completed on time, promoting effective controls assurance. It identifies previous claims made by the patient or complainant, and also has the facility to track staff involved in previous legal cases plus % involvement. It also collects payment information and is keeping a running total of the amount for each case is costing the Trust. Additional documentation could be attached as evidence and a complete folder for ease case can be created. Similar to the Incidents and Complaints modules, the Litigation module identifies legal cases of high risk using recognized risk assessment methods and transfers them to the Risk Register. This provides effective information for the management of risks within the organization.

### **PALS**

Safeguard PALS is a flexible, non-prescriptive tool for the management of all types of enquiry with complete confidentiality. PALS module is a very important and useful tool for managers. It records all the events and communication between PALS and the client and all types of enquiry, such as suggestions, concerns, general queries, etc. It also records all important dates, such as enquiry date, receipt, acknowledge, response and closure are entered and performance can be measured against locally defined standards. Furthermore, it records all issues raised, which are listed separately and for each of the location,



specialty, category of issue and customer experience. Finally, PALS tracks investigations and other actions or events identifying the member of staff responsible, with target and completion dates. The recorded information helps the manager to analyze the most common queries within the time period in their investigations and follow-up recommendations. It also ensures that information is gathered at the time of the event and information provided to the client, either written or verbal can be attached.

### **Training**

Similar to DATIX “Training Records” facility the system provides the users with tools, which can be used in order for a skills profile of the staff to be created. This facility is more advanced than the DATIX “Training Records” facility, as it is provided with a variety of useful supplements, such as the NHS Knowledge and Skills Framework with the Skills Matrix, Personal Development Plan and Course Management tools. The Training Skills Matrix identifies the training requirements of the staff based on the type and location of their work. This information is used to forward plan, ensuring that the courses provided meet the needs of the Trust. It reports on the percentage of staff with outstanding training requirements and enables the Trust to take appropriate action.

### **Occupational Health**

The Occupational Health facility collects all the required information for the staff in order to create a record for each person of the staff. The staff’s record contains information about the appointments for the periods of staff, whose occupation exposes them to some level of risk and about periods of absence along with type and date. Furthermore, any injuries caused by an accident at work are included in these records. This information can be used in statistical reports to highlight trends and could be very useful to the managers of the departments.

### **Request for Information (RFI)**

The Request for Information system facility provides users with tools in order to manage all types of requests including those covered by the data protection Act, freedom of information and environmental information regulations. Users can monitor the progress of the request and they can setup alerts at all stages including when response due dates are

nearing, that fees/further information deadlines are coming up, and to close cases where responses for fees/further information have not been received. Furthermore, the RFI facility deals with appeals including internal reviews, appeals to the information commissioner and the information tribunal. It provides appeal's information in report format including category of request, response times, costs and position in the organization.

RFI module is fully integrated with the other Safeguard system modules in order to exchange useful information. Some of these modules are the safeguard risk module, the incident module, the complaints module, the litigation module, the PALS module and the training systems module. However, the system is holding sensitive data and any information should be remained strictly confidential for security reasons.

### **2.6.3 DATIX & Ulysses Conclusion**

#### **DATIX User's Comments**

***"Completing an on-line form instead of a paper form has really encouraged our staff to start reporting more incidents. In the first few weeks alone, incident reporting in some areas has increased by at least 40%. It is a simple, easy system for front line staff to use."*** - Barts & The London NHS Trust

***"It is so much easier to produce reports in DATIX than the system I used to use. You can create them from within DATIX without the need to use a complicated report writer"*** - Risk Manager from a large Acute Trust

***"DATIX has transformed our complaints management. We cannot speak highly enough about DATIX"*** - Chair - PCT, West Country

#### **Safeguard User's Comments**

***"From an information perspective, we have found that it is important to use software that supports the flow of information within the Trust and Safeguard has definitely helped meet this need. In some areas we produce reports to identify patients involved in cases across more than one module. Furthermore, we have taken up the option of linking Safeguard to our PAS system, so that patient details are more accurate. From our experience, the modules have worked cohesively to support various aspects of Governance within the Trust."***

System Supervisor  
United Bristol Healthcare NHS Trust

***“The module is very useful in the day-to-day management of FOI requests. The user can quickly record and easily retrieve information, tailor the recording of information to suit the requirements of the organisation, track and keep up with each request and the 20 day rule, and produce formal letters from the mail merge templates. The clear design of the module makes it easy to use. It follows the standard Windows conventions recognised by most users, so you don't feel that you have to learn a whole new software package!”***

Document Control Manager  
Bolton PCT

***“Our Trainers have literally dropped all other fragmented paper and IT based systems to use One System. It does everything, and essentially it is linked to the Trust's other Safeguard Systems”. “Reporting from Safeguard Training has been one of many benefits; we can now report easily over any date range to all levels of the Organisation, complying with local HR, Health and Safety, and Nursing policies and to National requirements around CNST, KSF and Healthcare Commission”***

Training Manager  
South of Tyne and Wearside Mental Health NHS Trust

Based on all the above information, software system's overview and user's comments, obviously DATIX and Safeguard software systems are 2 very powerful and useful tools for NHS staff. DATIX software is providing service for Patient Safety, Risk Management, incident and adverse event reporting. DATIX is used by more than three quarters of the National Health Service in the United Kingdom, serving a population in excess of 40 million. Safeguard is powerful risk management software for healthcare professionals. Safeguard is a fully integrated Risk Management System providing organizational, Departmental and Ward based statistics across all areas, plus detailed analysis and tracking of patient and staff involvement in events. It combines different smaller management systems in order to provide healthcare professionals with proper tools to manage different issues in the NHS.

Both systems provide a number of facilities, which relate with risk management and give the ability to NHS staff of better monitoring and managing risks in the organization. So, based on the latest statistics figures, the number of accidents in hospitals has dramatically increased during the last years and one question is coming up:

*Why didn't these software systems help reduce the number of accidents in hospitals?*

## 2.7 Conclusions

The term “pathway” is very exploitable in NHS. It is used in many healthcare areas and it usefully varies in the healthcare sector, as many processes are described as a sequence, e.g. the clinical care pathway, which is a documented sequence of effective clinical interventions. There is also the national patient pathway, integrated care pathway, medicine care pathway etc.

In summary risk is a very serious issue for a huge organization. It affects human’s health and in some cases human’s lives. The NHS recognises that identifying risks and managing these correctly provides invaluable opportunities to improve patient care and especially avoid accidents in Trusts. The NHS was trying hard in the last years to place an active awareness of risk and how to manage it at the core of its activities. It has invested a substantial amount of money on the implementation of risk management methodology or strategy in each hospital, on employee’s education on risk management subject and on new risk management IT software systems. However, no specific, accredited bespoke training in health care risk management has been provided which delivered by independent consultants which are expensive to purchase. It also was not provided through the medium of IT (which would allow for reduced time away from the workplace) and was not delivered through a guaranteed educational quality assurance accreditation framework. Furthermore, the new risk management IT software systems did not have the proper functionality which educate NHS staff about risk management subjects. The NHS recognises it is vital to develop and maintain systems and procedures, which identify and minimise risks to patients, visitors, staff and others, if it is to achieve its commitment to providing high quality care.

However, based on the latest statistics figures the number of accidents in hospitals has dramatically increased over the last years. WRP observed, based on the assessments over the last years, that risk management education or practice is missing from the NHS. Furthermore, WRP believes that this is one of the main reasons for the high number of accidents in the hospitals.

Thus, for WRP and NHS to solve the risk management issue, it may be necessary to shift away from more traditional ways of thinking about workforce training, towards new approaches that better facilitate quick and effective learning and knowledge creation and dissemination. E-learning could be this new approach and the potential solution to the risk management issue in NHS.

## ***Chapter 3***

### **Background & Related Work – E-Learning**

#### **3.1 Introduction**

It is clear to see that electronic means of learning have developed rapidly over the past thirty years: spurred by various technological revolutions. Merely highlighting three key events, it is clear that e-learning has multiple components and many components. (1) The creation of the transistors enabled computers to be miniaturized and made into personal computers this allowed every-day people to have access to computers, and enabled computers to be used in the classroom. (2) The rise of the Internet provides a convenient and easy way to communicate and exchange information to the world, thus the impact of technology evolution on education and training was expected as technology evolution effects most of the sectors. The development of the internet and ICT (information and communication technologies) brought new opportunities to teach and learn outside the traditional classroom. Furthermore, (3) the rise and development of Web 2.0 enables interactive content to be created. Each of these effect electronic forms of learning differently. Not only from a historic viewpoint, but the world is still changing: computers are becoming smaller, more powerful, and cheaper to build; such that computer technology can be seen everywhere. Computers are fast becoming ubiquitous. Consequently as with any fledgling and fast-growing area there is discrepancy in the terminology that is used; further, e-learning technologies are broad and there are many application areas using e-learning.


This chapter provides an in-depth literature review of e-Learning. First the chapter explores various definitions for e-learning, second looks at technologies and finally discusses the most important form of e-Learning and Virtual Learning Environments.

#### **3.2 Definitions of E-learning**

Much of what most people regard as the principle growth of e-learning occurred in the 90s. However, year by year e-learning became broader and the term became more general, and consequently has lost some of its meaning. Thus, the term “e-learning” was used to describe any type of learning environment where computer technology is involved as

provider, such as web-based learning, computer-based training (CBT), distributed learning, electronically enabled distance learning, online learning, distance learning and technology-based learning (Gotschall 2000, Hall 1997, Cramer et. al. 2000, Collis 1996, Bates 1999). However, many authors (Hall & Snider 2000, Pollard and Hillage 2001, Gotschall 2000, Willis 1994, Porter 1997, Hall and Snider 2000) tried over the last years to define the above terms as each of them has its meaning. But, even they provide a big variety of definitions or descriptions for each of those terms and there is still not a clear use of them, especially between the e-learning and distance learning terms. Furthermore, authors agree that a single definition or description for e-learning has yet to be found (Rosenberg 2001, Sloman 2001).

Today, many people are still using the term “e-learning” and “distance learning” to describe the same thing because they believe that it is the same thing. However, “e-learning” and “distance learning” are not the same concepts. The main difference between those two terms is that distance education is the physical separation of the student from the tutor and the class room. However, e-learning can be part of the classroom environment as long as learning is delivered via electronic media. Hall & Snider (2000) characterized distance learning with three criteria; they are: a geographical distance, which separates communication between the trainer and the participant; the communication is two ways and interactive and some form of technology is used to facilitate the learning process. Urdan and Weggen (2000) define e-learning as “*the delivery of content via all electronic media, including the Internet, intranets, extranets, satellite broadcast, audio/video tape, interactive TV, and CDROM.*” Furthermore, they draw a useful schematic diagram, which describes the difference between the above terms. They described e-learning as a subset of distance learning, online learning a subset of e-learning and computer-based learning as a subset of online learning (figure 3).

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Today, e-learning mainly takes the form of online courses which are delivered synchronously or asynchronously.

Synchronous course delivery is real-time, instructor lead on-line learning, in which all learners are logged on simultaneously and communicate directly with each other. Synchronous courses could be virtual classrooms, audio/video conferencing, and two-way live satellite broadcast lectures (Urdu and Weggen, 2000).

Asynchronous course delivery is a learning event in which learners cannot communicate without time delay. Self-paced courses over the Internet or CD-ROM, streamed audio/video web presentations, online chats and discussion groups, e-mail, and video taped classes are kind of asynchronous courses (Urdu and Weggen, 2000). There are a big variety of synchronous and asynchronous technologies currently in the market to support e-learning course delivery.

### **3.3 E-Learning Technologies**

E-learning services have evolved since computers were first used in education. The trend to move toward blended learning services, where computer-based activities are integrated with practical or classroom-based situations, have led technology evolution to a specific new direction. From the other side, the technology evolution, specifically information and communication technologies (ICT), offered a new dimension to learning and helped e-Learning evolution as well. Technology and e-Learning have a strong interactive relationship and in many cases e-learning can be referred as technology.

Today, e-learning mainly takes the form of online courses. There are many methods used to deliver online courses. Web-based, CD-ROM, satellite, teleconferencing, and television are some of the more common delivery methods. Web-based is the most preferable method because web-based integrated learning systems are enabling personalized, interactive, just-in-time, current and user-centric learning tools (Cartwright, 1994).

A decade ago, there were a limited number of Web browsers, and most Web pages contained hyperlinks to other static documents. Furthermore, most home Internet connections were too slow and Websites with images took a long time to download. Internet connections also couldn't support the streaming audio or video that the users take for granted today. Today, fast speed Internet access is accessible in homes, offices, schools even coffee shops. Today's computers have multiple processors, are cheaper, and new formats for compressing audio and video enable their rapid transfer over the Internet (Frydenberg, 2008). By focusing on web-based technologies, which are part of the recent year's technological evolution, the World Wide Web was changed since its invention in 1989 from a static to a dynamic media. In 2005, Tim O'Reilly has termed "Web 2.0" the web services and applications that encourage the collaboration and sharing of implementation online (O'Reilly, 2005).

Web 2.0 focuses on services rather than software. The Web has evolved into a platform facilitating new ways of information sharing, collaboration and communication. The term "Web 2.0" describes the changes of World Wide Web technology that aim to enhanced creativity, communications, secure information sharing, collaboration and functionality of the web (Graham, 2005).

Web 2.0 concepts have led to the development and evolution of web culture communities and hosted services, such as social-networking sites, video sharing sites, wikis, blogs, and folksonomies. Web 2.0 is the business revolution in the computer industry caused by the move to the Internet as a platform (O'Reilly, 2006). Web 2.0 websites allow users to do more than just retrieve information. They can build on the interactive facilities of "Web 1.0" to provide "Network as platform" computing, allowing users to run software-applications entirely through a browser (O'Reilly, 2005). From technical aspect, Web 2.0 is working with a more flexible way where both the application and its data reside "in the cloud" of the Internet and not on the PC, so they are accessible from virtually anywhere.

In the wake of Web2.0 the changes in E-Learning have born the new term “E-Learning 2.0”. E-learning is evolving with the World Wide Web as a whole and the significant changes (Web 2.0) have influenced significant E-Learning. The term e-Learning 2.0 is used to refer to new ways of thinking about e-learning inspired by the emergence of Web 2.0 (Karrer 2006, Downes 2005).

E-Learning 2.0 places increased emphasis on social learning and use of social software and services such as blogs, wikis, podcasts and virtual worlds as Web 2.0 is providing the technological support of those services. The first 10 years of e-learning (e-learning 1.0) was focused on using the Internet to replicate the instructor-led experience. Content was designed to lead a learner through the content, providing a wide and ever-increasing set of interactions, experiences, assessments, and simulations. E-learning 2.0, by contrast (patterned after Web 2.0) is built around collaboration. E-learning 2.0 assumes that knowledge (as meaning and understanding) is socially constructed. Learning takes place through conversations about content and grounded interaction about problems and actions. Advocates of social learning claim that one of the best ways to learn something is to teach it to others (Brown & Adler, 2008). Furthermore, E-Learning 2.0 supports the social-constructivist pedagogical strategy where learners interact and learn together. Interaction typically occurs through discussion, communicating, collaborative writing, or working together on projects (Ocker 2001, Strijker & Collis 2002). Technologies such as wikis, blogs, delicious, e-portfolio and RSS are some of the most significant and preferable technologies are being used to support such community aspects in E-Learning.

Wikis are a technology introduced by Leuf and Cunningham in 1995 (Leuf & Cunningham, 2001). The term itself is derived from the Hawaiian word *wikiwiki*, meaning *quick*. Wikis are often used to create collaborative websites and to power community websites. The collaborative encyclopedia Wikipedia is one of the best-known wikis. In most cases Wikis technology is used in for design of simple Knowledge Management systems and allows all users to create and edit content online. All changes can be retraced by the other users and older versions of documents are available in a revision history. Obviously wikis technology is the easiest technology that can be used from applications

for collaboratively creating content as it enables documents to be written collaboratively, online, in a simple markup language using a Web browser. A single page in a wiki website is referred to as a "wiki page", while the entire collection of pages, which are usually well interconnected by hyperlinks, is "the wiki". Essentially, a wiki is a database for creating, browsing, and searching through information which can be built direct from simple users without technical IT background. E-Learning applications uses this technology to provide students with services where they can work together (online) by posting and answering each other's study questions or sharing links to interesting websites. Also, students can share in the responsibility of creating and organizing course materials for themselves and their classmates. This is an approach which involves learners in the direct process of production of learning contents. E-Learning is using strong technologies such as weblogs and podcasts to support this approach.

A blog (short for the term "Web log") is one of the most highly touted features of the Web 2.0 and tool of e-Learning applications. A bog is a web page, a personal home page, in diary format, maintained by an individual with regular entries of text, images, and links to other blogs, Web pages, and other media related to its topic, which are displayed in chronological order. Many blogs provide commentary on a particular subject; others function as more personal online diaries. The blog readers have the ability to leave comments in an interactive format on the blog's topic. Unlike a traditional Web page that requires knowledge of HTML coding in order to post information, updating a blog is as simple as completing an online form. So, users with limited IT knowledge can own a blog or to comment subjects on other blogs. Education also has benefited from blogging technology through the E-Learning as a course blog can increase or replace a traditional course management system. Both teacher and students can post content about a class session, make comments and ask questions. Communication is not limited to the written word. Furthermore, audio and video podcasts could also be available to record course lectures or summarize course concepts. Blogging provides a combination of solitary and social interaction (Cartwright, 1994). Finally blogging in e-Learning promotes creative, critical, analytical and associational thinking.

Another significant technology and blog feature is the RSS (Really Simple Syndication). RSS technology allows users to link not just to a page, but to subscribe to it and thus be informed about new content in a push approach rather than scanning for changes manually. RSS turns blogs from a re-active technology into a pro-active technology. This technology is a kind of automatic notifier which is used from Weblogs or any other web page to notify its regular readers (subscribed) for all kinds of data updates. It provides an end user with a notification that a new posting has been added to a blog or a web page they are interested in. RSS technology turns blogs and newsgroups from posting repositories into a form of interactive communication. Students can always be aware about new material by automatic notifications and they also organize their content by using the RSS feeds (Anido, 2006).

Social bookmarking is another technology which increased the e-learning variety of tools and services in order to increase the effectiveness. It is the technology that helps users to tag their favorite web pages more easily. The bookmarks can then be easily searched, retrieved and shared online. Unlike storing addresses in a "favorites" folder on your computer, tagged pages are stored on the web and are accessible from any computer. A user can easily tag a site which allows them to search among all your stored pages by keyword, eliminating the need to scroll through dozens of sites and remember the order in which the user's links are saved. Tags in social bookmark sites can also be subscribed to using RSS. Delicious (del.icio.us) is one of the most well known social bookmarking tools. Social bookmarking tools provide students and trainers with the ability to collect, list and share materials such online notes, e-books and websites over the duration of a course event. Students can also share links to current news items that relate to training discussions. Furthermore, trainers can create specific tag that can be used to direct individual students to specific reading or they can create a group tag in order to share to share educational resources on a blog, wiki or social networking site (Lomas, 2005).

Finally, there are a few enabling technologies that provide additional support for teachers and students to communicate. Two specifically: VVoIP and Instant Message (protocols) technologies enable users to communicate. The term VVoIP stands for Video

and Voice Over IP and it is the technology that is used to manage the service delivery of both voice and visual communications via internet. There are already many VVoIP applications in the market, including Skype, MSN and iChat. Instant Message (IM) technologies allow people to type online in real time. IM technologies allow the transmission of an electronic message over a computer network using software that immediately displays the message in a window on the screen of the recipient (Lederer, 2006). There are many IM systems, such as AOL IM, Yahoo IM and MSN IM, which use different technologies. E-Learning is already using these tools in order to improve the communication services between tutors and students.

All the above technologies are used for the implementation of a big variety of tools for teachers, students and administrators targeting the improvement of e-learning services. Teachers need tools for communication with student and other teachers, creating/importing/managing contents, assessment, course structuring, managing students and tracking student's activities. Students need tools for communication with teachers and other students, access to teaching material, access to libraries, creating and managing their work, sharing information and self-testing. Finally, administrators need tools for managing system's security levels, providing help and support to system's users and facilitating the system's users. The software provides a collection of these tools and technologies in order to support teaching and learning in education setting, is call virtual learning environment (VLE).

### **3.4 Virtual Learning Environment (VLE)**

Virtual Learning Environment (VLE) is an online set of tools and spaces that are managed by the institution for use in supporting teaching and learning. The Joint Information Systems Committee (JISC) defines a VLE as “An electronic system, providing online interactions of various kinds, that can take place between learners and other learners, and learners and tutors, including online learning”. VLE is password protected and has a number of privilege settings. Typically learners are enrolled on a course(s) with a provided list of modules that are managed by the subject teaching/support staff. The course

is available online and available 24/7 365 days a year with the exception of a short period for nightly backups or upgrades. A VLE can be used for distance learning courses where all teaching, support and learning takes place within the VLE and also for traditionally taught courses where the VLE is used to further support the learners. This latter usage is called a blended approach where students do have face-to-face contact with tutors and peers.

### **3.4.1 The form of VLEs**

#### System Heuristics

There are no fixed requirements for a VLE structure or any other e-learning environment and they vary in scope and design. VLEs, like any other system, are designed around a basic heuristic model of how the learning environment should be organised. Ellaway describes some of the more common heuristical models found in VLEs (Ellaway 2005):

- **Modular:** the principle unit of activity is a module, covering a discrete topic for a discrete number of students and staff over a discrete period of time. In this situation there is a separate VLE instance or container set up for each module in a modular programme. An institution may therefore have many hundreds of modules, each with a discrete VLE instance. This is equivalent to the ‘online course environment’. Problems can occur when a number of modules need to be grouped together so they can work as a whole as well as discretely.

- **Modular Institutional:** this is essentially the same as the previous system but with the addition of institutional tools such as portal functionality, student records and connection to library and other service systems, that span all of the module instances or containers.

- **Programme-wide:** this is where the primary heuristic is still based on the organisational disposition of an educational setting but differs from modular systems by focusing on a complete programme of study along with its constituent modules, courses and other activities. Although there have been some attempts to support this kind of

heuristic by modular systems, there is at the time of writing no commercial system that meets this description; all such systems have been purpose-built. This is equivalent to the ‘online programme environment’ or OPE described in an earlier section.

- **Single function systems:** while the previous types of system heuristic support a range of primary functions, there are VLEs which have only one primary function, which is therefore also its primary heuristic. These include course administration such as the VALE system at the University of Glasgow or communication such as the FirstClass system used by the Open University.

Not all educational settings are the same and a VLE’s heuristics will not suit all contexts of use. A VLE should therefore be matched to the educational context in which it will be used.

### System Features

VLEs are generally a combination of some or all of the following features which supported from a number of technologies that has been discussed earlier.

- **Communication:** this includes both one-way and two-way communication between staff and students including email, discussion boards (asynchronous) and chat rooms (synchronous). communication tools such as email, bulletin boards and chat rooms
- **Scheduling:** the provision of timetables or calendars of events, the organisation of staff and student time, the organisation of rooms, meetings and other events, and the milestones and stages of a course’s cycle.
- **Curriculum:** the provision of course and pedagogical frameworks such as curriculum guides and maps, learning objectives and outcomes and the options and opportunities students may pursue.
- **Content:** this would cover both the support of actual working processes of the course such as simulations, problem-based learning and group or project work, as



well as the storage, authoring and presentation of more static course content. This would also include the provision of banks of images and questions and learning object repositories.

- **Presentation:** the provision of the presentation and teaching materials (as opposed to learning materials) such as lecture and tutorial resources.
- **Assessment:** this includes both the support of formative and summative online assessment and the administration and logistics of assessment processes.
- **Personalisation:** the system may provide users with the ability to customise and personalise it to their own interests and activities. This would include personal pages, the provision of personal timetables and the ability to set up closed groups for communication and sharing resources.
- **Portfolio:** the submission and storage of portfolio items such as coursework, logbooks and personal reflections.
- **Security:** this includes the provision of authentication for users, security of content and the maintenance of privacy over sections and content within the system.
- **Administration:** this includes the creation and maintenance of class lists, the tracking of staff and student time, the use of resources, enrolment activities and record keeping activities.

### System Components

There are a number of components which can be brought together to create a VLE. These include:

- **Learning Management System (LMS).** –It is software for delivering, tracking and managing training. The LMS provides the learner with a point of entry for accessing their personalized learning plan. It provides the ability to administer, schedule and maintain a range of learning services. It can track learners and can include, for example, classroom management, roles management, facilities management, knowledge management, chat facilities, assessment/testing facilities, discussion boards and learner support networks (Caton et al 2001).

- Learning content management system (LCMS). An LCMS can provide the ability to create, store, re-use, deliver and maintain a range of interactive learning content from a centrally managed library or repository. With its repository of reusable learning objects, content management capabilities, and Web personalization technology, the LCMS provides important benefits for both the learner and training developer.
- Virtual classroom. A common training event launched by an LMS is a synchronous virtual classroom. Users gather in a virtual space where an instructor instruct, monitor and assess them in the same way as in a more traditional classroom using audio and learning content sharing facilities. Users have controls for asking questions and providing feedback about the pace or difficulty of the presentation. Chat functions, application sharing, and desktop sharing are often integrated into these types of solutions (Caton et al 2001).
- ICT Infrastructure. The information communication technology (ICT) infrastructure that forms the organisations underlying web-based technical architecture. This will need to integrate with the LMS, LCMS and virtual classroom technology to allow the learning services to link to your organisations management information systems, such as e-mail. Technologies that can be provided from the ICT infrastructure have been discussed earlier in this chapter.

### 3.4.2 VLEs Types

There are different types of VLE, which all work slightly differently but ultimately perform the same function and can deliver the same learning materials. A Higher Education institution is likely to have a licence for a VLE that fits into any one of the following three categories:

- off-the-shelf
- open source (often free to use and adapt but support is charged for). Open source applications are created by an institution or an individual who will then make the source code available free of charge to others provided they share their technical developments with those who use the software. Usually a user community will

build up around an open source application which will support the developers and users.

- bespoke (developed by institutions for their own individual needs). Bespoke systems are those which have been created from first principles by an institution or an academic specifically to meet the needs of a learning community. These systems tend to be more expensive to develop but because they are designed for a purpose they can be tailored to particular requirements. In most instances there will have been an e-learning champion within a department who has driven the project with excellent IT support.

The most well know VLEs are:

### **Moodle**

Moodle is a free open-source VLE. It has been designed to help educators create effective online learning communities. Moodle enables a forum for discussion, learning and integration for both inside and outside of the classroom.

### **Blackboard**

Blackboard is a widely used VLE that has many features other VLE's share. It has a number of versions available and many third party plugins that can be used to increase its functionality.

### **WebCT (acquired by Blackboard in 2006)**

WebCT was designed to provide teaching and learning experiences online by using the Internet as a platform. As a proprietary software tool, it is considered reliable and easy to use and has many features that will appeal to students and lecturers alike. WebCT was recently acquired by Blackboard and at some point will likely merge into a later version of Blackboard.

## **Bodington**

Bodington is a free open source Virtual Learning Environment/Learning Management System in use at Universities and Colleges worldwide. The Bodington project exists to provide an open source environment to support learning, teaching and research. It is particularly suitable for complex, multi-disciplinary and large organisations and for inter institutional collaboration. It delivers controlled access using open standards.

## **3.5 Conclusions**

The rise of networked technologies, in particular the internet and worldwide web, has impacted enormously on e-learning. The phenomenal rise of e-learning in the last years has taken place against a complex backdrop of cultural and social change, advances in technology and shifts in educational theory and practice. The term “e-learning” was used to describe any type of learning environment where computer technology is involved as provider, such as web-based learning, computer-based training (CBT), distributed learning, electronically enabled distance learning, online learning, distance learning and technology-based learning.

The trend to move toward blended learning services, where computer-based activities are integrated with practical or classroom-based situations, have led technology evolution to a specific new direction. From the other side, the technology evolution, specifically information and communication technologies (ICT), offered a new dimension to learning and helped e-Learning evolution as well. Technology and e-Learning have a strong interactive relationship and in many cases e-learning can be referred as technology.

Today, e-learning mainly takes the form of online courses. Web-based is the most preferable method because web-based integrated learning systems are enabling personalized, interactive, just-in-time, current and user-centric learning tools. Web2.0 is the latest generation of the web technologies. The term “Web 2.0” describes the changes of World Wide Web technology that aim to enhanced creativity, communications, secure information sharing, collaboration and functionality of the web (Graham, 2005). In the wake of Web2.0 the changes in E-Learning have born the new term “E-Learning 2.0”. The

term e-Learning 2.0 is used to refer to new ways of thinking about e-learning inspired by the emergence of Web 2.0 (Karrer 2006, Downes 2005). Today, there are many more significant technologies such as wikis, blogs, RSS, social networking, VVIOP, instant messaging etc. All the technologies plays vital role to the effectiveness of the e-learning by providing new facilities which helps students and tutors to perform their tasks faster and easier. Furthermore, they help any pedagogy to be applied in an e-learning environment. However, technologies have potentially profound impacts on pedagogy – on the ways people teach and the ways people learn.

There are a number of basic tools that feature in web-based e-learning such teaching materials, communication tools, assessment tools, scheduling tools, curriculum tools, content tools, personalisation tools, security tools and administration tools. A virtual learning environment (VLE) incorporates some or all the above tools within one single software environment that are managed by the institution for use in supporting teaching and learning. The Joint Information Systems Committee (JISC) defines a VLE as an environment where ‘online interactions of various kinds take place between learners and tutors’. Virtual learning environments (VLEs) are one form of e-learning technology. There are no fixed requirements for a VLE structure or any other e-learning environment and they vary in scope and design. The pedagogy is one of the concepts that effects the structure of a VLE/e-learning environment but also there are cases where the /e-learning environment effects the pedagogy.

## ***Chapter 4***

### **Development Methods & Research Methodology**

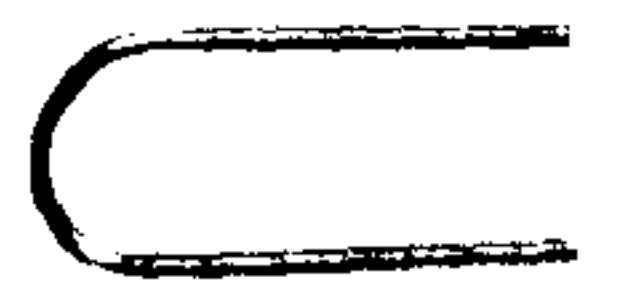
#### **4.1 Introduction**

There are many software development strategies that could be followed; each has several advantages and disadvantages. This chapter reviews various development methodologies and provides a discussion as to how they could be used to aid the development of the software developed in this thesis. In particular, the chapter introduces the development methodology used for this study, which is based on the software development life cycle (SDLC). Furthermore, it is important to closely integrate the data-collection and analysis with the software development. Consequently, this chapter also outlines the research methodology chose for this study. It identifies the research design for the study and what instruments were used for data collection. This will be followed by an identification of sampling procedures and respondent characteristics. At the end it provides an overview of the methods used for data analysis, followed by a discussion of reliability and validity of the chosen methods. Thus, this chapter provides a unique mix of software development methods and research methods conjoined in order a bespoke software application could be built which would meet the customer's expectations.

#### **4.2 Software Development Process**

A software development process (or Software Development Life Cycle, SDLC) is a process that describes the software development from the start to the end. The principle is that it forms a detailed plan on how a developer can create an 'information system' through a number of stages. The selection of an appropriate SDLC for the development of a software system is very important because it will help to ensure successful implementation of the system. This process provides visibility of design, development and implementation status needed to ensure software development on time and within budget.

There are several models that a developer can follow, each describe a variety of different tasks or activities that take place during the life cycle of the project development.



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model is an important model, which forms the basis of many other models; however for many modern projects it often viewed as being outdated. The main stages of the model are:

1. **Requirements analysis and definition.** By consulting with system users, the system's services, constraints, and goals can be established and then defined in such a way, such that both users and development staff can understand it.
2. **System and software design.** During this stage the established requirements, coming from the first stage, are identified as software or hardware requirements. The software requirements are then translated in such a way that they can be readily transformed into computer programs.
3. **Implementation and unit testing.** This is the stage where the computer programs are created. Each program is called a unit, and unit testing verifies that every unit meets its specification.
4. **Operation and maintenance.** This stage involves:
  - a) correcting errors that have not been detected before,
  - b) improvement and
  - c) other forms of support.

It is part of the life cycle of a software product, and not of the strict development.

The waterfall, as described above, has a numerous advantages and disadvantages.

Pros:

- It allows the better management and control of each development process stage. A schedule can be set with deadlines for each stage of development as a start and end point can be defined for every development process stage.
- The Waterfall model focus on the system's requirements and design before the implementation stage in order to reduce the risks of time and effort wastage.
- It is very straight-forward.
- It produces lots of documentation after each step.
- It has lots of reviews before, during and after each stage.
- Each step is producing specific outputs which can be used to measure the progress of the system development.



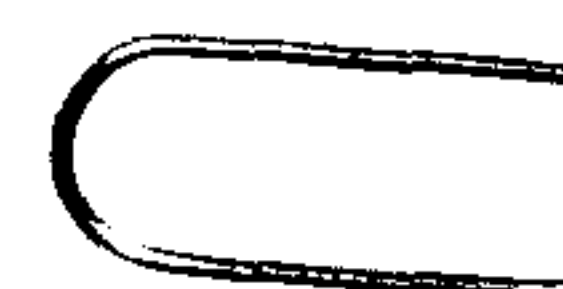
Cons:

- It provides a very linear process which must be followed in order, stage by stage. Any delay in one stage will affect the other stages as well.
- Requirements stage is the most important and the collection of really good requirements is essential.
- It does not provide flexibility and recoverability. Once an application is in the testing stage, it is very difficult to go back and change something in the previous stages that was not well-thought or well-planned out.

#### **4.2.2 Spiral model**

Boehm defined the spiral model at 1986. The spiral model focuses at risk reduction in any phase and that is the reason why often referred to as a risk-driven model. The spiral model is the evolution from the waterfall model. It was designed to include features from the SDLC and Prototyping models combined with risk assessment methods for every stage. The term “spiral” is used to describe the process (figure 5) that is followed during the system’s development as it is a spiral than a sequence of processes. Each loop in the model represents a phase of the process which passes from every stage producing outputs. There are 4 stages in the model: Planning, Risk Analysis, Engineering and Customer evaluation. Risks will be identified and treated in every of the phases.

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The spiral model, as described above, has a numerous advantages and disadvantages. It combines the advantages of the waterfall model with the flexibility of an iterative approach.

Pros:

- The method integrates both prototyping and the waterfall method, so advantages from both methods are applied to spiral model as well.
- The spiral process creates many prototypes (ie., a new prototype at the end of each phase). The valuation of each model produces a specification of how the prototype can be improved, and thus improving the quality of the whole system
- The spiral model can deal with changes between stages.
- Estimates (such as overall system costs) get more realistic as work progresses, because important issues are discovered earlier.

Cons:

- The production of many prototypes and their evaluation can be complicated and time consuming.
- Often the spiral method is used to mitigate risks; however this requires risk management knowledge.
- The spiral model does not allow any change inside a stage.
- Suitable for large scale projects as it takes long.

### 4.2.3 RUP (Rational Unified Process)

*“The Rational Unified Process provides a significant advantage for our customers who are building e-business applications. RUP provides the ability to tailor roles and processes for the individual development shop; the predictability provided by the perspective guidelines for each team member significantly increases productivity”*

Dr. Raymond B. Wells, IBM cited by (Næsset & Bhargava, 2003)

Rational Unified Process (RUP) is a software development process created by the Rational Software Corporation, division of IBM since 2002. IBM renames the RUP model into IBM Rational Unified Process. The RUP model has many similarities with spiral model. The assembly of spiral model contents elements into semi-ordered sequences

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phase. The focus shifts mainly to design and implementation. In some projects, this phase includes several construction iterations in order to divide the use case into manageable parts. The construction phase terminates with the Initial Operational Capability milestone.

### **Transition**

The transition phase is the fourth and final phase from the Rational Unified process. The main aim of this phase is to deliver the final product to the end users. The phase focus on the quality of the product and it is checked against the quality level set in the Inception phase. Finally training will be given to the end users and beta testing will occur during this phase. The transition phase terminates with the Product Release milestone.

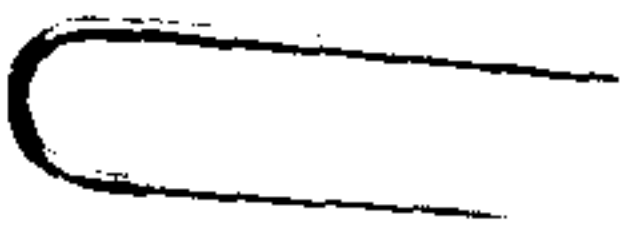
The spiral model, as described above, has a numerous advantages and disadvantages.

#### **Pros:**

- Risks are identified and treated of earlier
- Change is more manageable within the phases but not within iterations
- Provides high opportunities of reuse
- It gives emphasis to the product and process quality
- It gives emphasis to the real-time testing
- Expressed from perspective of users
- High degree of traceability

#### **Cons:**

- Too complicated and not suitable for small projects
- The spiral model needs to be customized before use
- The model is conceptually closer to a development process framework rather than a software process because it does not provide clear implementation guidelines.
- The model is not object-oriented and thus needs to be adapted to fit in with an object-oriented software development strategy.



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The requirements stage begins the life cycle model just like the waterfall model. In this stage, the requirements of the system will be gathered from the customers with a variety of methods. The requirements should describe the functionality of the system that meets the customer's needs. Before development is started, a system test plan is created and this is one of the main differences with the waterfall model. The test plan focuses on testing the functionality specified in the requirements gathering (Sommerville, 2000).

Similar to the waterfall model, a design stage is part of the V-Model. However, the difference with waterfall model is that the design stage in the V-Model is divided to two stages; high level design and low-level design. The high level design stage focuses on overarching architecture and design of the system. The low-level design stage focuses on the smaller units, components or the design of individual modules. The test plan will be created for both high and low level designs.

The implementation stage is, again, where all programming coding will be created. Once coding is finished, the path of process continues up the right side of the V-Model where the test stages developed earlier are now will be applied on the created code.

V-Model, as described above, follows closely to the advantages and disadvantages of the waterfall model. However, an extra advantage is that provide higher probability of success over the waterfall model due to the involvement of testing in every stage of the development process during the life cycle. An extra disadvantage is that V-Model does not provide clear description of the problems found during the testing (Wikipedia – V-Model, 2006).

#### **4.2.5 Agile**

In February 2001 a group of seventeen software experts got together in Snowbird UT to discuss the growing field of what used to be called lightweight methods. They decided to use the term agile to describe the new breed of agile methods. They also wrote the Manifesto for Agile Software Development, setting out the values and principles of these agile processes.



Agile software development is a group of software development methodologies that are based on similar principles but on different characteristics. Agile methodologies generally promote a project management process that encourages frequent inspection and adaptation, a leadership philosophy that encourages teamwork, self-organization and accountability, a set of engineering best practices that allow for rapid delivery of high-quality software, and a business approach that aligns development with customer needs and company goals (Kutschera et al 2002). The Agile Manifesto states the following values of the agile processes where the authors valued the items on the left more while there is value in the items on the right (Beck 2001, Kutschera et al 2002).

***Individuals and interactions over processes and tools.*** This means, the successful outcome of a project depends more on the interaction of skilled professionals than on the usage of a well-defined process or the latest tools.

***Working software over comprehensive documentation.*** This statement addresses the need to reduce comprehensive documentation, because an extensive documentation does not mean that the actual problems have been well understood. In addition, it incorporates significant overhead every time requirements are added or have to be changed.

***Customer collaboration over contract negotiation.*** The key message of this statement is that collaboration with the client is one of the critical success factors of a software project, because through active collaboration the client can help the team to understand the wants and needs.

***Responding to change over following a plan.*** This statement covers a slightly different aspect where changing requirements are not taken into account, because they do not fit according to the project plan. Obviously, to deliver a system in time that implements requirements no longer important to the user, is useless. The solution to this problem is the usage of short release cycles, together with the client's ability to introduce new requirements or change priorities.

Some of the principles behind the Agile Manifesto are:

- Customer satisfaction by rapid, continuous delivery of useful software
- Working software is delivered frequently (weeks rather than months)
- Working software is the principal measure of progress
- Even late changes in requirements are welcomed
- Close, daily cooperation between business people and developers
- Face-to-face conversation is the best form of communication (Co-location)
- Projects are built around motivated individuals, who should be trusted
- Continuous attention to technical excellence and good design
- Simplicity
- Self-organizing teams
- Regular adaptation to changing circumstances

There are many specific agile development methods. Most promote development iterations, teamwork, collaboration, and process adaptability throughout the life-cycle of the project. Agile methods choose to do things in small increments with minimal planning, rather than long-term planning. Iterations are short time frames (known as 'timeboxes') which typically last from one to four weeks. Each iteration is worked on by a team through a full software development cycle, including planning, requirements analysis, design, coding, unit testing, and acceptance testing when a working product is demonstrated to stakeholders. This helps to minimize the overall risk, and allows the project to adapt to changes quickly. Documentation is produced as required by stakeholders. An iteration may not add enough functionality to warrant releasing the product to market, but the goal is to have an available release with business value (with minimal bugs) at the end of each iteration. Multiple iterations may be required to release a product or new features.

Some of the well-known agile software development methods (Highsmith, 2006):

*Extreme programming (XP)* was developed by Kent Beck, Ward Cunningham and Ron Jeffries. XP is founded on four core values: communication, simplicity, feedback, and courage. Important aspects of XP are its contribution to altering the view of the cost of

change and its emphasis on technical excellence through refactoring and test-first development (Jeffries et al, 2000).

*Scrum*, was initially developed by Ken Schwaber and Jeff Sutherland, with later collaboration with Mike Beedle. Scrum provides a project management framework that focuses into 30-day sprint cycles in which a specified set of Backlog features are delivered. The core practice in Scrum is the use of daily 15-minute team meeting for coordination and integration.

*Dynamic Systems Development Method (DSDM)* was developed in UK in the mid-1990s. It is an outgrowth of, and extension to, rapid application development (RAD) practices. DSDM's nine principles include active user involvement, frequent delivery, team decision making, integrated testing throughout the project life cycle, and riverside changes in development (Stapleton, 1997).

*Crystal Methods*. Alistair Cockburn is the author of the "Crystal" family of people-centred methods. Crystal methods focuses on the people aspects of development - collaboration, good citizenship, and cooperation. Alistair uses project size, criticality, and objectives to craft appropriately configured practices for each member of the Crystal family of methodologies.

*Lean Development*, was developed by Bob Charette who writes that the measurable goal of LD is to build software with one-third the human effort, one-third the development hours and one-third the investment as compared to what SEI CMM Level 3 organization would achieve. Lean Development focuses on the creation of change-tolerant software. This methodology embodies the notion of dynamic stability which can be thought of as similar to how Scrum embraces controlled chaos.

*Feature Driven Development (FDD)*, Jeff De Luca and Peter Coad were both greatly involved in developing the Feature Driven Development methodology. FDD consists of a minimalist, five-step process that focuses on developing an overall model, building a

features list, and then planning-by-feature followed by iterative design-by-feature and build-by-feature steps. Chief architect and chief programmer are two key roles in FDD method.

The Agile methods, based on the principles focus on streamlining the SDLC by eliminating much of the modeling and documentation and the time spent on those tasks. They introduce short release cycles and to involve the customer as much as possible, as a reviewer and domain expert throughout a software development project. Finally, Agile methods emphasize simple, iterative application development.

#### **4.2.6 Evaluation of SDLC**

All these different software development models have their own advantages and disadvantages. Timing is very crucial in software development. Each stage of the life cycle model must be completed before the next stage begins. So, any delay in any of the stages will cause a delay to the whole software development process which affects the overall project's target. Also, if the product is launched in poor quality it may affect the reputation or the reliability of the product. So, there should be a corporation between the development time and the quality of the final product. During this thesis timing is very crucial in the development of the new software, this is because the thesis will integrate the development with the research of gathering customer's requirements and testing the system. Furthermore, the use of a simpler SDLC model will be beneficial based on the lack of resources issue.

Each development life cycle has the same end-goal: to develop effective software with the correct requirements as stipulated by the customer and that provides the best value-for-money. Each model subdivides the life-cycle into a series of stages. In fact, each has very similar patterns:

- problem analysis
- design
- implementation evaluation
- testing and maintenance

Consequently, the general, overarching model is shown in Figure 9:

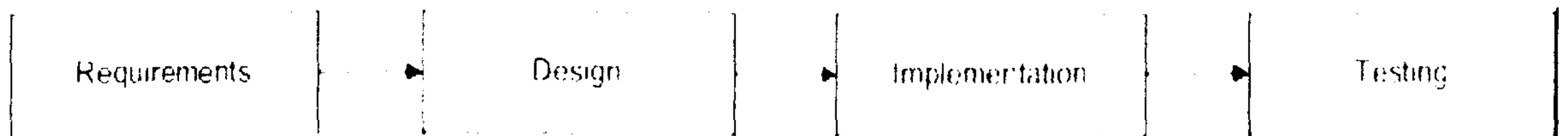


Figure 9: **General SDLC model**

Each phase produces deliverables required by the next phase in the life cycle. Requirements are translated into design. Code is produced during implementation that is driven by the design. Testing verifies the deliverable of the implementation phase against requirements.

### **Requirements**

The software application requirements will be gathered during this stage of the software development process. The system's requirements reflect the needs of the customers and should describe the functionality and the services provided by the system. Software requirements are usually classified as functional and non-functional requirements. There are many methods of gathering system's requirements such as interviews, questionnaires, and meeting with customers or potential system's users. A document with a list of requirements (functional and non-functional) will be created in this stage and it will be the fundamental ingredient of the next stage, design.

### **Design**

The software system design is produced from the results of the requirements phase. This is where the details on how the system will work are produced. The system's requirement will be transformed into a set of diagrams which will be used in the next phase of the SDLC. Architecture, including hardware and software, communication, software design (UML is produced here) are all part of the deliverables of a design phase.

### **Implementation**

Code is produced from the deliverables of the design phase during implementation, and this is the longest phase of the software development life cycle. This phase is equally important to the development of the software system and it the one of the phases where

error and lack of functionality can be found. Implementation may overlap in time both the design and testing phases. Many tools exist (CASE tools) to actually automate the production of code using information gathered and produced during the design phase. Rational Rose is one such tool that can transform the design into a code (at least the main classes) using selected programming language. Rational Rose provided an integrated Development Environment that follows the Unified Modeling Language, and in particular the graphical model notation by Grady Booch (Booch et al, 2005).

### **Testing**

During testing, the implementation is tested against the requirements of the system to make sure that the product is actually meeting the needs addressed and gathered during the requirements phase. Unit tests and system/acceptance tests are done during this phase. Unit tests act on a specific component of the system, while system tests act on the system as a whole.

### **SDLC Model for the “risk-e” project**

Based on the above information every software development model has more advantages than disadvantages. So, the use of a SDLC model will give an extra benefit to the development process in this study. Furthermore, a customized SDLC model has been created based on the study’s needs (facts and issues) and according the above information about the available SDLC models in the market. Figure 10 illustrates the customized SDLC model for this study.

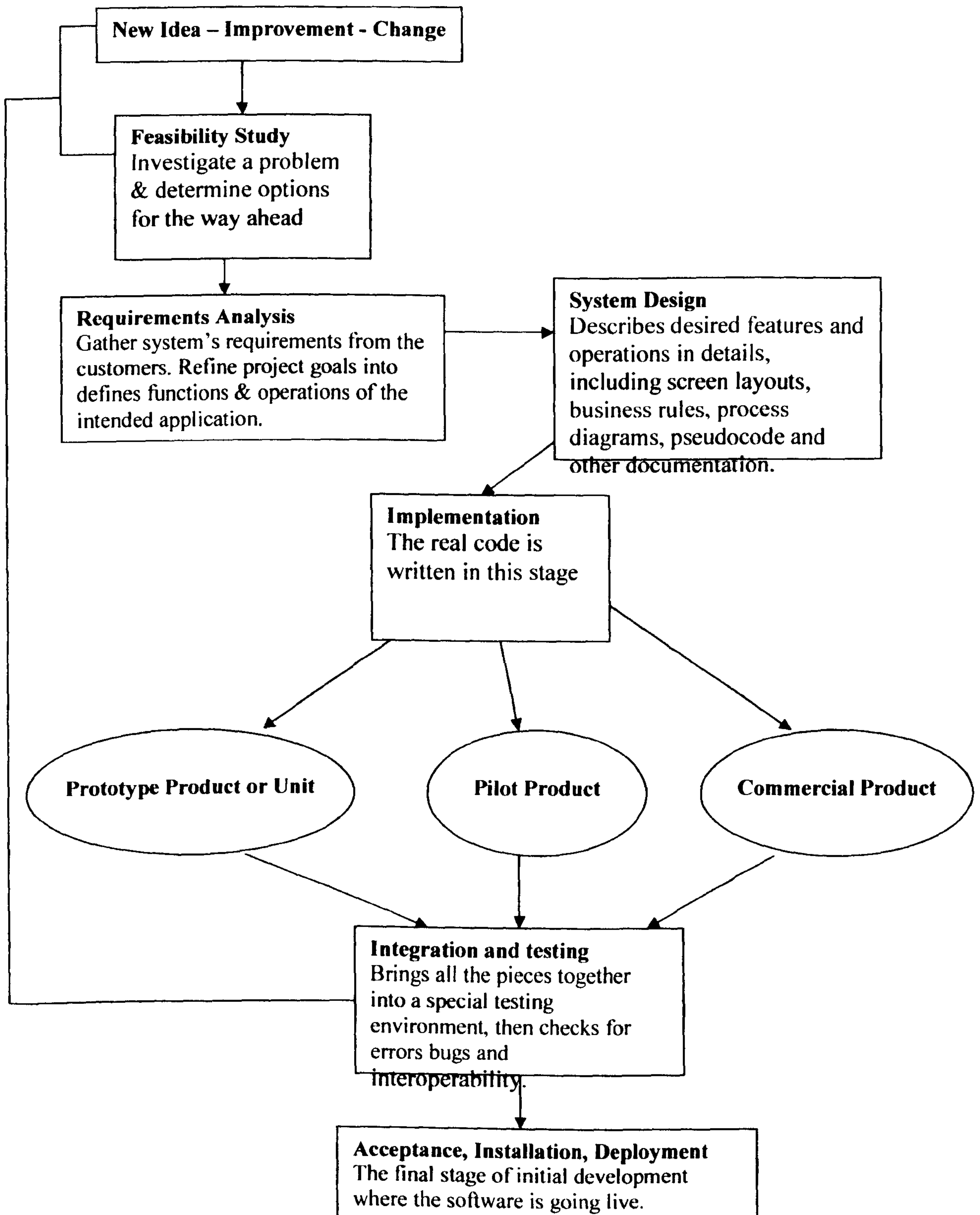


Figure 10: "risk-e" SDLC Model for the Study

## **4.3 Research Methodology**

### **4.3.1 Research Design**

This chapter has so far detailed and evaluated several software development methods, each with different advantages and disadvantages. Likewise this thesis could follow any one of these models. However, a customized software development model has been designed for this project and a research methodology has been used on some of its stages. The thesis combines exploratory and explanatory research. The work is exploratory research because the study gathered information and developed solutions about a serious problem (gathering and managing risk information). It is also explanatory research because it provides explanation and evaluation between phenomena. Due to the nature of the thesis qualitative and quantitative methods have been used and a research design has been created.

Qualitative methods have been used during the first stage (the requirements analysis of the system) of the development process, which is exploratory nature. The decision to use qualitative research methods came from the ability of qualitative research methods to develop explanations of social phenomena and the point of view of the people that are part of those phenomena (Hancock 1998, Berg 1998). Qualitative methods are not recommended for theory, methods or hypothesis testing, but the principle is recommended for the development of something new in a specific field.

Quantitative method is used for theory, methods or hypothesis testing in this study. It has been used during the last stage (testing) of the development process in order to analyze the results of the system's evaluation. The analysis has been used to explain the effectiveness and the behavior of the system. The logic behind choosing quantitative research in this stage of the development process came from the nature of the research, explanatory.

Quantitative research is often contrasted with qualitative research. The quantitative research is mostly concerned with numbers and measurement, rather than words, in the collection and analysis of data. Quantitative research usually tries to identify the



relationships between two or more variables, using statistical methods to test the strength and significance of the relationship.

The aim of this thesis was not to test a previous theory, but to focus at first on understanding and explaining a very serious problem within NHS and at second to develop and evaluate a solution for this problem. For this reason a combination of qualitative and quantitative design was considered to be the most appropriate one for the study.

Figure 11 provides a schematic overview of the overall research design chosen for this project and how it is fitted in the SDLC model. It was divided up in 3 stages and it is fitted in the first and forth stages of the SDLC model. In Stage 1 of the SDLC model the stage 1 of research includes the establishment of the theoretical framework (literature review), interviews in order to gather systems requirements (customer's expectations) and pre-testing of data collection instrument. In Stage 4 of the SDLC model the stage 2 and 3 of research includes two testing case studies (2 testing phases) data collection process (feedback form, questionnaires and interviews) and data analysis.

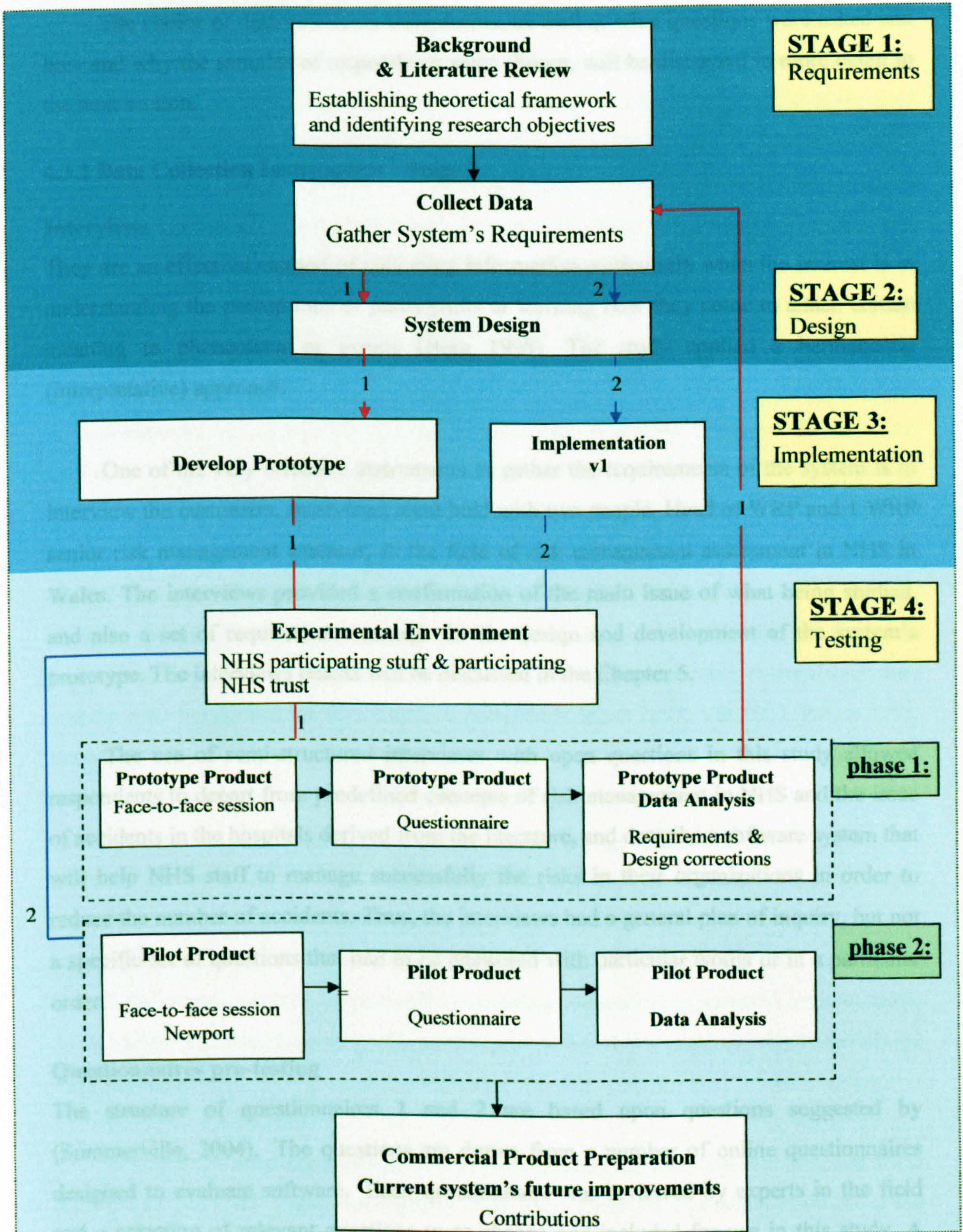


Figure 11: Research Design

The choice of data collection instruments, as well as what questions were asked and how and why the samples of respondents were chosen, will be discussed in more detail in the next section.

### **4.3.2 Data Collection Instruments - Stage 2**

#### **Interviews**

They are an effective method of collecting information particularly when the interest is in understanding the perceptions of participants or learning how they come to attach certain meaning to phenomena or events (Berg 1998). The study applied a hermeneutic (interpretative) approach.

One of the very effective instruments to gather the requirements of the system is to interview the customers. Interviews were held with two people, Head of WRP and 1 WRP senior risk management assessor, in the field of risk management assessment in NHS in Wales. The interviews provided a confirmation of the main issue of what being studied, and also a set of requirements enough for the design and development of the system's prototype. The interviews results will be discussed in the Chapter 5.

The use of semi-structured interviews with open questions in this study allowed respondents to depart from predefined concepts of risk management in NHS and the issue of accidents in the hospitals derived from the literature, and describe a software system that will help NHS staff to manage successfully the risks in their organizations in order to reduce the number of accidents. Thus, the interviews had a general plan of inquiry, but not a specific set of questions that had to be answered with particular words or in a particular order.

#### **Questionnaires pre-testing**

The structure of questionnaires 1 and 2 are based upon questions suggested by (Sommerville, 2004). The questions are drawn from a number of online questionnaires designed to evaluate software. Each questionnaire was reviewed by experts in the field and a selection of relevant questions were chosen and included for use in this study. A

number of experts reviewed the final questions to ensure face validity. In summary, the questionnaires have been discussed with a specialist in the field of software development, with two specialists in the field of e-learning development and with a specialist in the field of research. All of them provided suggestions of how to improve the format and content of the questionnaire. The rationale of a pre-testing questionnaire is based on the fact that it is impossible to design a questionnaire with no errors and these errors can be identified and be corrected in earlier stage (Bourque and Fielder 1995).

### **4.3.3 Data Collection Instruments - Stage 4 phase 1 & 2**

#### **Questionnaires**

A questionnaire was also developed and administered to provide direct results of system testing (prototype and pilot product) by the potential users during a face-to-face session. Questionnaires have a number of advantages and disadvantages as a research method. The use of the questionnaire method in a research has the advantages of cost effectiveness, anonymous administration that makes the respondents to be more honest with their answers, avoiding researcher influence to the participants, the collection of the same format data that provides the ability of easier analysis and comparison, easier distribution and the time freedom of the questionnaire completion (Case 2002, Yin 1994, Patten 2001, Burton 1990). However, this method has some disadvantages as well, such as the potentially low response in time and rates, sampling problems, validity problems, and the disadvantage that the subject will mis-interpret the question perhaps from a poor questionnaire construction (Case 2002, Yin 1994, Patten 2001, Burton 1990). This study considered the above disadvantages and it tries to minimize them during the research phase. The use of questionnaires during a face-to-face tutorial session was believed to benefit the overall research by particularly targeting and exploring potential improvements of the system and functionality problems that may occur. It also minimises and controls the response time.

The questionnaire consisted mainly of close-ended questions, but also included a few open-ended questions where respondents were asked about their personal opinions of the

produced software application. See Appendix 1 for a more detailed description of the structure and content of the questionnaire.

### **Pre-Questionnaire**

The pre intervention questionnaire contains general questions about each participant's computing experience and e-learning background. This allows a profile to be built for each participant against which subsequent data collection can be evaluated.

### **Post-Questionnaire**

The post intervention questionnaire contains more specific questions about the "risk-e" pathway in relation to the main characteristics and sub-characteristics of the software system specifically its functionality, efficiency, usability, reliability, portability and maintainability.

## **4.3.4 Sampling Procedures – Stage 2**

### **Defining the target population**

E-learning is a training method or a learning solution which easily can be adopted by a large organisation. However, as the purpose of the study was to develop a unique web based e-learning tool that educates NHS staff about risk management and it will help them to manage risks in their organisation at the same time. It was decided to target only NHS in Wales NHS staff as it is an average size in comparison with the NHS in England and NHS in Scotland. Furthermore, WRP is responsible only for the NHS in Wales and this organisation can easily be approached in order to participate to this study. Also, the contact with a similar authority as WRP in England or Scotland will be more difficult.

### **Sample selection**

The external review undertaken by the Welsh Risk Pool (WRP) assessors concentrates on the principle areas of risk within the organisation. WRP assessors measure organisation's risk management performance against the WRMS annually. The external assessment takes place over a period of 5 days at the Trust site. As well as a review of the documentation some interviewing of key staff takes place. The assessment is principally concerned with

ensuring that processes are in place to manage risk. Based on this information WRP assessors are the key people who can provide fundamental and important requirements. They are spending days in the Trusts and they are interviewing NHS staff responsible for risk management, in order to assess the organisation's risk management performance. Two most experienced WRP risk management assessors were selected for this stage; Head of WRP and 1 WRP senior risk management assessors. The interviews provided a confirmation of the main issue of what being studied, and also a set of requirements enough for the design and development of the system's prototype.

Each assessor that invited to be interviewed was given the explanatory statement as well as a consent form (Appendix 2) to sign that assured anonymity, confidentiality and freedom to withdraw from the study at any time.

#### **4.3.5 Sampling Procedures – Stage 4 phase 1 (prototype model)**

Software prototype is a model of the future software program, in most cases without the complete functionality, which can be used to let the users have a first idea of the completed program or allow the clients to evaluate the program. In this stage the prototype model of the “risk-e” software application is tested by the WRP assessors, such to confirm and accept the requirements of the system. Second, useful information will be collected from them where they used the system as potential instructors.

As it has been explained above WRP assessors are the key people who can provide fundamental and important system's requirements. WRP assessors know exactly what could be work in the Trusts in the field of risk managements. Eight WRP assessors were invited to participate in a face-to-face testing of the system. The face-to-face sessions were organized in WRP premises. The functionality of the system has been presented to them at the beginning of the session and they had the opportunity to use the system for 5 hours. At the end they had to complete a number of questionnaires.

Each instructor who invited to be participated in this study was given the explanatory statement as well as a consent form (Appendix 3) to sign or to accepted online before use the system, which assured anonymity, confidentiality and freedom to withdraw from the study at any time.

#### **4.3.6 Sampling Procedures – Stage 4 phase 2 (pilot model)**

In this stage the pilot model of the “risk-e” software application is tested from potential students in order important and useful information will be collected. The pilot model of the “risk-e” software application is tested with the same way as the prototype model of the system has been tested which has been described above. A face-to-face session has been organized in Newport where fifteen risk managers from NHS hospitals in Wales and two e-learning software applications experts. The functionality of the system was presented to them at the beginning of the session and they had the opportunity to use the system for five hours. At the end they had to complete a number of questionnaires.

Each student who invited to be participated in this study was given the explanatory statement as well as a consent form (Appendix 3) to sign or to accepted online before use the system, which assured anonymity, confidentiality and freedom to withdraw from the study at any time.

#### **4.3.7 Data Analysis**

##### **Interviews**

Interviews were transcribed to enable a more accurate qualitative analysis (Appendix 4). The help of the technology has been used for the interviews transcription. The “Dragon NaturallySpeaking Preferred” software application has been used during the interviews. The software allowed the instantly transcription of the interviews, transforming the voice into a text on a word document and providing the ability of saving valuable time. The method of analysis chosen for this study was an approach of qualitative methods of thematic analysis, and it incorporated both the data-driven approach of Boyatzis (1998) and the deductive a priori template of codes approach outlined by Crabtree and Miller (1999). Both are two significant qualitative methods of thematic analysis that helps to get

an understanding of the main themes in the interview transcript (Crabtree and Miller 1992). The analysis of the interviews was not too difficult because there were only two people interviewed, and also because each candidate provided a clear description of the main issue. Many different ideas and many different areas have been highlighted from the candidates based on their experience and knowledge on risk management in NHS.

### **Questionnaire**

The questionnaire data was analysed using Microsoft Excel, using simple diagrammatic analysis. The findings are part of the testing phase and highlight the problematic areas of the system. It was contrasted and compared to the overarching requirements of the system in order to highlight the gaps in the requirements. From the analysis of the questionnaires which are collected from the prototype product evaluation phase, a new software development life cycle started in order to improve and transform the prototype software product into a pilot one. Similar from the analysis of the questionnaires which are collected from the pilot product evaluation phase, a new software development life cycle can be stated in the future in order to transform the pilot software product into a commercial one.

### **4.3.8 Reliability and Validity**

Reliability and validity concepts are important for both qualitative and quantitative research.

#### **Reliability**

Reliability measures whether the research is really measuring what it says it is (Yin, 1994). A key of the questionnaires or interviews success in research is the reliability of results. The reliability level of the results shows the level of the successful research. Joppe (2000) defines reliability as: *“The extent to which results are consistent over time and an accurate representation of the total population under study is referred to as reliability”*. For the research interviews and questionnaires this means that all respondents need to understand and interpret the questions in the same way, under the same conditions. Actions were taken to ensure that during the face-to-face sessions, where they have to answer the questionnaires. Furthermore the questionnaires were pre-tested (as discussed earlier) to



avoid errors and to ensure that questions and terminology did not create confusion about their meaning.

### **Validity**

Validity actually refers to the truth of the outcomes of the research. Joppe (2000) defines validity as “*Validity determines whether the research truly measures what it was intended to measure or how truthful the research results are.*”

Wainer and Braun (1998) define construct validity as “*The construct is the initial concept, notion, question or hypothesis that determines which data is to be gathered and how it is to be gathered.*” It was enhanced through interviews and questionnaires as its data collection methods.

Content validity is concerned with coverage of all the conceptual space in the instruments. It is concerned if the instruments include all the appropriate contents in relation to the research study (Litwin 1995, Babbie 2001). Content validity was enhanced as conducting pre-testing of the questionnaire by experts.

Finally, validity has two other important types; internal validity and external validity. Internal validity is a result of the independent variable and it demonstrates a causal relation between them (Yin, 1994). Cook and Campbell (1979) define internal validity as “*the approximate validity with which we can infer that a relationship is causal*”. External validity involves whether a study’s results are generalizable (transferable) to other groups (populations) of interest outside the experimental environment (Last, 2001). Campbell and Stanley (1966) also define the external validity as “*external validity asks the question of generalizability: to what populations, settings, treatment variables, and measurement variables can this effect be generalized?*”.

Because this study aims to provide understanding of a serious problem, develop a solution for this problem, and evaluate the solution, rather than generalise findings to a wider population, except for the NHS organisation, internal and external validity were not considered critical.

#### **4.4 Conclusions**

The chapter introduced the system development methodology that has been used for this study, which is based on some of the most usable and successful system development methodologies. A customized software development life cycle (SDLC) model is identified for this project in order the software development process to be managed better and successfully. The chapter evaluated a number of software development methodologies, waterfall model, spiral model, RUP, V-Model, and Agile and provides a discussion as to how they could be used to aid the development of the software developed in this thesis. All these different software development models have their own advantages and disadvantages. Timing is very crucial in software development and especially in this study because of the limited resources and because the thesis will integrate the development with the research of gathering customer's requirements and testing the system. Each stage of the life cycle model must be completed before the next stage begins. So, any delay in any of the stages will cause a delay to the whole software development process which affects the overall target. A simpler SDLC model has been defined in this chapter which will be beneficial for this software development.

Furthermore, this chapter outlined the research methodology chosen for the study. It identified the research design for the study and what instruments were used for data collection. The thesis combines exploratory and explanatory research. The work is exploratory research because the study gathered information and developed solutions about a serious problem (gathering and managing risk information). It is also explanatory research because it provides explanation and evaluation between phenomena. Due to the nature of the thesis qualitative and quantitative methods have been used and a research design has been created. Sampling procedures, respondent characteristics and data analysis

methods has been also identified in this chapter for each stage of the study as part of the research approach.

The aim of this thesis was not to test a previous theory, but to focus at first on understanding and explaining a very serious problem within NHS and at second to develop and evaluate a solution for this problem. For this reason a combination of qualitative and quantitative design was considered to be the most appropriate one for the study. Furthermore, the thesis blended with a successful way the research design with the customized SDLC model which has been chosen for this study. The research methods have been used as tools for gathering requirements and evaluating the system during the particular stages of the SDLC model. It is important to closely integrate the data-collection and analysis with the software development.

## ***Chapter 5***

### **Towards Requirements**

#### **5.1 Introduction**

The objective of this chapter is to develop the requirements of the system. This chapter will list the functional and non-functional requirements for the prototype model of the “risk-e” software application. Functional requirements are statements of services that the system should provide: how the system should react to particular inputs and how the system should behave in particular situations. Non-functional requirements are not directly connected to the specified functions of a system but they are equivalently important for the software development. The results of the interviews provide information which directly informs the functional specification, moreover and more importantly the results of the interviews suggest a methodology of approach. Thus, the chapter introduces the risk-e pathway which identified from the interview discussions and provides a set of stages that (if followed correctly) enable users to mitigate the risk. Furthermore, the risk-e pathway forms an important part of the implementation and thus needs to be at the core of the functional specification. Additionally, there are certain functions that is necessary for any program (such as load and save), which are also included. Consequently the chapter lists the primary requirements of the system which will be used for the development of a prototype model which are gathered by interviewing a number of Welsh Risk Pool assessors. Finally, the education and learning process that will be applied as pedagogy method during the usage of the software will be identified and discussed in this chapter. The design guidelines have also been identified in this chapter in order for a very effective, usable and accessible environment to be developed.

#### **5.2 Data Gathering & Analysis**

Interviews have been used as an effective instrument for gathering useful data which directly informs the functional specification of the system. Interviews were held with two people; the Head of WRP and one WRP senior risk management assessor, in the field of risk management assessment in NHS in Wales.

Semi-structured interviews with open questions have been used in this study. The interviews had a general plan of inquiry, but not a specific set of questions that had to be answered with particular words or in a particular order.

Interviews were transcribed to enable a more accurate qualitative analysis (Appendix 4). The method of analysis chosen for this study was an approach of qualitative methods of thematic analysis, and it incorporated both the data-driven approach of Boyatzis (1998) and the deductive a priori template of codes approach outlined by Crabtree and Miller (1999). From the transcribed conversations, patterns of experiences have been listed. The first pattern of experience listed, was the reasons of the issue with the accidents in NHS and the different explanations from the WRP members. The second pattern of experience listed was the potential solutions that each WRP member had suggested toward the issue. The third pattern of experience listed was the attitude that each WRP member had towards to e-learning as solution to the issue. Finally pattern of experience listed was the different view that each WRP member had for a potential e-learning system functionality which will solve the issue with accidents in NHS.

All data that relate to the already classified patterns has been identified in order the patterns to be expounded. All of the talk that fits under the specific pattern is identified and placed with the corresponding pattern. The related patterns have been combined into themes which are defined as units derived from patterns such as "conversation topics, vocabulary, recurring activities, meanings, feelings, or folk sayings and proverbs" (Taylor & Bogdan, 1989, p.131). Themes are identified by "bringing together components or fragments of ideas or experiences, which often are meaningless when viewed alone" (Leininger, 1985, p. 60).

Four main themes have been identified during the thematic analysis of the interviews; accidents issue in NHS, reasons for the existence of this issue, solutions for this issue and e-learning system as potential solution. Both WRP members confirm the existence of the issue of accidents in NHS and they highlight importance of this issue and the needs of finding a successful solution. They also agree that the lack of risk

management knowledge is the main reason causing incidents in hospitals, and costs a lot of money and damage to NHS reputation. Furthermore, they believe that a potential effective solution to this issue is a new risk management training strategy in NHS which will be based on the action learning approach by blending the theory and practice. Finally they found e-learning as the most appropriate distribution method of the new risk management training strategy and they describe the main functionality of a potential e-learning system which will help NHS to reduce the number of adverse incidents in hospitals. The descriptions provide a set of the functional requirements for the e-learning system enough for the design and development of the system's prototype.

## **5.3 Functional Requirements**

### **5.3.1 Overview**

The functional requirements for a system describe what the system should do in order to cover the customer's needs. Functional requirements capture the intended behavior of the system. This behavior may be expressed as services, tasks or functions the system is required to perform. The system's requirements reflect the customer's expectations and they fully describe what the software will do and how it will be expected to perform. However, functional system requirements describe the system function in detail, its inputs and outputs, exceptions, and so on (Sommerville, 2004). The main system's requirements are gathered and determined by interviewing a number of customers, WRP members, as discussed above. The functional requirements describes a functionality that a risk management software application should provide, as WRP experts believe, in the healthcare risk management field where current software applications (Datix or Ulysses) do not provide and it could be the solution for the high number of incidents issue in the NHS.

### 5.3.2 User Details

#### Administrators Account

The system must have at least one administrator account with a password, which the administrator must be able to change. The system can have more than one administrator if it will be used in a big Trust. An administration account should be already created before the system is delivered. Furthermore, the Trust needs someone to administer the system especially when the Trust is big and therefore lots of people are using the system. Prototype model of the system should not provide the administrator with proper advanced online tools as it should focus on the e-learning area operation. However, system's administrator should have direct access to the system's database in order to manage and support the system and user's activities.

The main tasks for the system's administrator are:

- Manage Users
- Manage Help System
- Manage Pathway Contents
- Manage Profile
- Monitoring Database

**Manage Users:** One of the main administrator responsibilities is to manage the system's users. The administrator should have direct access to the systems' database in order to be able to manage the users in the system. Administrator "manage users" activities should include:

- Add or delete user account
  - Create or delete User's Folder
  - Create or delete User Profile File
- Update user's details
- Update user's status

**Add or Delete user:** The administrator should be the only person who can add or delete users from the system. He/She should be able to add or delete a tutor, a student, an administrator, or a visitor account.

**Create or delete “User’s Folder”:** The user’s folder should be created or deleted manually from the administrator, when the administrator creates or deletes a user account. However, the user’s folder should be independent from the user’s account. It should be still existed event when the user’s account will be deleted. However, any user account should not be existed without the appropriate user folder. This folder will be a specific area in the system’s database for each user where the “risk action plans” will be stored.

**Create or delete “User’s Profile”:** The user’s profile is a file, which will be created or deleted manually from the system when the administrator creates or deletes a user account. The administrator can update the details in the file at any time. User profile file will contain the user’s details such as first name, surname, contact details etc. The profile file should be working with the same way as student’s folder.

**Control the system’s database:** The administrator should be the only system’s user who has direct access to the system’s database. He/She is responsible for the smooth flow of the data in the database. The database is a very important part of the system because all the information will be stored there. The administrator should also be able to delete files in the database or transfer files in the database and to directly query the database.

**Manage Pathway Content:** The administrator should have the authorization to update the studying materials by direct accessing the system’s database. The studying materials should be divided into two parts; theory and resources (examples, background info and how to tasks) which will be stored in the main database. He/she should be also able to remove a studying material slide of any section or to transfer it between sections. Furthermore, he/she should be able to change the order of the slides in the theory area of each step.



**Manage Profile:** The system should allow the administrator to change his/her personal details such as first name, last name, email, location and phone number, by direct accessing the database at any time. The administrators should also be able to change their password at any time. Furthermore, administrator should be able to change other user's details except their password.

**Manage help system:** The administrator should have direct access to the help information. The administrator should be able to change the information on the online active help system for each part of the system. He/she should be also able to activate or deactivate help screens of the help system.

### **Pathway System (e-Learning Area)**

This part should provide the users with a virtual pathway, which will help them to build their risk management risk report (action plans). The layout of the risk report can be found in Appendix 5. The users should go through six steps in order to complete the risk report. Each step should provide them with three main areas:

- Theory
- Resources
- Action panel

#### ***Theory***

The theory area should display the studying material as a slide show. The study material will be in a slide formation in order to be presented easier to the students. The instructors will have the ability to use the slide show in a face-to-face teaching session and the system can be used as a teaching tool.

#### ***Resources***

The theory area in each step should be supported with a resource area. The resources are there to further deepen the understanding of risk management and they should be divided into three categories; examples, how to, and background information.

The theory area should refer the users to the resources area using a symbols method. For example, if users see the following symbols at the side of the text they are reading, it will indicate that there is a resource available to help them understand what they are reading. The following colours have been chosen randomly in order to highlight the different between the categories.

- Means there is an example to support the theory
- Means there is information on how to develop their practice
- Means there is supporting background information available

### *Action panel*

The action panel should allow the users to organize and populate a database with risks that the users will identify within in their organization. Once populated the users could then start writing risk reports (action plans) for each risk they have identified. This area gives the users a tool to start planning, acting and reflecting upon the theory they read about in each step.

### Loading area

The loading area should allow users to navigate through the database showing them how their organizational risks have been organized into files and folders. By clicking on a particular risk report saved on the database, it should be loaded into the system, which then the users should be allowed to start inputting information about the risk report into.

### The menu

Each action panel should provide options organized in a menu in a priority order.

### **Step 1**

Step 1 should ask the users to first turn their attention to understanding, as described in the theory section. Finding out about their organization means they can start to build up an understanding on how their role in risk management fits into the organization's profile.

So, no actions should need to be offered from the system in this step.

**Step 2**

In this step the action panel should allow the users to create or delete area, subsections and risk report, as described in the theory section.

**Step 3**

In this step the action panel should allow the users to create, edit or delete data relating to the action plan, who will be the risk lead, the current controls, the risk score and its acceptability within the organization, as described in the theory section. The users should have first load a selected risk report to the system, using the loading area, in order to activate the menu and be able to work within this step.

**Step 4**

In this step the action panel should allow the users to create, edit or delete data relating to the new controls they will put in place, the barriers they may come across when they start to implement their action plan, and the specific actions they need to take in order to carry through their action plan in practice. The theory section should give them a full explanation of this step. In order to work within this step and the menu to be activated, the users should have first loaded the risk report they would like to work with to the system, using the loading area.

**Step 5**

In this step the action panel should allow the users to create, edit or delete data relating to the indicators they choose to put in place to monitor and review the management of their risk. In order to work within this step and the menu to be activated, the users should have first loaded the risk report they would like to work with to the system, using the loading area.

**Step 6**

In this step the action panel should allow the users to create, edit or delete data relating to their reflections upon the process they have gone through in order to implement their risk reports. They should also be able to view their risk reports. The theory section should give

them a full explanation of this step. In order to work within this step and the menu to be activated, the users should have first loaded the risk report they would like to work with to the system, using the loading area.

### Display area

The system should display the most important information of the risk reports that are already added to it and it should relate with the step, on which the user is currently working, when he/she loads the risk report to the system.

### *Navigation Tool*

The system should provide the users with a navigation tool, which will help them to move around the pathway system steps.

### *Step Title*

Each step should be clearly displayed on top of the step title in order to avoid any confusion and to help the user navigate easier through the steps in the system.

### **User Profile File**

It should be created or deleted only by the administrator. In addition, the user profile file contains personal details of the user and the system should allow the administrator only to create, delete or update them. The user also will be able to update them with administrator's help.

### **User's Folder**

It should be created or deleted only by the administrator. In addition, the user's folder contains the risk plans that have been created from the student and categorized under folders called "Areas" and subfolders called "Subsections" that are stored in the user's folder as well. The users should not have access to other user's folders.

## 5.4 Non-functional requirements

### 5.4.1 Overview

The “risk-e” system should adhere to the following non-functional requirements. Non-functional requirements are not directly connected to the specified functions of a system. They may be related to certain aspects that have an impact on the system. The non-functional requirements support the requirements, they are equally important and they should be stated separately in the requirements document. They could relate to reliability, storage space and appropriate reasonable time for the system to respond to the user.

The above main categories are very broad but very important for “risk-e” software application. In addition, the non-functional complexity requires one to state them clearly in order to avoid confusion. One can break them further down to Product, Process and External non-functional requirements types, as Ian Sommerville has summarized.

***Product requirements*** – These requirements specify product behaviour. For example performance requirements on how fast the system must execute and how much memory is required; portability requirements and usability requirements.

***Organisational requirements*** – These derive from policies and procedures in the customer and developer’s organisation. Examples include standards, which must be used; implementation requirements, such as programming language or design method used; and delivery requirements, which specify, when the product and its documentation are to be delivered.

***External requirements*** – This broad heading covers all requirements, which are derived from external factors to the system and its development process. These include interoperability requirements, which define how the system interacts with systems in other organisations; legislative requirements, which must be followed to ensure that the system operates within the law; and requirements (Sommerville, 2000).

## 5.4.2 Product requirements

### Performance Requirements

- The minimum specification should be an IBM compatible company computer running Windows<sup>®</sup> OS (95, 98, Me, NT, 2000, XP) operating system, based on IEEE standards (IEEE Std 830-1984, IEEE Std 830-1998).
- Internet Explorer 3.x or later
  - Cookies should be enabled

Additionally, some of the minimum specifications that the user's computer should have are:

- RAM min. 128 MByte
- Internet connection (fast connection is beneficial but not essential)

### Space Requirements

**User's machine:** The system should be a web based application. All the information should be stored in the server database. The system itself should be installed on the same server machine on which the database is installed. The database and system could be installed on different server machines as well. It is envisaged that the users will use the application through the internet or hospital intranet and they should not need to provide any additional storage space on their machines; i.e., it will run as a thin client.

**Web server machine:** As described above, the level of hard drive storage afforded to the installation and runtime of the software should be more than the capabilities of an average company computer. The system should be installed on a web server and it should store the risk reports in the database, which is connected with the web server. Each risk report should not contain images or graphics that need many megabytes for storing. But each user should have the ability to create unlimited risk reports and the system should be able to support unlimited users. Furthermore, the instructors should be able to create teaching materials, which could contain images and graphics that need more space for storing. The server machine should provide minimum 1 GB storage space (including the database) in order to the system to be installed and start running

properly. Of course the hardware (web server) should provide the ability for future storage space extension.

### **Usability Requirements**

- The design process for the system's interface should be user centric. The system should provide a common interface to all users with different facilities based on the user's role. The interface should interact with the user in their terms in a logical and consistent manner.
- The interface of the system should have the facility to help the user with the system and to recover from their mistakes. The interface should provide the "help" option that can be used from the user when he/she is in trouble or he/she needs information. The interface of the system should allow users to recover from their mistakes. For example the system interface should provide the undo option in the text areas. The undo option will allow the users to undo the very last action that he/she took. Also, the pathway system interface should provide the delete and edit option as a recovery facility. The user can use them to recover from their mistake. Furthermore, the system should provide a confirmation message to the user before a crucial action, such as delete.
- The error messages produced by the system should not suggest that the user is responsible; on the contrary, they should offer suggestions concerning how to repair the error and provide a link to a help system. This will make the system more useful, operational and of course more helpful. It will also help the users to learn how to use the system more quickly and it will help them move easier around in the system.
- The system should be delivered with user documentation. This documentation should contain manuals at beginners' level. All manuals should explain all the facilities that the system provides to the users in detail plus any potential problems which the users may be faced with, with solutions.

### **Portability Requirements**

- The system should be portable within the needs of the users, especially the students. This facility will allow users to work from home or any other environment outside the NHS Trust. This is a beneficial facility, because it recovers problems that may cause backwards on risk report schedule. This may require the software to be able to run on an average laptop PC with the same minimum specifications as the clinic's computers (see Performance Requirements above).

### **5.4.3 Organizational Requirements**

#### **Delivery Requirements**

- The installation should be easy and provide acceptable documentation and understandable to the average clinic administrator and computer user.
- The system is running online via the internet or intranet using Internet Explorer browser. Maybe installation of other software application will be required, such as flash macromedia reader.

#### **Implementation Requirements**

- The system should be implemented using development tools that will produce a deliverable that is capable of running on the average Trust computer; otherwise the installation of the proper programming environment should be feasible to the NHS Trust computers. The potential implementation language that will be used for the implementation of the system will be one or a combination of two or three of commercial computing web programming languages such as ASP.NET, PHP, JavaScript, VB.NET, XML, etc. If the computers in the NHS Trust do not support the chosen implementation language then it is necessary to install the proper environment.

#### **Standards Requirements**

- All users should login to the system, by using a personal username and password.
- Only the instructor and administrator can change teaching materials.
- Only the administrator can delete users from the system.



#### **5.4.4 External Requirements**

##### **Interoperability Requirements**

- The software needs to interact with the external system; printer. It needs to interact with the printer in order to provide the print option to the users.

##### **Privacy Requirements**

The privacy requirements are very important because the system will store information about risks in Trusts, whose privacy is protected by law. Furthermore, it will also store personal data and NHS sensitive data that is protected from the law. For this reason the system should provide the following features:

- Each user should use a username and password to login to the system.
- The security should prevent the unauthorized viewing and alteration of information. For example the administrators and instructors should have access to student's risk reports but only to read them. He/she shouldn't have access to add or delete information of those risk reports.

The security should protect the data transfer. The transfer of risk report information from a user's machine to the system's database should be protected because someone can spy the system with the affect that NHS sensitive information will be misused.

### **5.5 Pedagogy philosophy**

Pedagogy is important for the design and success of the e-learning software system. Any e-learning system provides the appropriate facilities which will support and help the selected pedagogy to be applied. It is very important the pedagogy to be defined and discussed in this part of the thesis by taking into account the above requirements.

#### **5.5.1 A deep approach to learning**

Marton and Saljo (1976) suggest there are different levels of learning a student can engage in. Surface and deep learning were two of the suggested levels. At a surface level students

do not relate what they learn to real life, the concepts that they have learnt seem independent and the students find it difficult to apply the ideas to different domains. Their ‘surface’ understanding may be because they have received information passively and as such they do not attempt to make mental connections between different concepts that they have been presented with. Deep learning, on the other hand, enables the student to link the course content to real life situations and they also relate new material to material already learnt. Deep learning encourages the student to question and look for meanings. Consequently, such a ‘deep’ approach is to be encouraged when managing risks, because the users need to gain an understanding of the complex and interrelated nature of the task. Welsh Risk Pool (WRP) believes, based on the risk assessment’s results and based on the expensive NHS training scheme that NHS staff are surface learners as they do not relate what they learn to real life.

### 5.5.2 Outcomes of learning

The work of Biggs and Collis (1982) identified that the outcome of student’s learning can occur at differing levels. They categorised each level and called this the Structure of Observed Learning Outcomes (SOLO) taxonomy. The categories within this taxonomy are as follows (Biggs 1990 in (Entwistle, 1990)):

Prestructural	The task is engaged but the learner is misled by an irrelevant aspect belonging to previous and simpler mode of operating No structure to knowledge.
Unistructural,	The learner picks up one or very few aspects of the task
Multistructural	The learner picks up more and more relevant features, but does not then integrate them
Relational	The learner now integrates the parts so that the whole has a coherent structure and meaning
Extended abstract	The learner generalises the structure to take in new and more abstract features, representing a higher mode of operation

Table 8: Categories in SOLO taxonomy

The category of Biggs’ *extended abstract* was linked to deep level learning by Biggs (1979) as similarities can be seen in the student who undertakes deep learning and who displays outcomes at the relational or extended abstract level. The characteristics of good

risk management are that users are able to see the bigger picture of the organisation and to be able to see how risks interrelate and are influenced by numerous factors. Subsequently, in order to do this a risk manager should be processing risk management information at the deep level whilst working towards relational and extended abstract outcomes.

In order to add structure to this concept Biggs (1990) introduced the 3P model of Presage, Process and Product:

### **Presage**

Presage involves consideration of student and tutor characteristics.

Student characteristics that are suggested to have an impact on learning include: background, motivation, interest, age and experience and approach to learning.

The important aspects of the tutor include teaching content, structure and design, time allowed for study and methods of delivery used. The concern here is how the tutor can affect the student's learning process.

### **Process**

The presage factors relate to how teaching methodologies encourage learning at different levels. However the process of learning can not be forced. Process involves the setting of mutual goals and the decision about how the tutor and learner decide to reach that goal. The actions of students should lead to desired outcomes.

### **Product**

The product of learning can be qualitative, where all the knowledge "is placed in a framework and enables it to be understood and applied" (Biggs 1990). Other outcomes can include quantitative outcomes, where the amount of knowledge is seen to be important and an institutional outcome, which is reflected in a grade as a result of some exam or assessment.

Further work of Biggs (1997) suggested that the manner in which material is designed, presented and later assessed will have a marked effect on the student learning. He argued that for learning to be effective and at a higher level in the SOLO taxonomy, the process must be 'constructively aligned'. That is to say if one thinks about what is expected of the student at the end point in the teaching. With specific relation to this thesis, this is the system with the ability to introduce sound risk management into practice, the process by which risk management training is planned, delivered and assessed must reflect the expected outcome. A team of tutors (administrators) will monitor and control the whole process.

### **5.5.3 Designing teaching methodology**

In order to apply this to the delivery of the "risk-e" pathway the following application of the 3P model is suggested:

#### **Discussion of presage and process within the "risk-e" pathway**

It is easier to approach process and presage of teaching as one as the course content will subsequently affect the process of learning.

With regards to student characteristics they cannot be selected, consequently there will be a presumption made that as self selected students they will be motivated to follow the course of training provided. The approach and conception that students have to learn are important and the teaching design explained below will try and influence this.

With regards to teaching presage and process, this will be linked to the developments of deep learning among the students and, as the author predicts, it will bring about an improvement in risk management practice.

Teaching can be designed to encourage deep learning. Gibbs (1992) identified the following areas as important in promoting such learning; motivational context, learner activity, interactions with others and a structured knowledge base.

It is for this reason the chosen mechanism for presenting the “risk-e” pathway is in an e-learning format. Such an approach allows tutors to give information to students in a structured format that differs from the standard paper based risk management information. By making the intervention as practical and interactive as possible it is hoped that staff will instantly be drawn into feeling risk management is an inter- and pro-active experience.

Of course the “risk-e” pathway could be used as a teaching tool. Risk managers from each hospital could introduce “risk-e” pathway to hospital staff dealing with risks by organizing teaching session(s). Biggs (1990) suggests that if the student’s interest is aroused then deep learning is likely to follow. He suggests having teachers interested in the subject, confronting student misconceptions and engaging in active learning and relating materials to what students already know, will encourage deep learning. Other teaching techniques suggested by Biggs (1990) to encourage deep learning are:

- ‘think aloud modeling’ where the teacher talks out loud to the class while performing a complex task
- peer teaching
- self-questioning
- group activities

These teaching methodologies will all be utilized by the teacher when presenting the “risk-e” pathway to the students.

In order to promote sound process the teaching methodology will be made explicit to the students. This approach is supported by Ramsden (1992); he suggested that students should be aware of expected teaching outcomes and methodology. Such knowledge promotes them to address their learning in the way that is expected of them. He found that when students were aware of the rationale of deep learning they were more likely to approach their learning in this manner.

### Discussion of “risk-e” pathway outcomes

In presenting the “risk-e” pathway the author is interested in neither quantitative knowledge nor devising an institutional score for the learners taking part. He is interested in their *quality* of learning. Of whether the materials presented have had an impact on their beliefs and understanding of risk, and ultimately whether this improved quality of learning and has had any impact upon their practice.

Morton and Saljo (1984), Entwistle (1990) and Biggs (1990) places learning into five conceptions:

1. Learning means ‘knowing more’ in some vague way
2. Learning means learning by heart
3. Learning means acquiring various facts and skill, to be retained and used when necessary
4. Learning means finding out what something really means
5. Learning means using what is learned to construct a personal philosophy

It would be hoped that the outcome of learning for the students of the “risk-e” pathway would be at level 4 or 5. In order to encourage this consideration an assessment technique is necessary. Rust (2002) comments on how assessment drives the way the student will undertake learning. He presents the view of the students who will not carry out work if it’s not going to be assessed, a view that many teachers will relate to. The tutor does not seek to use assessment as the strict hand of learning; however he needs to be aware that assessment is a key concept that affects learning. The author seeks to incorporate assessment that will *encourage* rather than worry the students.

The assessment of the “risk-e” pathway will therefore be largely individually driven. The NHS has been criticised for its blame culture and its unsupportive approach to managing risk (Department of Health, 2000). It is important that this is not reflected during participation in the “risk-e” pathway. The study seeks to foster a supportive environment where students are happy to share their work for assessment in order to receive feedback.

Students must never fear being blamed or penalised for inaccuracies or inappropriateness of their planned actions.

Throughout the “risk-e” pathway students are encouraged to plan their actions at each of the six steps which discussed above and their resulting actions are then recorded on an action plan. The production of action plans, produced as a result of their learning, will therefore be the medium of their work that is ‘assessed’ by the tutors. It will not be graded or marked – simply constructive feedback will be given regarding how the student has integrated their learning into their work.

### **Introducing the reflective cycle**

The steps of risk management are typically presented in a cyclical format (The NHS Executive 1993, AS/NZS 4360: 1999, Carroll 2001, HM Treasury 2001, HM Treasury 2004, Treasury Board of Canada Secretariat 2004) where to ensure risks are soundly managed, the practitioner works through steps 1 – 6 and then returns again to step 1 to ensure a constantly evolving cycle of practice that is monitored and reviewed throughout.

Anecdotal evidence suggests that this constant thoughtful cycle may not always be in existence in the healthcare setting; procedures will be written with no clear plan about how they will be acted upon, initiatives will be introduced without any clear method of monitoring and reflecting upon effectiveness.

The cycle of plan-act-reflect, an adaptation of Lewin’s (1948) plan-act-observe-reflect (which laid the foundations for many subsequent variations on the idea), has been incorporated into the 6 step risk management process. The software encourages groups of practitioners to work within in their own environments to commence a process of change through an action based cycle. Evidence is growing that such an approach encourages practitioners to truly understand the nature of risks they are dealing with and how to practically manage them.

The 6 steps are represented cyclically as shown in figure 12:



Figure 12: Cyclical representation of the risk management cycle

The cyclical representation of the risk management cycle guides people how to plan-act-reflect in each of the 6 risk management process steps. It is also will be used as a navigation tool in the system as which is part of the human computer interaction concept and usability of the system. The navigation tool will help users to move around the “risk-e” pathway system in order to improve systems’ usability.

## 5.6 Design Guidelines

### 5.6.1 Human Computer Interaction – Web Accessibility

Human Computer Interaction and Accessibility are two significant areas that are relevant for this thesis. These areas are linked to this thesis via the usability aspect which is linked to the e-learning aspect (which is a principle concern of this work). Both concepts are very important because they provide useful guidelines that will improve the development of the system and enable that the developed system is effective.

Human Computer Interaction (HCI), as its name implies, studies the interaction between humans (users) and computers. It consists of three parts: the human (user), the computer and the interaction. Grunwald (1997) defined Human-Computer Interaction (HCI) as *"a field of study that studies ways to improve on the interaction between computer users and computer systems. In this case the Internet and multimedia. HCI*



*research has led to an abundance of information concerning the effective design, development, implementation, and evaluation of computer interfaces. The rapid growth of computer use in many facets of society has made the study of human-computer interaction essential to good interface design, including the design of web sites"*

NHS staff (potential "risk-e" users) do not often have an advanced IT background and they prefer to spend much time focusing on learning part of the system rather than to spend time on learning how to operate the system. Hence, it is necessary to develop a usable system and following principles of HCI can help.

The user interface of a system is often the measure by which the system is judged because it is the first part of the system that will be met from the user for the first time when using the system and it will be used for the interaction between the user and the system.

Should the users have difficulties with the user interface then it will create an unpleasant environment, in which they will interact with the system, and immediately will affect the system usability. The user interface is a crucial part of a user's interaction with a software system. E-learning interface design is especially critical, as learning effectiveness and interface design are substantially intertwined.

The mouse is the primary physical interface device that the user will use to interact and interface with the system. It is essential that the interface provides an intuitive mechanism for the user to use. The mouse cursor is a semantic feedback to the user and makes the system more usable and accessible. The cursors and their explanation of the "risk-e" system are displayed in the next table. The cursors could be different and provide different feedback when used from different system's users. The cursors in the following table are used for all systems' users.





	Default Cursor: Used to signal that the mouse is ready to receive an event from the user.
	Busy Cursor: Used to signal that the system is busy and the mouse is not ready to receive an event from the user.
	I-beam Cursor: Indicates that the mouse is currently in the text area, where the user can type or can select the current text in order to copy it.
	Hand Cursor: Indicates that the mouse is currently over a link (hyperlink) that can be opened.

Table 9: Cursors

Usability is the link between HCI and Accessibility. Usability is one of the main concepts in HCI and makes systems easy to learn and use. The main goal of HCI is to produce a usable system and everything about HCI should be applied in order to achieve that. On the other hand, accessibility is a subset of usability and focus specifically to the people with disabilities and their access ability to the system. This study relates with web accessibility as the “risk-e” system is a web-based application. Web Accessibility targets people with disabilities accessing the web or a web-based application.

There are millions of disabled people in the world. Based on the latest statistical figures (2004-2005) from National Statistics there are 10 million disabled people in the UK. More than half of them (5.8 millions) are people with hearing problems but they are people with other disabilities such as sight, mobility, speech, etc. 6.8 million people from the 10 millions disabled people living in UK, one in five of the total population, are able to work and they are working. Another one million are able to work but are currently unemployed. The UK Government is very sensitive with matters involving disabled people and for this reason several laws have been created such as the Disability Discrimination Act 1995 (the DDA) and the Special Educational Needs and Disability Act 2001 (SENDA) in order to provide equal opportunities and significant rights to disabled people. These

laws also protect disabled people from any discrimination in the working environment. NHS, the same as UK Government, produced equal opportunity laws for disabled people in the NHS organization working environment. Today around 5-7% of staffing in a Trust are disabled people.

Furthermore, Disability Equality Duty, which is responsible for disabled people's rights in the public sector, is considered of accessibility in the procurement of software.

*"A Government department that is planning to procure a new IT system should ensure that its action plan includes the work it will do to ensure that the new system is suitable for use by disabled employees. The action plan should also indicate the way it will develop the specification so that the system delivers the right products for disabled customers."*

Statutory Code of Practice for England and Wales, section 3.46

### **5.6.2 Design Guidelines**

"risk-e" software application is a web based e-learning system. Based on previous research many researchers suggested a number of guidelines that help developers implement effective online environments. There are also many organisations created to design guidelines covering categories such as usability, accessibility and HCI. The oldest and most well-known are W3C and IMS Global Learning Consortium providing a set of guidelines for developing accessible learning applications. All these organisations spent years of research and study in order to create a complete recommended set of guidelines. As discussed in chapter 5, design and implementation overall can effect or even increase the usability of a system.

Accessibility improvements sometimes lead to better design and implementation of a system, which automatically effects usability of the system. As discussed above, usability and accessibility are related. Furthermore, designed and implemented is a system fully acceptable and usable for people with disabilities that definitely benefits people without disabilities. The use of usability guidelines is vital for the acceptance of e-learning material.

This part of the chapter outlines a set of guidelines for web application interfaces, which combine e-learning application guidelines, Web design usability guidelines and especially web accessibility guidelines together, to form a solid foundation for “risk-e” system interface design.

Universal and widely applicable design guidelines have been developed based on many research projects and online application development projects. These design guidelines can improve the accessibility, interoperability, usability and flexibility of a software system. E-learning software application effectiveness, learnability, memorability, satisfaction and efficiency are strongly related with the above aspects. W3C, IMS, JIC, Section 508, IBM, ISO 9241-171 are some of the most famous design guidelines but also there are many more organisations that developed a set of general or specific design guidelines for software applications. Also a number of well-developed Web usability guidelines have been created by Lynch and Horton (1999) and Nielsen (2000). Some of significant web usability and accessibility design guidelines for a web-based e-learning application will be mentioned below.

## **Usability**

### *Simplicity*

The system should provide only the important information in order firstly to focus on user’s attention on important information and secondly to avoid confusion of information. Furthermore, the system will be more simply and of course more useable.

### *Minimize the memory load of the user*

The system should deliver information to the user in a way, where it will be easy for the user to remember them. That will help the user to remember only the important information that he/she needs in order to move between the system’s steps.

### *Consistency*

Terminology is very important for the usability of the system. Terms that are used in a system should always mean the same thing in each circumstance where they occur in the system (Dix et al, 1992).

### *Navigation*

The system should be designed based on a very strong navigation method in order to help the user to never be lost in the system's environment. The user should implicitly understand where they are in the menu of the system. For instance, users may get lost, or not find a particular operation command if it is far down a nested menu. Microsoft altered their menu system on their Office product, to a menu strip, based on users' comments and their analysis that users regularly only used the top few menu items. It is also important that users easily understand how to exit from the current session and save the details to file.

### *Messages*

The system must provide users with clear messages and inform them about their actions. The messages can be a confirmation message before an action or an error message. The confirmation message should ask the user if he/she is sure for the selected action. The error message should highlight the error and offer suggestions concerning how to repair the error and provide a link to helpful information. The messages should be provided in a plain and understandable language where the user can easily identify the problem.

Messages should be provided in a timely and relevant way. A careful design will prevent a problem from occurring and covers a big range of potential situations where an error message should be displayed.

### *Keyboard Shortcuts*

The system should provide the users with the ability to use keyboard shortcuts. It is often useful to follow popular conventions that have been used by well-known packages. For instance, it may be useful to follow keyboard shortcuts conventions that are consistent over all the Microsoft Office packages, which are familiar to many people. The use of keyboard shortcuts increases the user's speed of interaction with the system.

<b>Press</b>	<b>To</b>
Ctrl-Z	Undo
Ctrl-X	Cut
Ctrl-C	Copy
Ctrl-V	Paste
Ctrl-A	Select All
Ctrl-P	Print
Ctrl-H	Help

Table 10: Keyboard shortcuts

### *Help and documentation*

Each system should contain an online help system, which provides relevant information about the functionality of the system. The online help system should provide two types of help: “Help I’m in trouble!” and “Can you help me please; I need information?”

A user manual should be provided with the system in an online format or hard copy format. The user manual should be written at beginners’ level and it should also contain a separate documentation for system administrators if applicable.

### **Accessibility**

As accessibility is a subset of usability then the above guidelines are part of the accessibility guidelines as well. Additional to those guidelines there are:

*Full screen size browser use.* Full screen allows maximum information to be displayed or gives the advantage of more available space to be used. Hiding the browser tool bars helps learners to be easily focused on specific information. Furthermore, the minimum use of web browser borders and tool bars makes the browser less confusing. Finally, the web browser tools could be provided by the software application, which makes them more interactive.

*Minimize the number of pop-up windows.* The low number of windows relating to the system’s functionality and interface reduces the user’s mental load with information, reduces the possibility of confusion and losing attention to important information, and finally reduces the possibility for hardware system’s memory overload and corruption.

*Browser compatibility.* The software application should provide the same functionality and should be accessible from any browser such as Internet Explorer, Firefox, Netscape, Opera, etc.

*Provide rollovers.* The concept of rollovers is used on the web and users are familiar with them. Web buttons react (activation) when the cursor is rolling over the button, which is another way to interact with the system. Furthermore, it improves the system's accessibility as it is useful for people with sight or hearing disabilities.

*Hyperlink facility.* This facility provides the ability to link web pages together and to create a web site. The hyperlink option can be used not only to create a plain text into a link but also images and symbols. So, it will give an action to the images and symbols, which will increase the accessibility of the system. The users will move their mouse until a clickable area appears. This facility will create a more interactive environment.

*Use the correct colours or combination of colours.* Colours are very important for the usability and accessibility of the system. The correct colours can emphasize important information but can also show the sequence history of tasks. For example, hyperlink actions will be visually represented with unsaturated version of colour before the execution and with saturated version of the same colour after the execution.

*Maximize the use of web tools (radio buttons, checkbox etc) in a web page.* Minimise the user's effort to interact with the system. These tools help the user to interact with the system with only a few actions. Furthermore, all these tools are familiar to users with basic IT background knowledge. Finally these tools help to manage and design the limited web screen space better. Clearly the use of web tools benefit the system's accessibility.

*Synchronous and asynchronous communication and collaboration tools.* Communication and collaboration tools, such as thread message board, e-mail, document repositories, organizers, calendars, presentation tools, synchronous text chat, audio-conferencing, video-conferencing, whiteboards etc. are increasingly important components of online learning

systems and should provide functionality that facilitates the full participation of learners with disabilities.

## 5.7 Conclusions

This chapter lists the functional and non-functional requirements for the prototype model of “risk-e” software application. The main system’s requirements are gathered and determined by interviewing the Head of WRP and one WRP senior risk management assessor, in the field of risk management assessment in NHS in Wales. The interviews data analysis produced a list of requirements which describes a functionality that a risk management software application should provide, as WRP experts believe, in the healthcare risk management field where current software applications (Datix or Ulysses) do not provide and it could be the solution for the high number of incidents issue in the NHS. The analysis was not too difficult because there were only two people interviewed, and also because each candidate provided a clear description of the main issue. Many different ideas and many different areas have been highlighted from the candidates based on their experience and knowledge on risk management in NHS. The method of analysis chosen for this study was an approach of qualitative methods of thematic analysis which helps to get an understanding of these different ideas and themes.

The list of functional requirements describes what WRP assessors are expecting from an online learning risk management tool for health care professionals in Wales. WRP assessors experience provides the knowledge of the functionality that risk management software should provide in this field where other software applications does not. The design and implementation of the prototype model of this project will be based on this chapter and therefore this particular chapter is very important in order to move on to the next step, the design and implementation stage. The requirements will be changed after each phase in the testing stage in order to be improved and be used for the implementation of the new version of the system, the pilot model.

The pedagogy strategy and the design guidelines have been discussed on this chapter as part of the requirements, because the design and the implementation will be based on



those aspects as well. This pedagogy strategy is a combination of individual learning, case study learning and problem based learning. Moreover, it blends theory and practice, which is one of the most effective learning ways for most people, especially in risk management. The notion of deep learning and the concentration of efforts on to higher learning outcomes will be incorporated into teaching methodologies using Bigg's (1990) 3P model, in order to introduce healthcare staff to the step by step approach to risk management via an e-learning program and face to face teaching. Such an approach will be introduced through action research where the intervention can be evaluated for impact on practice in a real life setting.

HCI, Web Accessibility and Usability are significant subjects for this study and generally for the development of an e-learning environment. Universal and widely applicable design guidelines have been developed based on many research projects and online application development projects. These design guidelines can improve the accessibility, interoperability, usability and flexibility of a software system. E-learning software application effectiveness, learnability, memorability, satisfaction and efficiency are strongly related with the above aspects. The design guidelines have been identified in this chapter in order for a very effective, usable and accessible environment to be developed.

## ***Chapter 6***

### **Prototype Implementation**

#### **6.1 Introduction**

Following from the requirements in Chapter 5, this chapter describes how the first prototype was created and how it implements the requirements. The objective of this chapter is to explain the implementation of the system's prototype model and to show how the requirements are transformed into a software application. The education and learning process – the pedagogy that was developed in Chapter 5 – will be applied and integrated into the system. Furthermore, such to provide a usable, effective and accessible software system, various design guidelines will be identified in this chapter in order for a very effective. The UML notation has been used to create an appropriate Object Oriented solution, consequently various UML diagrams will be presented that translate the project requirements into the diagrams. In addition, the final prototype will be presented, demonstrating how a user would operate the tool and use the software that has been developed. Finally, various issues such as how the database is integrated and what security functionality is included will be discussed in this chapter as two very import parts of the system.

#### **6.2 System Architecture**

##### **6.2.1 3-tier Architecture**

The architecture for the prototype system is based on the widely adopted N-tier model. The prototype “risk-e” system is organized into three major parts, tiers, each of which is distributed to a different place or places in a network (figure 13).

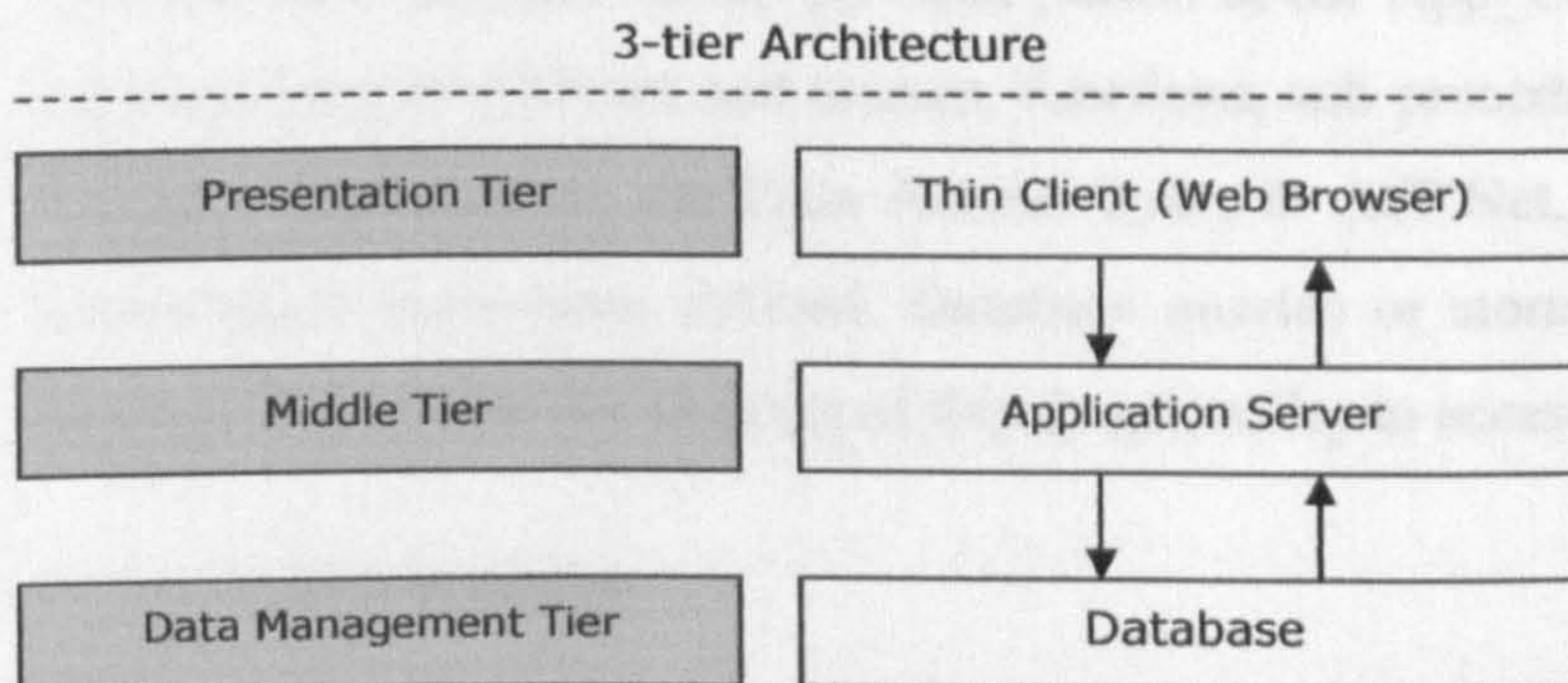


Figure 13: 3-tier Architecture

A tier is a functionally separated hardware and software component that performs a specific function. The architecture includes the following tiers: presentation, application and data management. The first tier or presentation tier is the graphical user interface or interactive window which for “risk-e” system is the web browser. The middle or application tier is responsible for the presentation of data to the users, acts as the server for client requests from workstations when a user submits a form. In turn, it determines what data is needed (and where it is located) and acts as a client in relation to a third tier of programming that might be located on a mainframe computer. The third or data management tier includes the database and a program to manage the database transactions. Because each tier can be managed or scaled independently, flexibility and performance are increased in the IT infrastructure that employs it. Communication between tiers is accomplished through standard protocols such HTTP and XML. Moreover, the middle tier limits the user’s access in secure data, enforcing system security. System’s security is very important and it will be discussed separately.

ASP.NET web application framework, the latest powerful web technologies, is used for the development of “risk-e” application. The above 3-tier architecture model supports perfectly the ASP.NET environment. The Presentation Tier is the portion the user sees when they open a web page in the browser. MasterPages has been used, as ASP.Net allows, in order setup the site look and feel. WebForm has been also created which utilizes the MasterPage and allows the code to be placed in a separate file, known as codebehind, thus keeping the business logic in a separate layer from the look and feel. The Business Logic is kept in a separate layer, middle tier. In ASP.net, this is where classes and source

code has been defined which has been placed in the App\_Code folder. VB web language has been used in ASP.net and classes, functions, sub procedures and properties have been defined. Furthermore, the Data Access layer, in ASP.Net, is where typed datasets and tableadapters have been defined. Database queries or stored procedures have also been defined. The middle tier is using of this functionality to access the database.

### 6.2.2 IT Infrastructure

The IT infrastructure that employs the system 3-tier architecture is consisting of a web server and a database server. The web server is IIS, the database is SQL server and the application server layer is also IIS. The figure 14 illustrates the 3-tier architecture.

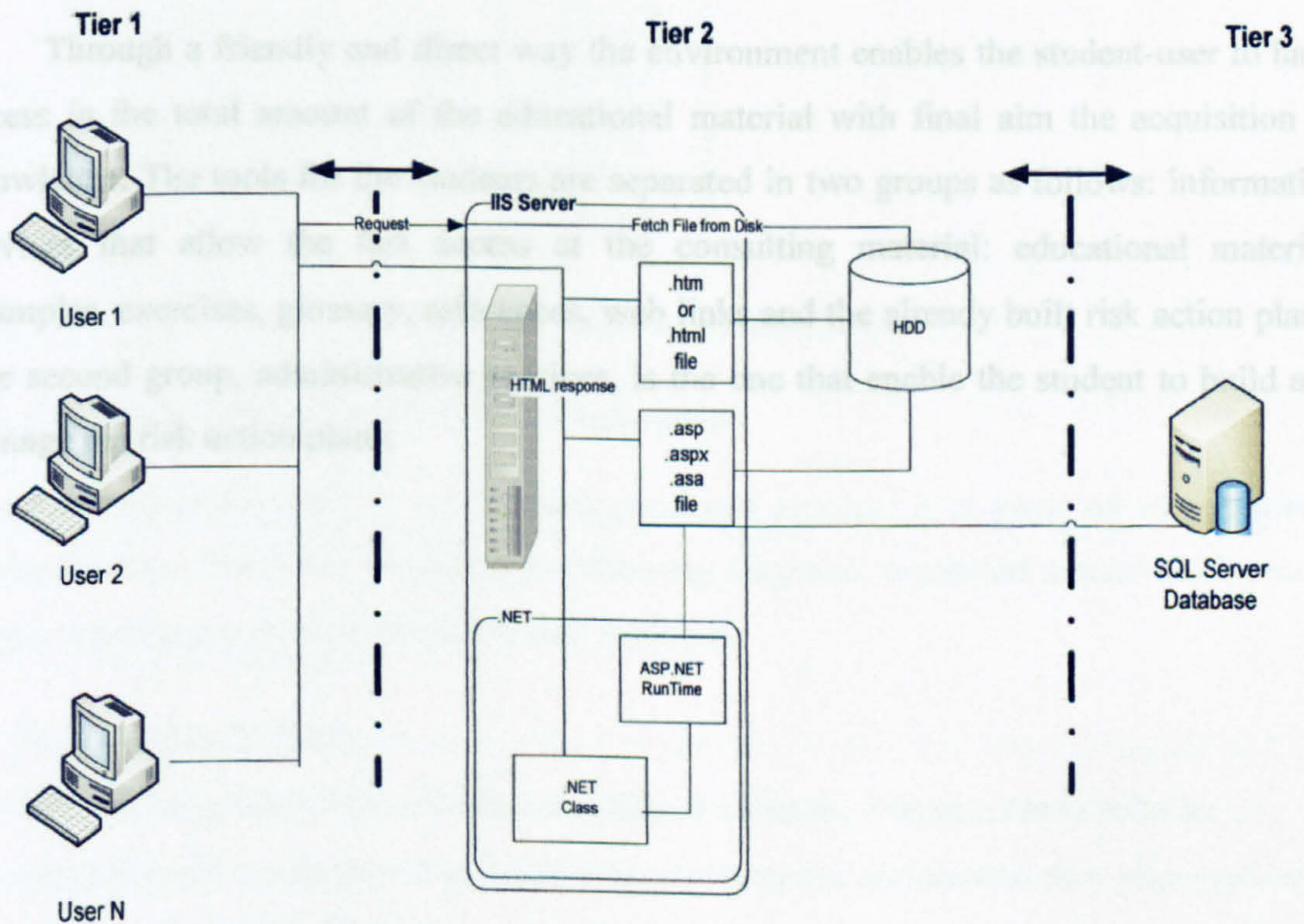


Figure 14: 3-tier Architecture Infrastructure

### 6.2.3 User Tools and Services

Only student user level is distinguished (figure 15) in the prototype environment. Users are redirected to the learning environment after a successful login and they can use the system as students. In this level the students can determine the successful development of action plan for a specific area and subsection in their organization (NHS Trust) based on the theory/resources that the system should provide in each step. The system provides the students with resources in order to support the educational materials. The students are referred to the specific resource from the system during the theory reading. Furthermore, the system provides an action panel with specific tools, in each procedure step, where the student can develop the risk report step by step.

Through a friendly and direct way the environment enables the student-user to have access in the total amount of the educational material with final aim the acquisition of knowledge. The tools for the students are separated in two groups as follows: informative services that allow the fast access at the consulting material: educational material, examples, exercises, glossary, references, web links and the already built risk action plans. The second group, administrative services, is the one that enable the student to build and manage the risk action plans.

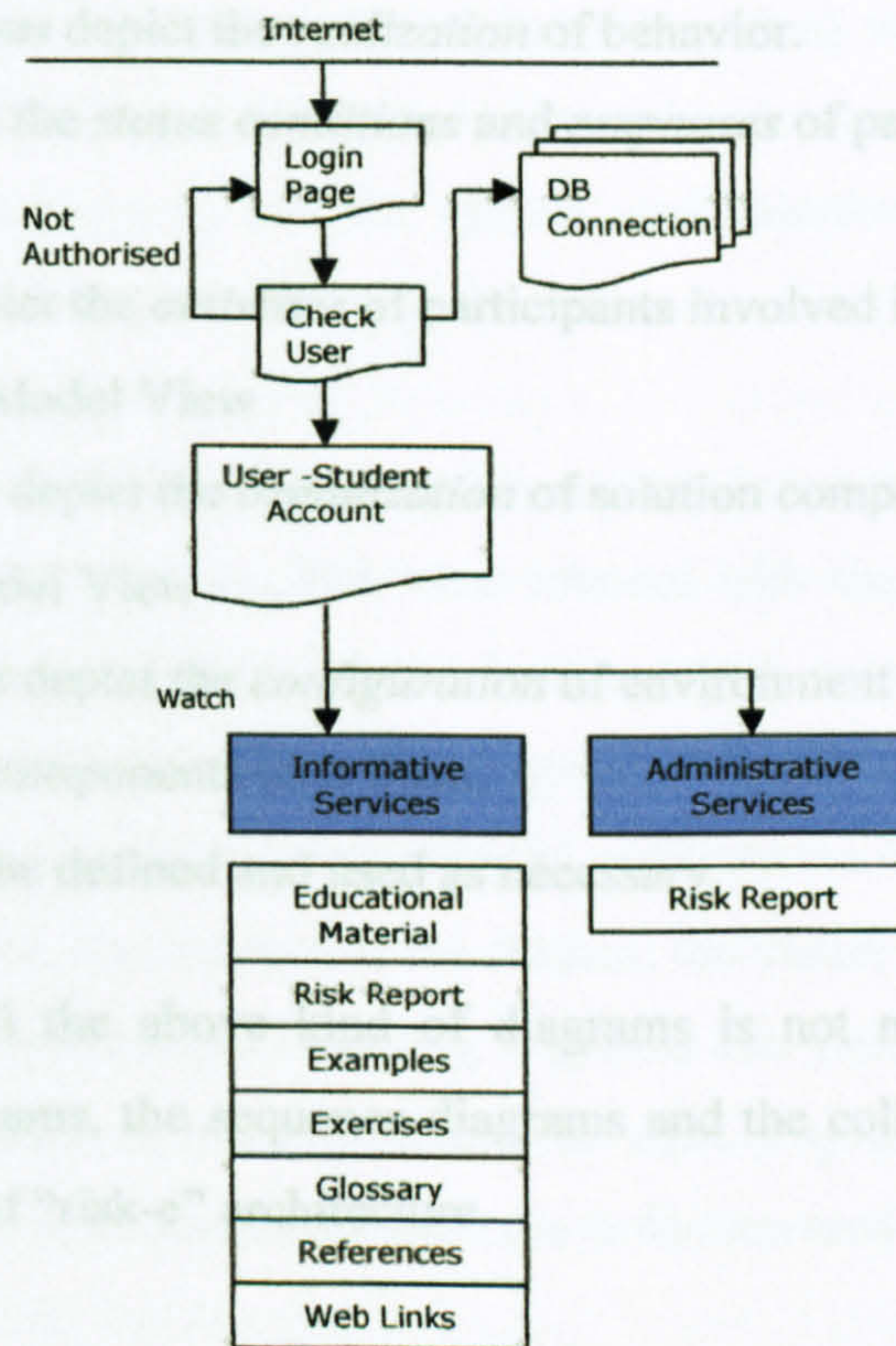


Figure 15: User-Student Level Diagram

### 6.3 System's Design with UML diagrams

The software architecture is not a one-dimensional process; it is made up of concurrent multiple views. The UML provides the following diagrams, organized around architectural views, regarding models of problems and solutions:

- **The User Model View**  
*Use case diagrams* depict the *functionality* of a system. Use cases are useful in capturing and communicating functional requirements, and as such they play a primary role in product definition.
- **The Structural Model View (or Logical View)**  
*Class diagrams* depict the *static structure* of a system.  
*Object diagrams* depict the static structure of a system at a particular time.
- **The Behavioral Model View (or Dynamic View)**  
*Sequence diagrams* depict the *specification* of behavior.

*Collaboration diagrams* depict the *realization* of behavior.

*State diagrams* depict the *status conditions* and *responses* of participants involved in behavior.

*Activity diagrams* depict the *activities* of participants involved in behavior.

- The Implementation Model View

*Component diagrams* depict the *organization* of solution components.

- The Environment Model View

*Deployment diagrams* depict the *configuration* of environment elements and the mapping of solution components onto them.

- Other *diagrams* may be defined and used as necessary.

The creation of all the above kind of diagrams is not necessary. The use case diagrams, the class diagrams, the sequence diagrams and the collaboration diagrams will be created in the design of “risk-e” architecture.

The use case diagrams describe the scope of the system, identify users, establish the characteristics of significant input and output hardware, and prioritize the requirements. The class diagrams show the classes within the system being designed and the relationships between those classes. The sequence diagrams describe the interactions between objects and the collaboration diagrams describe the interactions among objects.

### 6.3.1 Use case Diagrams

A *use case* defines a goal-oriented set of interactions between external actors and the system under consideration. *Actors* are parties outside the system that interact with the system (UML 2003, pp. 2.129- 2.140). An actor may be a class of users, roles users can play, or other systems. Cockburn (1997) provides the terms for the primary and secondary actors. A *primary* actor is one having a goal requiring the assistance of the system. A *secondary* actor is one from which the system needs assistance. A use case is initiated by a user with a particular goal in mind, and completes successfully when that goal is satisfied. It describes the sequence of interactions between actors and the system necessary to deliver the service that satisfies the goal.

The use cases capture *who* (actor) does *what* (interaction) with the system, for what *purpose* (goal), without dealing with system internals. A complete set of use cases specifies all the different ways to use the system, and therefore defines all behaviour required of the system, bounding the scope of the system.

A use case diagram consists of actors and use cases. Actors are not part of the system – they represent anyone or anything that must interact with the system. Actors can be human actors, potential systems' users, or non-human actors, external systems or devices. An actor may not only input information to the system, not only receive information from the system but also input and receive information to and from the system. “risk-e” systems' actors are the administrator, the instructor, the student, the visitor and the database. A use case is a sequence of transactions performed by a system that yields a measurable result of values for a particular actor. A use case describes what a system does but it does not specify how it does it. For this reason each use case is documented with a flow of events.

Use case diagrams describe the functionality of a system and the users of the system. Each system typically has a Main Use Case diagram, Level 0, which is a picture of the system boundary (actors) and the major functionality provided by the system (use cases).

UML (2003, pp 3.94-2.100) provides three relationships that can be used to structure use cases. These are generalization, include and extends. An *include* relationship between two use cases means that the sequence of behaviour described in the included (or *sub*) use case is included in the sequence of the base (including) use case. Including a use case is thus analogous to the notion of calling a subroutine (Coleman, 1998).

The *extends* relationship provides a way of capturing a variant to a use case. Extensions are not true use cases but changes to steps in an existing use case. Typically extensions are used to specify the changes in steps that occur in order to accommodate an assumption that is false (Coleman, 1998). The extends relationship includes the condition that must be satisfied if the extension is to take place, and references to the extension



points which define the locations in the base (extended) use case where the additions are to be made.

A *generalization* relationship between use cases “implies that the child use case contains all the attributes, sequences of behaviour, and extension points defined in the parent use case, and participates in all relationships of the parent use case.” The child use case may define new behaviour sequences, as well as add behaviour into and specialize existing behaviour of the parent. (UML, 2003, pp 3.94-2.100)

The use case structure is graphically summarized in a *use case diagram* (UML, 2003, pp. 3.94-2.100), which also shows which actors interact with which use cases.

A use case system’s analysis can have many levels; Level 0, Level 1, Level 2 etc. The idea during the design process is moving down a “level” at a time from abstract ideas to concrete implementation. As you move down you have enough information from the level above to make informed choices about implementation at the level below. As a conclusion, Level 1 is more detailed than the Level 0 and the Level 2 is more detailed than the 2 previous Levels and so on. The analysis can be stopped in any Level depending on the system’s requirements. The “risk-e” system analysis will be stopped in level 2, producing a big number of diagrams for each level and for each system’s function. Some of each level diagrams will be described later in this chapter.

### Level 0 of systems' use case analysis

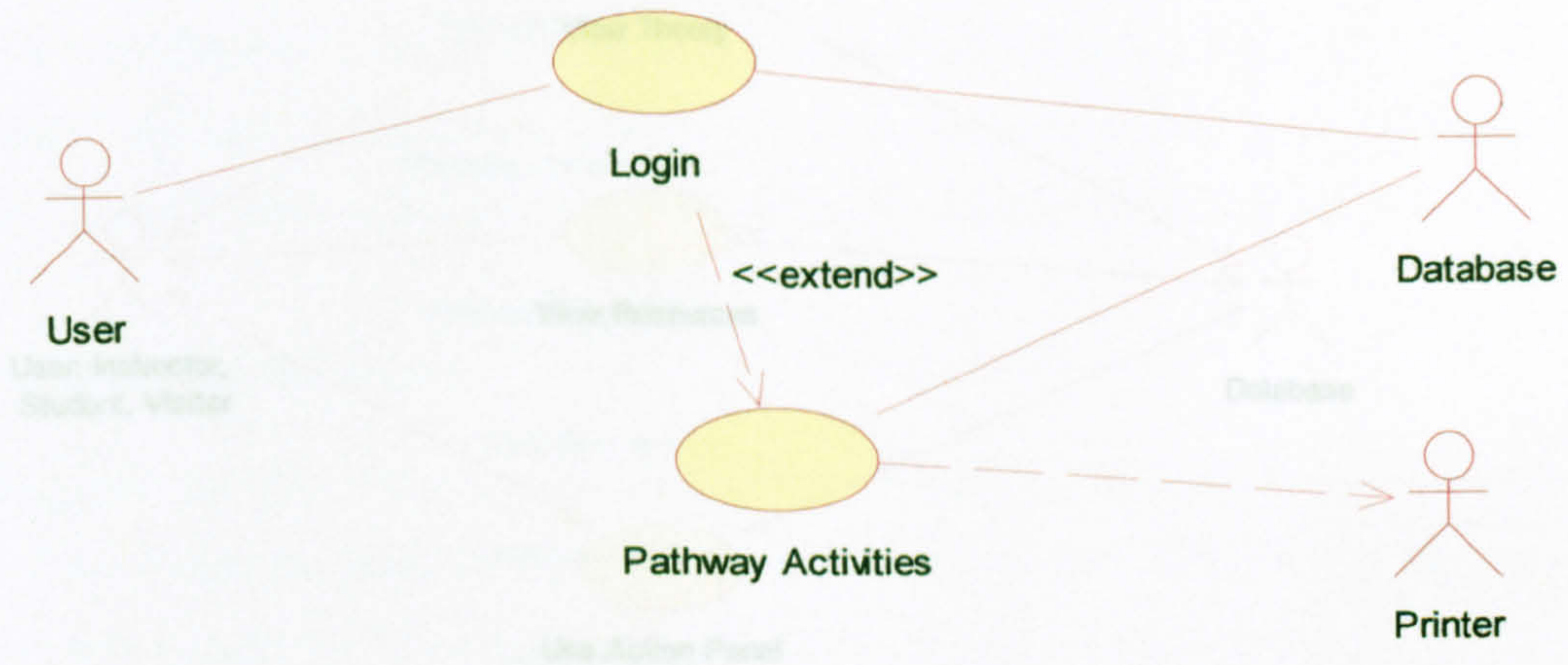


Figure 16: Level 0: Pathway Main Use Case Diagram

Figure 16 illustrates the main use case diagram of the system. This diagram is level 0 of the use case system's analysis. The diagram contains three actors (User, Database and printer) and two main use cases (Login and Pathway Activities). This diagram shows that any user should login to the system in order to have access to the main system sequences of transactions; Pathway Activities. The second actor is the database that the system will use to store all the information. This should be an actor of the system because it will take information of the system and also it will give information to the system when this is required. The last actor is the printer which has been illustrated on the diagram as an external actor as it is not part of the system.

### Level 1 of systems' use case analysis

Level 1 contains more detailed use case diagrams for the system and the creation of them based on Level 0 use case diagram of the system.

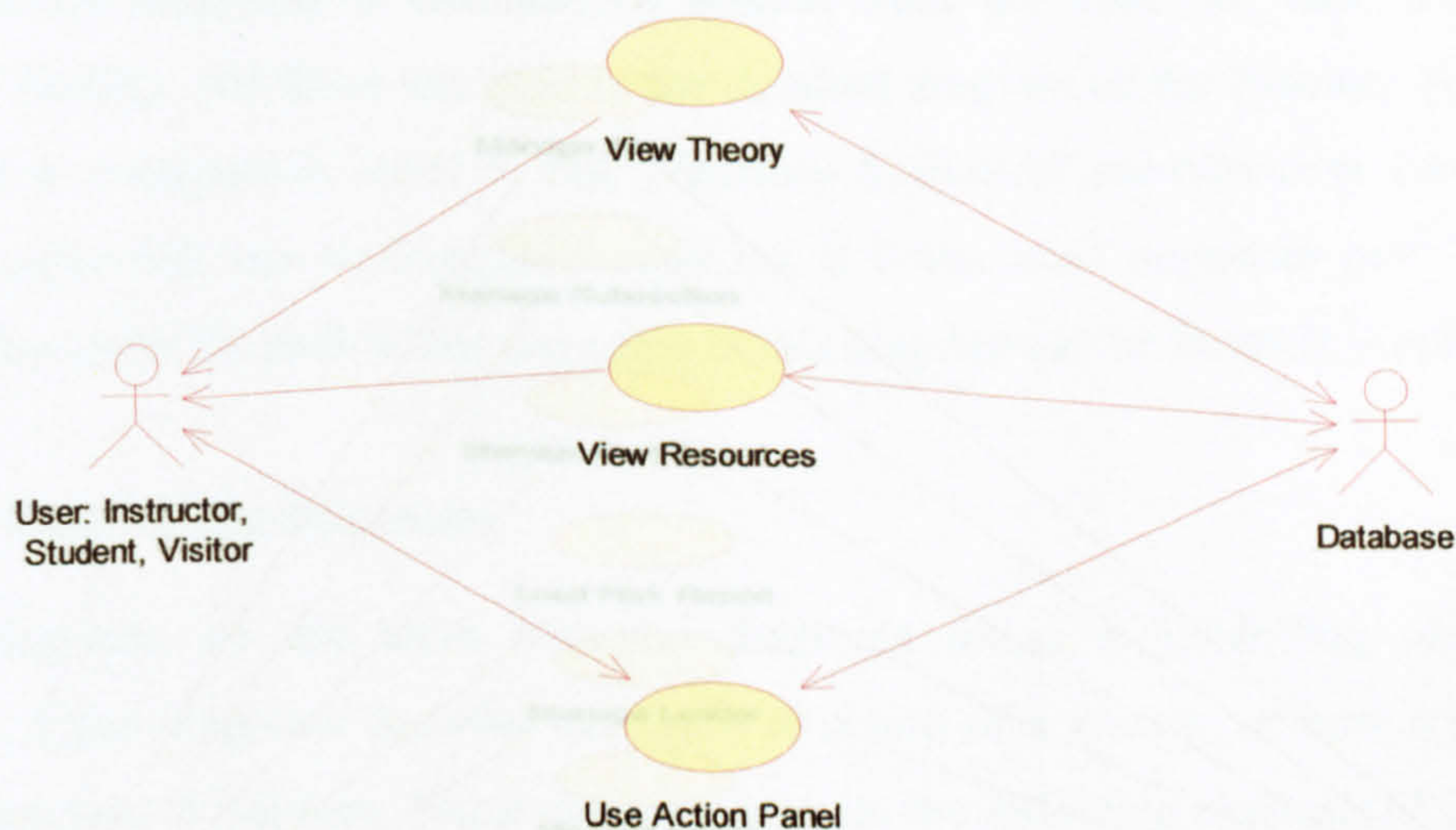


Figure 17: Level 1: Pathway Activities Use Case Diagram

The figure 17 illustrates the Level 1 pathway activities use case diagram. The diagram contains three use cases; View Theory, View Resources and Use Action Panel, and two actors; User: Instructor or Student or Visitor and Database. All these use cases represent the sequence of transactions that is needed in the system for each Instructor or Student or Visitor activities in the proper account and the detailed analysis of the “Pathway Activities” use case that are contained in the Level 0 system’s use case diagram. The flow of events document for each of the use cases in this diagram can be found in Appendix 6.

### Level 2 of systems’ use case analysis

Level 2 contains use case diagrams and more details from the use case diagrams in Level 1. In fact it makes the use cases diagrams for Level 1 more detailed if possible and necessary. The “Pathway Activities” use case is the most important part of the system and as it can be detailed further, the provision of this diagram is important and necessary.

The above figure 18 illustrates Level 2, pathway activities use case diagram. The diagram contains 14 use cases; Manage Area, Manage Subsection, Manage Risk Report, Load Risk Report, Manage Leader, Manage Score, Manage Indicators, Manage Controls, Manage Acceptance, Manage Actions, Manage New Controls, Manage Barriers, Manage Reflections and Print Risk Report. All the use cases that are contained in this diagram

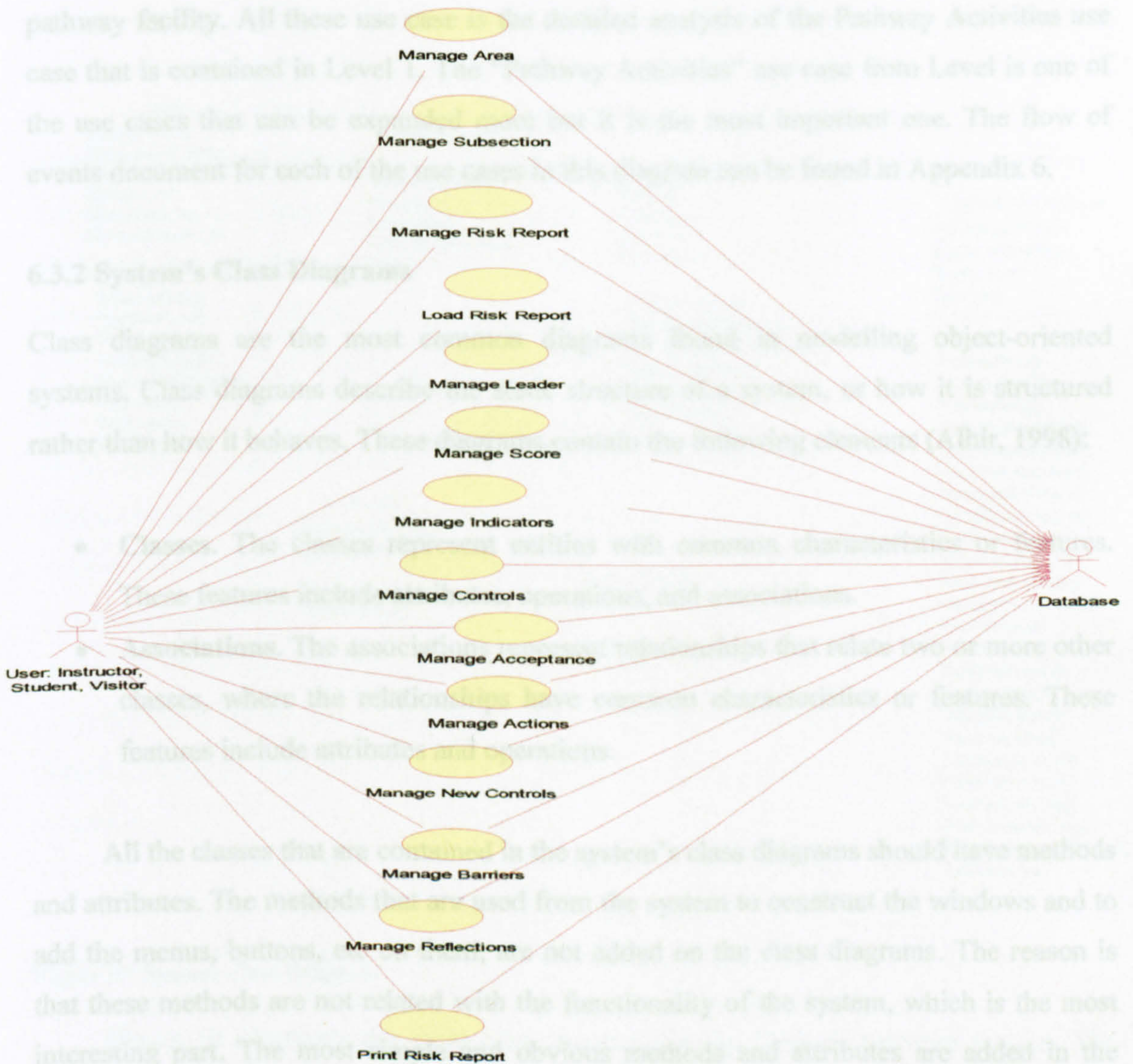


Figure 18: Level 2: Pathway Activities Use Case Diagram

The above figure 18 illustrates Level 2, pathway activities use case diagram. The diagram contains 14 use cases; Manage Area, Manage Subsection, Manage Risk Report, Load Risk Report, Manage Leader, Manage Score, Manage Indicators, Manage Controls, Manage Acceptance, Manage Actions, Manage New Controls, Manage Barriers, Manage Reflections and Print Risk Report. All the use cases that are contained in this diagram

represent the sequence of transactions needed from the User for each activity in the pathway facility. All these use case is the detailed analysis of the Pathway Activities use case that is contained in Level 1. The “Pathway Activities” use case from Level is one of the use cases that can be expanded more but it is the most important one. The flow of events document for each of the use cases in this diagram can be found in Appendix 6.

### 6.3.2 System’s Class Diagrams

Class diagrams are the most common diagrams found in modelling object-oriented systems. Class diagrams describe the static structure of a system, or how it is structured rather than how it behaves. These diagrams contain the following elements (Alhir, 1998):

- **Classes.** The classes represent entities with common characteristics or features. These features include attributes, operations, and associations.
- **Associations.** The associations represent relationships that relate two or more other classes, where the relationships have common characteristics or features. These features include attributes and operations.

All the classes that are contained in the system’s class diagrams should have methods and attributes. The methods that are used from the system to construct the windows and to add the menus, buttons, etc on them, are not added on the class diagrams. The reason is that these methods are not related with the functionality of the system, which is the most interesting part. The most simple and obvious methods and attributes are added in the design stage of the system. Furthermore, the diagram in the design stage may be changed after the requirements review or during the implementation stage. Of course during the implementation stage more classes and methods could be added or removed. The class diagrams tries to create the base of the code implementation of the software system with as much accuracy as possible in the first approach. The class diagrams could be changed after each requirements review.

### System Class Diagram

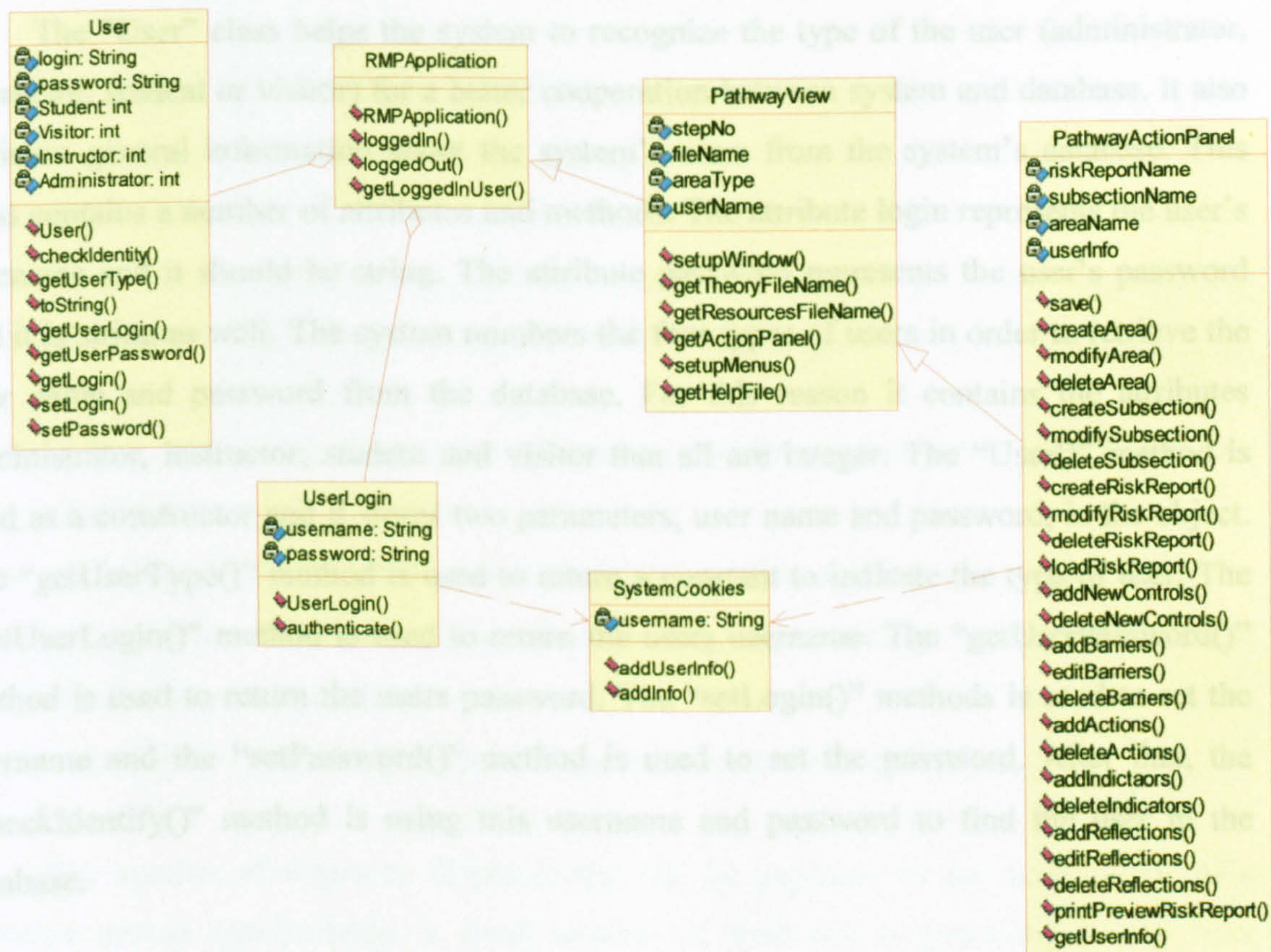


Figure 19: System Class Diagram

Figure 19 illustrates the main class diagram for the “risk-e” software system. The “RMPApplication” is the main class of the system. The application will be started when this class is called. The application call the “UserLogin” class and the login screen is displayed. The “RMPApplication” obviously contains a main method called “RMPApplication()”, the “loggedIn()” methods which is used to call the user interface when a successful login occurs, the “loggedOut()” is used to open the login interface when the interface close. The “UserLogin()” class has 2 attributes that represents the username and the password of the user and both are string. Obviously the “UserLogin()” class have a main class with the same name. The “authenticate()” method checks if the username,

password combination is valid by calling a database function to attempt to get the user details.

The “User” class helps the system to recognize the type of the user (administrator, instructor, student or visitor) for a better cooperation between system and database. It also retrieves general information about the system’s users from the system’s database. This class contains a number of attributes and methods. The attribute login represents the user’s username and it should be string. The attribute password represents the user’s password and it is string as well. The system numbers the four types of users in order to retrieve the user name and password from the database. For this reason it contains the attributes administrator, instructor, student and visitor that all are integer. The “User()” method is used as a constructor and it stores two parameters, user name and password, in the object. The “getUserType()” method is used to return a constant to indicate the type of user. The “getUserLogin()” method is used to return the users username. The “getUserPassword()” method is used to return the users password. The “setLogin()” methods is used to set the username and the “setPassword()” method is used to set the password. After that, the “checkIdentify()” method is using this username and password to find the user in the database.

The “SystemCookies” class is a class that is called from the “UserLogin” class in order to pass user’s information to the cookies. It also could be called from any other class such “PathwayActionPanel” in order to pass specific information to the cookies.

The system will transfer the user to the learning area of the system, pathway, when the user completes the login successfully. The “PathwayView” class is the main class of the learning area of the system. The class contains all the methods and attributes that the system needs to retrieve proper information of the system’s DB in order to assemble the learning area of the system. The learning area of the system will contain six steps and each of them will be divided into 3 areas; theory, resources and action panel.

The “PathwayActionPanel” class will be called from the “PathwayView” class when the user will visit the action panel of any pathway step. The class contains all the methods

and attributes that the system needs to support the pathway action panel mechanism from each pathway step in order to provide the ability to the user to use the action panel facilities of each pathway step. The name of each method describes the action as well.

### 6.3.3 Sequence & Collaboration Diagrams

Sequence diagrams describe interactions among classes. These interactions are modelled as exchanges of messages and this diagram emphasizes the time ordering of this messages. These diagrams focus on classes and the messages they exchange to accomplish some desired behaviour. These diagrams contain the following elements (Alhir, 1998):

- **Class roles.** The class roles represent roles that objects may play within the interaction.
- **Lifelines.** The lifelines represent the existence of an object over a period of time.
- **Activations.** The activations represent the time during which an object is performing an operation.
- **Messages.** The messages represent communication between objects.

The number of sequence diagrams that can be produced in the design stage of a software system can be huge. A small number of them will be produced for the “risk management pathway” software system and they will be displayed in this section with purpose to give an understanding view of the sequence diagrams.

The collaboration diagrams are interaction diagrams that emphasize the structural organization of the objects that send and receive messages. Collaboration diagrams describe interactions among classes and associations. These interactions are modelled as exchanges of messages between classes through their associations. Collaboration diagrams contain the following elements (Alhir, 1998):



- **Class role.** The class roles represent roles that objects may play within the interaction.
- **Association roles.** The association roles represent roles that links may play within the interaction.
- **Message flows.** The message flows represent messages sent between objects via links. Links transport or implement the delivery of the messages.

Figure 20 illustrates the sequence diagram which shows the interactions between proper system’s classes, when a user wants to login to the system. The corresponding collaboration diagram for the “login” sequence diagram is illustrated in figure 21.

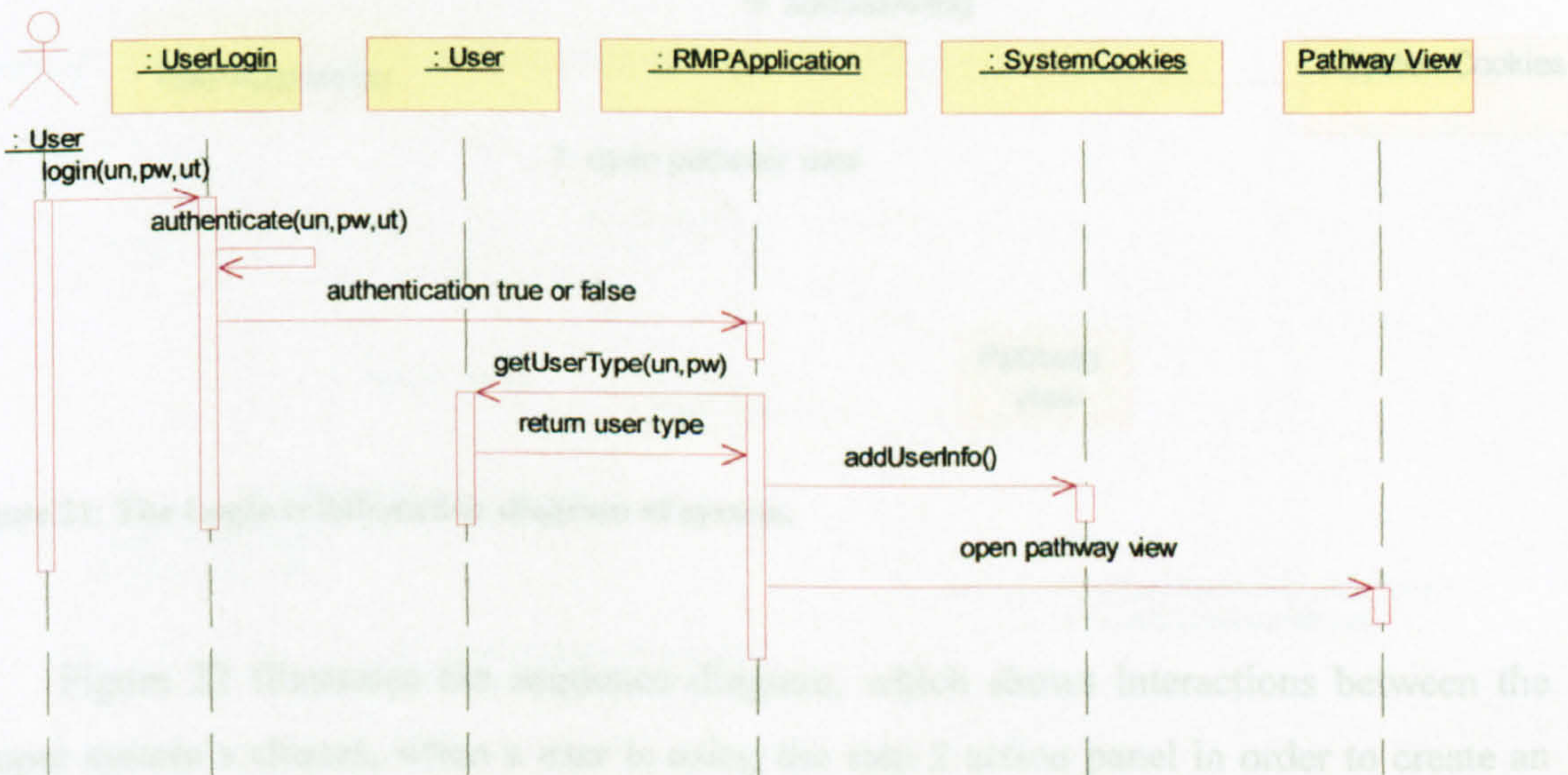


Figure 20: The Login sequence diagram of system.

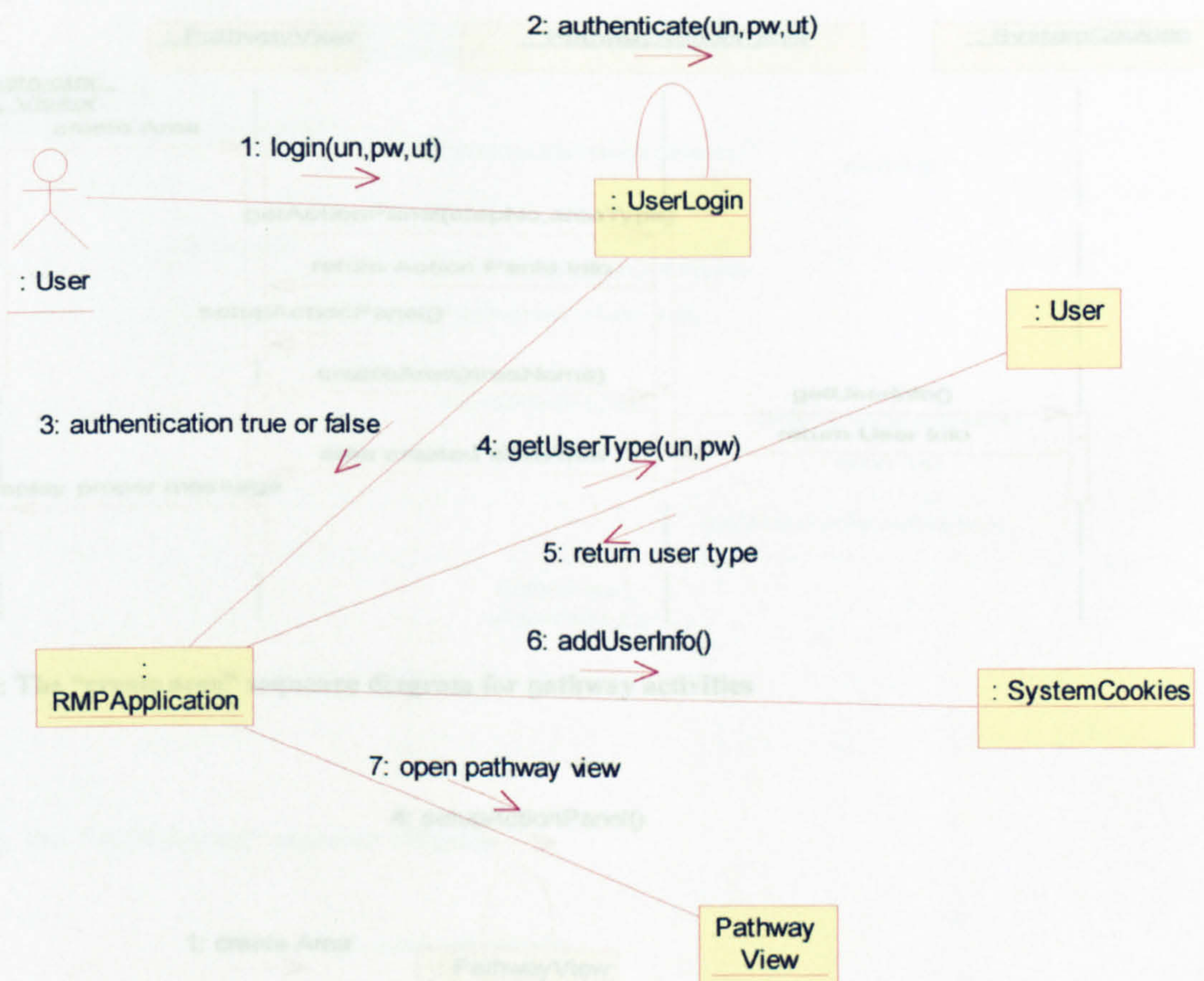


Figure 21: The Login collaboration diagram of system.

Figure 22 illustrates the sequence diagram, which shows interactions between the proper system’s classes, when a user is using the step 2 action panel in order to create an area of risks. The corresponding collaboration diagram for the “create area” sequence diagram is illustrated in figure 23.

Figure 24 illustrates the sequence diagram which shows the interactions between the proper system’s classes, when a user wants to add information about risk barriers in a selected risk report. The corresponding collaboration diagram for the “add barriers” sequence diagram is illustrated in figure 25.

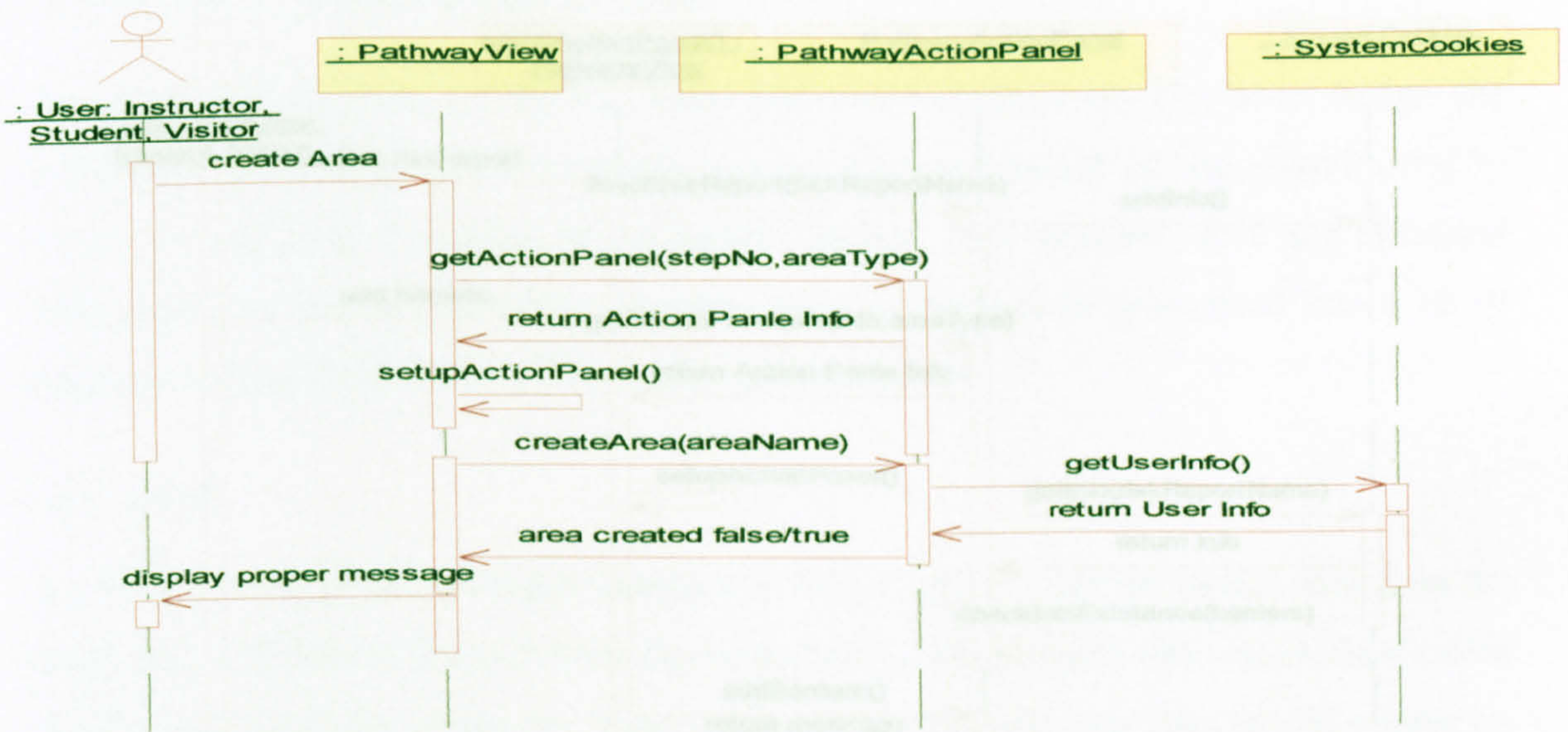


Figure 22: The “create area” sequence diagram for pathway activities

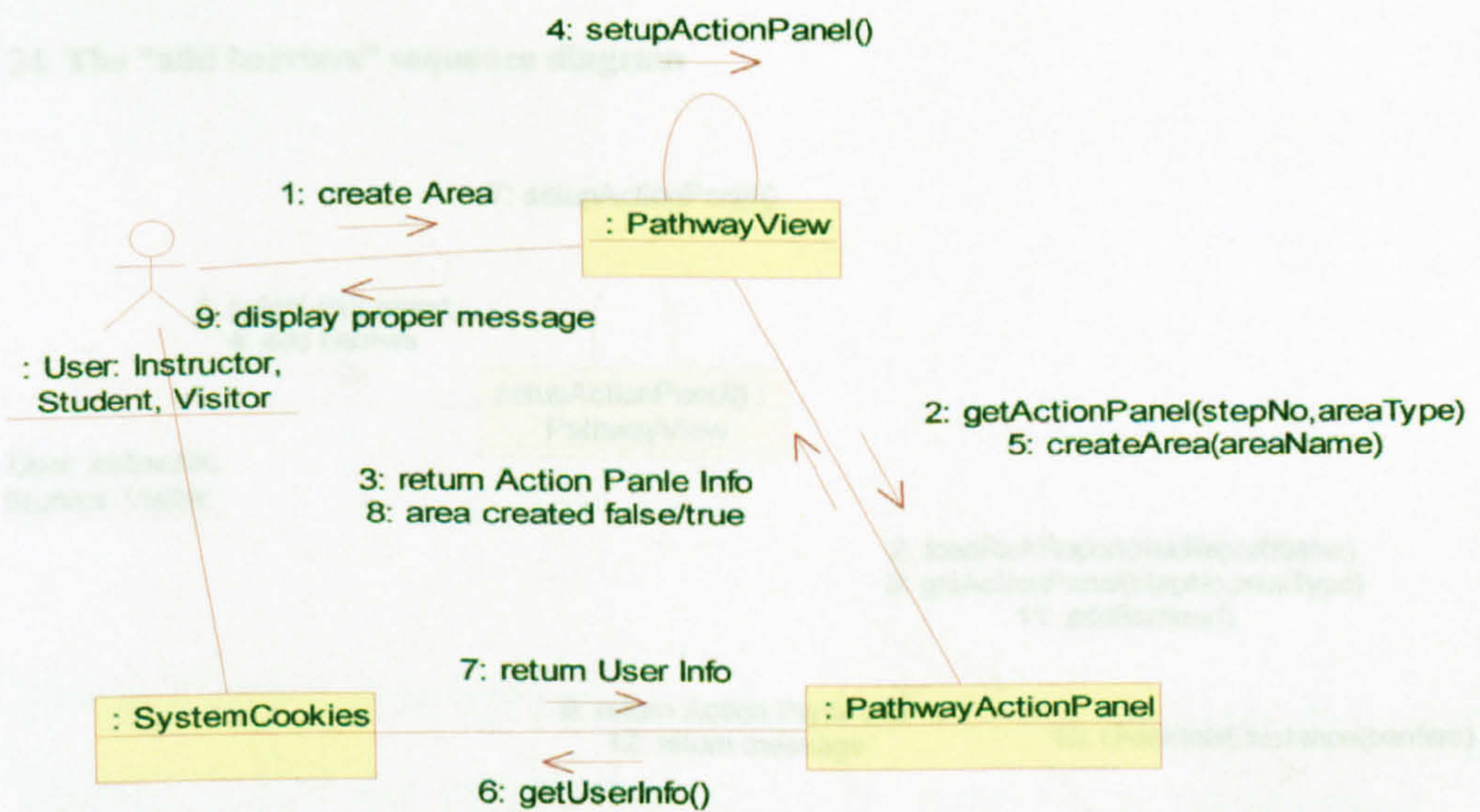


Figure 23: The “create area” collaboration diagram for pathway activities

Figure 24 illustrates the sequence diagram which shows the interactions between the proper system’s classes, when a user wants to add information about risk barriers in a selected risk report. The corresponding collaboration diagram for the “add barriers” sequence diagram is illustrated in figure 25.

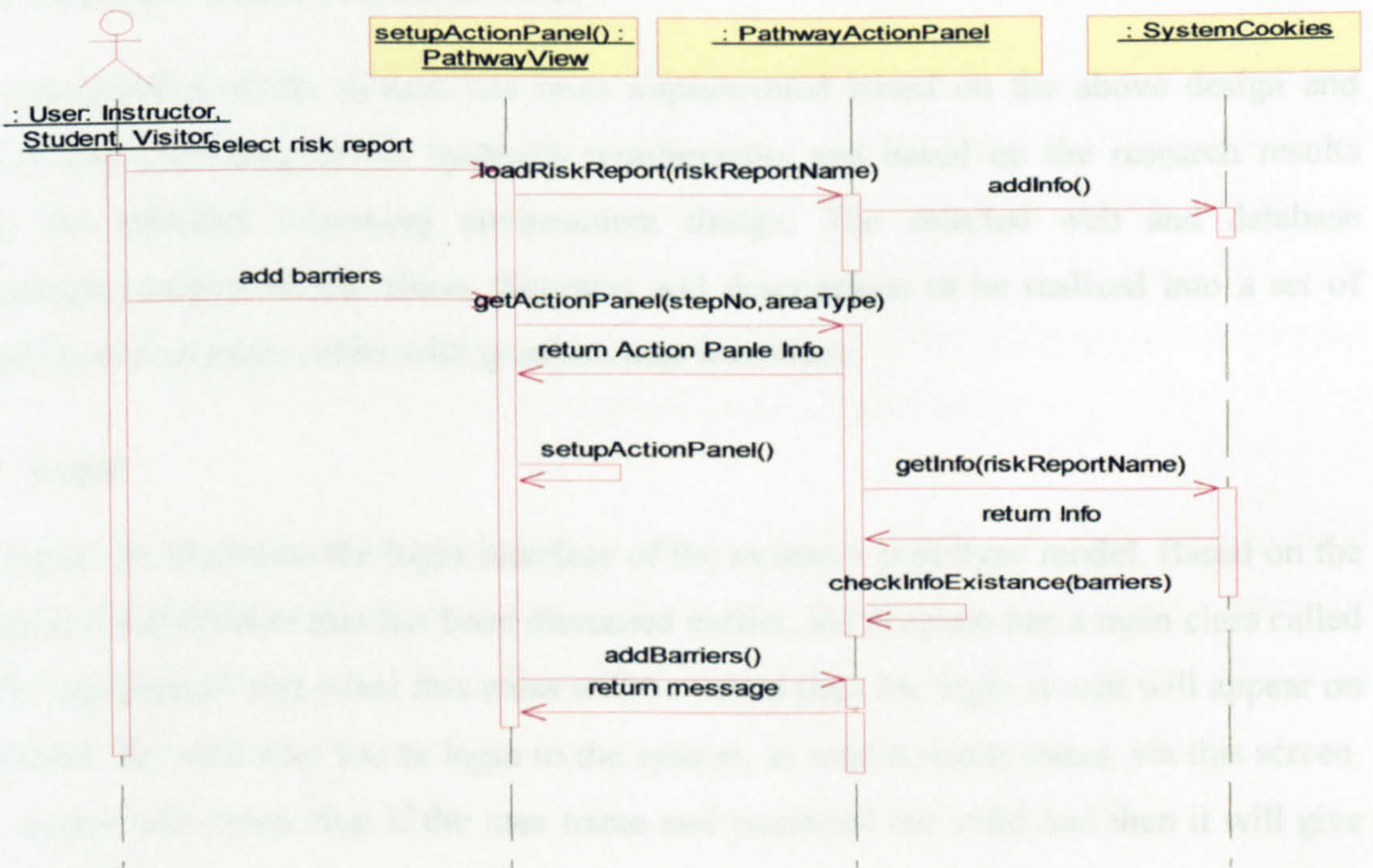


Figure 24: The “add barriers” sequence diagram

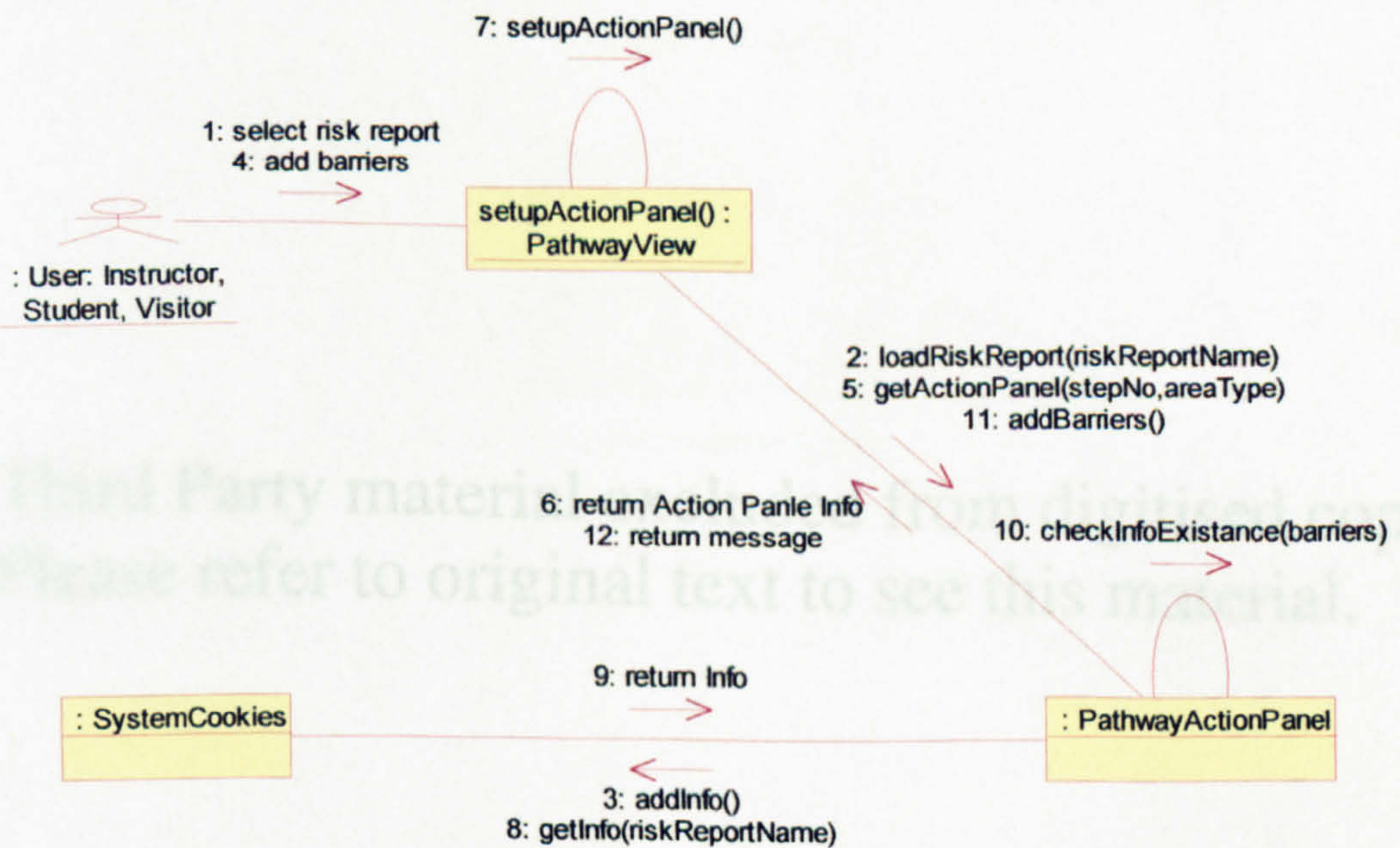
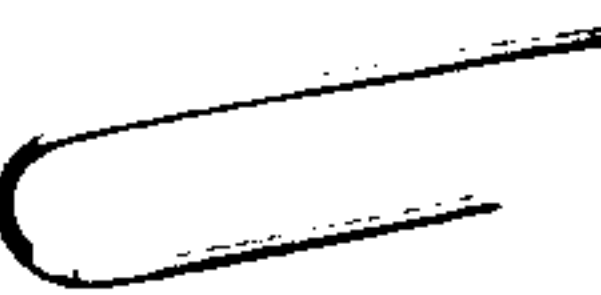
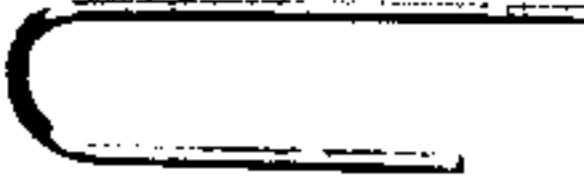


Figure 25: The “add barriers” collaboration diagram

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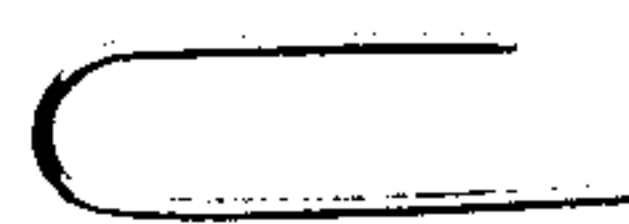
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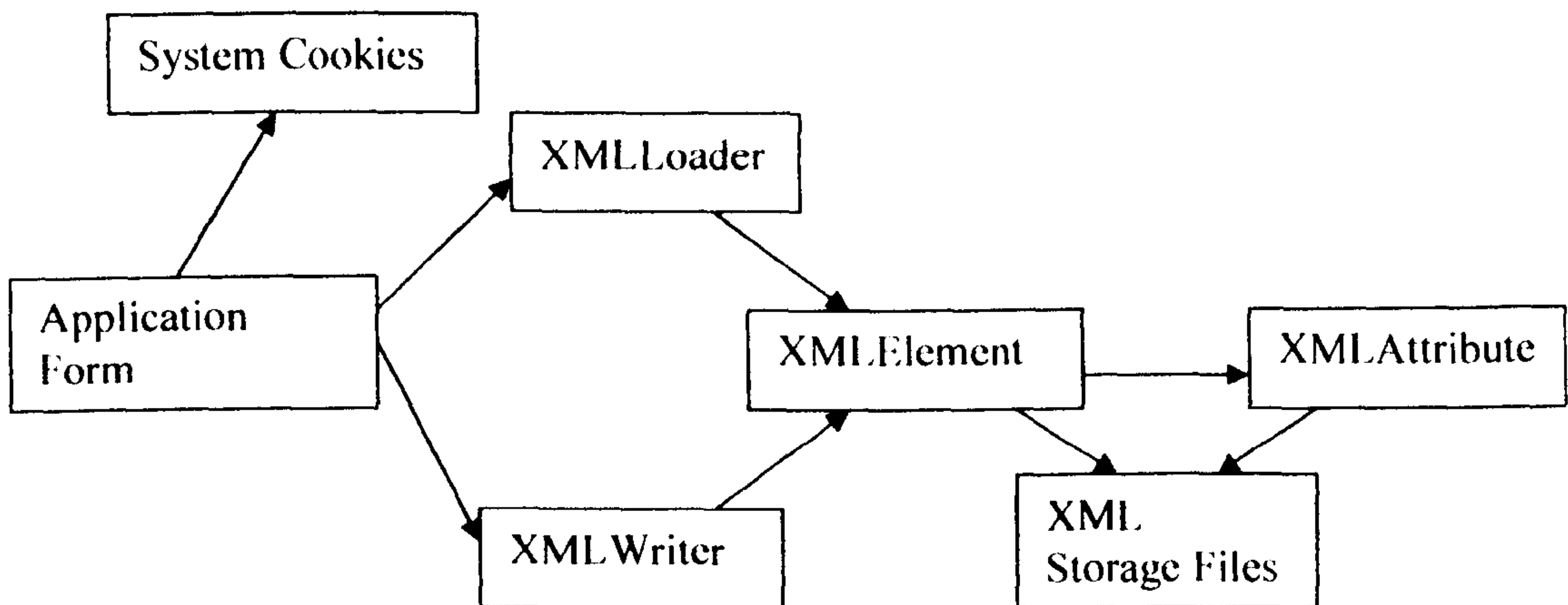


Figure 32: XML Design data storage mechanism

The project is using asp methods inside the specific classes in order to save data in the system's DB. The methods are:

**XMLLoader** – This method is used to load data to the system from an XML file into the correct data structure.

**XMLAttribute** – This method is used to build a representation of an attribute within an XML element.

**XMLElement** – This method is used to build a representation of an XML element. An XML element can hold attributes, which are represented using XMLAttribute.

**XMLWriter** – This method writes the correct elements to the proper xml files.

The above mechanism is used from the system in some facilities in order to store in XML files or to retrieve data from the XML files. The most important data is stored in tables in an SQL database and the mechanism is explained below. The system is using two different mechanisms to store or retrieve data for specific facilities for flexibility and backup reasons. XML formatted stored data can be easily transformed with SQLXML into

SQL tables and vice versa. SQLXML enables XML support for SQL Server, bridging the gap between XML and relational data. An XML view can be created of an existing relational data (SQL) and work with it as if it were an XML file.

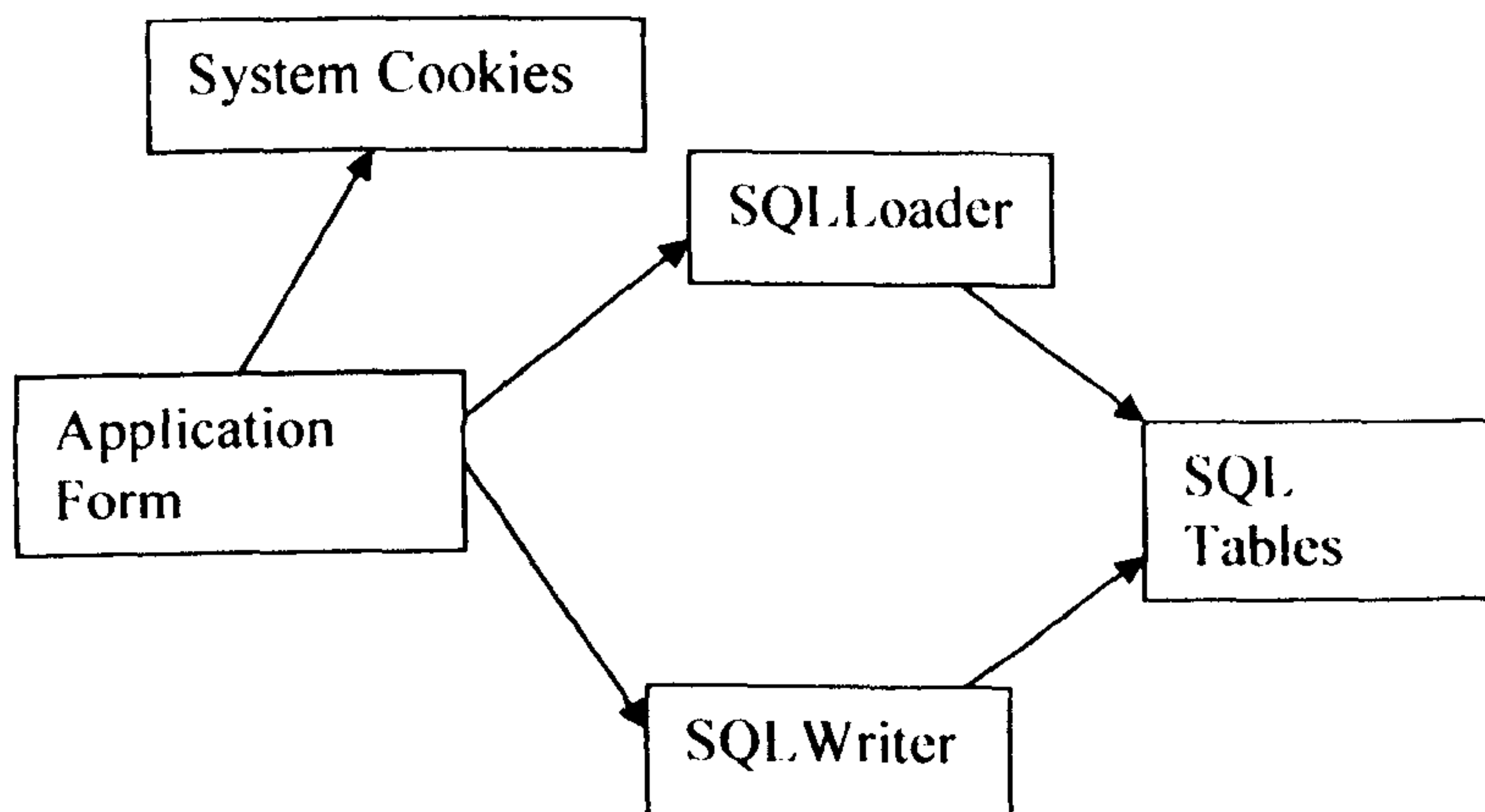


Figure 33: SQL Design data storage mechanism

**SQLLoader** – This method used to load data to the system from an SQL table into the correct data structure.

**SQLWriter** – This method writes the correct values to the proper SQL tables.

The following table shows which system's facilities interaction with the system's database. All the system's users interact with the system's database by storing or retrieving information or both.

System's Facilities interact with Database		User: Student - Visitor		User: Admin - Instructor	
		Store	Retrieve	Store	Retrieve
Pathway facilities	Theory		✓	✓	✓
	Resources		✓	✓	✓
	Action Panel	✓	✓	✓	✓

Table 11: System's Facilities interact with Database (Prototype)

## 6.6 Security of a system

In real life there are many Internet attack cases every day, which cause big losses of money and reputation. This is one of the main reasons why many people do not trust software systems dealing with data transfer; because they are not sure if their sensitive information

is secure. Very sensitive information (personal details or NHS important information) will be transferred from the user browser to the “risk-e” network and it will also be stored to the server database. This could be a good target for internet attackers, who are looking to steal sensitive information such as personal data. So security is an important function that needs to be given attention and for this reason a secure computing environment has been built, in which the secure data transfer channel is operating.

### **6.6.1 Securing the Web Server and “risk-e” Network**

Public web servers continue to be attractive targets for hackers. Good security techniques can protect the site from the hackers. Many techniques can be used for the web server security; one very good technique is the firewall.

The term firewall means some kind of filter or barrier that affects the internet traffic, which passes between two networks. The firewall is a program that will be installed to the web server and only authorized users can access the web server or any other machine that sits inside the firewall (“risk-e” network).

Furthermore, the “risk-e” server is running on University Wales Bangor (UWB) network (for the prototype and the pilot stage). Of course the system could be installed in any other environment, (network) such as hospital (NHS) network, if it provides high level security. The university network is a very powerful secure network and the UWB is using the latest technology in order to make this network secure. But this is another reason that makes this network more attractive to the hackers. The statistics result shows that most hackers prefer to attack large and very secure networks because these kinds of networks are the real challenge for them.

### **6.6.2 Securing Information in Transit**

Much of the initial emphasis in the field of web security involves the problem of protecting information as it travels over the internet from a web server to the end user’s computer. The concern is that someone is spying on the network and might copy sensitive

information, or alter information in transit. One good technique to secure information sent over the Internet is to use the Secure Socket Layer protocol.

SSL is the Secure Sockets Layer, a general-purpose protocol for sending encrypted information over the internet. SSL is a method of encryption that allows communications between a web browser and a web server to be private. The SSL protocol provides "channel security" which has three basic properties (Hickman, 1995):

- The channel is private
- The channel is authenticated
- The channel is reliable

For example, when the user types the name of a hospital into the form in the proper screen, the "risk-e" web site is in secure mode. This means that the user browser encodes what the user types, and the "risk-e" server decodes it. So, anyone "listening" to traffic en route cannot make sense of the information. The user can be sure that the web browser is operating in secure mode when a small padlock icon appears on the bottom of the screen.

The SSL is using cryptography technology for protecting information. Cryptography is a collection of mathematical techniques for protecting information. Using cryptography, you can transform messages so that they are meaningless to anyone who does not possess a specific mathematical key necessary to unlock the message. The process of using cryptography to scramble a message is called encryption and the process of unscrambling the message by use of the appropriate key is called decryption. So, encryption is the conversion of data into a form that cannot be understood by unauthorized people. Decryption is the process of converting encrypted data back into its original form, so it can be understood.

The system will use asymmetric key algorithms for the cryptography. That means that one key (algorithm) is used to encrypt the message and another key to decrypt it. The encryption key is normally called the public key because it can be made publicly available

without compromising the secrecy of the message or the decryption key. The decryption key is normally called the private key.

People who wish to receive encrypted messages will make their keys readily available. So, if someone wants to send a message to one of these people, he/she gets a copy of their public key, encrypts the message, and sends it to them. After that the only person who can decrypt this message is the person who has possession of the matching private key. The following example from real life has been given to better understand the above mechanism.

One person (sender) wants to send a message to another person (receiver) in secure mode. The sender locks the message in the box with the padlock and sends it to the receiver without the padlock key. The message will travel securely and nobody can open the box except the person who has the key. The sender has to send the key separately to the receiver but this is not secure because someone can steal the key. So, the receiver can send a padlock to the sender and he/she keeps the key.

Then the sender can lock the message in the box and send it to the receiver who has the key and he/she is the only person to unlock the box. This is a more secure way to send a message from one person to the other. The same theory is used by SSL protocol to send message between two ends.

### **6.6.3 Securing the User's Computer**

The SSL is one component of security. SSL makes it possible sensitive data (information) to be sent securely over the internet, but SSL doesn't provide protection for the information at the two ends of the connection (Garfinkel & Spafford, 2002). The security of the first end, web server, is discussed above. The other end is the user computer, web browser.

Million of computer users suffered huge losses from real attacks experienced over the internet. Most of the damages were caused by fast-moving computer viruses and worms that travelled by email, or that involved automated exploitation of flaws in network service programs.

The company doesn't have access to the user computer and of course can not make them secure. But it can inform the user not only about the system security that the business provides, but about security that the user computer should have. It should also provide solutions that the user can use to make his/her system secure. Some of these solutions are:

- install anti-virus software
- install a personal Firewall
- protect the browser

Anti-virus software will protect the system from known viruses, including Trojan Horses, which can monitor key strokes and pass on the information across the internet. So it may be useful to install suitable software and to scan the systems before logging on. Users can find good quality anti-virus software on the internet.

Firewall software will prevent other internet users from doing anything on the PC that they should not do. It will screen all messages coming in or going out of the computer. Good quality personal firewalls are available on the internet.

As the software companies are quick to fix any browser security problems before they can be exploited by a third party, it is worth keeping up with the latest security patches they issue.

## **6.7 Conclusions**

This chapter presented the implementation of a risk management e-learning environment prototype model for healthcare professionals. The system's requirements which has been defined and discussed in Chapter 5 are transformed into a software application. The pedagogy strategy and the design guidelines which also have been defined and discussed in



Chapter 5 have been applied during the implementation. Both of them played vital role and directed the implementation stage without significant issues because of their deep exploration and analysis in Chapter 5 which covers majority of the potential aspects by focusing on HCI, Web Accessibility and Usability. Those aspects are strongly related with e-learning software application effectiveness, learnability, memorability, satisfaction and efficiency which are the key for success.

The system architecture conforms to the principles of interoperability, user-friendly interactiveness and flexibility. The system design is the translation and transformation of the system's requirements into a number of diagrams, UML notation, which will help the developer to understand the functionality of the system. The e-learning tools will be implemented based on e-learning standards and usability principles in order to be used for e-content authoring and management but also to be accessible and usable from everyone.

This "risk-e" system uses the XML data store and SQL data store mechanism for storing sensitive data from different parts of the system in the main system's DB. Both XML and SQL mechanisms functionality are discussed in this chapter and are described are the best technologies for data storage. The system is using two different mechanisms to store or retrieve data for specific facilities for flexibility and backup reasons.

Moreover, this chapter described how a web-based data transfer channel can be added to a software system. The security of the system was the main subject of this implementation because this system will provide online transfer and storing of sensitive data from the NHS to the server via the internet. So, the system should be protecting this information for any kind of attack. Any loss of sensitive data in NHS will stir up variety reactions storm in any level.

Finally, the new knowledge from this chapter about all these aspects will support the new innovation, risk-e, in this field. The information about the analytical software design, pedagogy strategy, accessibility, usability and security will help the further development and research of this software and study.

## ***Chapter 7***

### **Prototype Testing & Evaluation**

#### **7.1 Introduction**

Within the product lifecycle, software will go through testing to correct errors and to comply with changes to requirements. This chapter describes the process of testing the functionality and correctness of the software. The testing process will execute a program or system with the intent of finding errors. It will also evaluate an attribute or capability of a program or system and will determine if it meets its required results (customer's requirement). Evaluation of the software application has taken place at the testing stage of the SDLC in order for the prototype model of the "risk-e" software to be evaluated. This evaluation formed an important part of the thesis and is achieved through quantitative methods (questionnaires) to evaluate "risk-e" for users.

In fact, there are several definitions for software testing since the seventies. Hetzel W, Hetzel B. and Myers are some authors, who studied the software testing process for years and they provided a few definitions of the software testing over the last decades. Testing is the process of establishing confidence that a program or system does what it is supposed to do (Hetzel, 1973). Software Testing is the process of executing a program or system with the intent of finding errors (Myers, 1979). Testing is any activity aimed at evaluating an attribute or capability of a program or system and determining that it meets its required results (Hetzel, 1983). Software testing is a process, or series of processes, designed to make sure computer code does what it was designed to do and that it does not do anything unintended (Myers, 2004).

Testing is the last stage of the SDLC model that has been used for this development. During testing, the implementation is tested against the requirements to make sure that the product is actually solving the needs addressed and gathered during the requirements phase. Unit tests and system/acceptance tests are done during this phase. Unit tests act on a specific component of the system, while system tests act on the system as a whole.

Defects in software systems, bugs, will almost always exist in any software module with reasonable size. Bugs are there because the complexity of a software program is generally intractable and humans have only limited ability to manage complexity. Discovering the defects in software system is equally difficult, for the same reason of complexity. Because software and any digital systems are not often continuous systems, merely the operation of testing boundary values is not sufficient to guarantee correctness.

Although software testing is important, software testing alone cannot guarantee the production of high quality software systems. The correctness of the system through the testing stage (process) can only guarantee that a software system (which exactly meets its requirements) will always operate in an expected manner. On the other hand, the software testing that is not fully exhaustive can only highlight the existence of bugs and cannot prove their absence. Moreover, Kaner et al. have noted that it is impossible to completely testing an application because (Kaner et al., 1993): (1) the domain of program inputs is too large, (2) there are too many possible input paths, and (3) design and specification issues are difficult to test. Kapfhammer adds that the first and second points present obvious complications and the final point highlights the difficulty of determining if the specification of a problem solution and the design of its implementation are also correct (Kapfhammer, 2004).

There is a plethora of testing methods and testing techniques, serving multiple purposes in different life cycle phases. Classified by purpose, software testing can be divided into four categories: correctness testing, performance testing, reliability testing and security testing. Classified by the life-cycle phase, software testing can be classified into the following categories: requirements phase testing, design phase testing, program phase testing, evaluating test results, installation phase testing, acceptance testing and maintenance testing. The software testing can be categorized as follows: unit testing, component testing, integration testing, and system testing.

“Verification and Validation” (V&V) process is the one of best and the most widely used testing processes, which starts at the same time as the SDLC process. It is running

through all the stages of the SDLC model; requirements, design, implementation and testing. V&V is the process of ensuring that software being developed or changed will satisfy functional and other requirements (validation) and each step in the process of building the software yields the right products (verification). Unfortunately V&V was not used during these stages of the project because of the constraints of time but it is necessary to use it during the transformation process of the pilot product into a commercial one.

## 7.2 Testing Strategies

The testing strategy helps the better management of the test resources. A system can be formalised as a tree structure in which the parts of the system are children to the root node. A subsystem will have a number of children indicating modules, which will in turn have child nodes indicating procedures or functions. The software tree structure formation is totally compatible with the Object Oriented testing. Using this view one can take one of the following strategies:

**Top down testing** – Testing starts with the top level module (root node and immediate children to the root) and works progressively towards the lower levels modules.

**Bottom up testing** – This is the converse of top-down. In this approach the lower levels modules are tested first, then the modules at the high levels are tested.

The use of top down testing can be risky because lower level modules may not yet exist. The top down is a very useful testing strategy for the system's user interface testing. The bottom up testing can be used even when the system components does not exist. Top down testing strategy has been used in the testing phase of "risk-e" software application as all the components of the system are developed based on the requirements and because it emphasises the planning and understanding of the system.

### 7.3 Testing Process

The most widely used testing process consists of five stages as shown in figure 34. However, as defects are discovered at any stage, they require program modifications to correct them and this may require other stages in the process to be repeated.

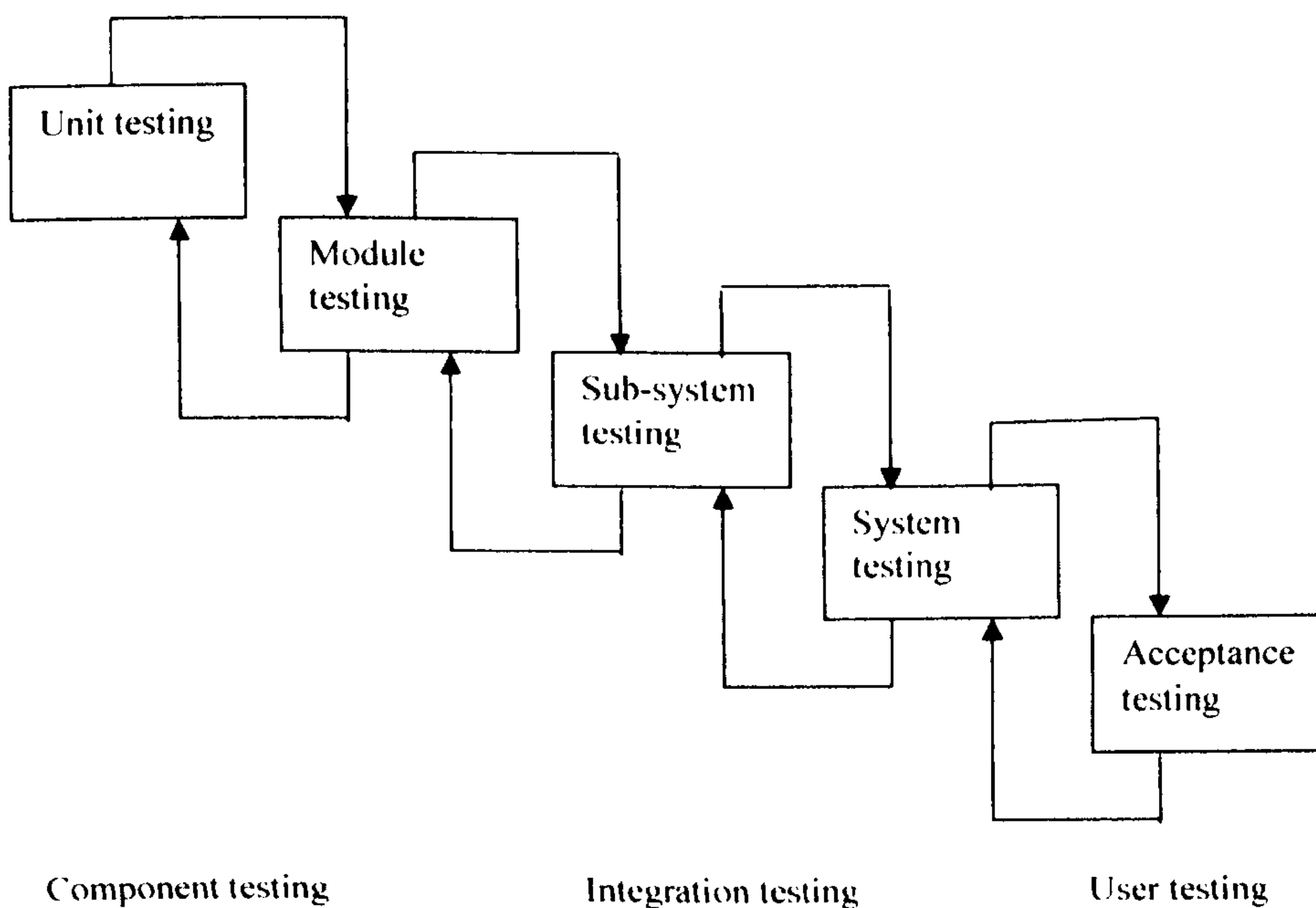


Figure 34: The testing process

The stages in the testing process are (Sommerville, 2000):

- **Unit testing.** Individual components are tested to ensure that they operate correctly. Each component is tested independently, without other system components.
- **Module testing.** A module is a collection of dependent components. Each module can be tested without other system modules.
- **Sub-system testing.** This phase involves testing collections of modules, which have been integrated into sub-systems.
- **System testing.** The sub-systems are integrated to make up the entire system. The testing process is concerned with finding errors, which result from unanticipated

interactions between sub-systems and system components. It is also concerned with validating that the system meets its functional and non-functional requirements.

- **Acceptance testing.** This is the final stage in the testing process before the system is accepted for operational use. The system is tested with data supplied by the system procurer rather than simulated test data.

## 7.4 Testing the risk software prototype

The above testing process is used to test “risk-e” software application. It is being used two times, one for the GUI interfaces and another when the functionality is added to the GUI.

The modules that are used in order to test this software are:

- Login screen module
- Pathway System module

Each from the above modules has a number of units. For example, the units for the first module (Login screen module) are:

- User Type drop down list
- Username field
- Password field
- Submit button

Following the above testing process during the GUI interface implementation phase of the system, all the units from each module have been tested individually and also each module has been tested individual. So, at the end of the GUI interface implementation phase all the modules of the software had been tested. This phase was stopped when all modules of the system have been tested because the functionality didn't exist and the sub-systems didn't exist.

The same testing process is used during the system's functionality development. During the GUI interface implementation phase the process starts from the first module,

first unit. Because in this phase the system's functionality has been added, the testing process tests the sub-systems of the software individually and the system, when all the sub-systems have been integrated. Some sub-systems that are developed in the systems' functionality implementation phase are:

- Login screen module – pathway system module
- Pathway system module – step1 module
- Step1 module – step1 theory module
- Step1 module – step1 resources module
- Step1 module – step1 action panel module
- Pathway system module – step2 module
- Pathway system module – step3 module
- etc

At the end of the testing during the system's functionality implementation phase all the modules have been tested individually and all the sub-systems have been tested individually as well. After that all the sub-systems have been integrated and make up an entire system. The system has been tested with the purpose to test the interactions between sub-systems and system components, and to validate that the system meets its functional and non-functional requirements.

The last stage from this testing process that is used for the software testing was to test the system with data supplied. The results from each test were positive or negative. Of course, many problems have been encountered during the testing process but all of them were solved. Some of them were about the GUI interface and some of them about the system's functionality. Problems had been encountered after the sub-systems integration, the interactions between the sub-systems and the system's components.

## 7.5 Testing Techniques

Figure 35 provides a useful hierarchical decomposition of different testing techniques and their relationship to different classes of test adequacy criteria. While this hierarchy generally follows the definitions provided by Binder and Zhu et. al, it is important to note that other decompositions of the testing process are possible (Binder, 1999, Zhu et al., 1997).

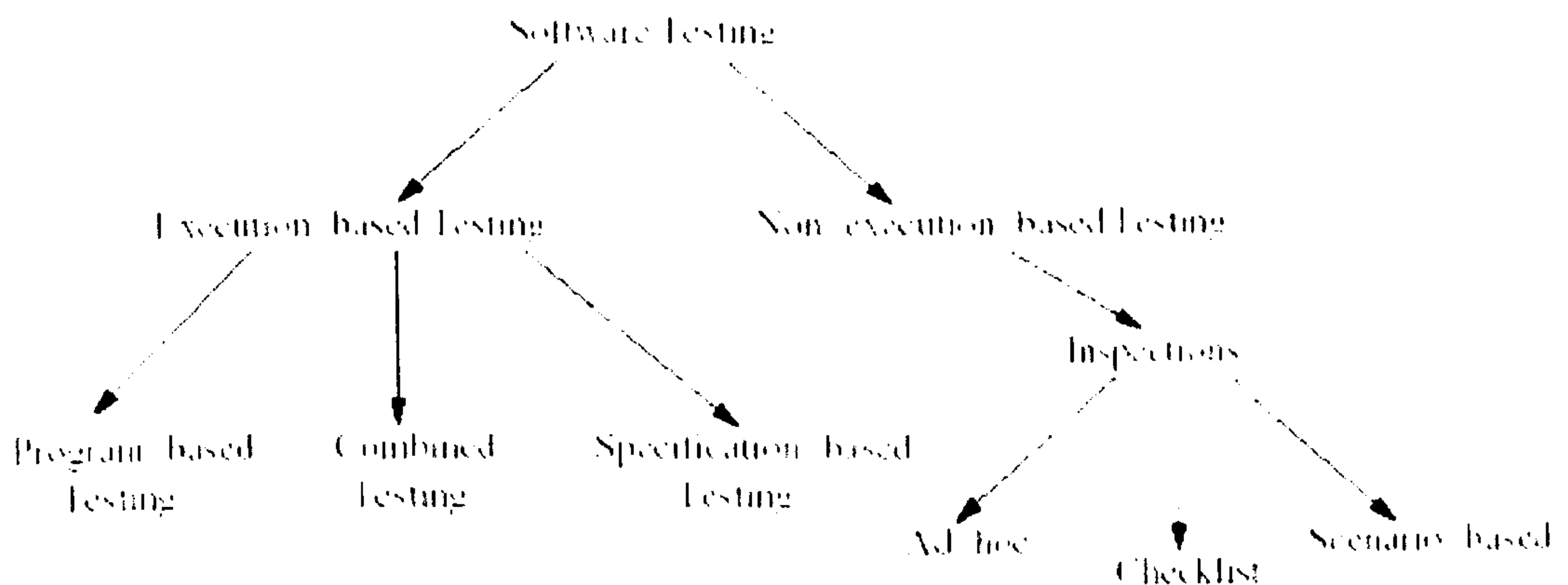


Figure 35: **Hierarchy of Software Testing Techniques**

### 7.5.1 Execution-based Testing

As shown in figure 35, all execution-based testing techniques are either program-based, specification-based, or combined (Zhu et al., 1997).

#### Program based testing

The program-based testing of a class will test all its methods and will test the class as a unit. The test plan will consider the coding in individual methods in isolation and then consider the interaction between methods. Each method can be tested over its domain of inputs but the interactions between methods need to be tested before testing is adequate. Method testing involves checking that the method performs as specified. The class must be exercised over a representative set of its stages.

#### Specification-Based Testing

Specification-based testing includes both class specification and method specification, functional and/or non-functional.



### **Combined testing**

A combined testing technique creates a test suite that is influenced by both program-based and specification-based testing approaches (Zhu et al., 1997).

### **7.5.2 Non-Execution-based Testing**

As shown in figure 35, all non-execution-based testing techniques are ad-hoc, checklist, or scenario-based (Zhu et al., 1997). Non-Execution testing is basically based on identifying the part of the programming code based on errors (practical or syntax) and to ensure that all coding requirements are followed. There are two types of Non-Execution based testing; inspections and walkthroughs. An inspection or walkthrough is a detailed examination of a product on a step-by-step or line-of-code by line-of-code basis. The purpose of conducting inspections and walkthroughs is to find errors.

#### **Inspection**

Inspection is a more rigorous procedure where a checklist of potential faults are drawn up and carefully checked to see if they are present or not in the documents. The goal of the inspection process is the detection, logging and correction of defects. To accomplish this, the product document is checked against its sources, and the rules that manage its production.

#### Ad hoc

Ad hoc testing is concerned with Application Testing without following any rules or test cases.

#### Checklist

A number of questionnaires created to help developers or testers find more defects. Checklist questions interpret specific rules.

#### Scenario-based

A scenario test is a test based on a hypothetical story used to help the user think through a complex problem that he can apply using the system. A scenario can be designed as a

simple diagram or as a description written in prose. The scenario that will be used for a software application testing should cover a number of steps and it should be a realistic complex story that is motivating the users to evaluate the case using the system.

The software application has been tested by using both execution-based and non-execution-based testing methods. Program based testing technique from execution-based techniques category and ad-hoc testing techniques from non-execution-based techniques category are used to test the pure code of the system before the system will be called as a prototype or pilot product. Code bugs were identified and fixed during this stage of the system's development life cycle. The system's programming code has been tested by the developer with strong knowledge about the application, which is necessary especially for the ad-hoc testing.

## **7.6 Accessibility Testing**

As described in Chapter 6, accessibility is a very important subject especially for e-learning platforms. For this reason the accessibility testing is analyzed as an individual testing process. The "risk-e" application is a web based environment and the accessibility testing for web sites is the most appropriate method to use for testing the accessibility of the system. Accessibility testing for web sites is a service that can provide detailed analysis of the content and layout of the page elements, site remodeling, or evaluation of a web site for quality, accessibility, and privacy issues. The main testing process is used in this part as well. Individual components go through the accessibility testing procedure in order to ensure that they are accessible for users with disabilities. The same accessibility testing procedure is applied to the next stages, where module, sub-systems, systems and the final product is tested. The testing procedure audits the "risk management pathway" application against the chosen design guidelines (combination of "Web Standards (W3C) guidelines" and "IMS Guidelines for Developing Accessible Learning Applications 1.0). The testing helped the author as web designer and software developer to ensure that the software web based application is accessible and usable by the visually impaired and generally users with disabilities.

A combination of accessibility testing techniques has been used; execution based and non-execution based. The execution based technique is a program based testing. Several software tools, which automatically test a web page, or an entire site, for accessibility guideline conformance are available online. A number of those free online tools are used in order to test the accessibility of the system. More than one tool is used for 2 reasons. The first reason is because specific tools have been used for specific needs. Some of them are expert on a part of accessibility and produce specific results for those parts. The second reason is because the cross of the results produces more accurate results. The main set of tools is coming from the W3C organisation, which produced the web content accessibility guidelines, part of them are used in the development of “risk-e” application. Furthermore all the other available tools are testing the applications against those guidelines.

W3C organization is suggesting a number of free online tools for accessibility testing. The tools that have been used for the testing of “risk-e” application are listed below. All of them are used to test different parts of the software application as part of the accessibility testing execution based technique.

- Markup Validation service that checks Web documents in formats like HTML and XHTML. for conformance to W3C Recommendations and other standards. Markup validation tool can be used online via the official web site; <http://validator.w3.org/> [accessed: 2006]
- Link Checker checks anchors (hyperlinks) in a HTML/XHTML document. Useful to find broken links, etc. Link Checker tool can be used online via the official web site; <http://validator.w3.org/checklink> [accessed: 2006]
- CSS Validator validates CSS stylesheets or documents using CSS stylesheets. CSS Validator tool can be used online via the official web site; <http://jigsaw.w3.org/css-validator/#validate-by-upload> [accessed: 2006]
- Semantic Extractor sees a Web page from a semantic point of view. Extracts such information as outline, description, languages used, etc. Semantic Extractor tool can be used online via the official web site; <http://www.w3.org/2003/12/semantic-extractor.html> [accessed: 2006]

- Log Validator is a free, simple and step-by-step tool to dramatically improve the quality of a website. Finds the most popular invalid documents, broken links, etc., and prioritizes the work to get them fixed. Log Validator tool can be used online via the official web site; <http://www.w3.org/QA/Tools/LogValidator/> [accessed: 2006]
- Accesscolor. It is an online tool for colour contrast. AccessColor tests the color contrast and color brightness between the foreground and background of all elements in the DOM to make sure that the contrast is high enough for people with visual impairments. This tool help thee author build accessible web-based system by visually flagging the section(s) of a page with problematic color combinations. AccessColor can also find the relevant colour combinations within HTML and CSS documents rather than requiring the user to find each value and input it himself in order to test the contrast between each colour combination. Accesscolor tool can be used online via the official web site; <http://www.accesskeys.org/tools/color-contrast.html> [accessed: 2006]
- CSS Analyser. It is another free online tool similar to AccessColor tool. It checks the validity of CSS against the W3C's validation service, along with a colour contrast test, and a test to ensure that relevant sizes are specified in relative units of measurement. One difference from AccessColor tool is that if the CSS is specified by a URL, it will be loaded into the text area to offer an option to make changes for testing without having to re-upload. CSS Analyser tool can be used online via the official web site; <http://juicystudio.com/services/csstest.php> [accessed: 2006]

The non-execution based techniques are a checklist- and a scenario-based technique. The use of the above tools actually can be used as non-execution based checklist technique because the systems examine pages selection using relevant checkpoints from the Checklist of Checkpoints for Web Content Accessibility Guidelines 1.0.

The use of these tools is a very valuable step in assuring that a web site meets these standards, but someone can not solely rely on their evaluation, neglecting to perform a "manual" check of certain accessibility aspects, which can result in circumstances that may

exclude some segments of the public from a site. Involving persons with disabilities in the evaluation process provides a much greater understanding of the accessibility issues of a web site, and allows implementing accessibility solutions, which have shown real-world practicality. Moreover, internet users with disabilities provide valuable guidance during the development of a web site, but this alone does not determine the level of a site's accessibility.

Unfortunately, in “risk-e” case, testing with disabled people was not an easy task, based on lack of resources and time pressure. But as alternative solution scenario-based, non-execution based technique is used where the software application is tested with real users and actual potential customers. During the prototype and pilot phase testing, a number of WRP assessors and risk managers of NHS had the opportunity to use the software system using their own scenario. Based on their experience they had to fill in a number of questionnaires. The analysis of those questionnaires will be discussed later.

## **7.7 Software Evaluation**

Evaluation of the “risk-e” software application has taken place at the testing stage of the SDLC in order for the prototype model of the software to be evaluated. A quantitative method (questionnaires) was used to evaluate “risk-e” for users.

### **7.7.1 Prototype product evaluation**

Software prototypes are incomplete implementations of the future full-featured software program, which can be used to let users have a first idea of the completed program or allow clients to evaluate the program. Consequently, at this stage the prototype model of the “risk-e” software application is tested from WRP assessors in order to ascertain whether (1) the requirements of the system have been respected and whether they are acceptable, and (2) to gain useful information and feedback from the users, when they trailed the prototype in the role of system instructors. A face-to-face session was organized in WRP premises, where eight WRP assessors had the opportunity to use the software for five hours and participate to the research by filling in a number of questionnaires.

The pre intervention questionnaire contains general questions about each participant's computing experience and e-learning background. This allows an average participant profile to be built, against which, subsequent data collection can be evaluated. The post intervention questionnaire contains more specific questions about the "risk-e" pathway in relation to the main characteristics and sub-characteristics of the software system, specifically its functionality, efficiency, usability, reliability, portability and maintainability. The questionnaires can be found in Appendix 1 and their diagrammatic data analysis can be found in Appendix 8.

### **Respondent General Experience**

All participants have strong computing experience. Most of the respondents are using PC (desktop or laptop) several times a day at work and/or at home. Most of them (62.5%) rate their current computer skills as "very good" and they were confident that they can learn how to use computers in order to improve their computer skills. 75% of the respondents are using the internet every day or every two days and 100% of them are using the internet to get information to support their work. 75% of them rate their current internet skills as "very good" and 25% rate it as "good".

All the respondents believed that e-learning can be an effective method of learning and all of them were involved with e-learning as students. All the respondents involved with e-learning, acquired knowledge through e-learning that affected their professional life and they had a positive learning experience. Finally they are happy to use e-learning in the future, but 66.5% of them are confident to use an e-learning tool for their work.

So, based on the above results, the average participant's profile is a person with good computer/internet skills and experience, average e-learning experience but happy to use e-learning in the future even during their work.

**Respondent “risk-e” Experience**

75% of respondents agreed with the statement: “risk-e is easy to use”. (12.5% strongly agreed). The findings (figure 36) show that respondents agreed in general on that they was able to complete their work effectively, efficiently, and fast with comfort using the system. Obviously the system provides high usability because the web design guidelines have been applied successfully during the development of the prototype model.

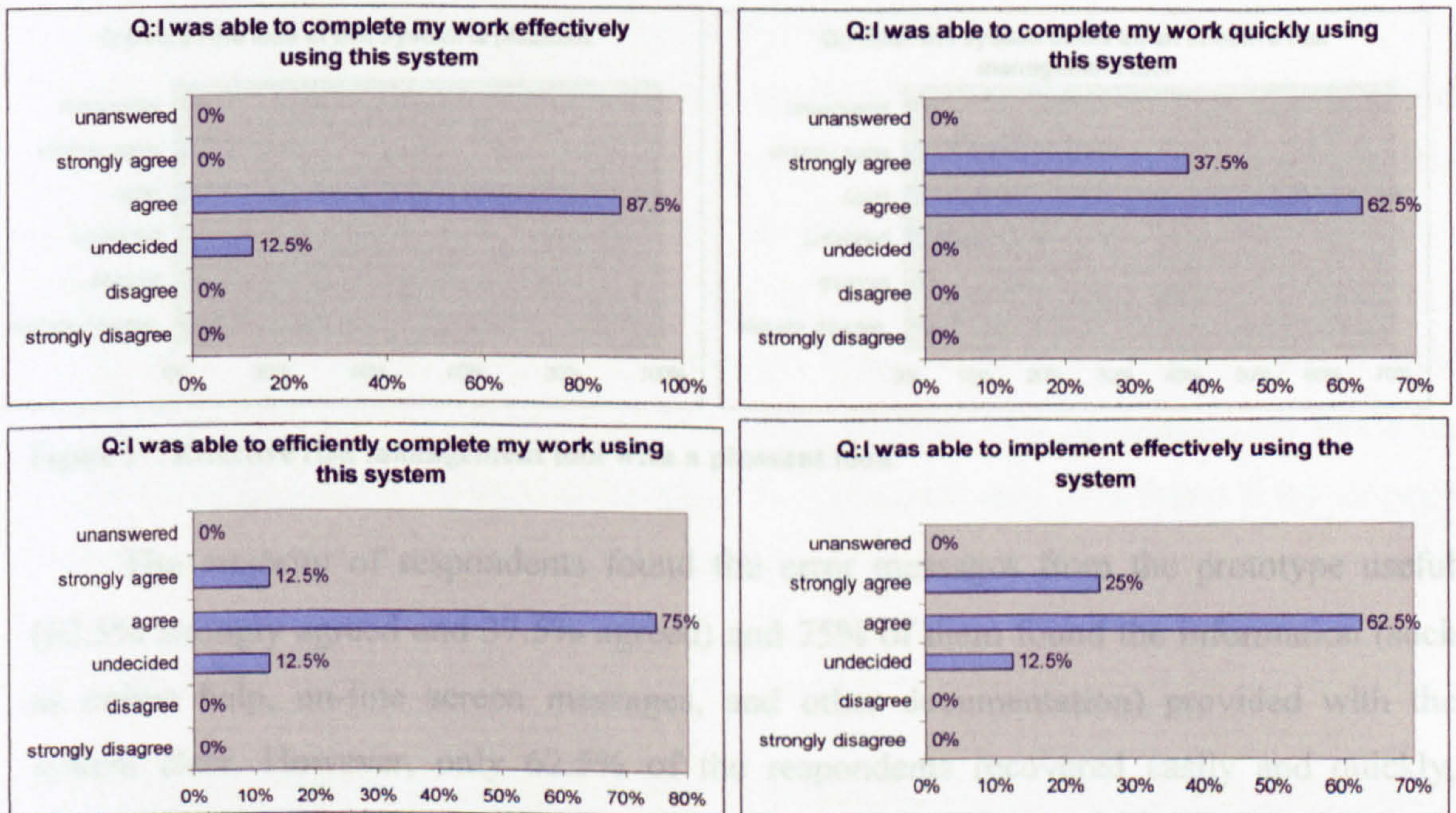


Figure 36: Users were able to complete their work effectively, efficiently, and fast with comfort

All the participants believed that they will become more productive with further use of the “risk-e” system. However, only 50% of them believed that they became quickly productive when they used “risk-e”, 37.5% were undecided and 12.5% did not become quickly productive. These results show that even if the system is easy to use, something is stopping the instructors being productive quickly and that should be highlighted for further investigation as this “something” can be anything.

87.5% of the respondents agreed with the statement: “overall the look of this system is pleasant”. (12.5% strongly agreed). Furthermore, 62.5% of them agreed that the system’s pages were loaded quickly but 37.5% were undecided. The system’s speed is

based on the network (internet connection) speed and the hardware’s specifications. The day when the session took place the network provided an average speed and the hardware’s specifications were average. Also, 87.5% of the respondents agreed (62.5%) or strongly agreed (25%) with the statement that “risk-e” could be an effective risk management tool, 12.5% answered undecided but the good news is that none disagreed with the statement.

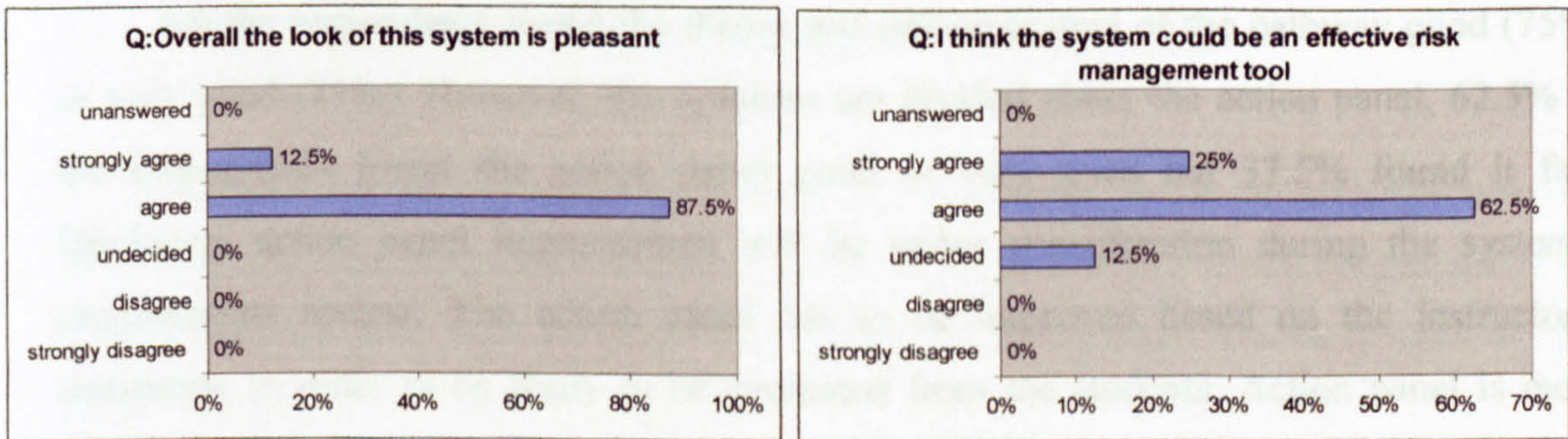


Figure 37: Effective risk management tool with a pleasant look

The majority of respondents found the error messages from the prototype useful (62.5% strongly agreed and 37.5% agreed) and 75% of them found the information (such as online help, on-line screen messages, and other documentation) provided with the system clear. However, only 62.5% of the respondents recovered easily and quickly, whenever they made a mistake using the system, 25% answered undecided and 12.5% did not recover whenever they made a mistake or they recovered with difficulties.

Most of the respondents, 87.5%, agreed or strongly agreed that it was easy to find the information they need in order to use the system effectively, 12.5% disagreed with that statement. 50% of the respondents found it easy to navigate in the system environment but 50% of them were undecided. These findings should be taken under serious consideration, as the usability is a fundamental ingredient for an effective e-learning environment and the navigation subject is part of the usability.



Finally, 75% of the respondents agreed (50%) or strongly agreed (25%) that the system has all the functions and capabilities they would expect it to have, there were also 25% of them, which were not sure about that but they did not disagree either with that opinion. Moreover, 88% were overall satisfied with the system and only 12% were not decided.

### Specific facilities

All the respondents found the theory and resources area of the pathway good (75%) or very good (25%). However, the opinions are divided about the action panel, 62.5% of the respondents found the action panel good or very good but 37.5% found it fair. Obviously action panel improvement will be under consideration during the system's requirements review. The action panel has to be improved based on the instructor's comments in order to be ready to be evaluated from the students. Action panel is more important and useful to students than instructors. Finally, 75% of respondents found the pathway management contents facility good or very good, only 25% found it fair or poor. The results are presented in the following figure.

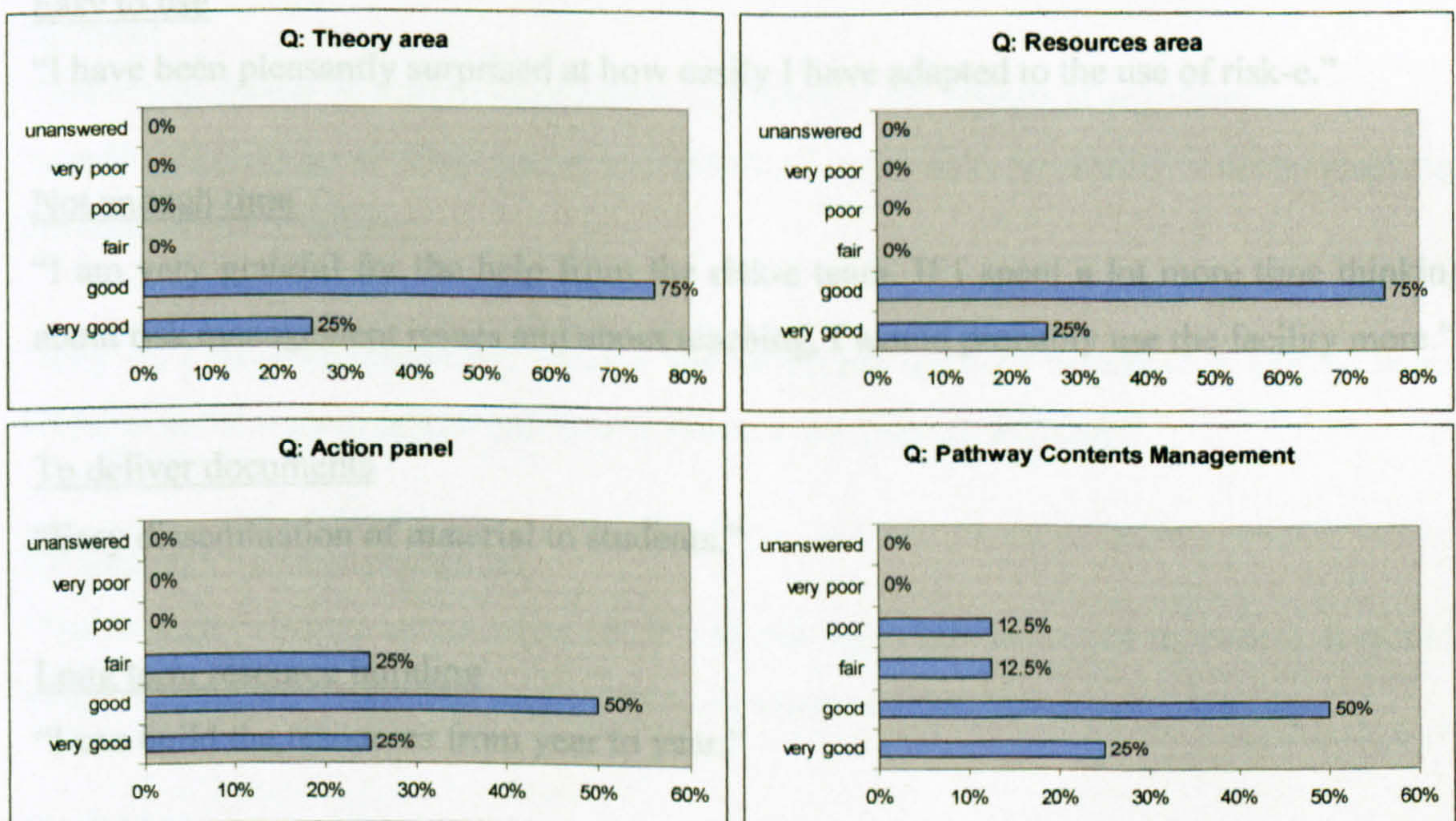


Figure 38: System facilities

### System interface

62.5% of the respondents believed that the overall visual design and layout of the system's interfaces is good but 37.5% of them believed that it is fair. This percentage (37.5%) is high and it should be taken into account when the system's requirements will be reviewed. Visual design and layout are very important for the usability of the system and it is directly related with the effectiveness of the e-learning environment. System's interface graphics could be improved in the future with the contribution of a professional graphic designer in order a more attractive and effective e-learning environment to be built.

Furthermore, an impressive 87.5% of the respondents found the system's interface error messages and the page instructions-online help good or very good. Finally, all of the respondents found the flexibility and the usability of the system's interfaces good or very good.

### **Comments**

Below are some examples of comments that instructor respondents made:

#### Easy to use

"I have been pleasantly surprised at how easily I have adapted to the use of risk-e."

#### Not enough time

"I am very grateful for the help from the risk-e team. If I spent a lot more time thinking about risk management issues and about teaching, I would probably use the facility more."

#### To deliver documents

"Easy dissemination of material to students."

#### Long term resource building

"I can build the resources from year to year."

Alternative learning mode

“It enables students to take an alternative approach to learning by actions rather than by books and notes”

Communication

“Online discussion could not take place. An important weakness for that software.”

“The system does not provide the best way to communicate with other users; instructors or students.”

Resources

“Resources and library are the best part of the system. Everything is in one place with 24x7 access.”

“I like the ability to download or print the materials. I think students will like it as well.”

“I think we would be missing a major resource if it was NOT to be provided.”

Facilities

“Instructors should be able to have access to student’s risk reports at any time.”

“It will definitely be an advantage if as instructor I could have the ability to create teaching material online or offline.”

“Why do I have to completely remove the unwanted teaching material? It will be more useful to archive them online and access them or use them at any time.”

No student to tutor conversation

“Not enough two-way communication, it’s all one way from instructor to student. It would be good if student to student and student to instructor communications were easier.”

Navigation

“The system provided me with information at all times in order to navigate me.”

### Action Panel

“Characters limitation rules applied on the text boxes. Not useful at all.”

“I would like to see the old information in a risk report before I add new.”

“I could not copy information. I had to re-write it most of the time.”

“Similar options to Microsoft Word will definitely be beneficial in the action panel. I could make the risk report layout more useful and effective.”

Overall the findings of the questionnaires helped the identification of the problematic system's areas that need improvements based on the potential instructors experienced view. Furthermore, it provided evidence that first main system's requirements are confirmed and accepted from a number of risk management assessors in the healthcare sector. The extra comments provided from the respondents will be used for further system improvements. Some of the main areas which are under consideration for improvement on the next system's version are communication, categorization of user's facilities by role, more advanced instructors and students facilities. The list of requirements for pilot model of the system will be based on these results. Pilot model development life cycle steps will be discussed on the next chapter.

## **7.8 Conclusions**

At the end of the system's prototype model implementation all the systems' modules have been tested and all the encountered problems have been solved.

A top-down testing strategy has been used for this software development as it seems to be the most appropriate. A specific testing process, which is recommended by Ian Sommerville, and its stages has also been used; unit testing, module testing, sub-system testing, system testing and acceptance testing. Finally a combination of execution-based and non-execution-based testing techniques has been used in order for the program code to be tested and code bugs to be identified.

Accessibility is generally a very important subject in the field of software application development and it is strongly related with the usability aspect. Usability is very important for any e-learning platform and it can directly affect the level of effectiveness of the e-learning environment. For this reason the accessibility/usability has been tested separately by using a number of free tools, which are provided mainly by W3C.

Finally, the prototype model has been evaluated by potential users in a real environment. A quantitative method (questionnaires) was used to evaluate "risk-e" for both users. The implementation of the pilot model will be based on the findings of the prototype model's evaluation. The findings of the pilot model's evaluation can be used for the implementation of the commercial product. Furthermore, the results of the evaluation are used as a confirmation and improvement of the system's requirements. General, the research part of this chapter provides many useful information about how WRP assessors (potential tutors) react on this innovation and what kind of functionality they are expecting from an application like this in their sector.

## ***Chapter 8***

### **Pilot Model Development**

#### **8.1 Introduction**

The objective of this chapter is to discuss, explore and explain the pilot model development life cycle of the “risk-e” system. This pilot model develops from the prototype model. The pilot model development life cycle is based on the prototype model life cycle outcomes and it is tested in more realistic environment.

The specific and updated requirements of the pilot model will be introduced in this chapter. Functional and non-functional requirements are listed which are gathered by evaluating the prototype model system in a face-to-face session with eight WRP assessors. The full implementation of the pilot model is also explained in order to show how the requirements are transformed into a software application. UML is used in this stage of the project to translate the project requirements in the diagrams. Furthermore, the software design and architect are realized as a set of programs or program units and interfaces. Finally, testing and evaluation is achieved and presented in this chapter and the findings analysed. Testing is achieved such to locate errors and any potential problems with the software. Finally, the thesis discusses and evaluates each attribute and capability of the program to determine if it satisfactorily meets the customer’s requirements.

#### **8.2 Requirements**

There is much to learn from the first prototype, and the requirements need to be updated. Consequently, significant and more advanced functionality needs to be implemented. The idea is that the pilot system provides key users with a more complete environment than the prototype model and with more appropriate and useful tools. In fact, the testing and evaluation of the prototype model highlighted the main requirements for the pilot model as discussed in the previous chapter.

Specifically, eight parts need to be revised in the requirements specification (from the prototype to the pilot), these can be divided into two parts: (1) Account details, which include updated requirements on administrator's account; instructor's account, student's account; and visitor's account and (2) other support requirements, including non-functional, usability and requirements imposed by standards. Details follow in the next two subsections.

### **8.2.1 Account details**

#### **Administrator's Account**

The functionality of the administrator account has to be improved based on the prototype model testing and evaluation. The pilot system should provide the administrator with a number of online tools in order to be able to perform more tasks, than existed in the prototype administrator specification, in order to manage and support the pilot model system. An administrator should be able to perform all these tasks by interacting with the system through a comprehensive interface (admin desktop), online and at any time. The prototype model allowed the administrator to perform all these tasks by providing direct access to the system's database which request database programming knowledge and which raises security questions. This improvement will make the administrator account more flexible, accessible and usable than it is in prototype model system. Administrator tasks have been discussed in chapter 5 and 6. However, the improvement of them and the additional of new tasks will be discussed in this chapter.

The main tasks for the system's administrator are:

- Manage Users
- Manage Library
- Manage Help System
- Manage Pathway Contents
- Manage Announcements Board
- Communicate with other Users
- Manage Profile
- Monitoring Database

**Manage Users:** One of the main administrator responsibilities is to manage the system's users. The system should provide the administrator with a number of tools in order to be able to manage the users in the system. Administrator "manage users" activities should include:

- Add or delete user account
  - Create or delete Student's Folder
  - Create or delete User Profile File
- Update user's details
- Update user's status

**Add or Delete user:** The administrator is the only person who can add or delete users from the system. He/She can add or delete a tutor, a student, an administrator, or a guest.

**Create or delete "Student's Folder":** The student's folder will be created or deleted automatically from the system, when the administrator creates or deletes a student account. This folder will be a specific area in the system's database for each student where the "risk action plans" will be stored. Furthermore, the administrator will have access to create or delete this area independently from creating or deleting student account action.

**Create or delete "User's Profile":** The user's profile is a file, which will be created or deleted automatically from the system when the administrator creates or deletes a user account. The administrator can update the details in the file at any time. User profile file will contain the user's details such as first name, surname, contact details etc.

**Control the system's DB:** The administrator is the only system's user who has direct access to the system's database. He/She is responsible for the smooth flow of the data in the database. The database is a very important part of the system because all the information will be stored there. The pilot model system will provide the administrator with a monitoring panel in order for him to be able to monitor the data in the database for each user. The administrator should also be able to delete files in the database or transfer files in the database and to directly query the database.



**Manage library:** The pilot model system will provide the administrator with a number of tools in order for him to be able to manage the library. They should be able to add documents in the correct section or to delete documents from a section in the library. They also should be able to edit or update document's details.

**Manage Pathway Content:** The administrator should have the option to update the studying materials. The studying materials should be divided into 2 parts; theory and resources (examples, background info and how to tasks). The pilot model system should provide the administrator with tools in order to be able to create new slides of studying material or to edit the current one online and at any time. He/she should be also able to remove a studying material slide of any section or to transfer it between sections. Furthermore, he/she should be able to change the order of the slides in the theory area of each step.

**Manage the Announcements Board:** The pilot model system will provide the administrators, tutors, students and visitors with announcements board in order to keep them informed about any change, upgrade or maintenance of the system. The admin will have the ability to send messages to the board or to delete messages from the board. The admin will be the only system's user with the authorisation to delete messages from the announcements board.

**Communicate with users:** The pilot model system should provide the administrators with 2 ways of communications with other system's users; e-mail system and announcement board. The announcement board should be used for general messages. They should receive messages to their e-mail inbox from the "contact us" form or from the e-mail system and they should be able to reply them back through the e-mail system.

**Manage Profile:** The pilot model system should allow the administrator to change his/her personal details such as first name, last name, email, location and phone number, online at any time. The administrators should be also able to change their password online

and at any time. For security reasons, the system should ask the administrators to provide the old password before they will proceed to the password change.

**Manage help system:** The pilot model system will provide the administrator with a number of tools in order for them to be able to manage the help system. The administrator should be able to change the information on the online active help system for each part of the system. He/she should be also able to activate or deactivate help screens of the help system.

### **Instructor's Account**

This part of the pilot model system will assist instructors in managing students and control the pedagogical philosophy of the system. Instructors will have sub-admin role in the system. The system will also provide the instructors with administration tools in order to be able to administrate some parts of the system. The prototype model system doesn't provide instructors with an individual environment with appropriate tools which will help them to perform a list of fundamental task as instructors in an e-learning environment. So, the instructors must be capable for the following activities in the pilot model system:

- Manage Library
- Manage Pathway Content
- Manage Profile
- Access to Pathway System
- Communicate with users
- Access to Student's Risk Reports

Some of these facilities (Manage Library, Manage Profile and Manage Pathway Contents) have been described in the Administrator part above.

**Access to Pathway system:** The instructors should have access to the pathway system (e-learning area) in order to be able to produce risk reports (action plans) and to teach risk management to the students during face-to-face sessions. The requirements of the Pathway system will be discussed later.

**Communicate with users:** The instructors should be able to send messages to the members through the email system or the announcement board. If the system has more than one instructor then all the instructors should agree on the contents of the message that will be sent to the announcement board. The announcement board should be used for general messages. They can receive email from a member through the email system.

**Access to Student's Risk Reports:** The instructor should also have access to the student's database. He/She should be able to check any time any risk report from any student. The system will provide the instructor with a monitoring panel in order to be able to view and print out a risk report from any student.

### **Student's Account**

The prototype model system is treating any user as a student. It has been developed by focusing on the core e-learning functionality. This is the reason why the system redirects any user direct to the e-learning area after a successful login. However, even students facilities have to be improved. So, the pilot model system should provide the students with proper facilities which will help them to perform a list of fundamental activities. These activities which can be performed via new improved system's tools will connect all the different user's roles together in order to make the system's user interact together in one environment. The pilot model system will redirect any user to the appropriate user account desktop after a successful login where a list of supporting tools will be existed.

The students must be capable for the following activities:

- Access to Pathway System
- Communicate with other users
- Manage Profile
- Access to Personal Calendar
- Monitoring own risk reports
- View and print risk reports
- Access to online library

**Access to Pathway System:** The students should have access to the pathway system (e-learning area) in order to be able to produce risk reports (action plans) for their organization according to the provided method. The student will be redirected to this area only if they choose the appropriate option of their account desktop. The layout of the risk report can be found in Appendix 5.

**Communicate with users:** The students should communicate with the administrator through the “contact us” facility and they should contact with the other system’s user through the e-mail system. They should also be able to receive e-mails from other system’s users through the e-mail system.

**Manage Profile:** As any other user in system, the students should have the ability to change his/her personal details such as first name, last name, email, location and phone number, online at any time. They should be also able to change their password online and at any time. For security reasons, the system should ask the students to provide the old password before they will proceed to the password change.

**Access to Personal Calendar:** Students should be able to view their personal calendar in order to know when the next risk report review date is. The personal calendar is an extension on the pathway system.

**Monitoring risk reports:** The students should be able to monitor their own risk reports by using a “monitoring tool”.

**View and print risk report:** The student should have the option to view each individual risk report using the monitoring panel tool. Each of them should be displayed on a new separate window with an available print out option.

**Access to online library:** Students should have access to the online library in order to download studying or supporting material.

**Visitor Account**

The pilot model system should provide the potential users with a visitor account. So any potential students can have a first experience with the environment and they can evaluate if that can help them to learn before they enroll to the system. The prototype model system doesn't provide this facility but it is very useful for the future as it can be part of the system's future promotional scheme. So, any potential user should contact with the system admin in order to request access to the system through a visitor account. The visitor account should provide the user with limited access to the same facilities as a student account.

A visitor should be able to use the pathway tool but he/she should only be able to create a maximum of 10 risk reports in contrast to students who should be able to create unlimited risk reports.

A visitor should not be able to communicate with any other user in the system, for security reasons, except with the system administrator. Visitors should contact with the administrator using the "contact us" tool if they face any problem with the system or have any other question to ask and they should receive emails from the administrator through the e-mail system.

A visitor should be able to view his/her personal details but he/she should not be able to update them. Visitors should also be able to change their password at any time. If the visitor wants to update his/her personal details they should contact with the administrator.

Finally, a visitor should only be able to download the "visitor package". The "visitor package" will be a collection of documents that will be very useful for the visitor and will protect the copyright of the studying materials, which will be provided through the system.

## **8.2.2 Other support requirements**

### **Non-Functional Requirements**

Non-Functional requirements are still important as they were during prototype model implementation. Non-functional requirements are not directly connected to the specified functions of a system but they are related to certain aspects that have an impact on the system. There is no significant difference from the prototype model non-functional requirements which has been discussed in chapter 5. The pilot model of the “risk-e” system should adhere to the prototype model system non-functional requirements including the following non-functional requirements.

### **Product requirements - Usability Requirements**

- The design process for the system’s interface should be user centric. The system should provide 4 different permissions which will allow users to have access to 4 different interfaces with different available options; the administrator’s account interface, the instructor’s account interface, student’s account interface and visitor’s account. The interfaces should interact with the user in their terms in a logical and consistent manner.
- Internet Explorer 6.x or later, with enabled cookies
- Flash macromedia reader should be installed as part of the system has been developed with flash technology

### **Organizational Requirements - Standards Requirements**

- Only the instructor and administrator can upload or remove documents to/from the library.
- Only the administrator and instructor can send messages to the announcement board.
- Only the administrator can receive messages from users through the “contact us” tool.
- The visitors should have limited access to the system and they can not communicate with any other system’s user except the administrator.

## 8.3 Implementation

### 8.3.1 System Architecture

The pilot model of the “risk-e” system is organized into three major tiers, as the prototype model which has been discussed in chapter 6, each of which is distributed to a different place or places in a network. The IT infrastructure that employs the system 3-tier architecture is the same that has been used for the prototype model. It is consisting of a web server and a database server. The web server is IIS, the database is SQL server and the application server layer is also IIS. However, there are some major software architectural differences between the prototype model and the pilot model. The pilot model functionality architecture provides a better users role leveling by grouping the users under roles and provides them with individual set of tools based on their role.

#### User Levels

Four user levels should be distinguished (figure 39) in the pilot model environment. In each of them different supporting tools exist. Depending on the corresponding use, these levels should also have a different role: administrator, instructor, student and visitor user.

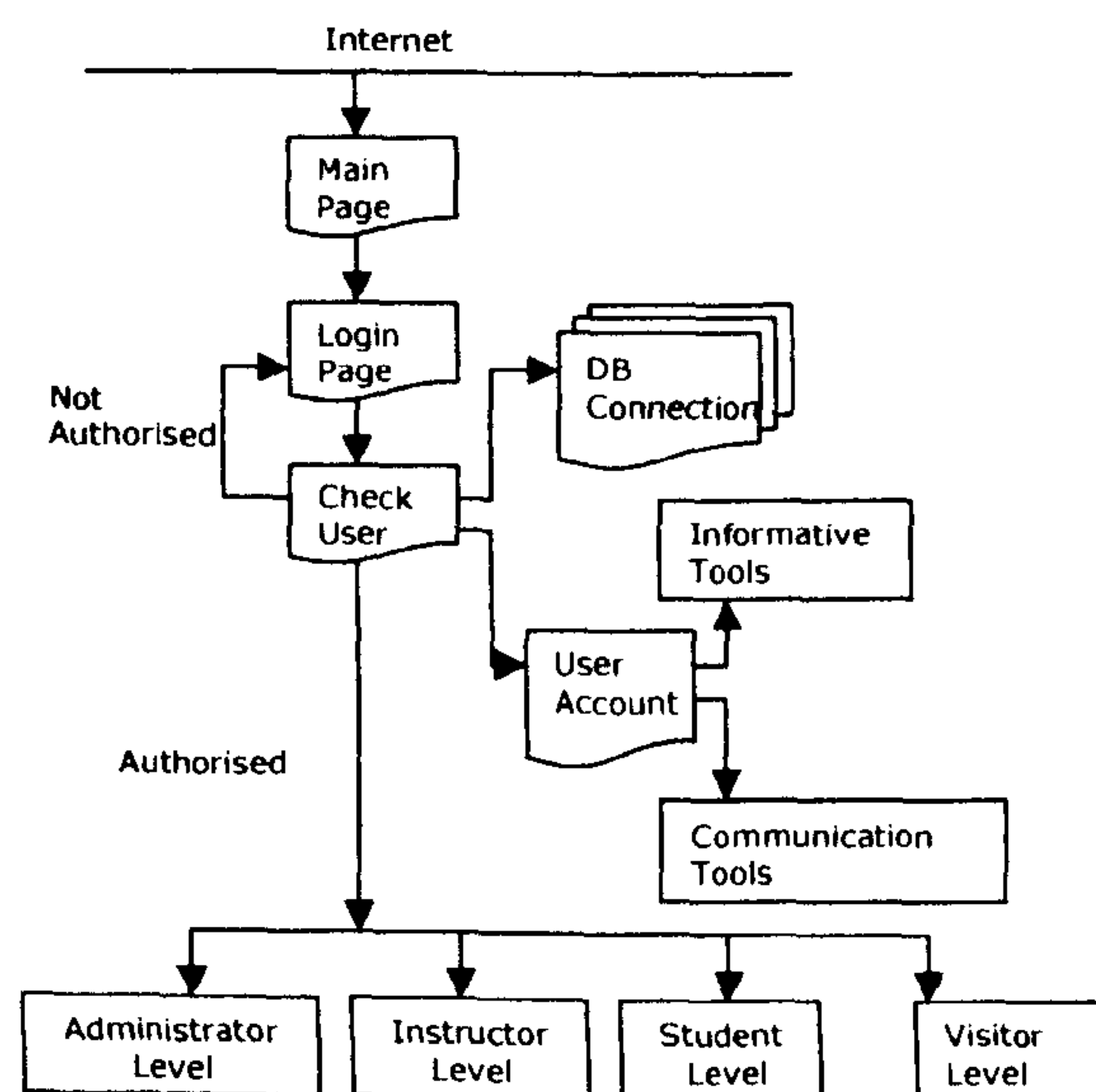


Figure 39: The user-level diagram

### Administrator

The administrator should coordinate and manage the e-learning application via the administrator tools. The administrator should determine which user level-group has the permission to use the system and in which level. Moreover the administrator should be able to communicate with the users in order to keep them informed about the progress of the system or news about the system.

### Instructor

In this level, the instructor should determine the educational material and resources. The instructor should also determine the development and the way that the material will be presented to the students. He/she should be able of producing/editing the e-content for risk management subject, aiming at the better comprehension and adaptation of the material from the students or the unauthorized visitors. The system should provide the students with the ability to teach (not online) using the downloadable theory (presentation format) from the system (library). Finally, in this level, the communication between the instructor and the students should not be synchronous but asynchronous (message tool) and it should aim at the resolution of student's questions.

### Student

The student should determine the successful development of action plan for a specific area and subsection in their organization (NHS Trust) based on the theory/resources that the system should provide in each step. The system should provide the students with resources in order to support the educational materials. The students should be referred to the specific resource from the system during the theory reading. Furthermore, the system should provide an action panel with specific tools, in each procedure step, where the student can develop the risk report step by step.

### Visitor User

Very sensitive data should be stored in this system and for this reason the security is very strict. No one should be able to see any part of the system (theory, resources or action panel) if he/she does not have valid access (user name and password). In this level any visitor should easily browse e-content from the system only if he/she will have access



under the visitor account, which could be created from the administrator after request. The innovation of this level is due to the fact that the visitor could have access to the educational material and resources, but also could have a complete view of the system's functionality. Finally, this level should follow the philosophy-standard "knowledge-access for all" giving the permission to the random visitor to obtain the knowledge of his/her objects of interest, in this case about risk management.

## **User Tools and Services**

### Administration Tools

The environment should provide administration tools that are separated in four groups as follows: management of general services, management of "informative" services, management of "communication" services and management of pathway services (figure 40). The transactions executed in each of these groups concern the retrieval, insert and update of the corresponding data in the system database. All web requests/responses should be carried out through interactive and user-friendly CGI forms. More explicitly, the "general services" group of tools should include management of the data structures of: news, events, announcements and users. The management of the "information" services should be of major importance, as it should enable the administrator to monitor the areas, subsections and risk reports that should be created from the users.

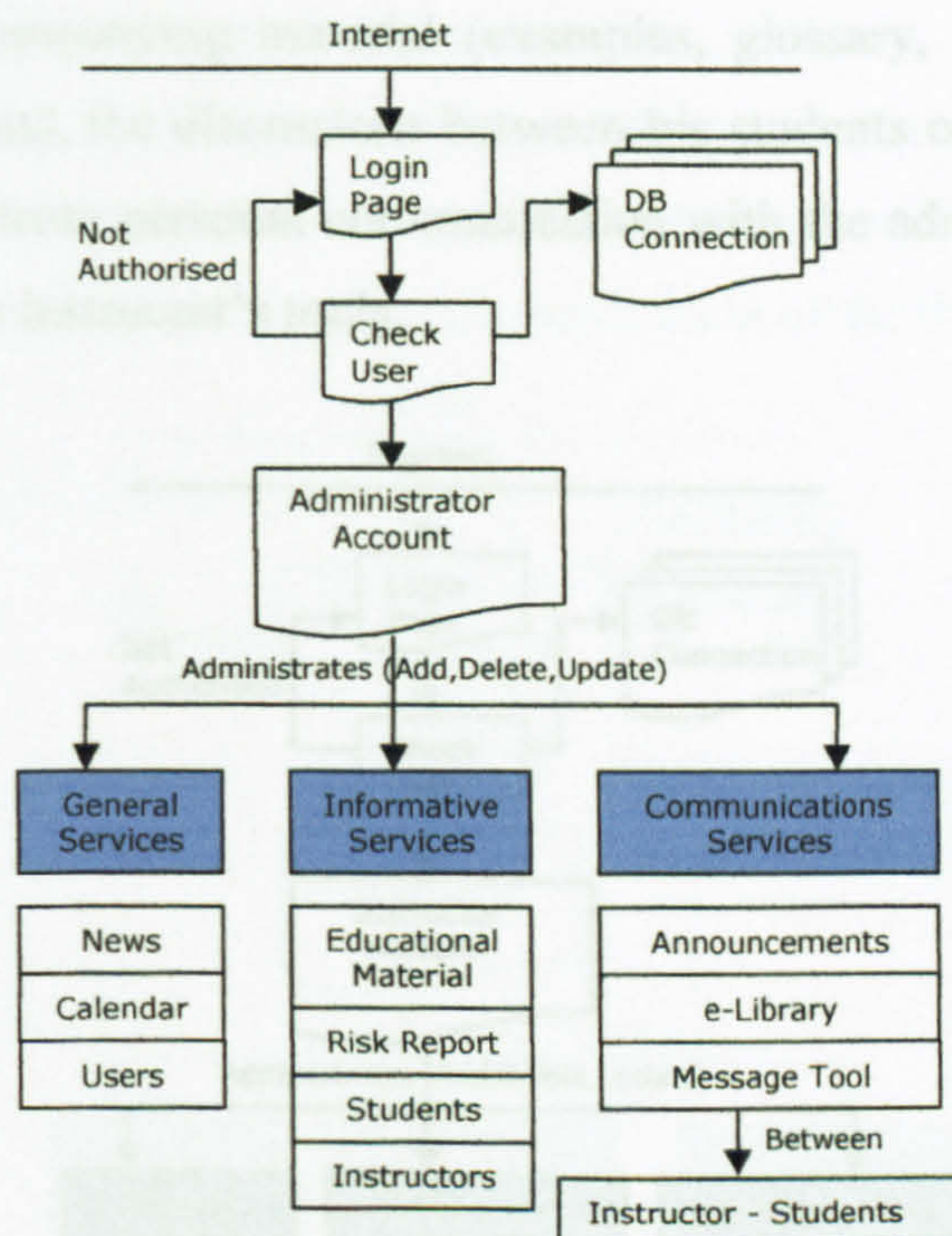


Figure 40: Administrator Level Diagram

The “communication services” group should include services through which the administrator can manage announcements and electronic library. Moreover, through certain services, the administrator should communicate with each of the users separately. The “pathway services” group should enable the administrator to manage the contents of the theory and resources area from each step in the environment.

### Instructor’s Tools

The tools should help the instructor to organize the theory material and resources in a way that it will help the students in the direct comprehension of the risk management subject. More explicitly, the instructor’s tools should be separated in three groups as follows: general services that include management tools of news, events, profile and educational material. The second group should include tools that allow the fast access at the already consulting material as: examples, exercises, glossary, references, web links, e-library, announcements, discussions between students and instructors. The third and more basic group of administrative services is the one that should enable the instructor to build and manage the educational material: the educational material (chapters, sub-chapters,

paragraphs), the accompanying material (examples, glossary, references, web links, e-library, announcements), the discussions between his students on the answer of questions via the message box from personal communication with the administrator. The following diagram illustrates the instructor's tools.

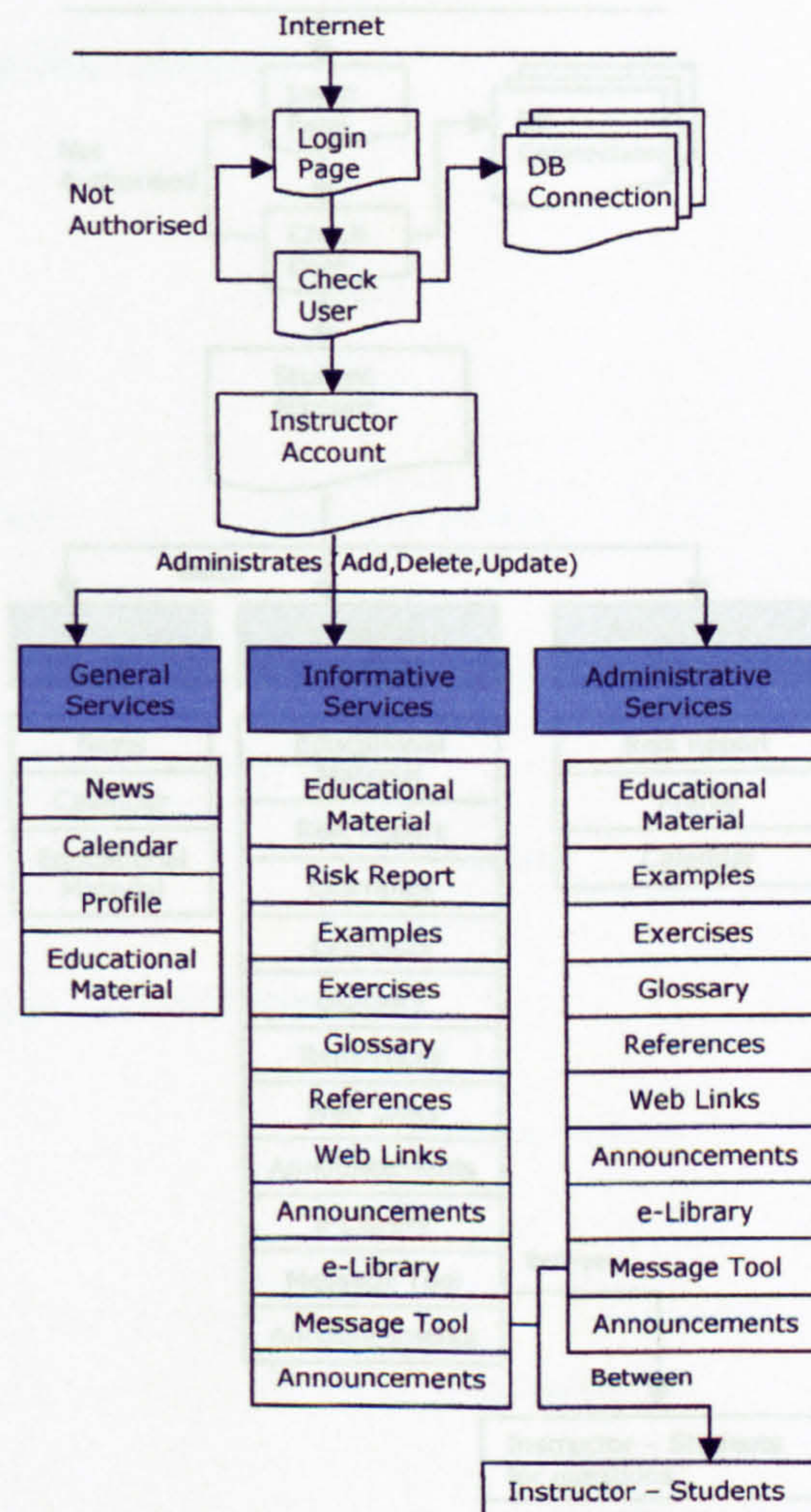


Figure 41: Instructor Level Diagram

Students Tools

Through a friendly and direct way the environment should enable the student-user to have access in the total amount of the educational material with final aim the acquisition of knowledge (figure 42). The student's tool should be separated in two groups as follows: general services that should allow the fast access at: news, events and educational material. The second group should include tools that allow the fast access at the consulting material:

examples, exercises, glossary, references, web links, e-library. What is important in this group is the possibility of communication with the instructor via the message tool. Moreover, the student should have access at the answers of his/her questions but also discussion with the instructor at the practical application of the theoretical subjects.

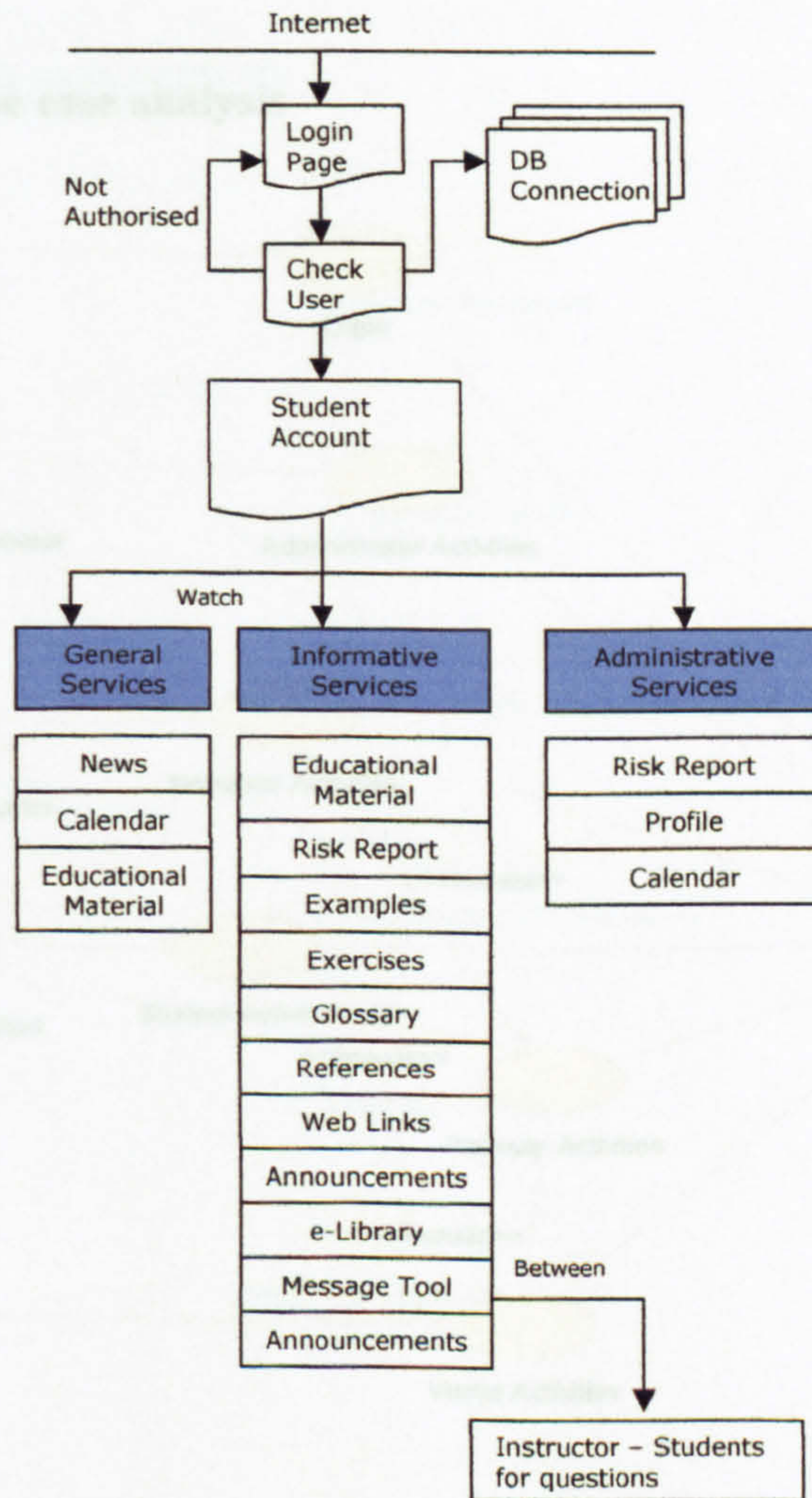


Figure 42: Student Level Diagram

### 8.3.2 System’s Design with UML diagrams

The pilot model design with UML diagrams is different from the prototype model design because of the new requirements and the new functionality architecture. There is significant additional functionality that has to be designed. However, the core e-learning functionality will be remaining the same. The core e-learning functionality has been

discussed in chapter 6. The pilot model of the “risk-e” system analysis will be stopped in level 1, producing a big number of diagrams for each level and for each system’s function. Some of each level diagrams will be described later in this chapter.

### Use Case Diagrams

#### Level 0 of systems’ use case analysis

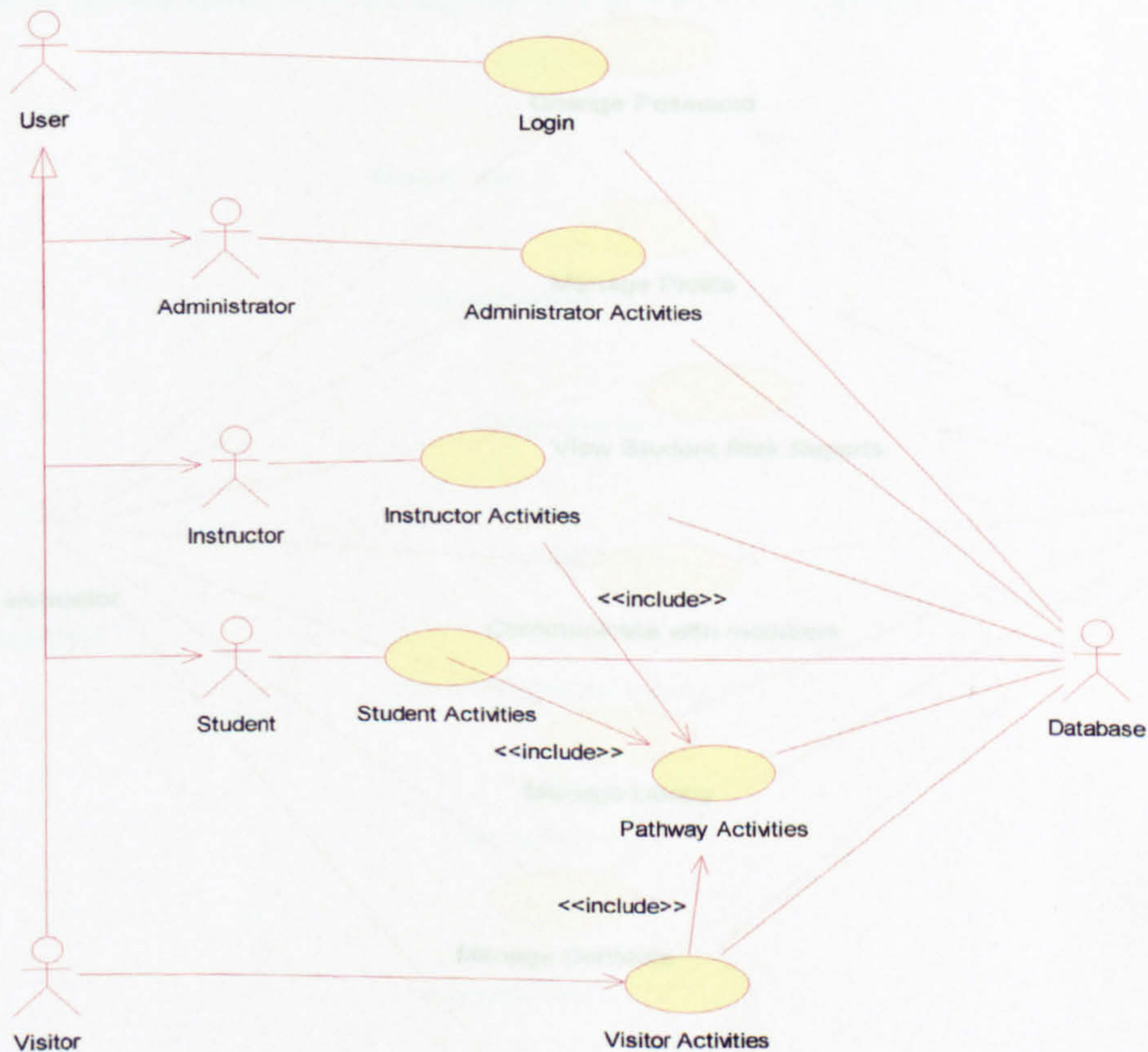


Figure 43: Level 0: Main Use Case Diagram

Figure 43 illustrates the main use case diagram of the pilot model system. This diagram is level 0 of the use case system’s analysis. The diagram contains 5 actors (Administrator, Tutor, Student, Visitor and Database) and 6 use cases (Login, Admin Activities, Tutor Activities, Student Activities, Visitor Activities, and Pathway Activities). This diagram shows that all the actors should login to the system. The Instructor, Student and Visitor account will be spited to two main sequences of transactions; Main User

Activities which extends to Pathway Activities. The administrator has 1 use case; Administrator Activities. The fifth actor is the database that the system will use to store all the information. This should be an actor of the system because it will take information of the system and also it will give information to the system when this is required.

### Level 1 of systems' use case analysis

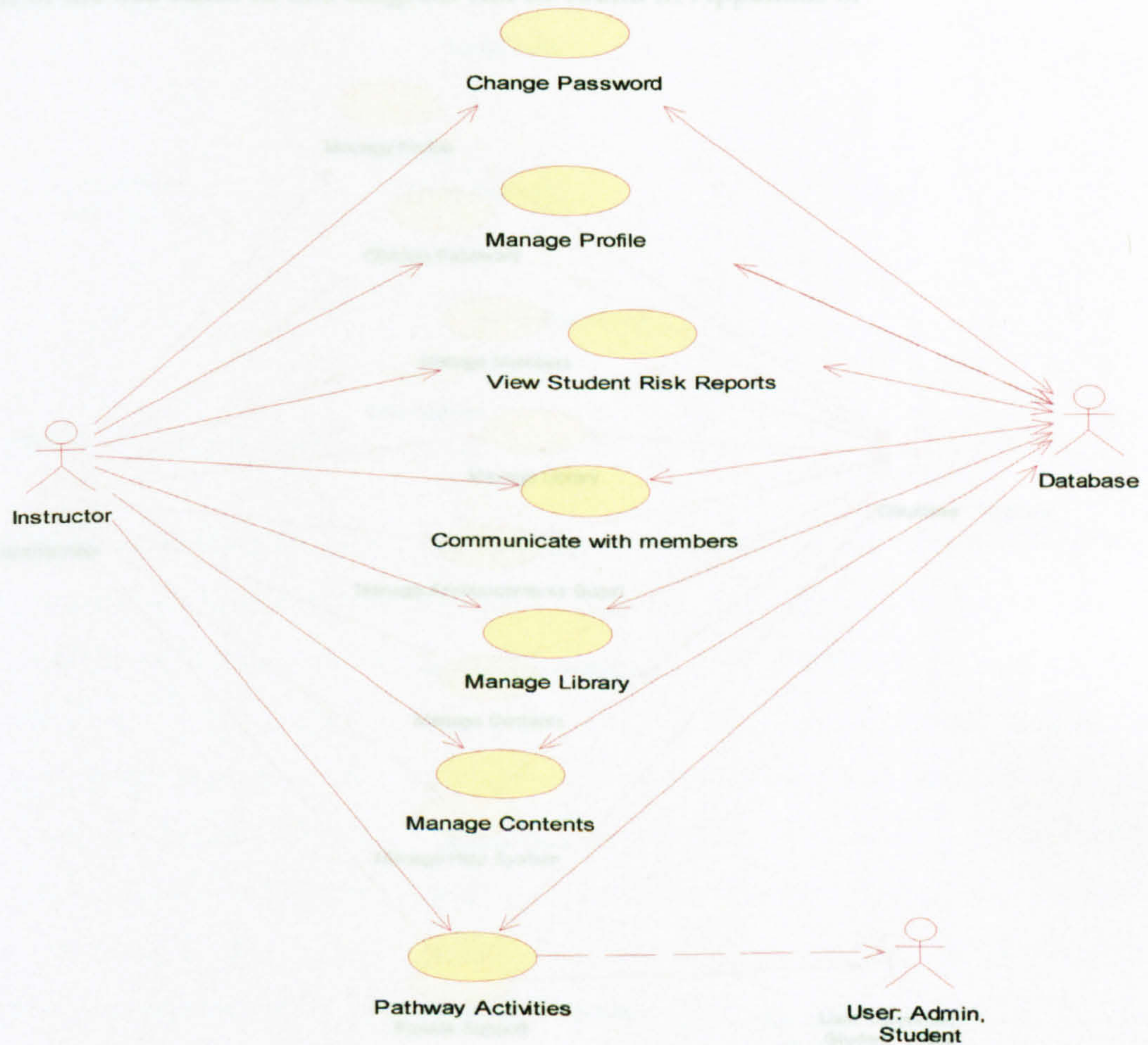


Figure 44: Level 1: Instructor Use Case Diagram

The above figure, illustrates Level 1 instructor use case diagram. The diagram contains 7 use cases; Change password, Manage Profile, Manage Announcements Board, Communicate with members, Manage Library, manage Contents and Pathway Activities, and 2 actors; Instructor and Database. All the use cases that are contained in this diagram

represent the sequence of transactions that is needed in the system for each instructor activities in the instructor's account.

All the use cases are the detailed analysis of the Instructor Activities use case that are contained in Level 0 system's use case diagram. For this reason the use case diagram in figure 44 is called Level 1 "Instructor" Use Case Diagram. The flow of events document for each of the use cases in this diagram can be found in Appendix 6.

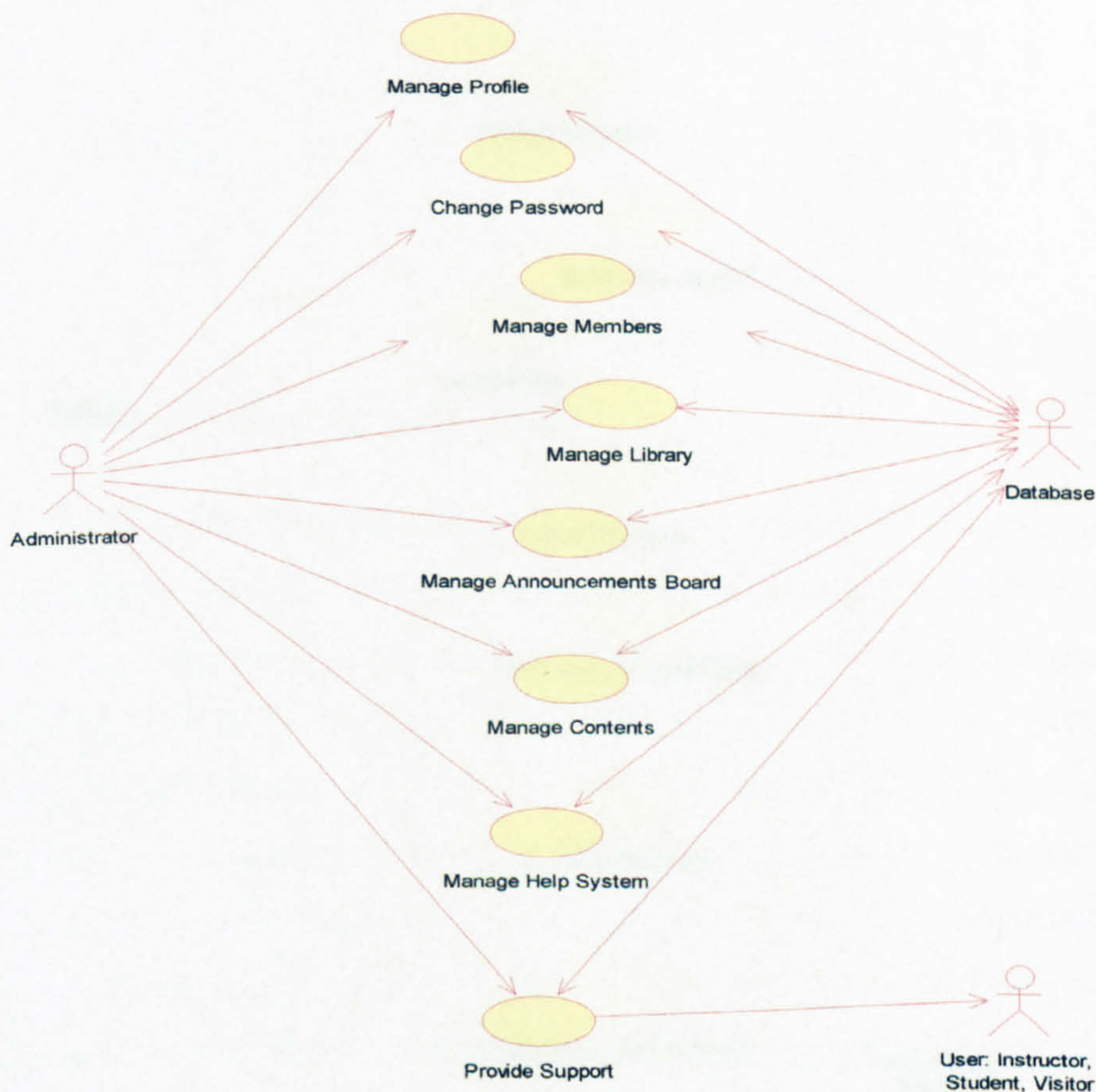


Figure 45: Level 1: Administrator Use Case Diagram

The above figure, illustrates Level 1 Administrator use case diagram. The diagram contains 8 use cases; Manage Profile, Change Password, Manage Members, Manage Library, Manage Announcements Board, Manage Contents, Manage Help System and Provide Support, and 2 actors; Administrator and Database.

All these use cases represent the sequence of transactions that is needed in the system for each administrator activities in the administrator's account and the detailed analysis of the "Admin Activities" use case that are contained in the Level 0 system's use case diagram. The flow of events document for each of the use cases in this diagram can be found in Appendix 6.

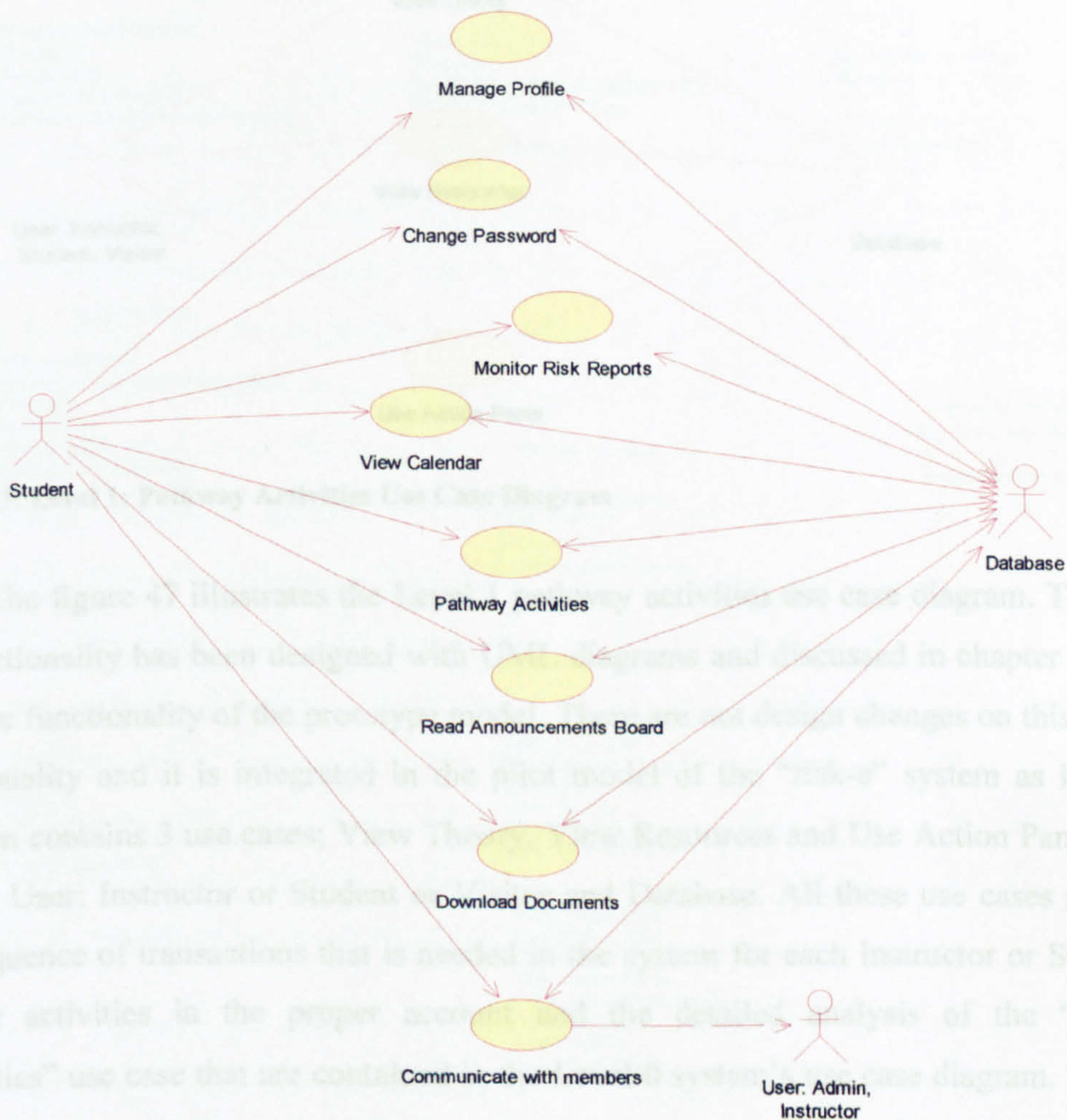


Figure 46: Level 1: Student Use Case Diagram

Figure 46, illustrates the Level 1 student use case diagram. The diagram contains 8 use cases; Manage Profile, Change Password, Manage Members, Monitor Risk Reports, View Calendar, Pathway Activities, Read Announcements Board, Download Documents and Communicate with members, and 2 actors; Student and Database. All these use cases



represent the sequence of transactions that is needed in the system for each student activities in the proper account and the detailed analysis of the “Student Activities” use case that are contained in the Level 0 system’s use case diagram. The flow of events document for each of the use cases in this diagram can be found in Appendix 6.

#### System Main Class Diagram

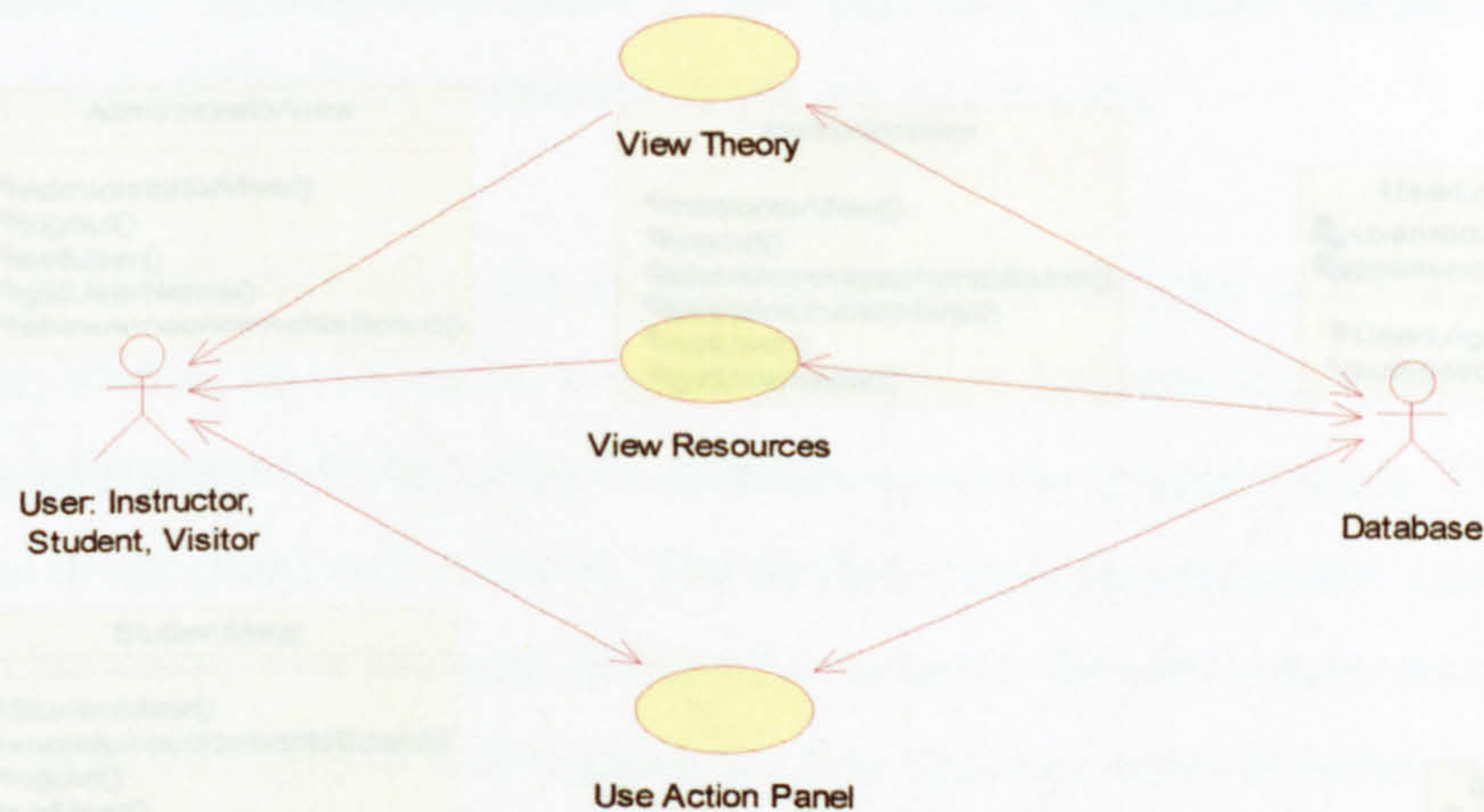


Figure 47: Level 1: Pathway Activities Use Case Diagram

The figure 47 illustrates the Level 1 pathway activities use case diagram. This piece of functionality has been designed with UML diagrams and discussed in chapter 6 as it is the core functionality of the prototype model. There are not design changes on this piece of functionality and it is integrated in the pilot model of the “risk-e” system as it is. The diagram contains 3 use cases; View Theory, View Resources and Use Action Panel, and 2 actors; User: Instructor or Student or Visitor and Database. All these use cases represent the sequence of transactions that is needed in the system for each Instructor or Student or Visitor activities in the proper account and the detailed analysis of the “Pathway Activities” use case that are contained in the Level 0 system’s use case diagram. The flow of events document for each of the use cases in this diagram can be found in Appendix 6. “Pathway activities” use case Level 2 analysis has been discussed in chapter 5 and 6.

#### Class Diagrams

There are major differences between pilot model class diagrams and prototype model class diagrams. There is new extra functionality that has been added to the prototype model in order to support the pilot model new facilities. The class diagrams tries to create the base

of the code implementation of the software system with as much accuracy as possible in the first approach. The pilot model class diagram is being split into smallest class diagrams for better analyses and view.

### System Main Class Diagram

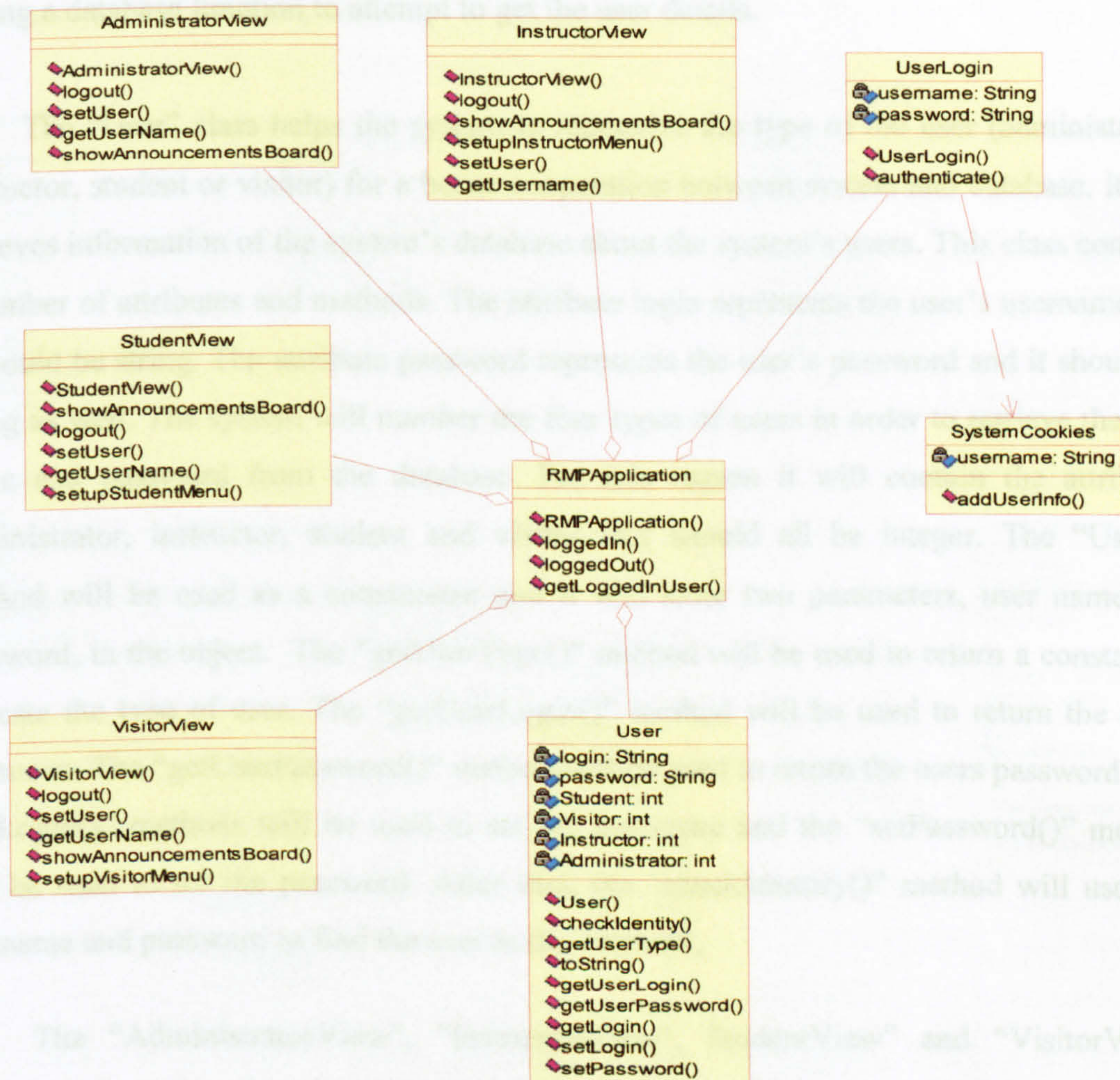


Figure 48: System Main Class Diagram

Figure 48 illustrates the main (login) class diagram for the "risk-e" software system. The "RMPApplication" is the main class of the system. The application will be started when this class is called. The application will call the "UserLogin" class and the login screen will be displayed. The "RMPApplication" obviously contains a main method called "RMPApplication()", the "loggedIn()" methods which will be used to call the proper user

interface when a successful login occurs, the “loggedOut()” will be used to open the login interface when a particular interface close. The “UserLogin()” class has 2 attributes that represents the username and the password of the user and both should be string. Obviously the “UserLogin()” class should have a main class with the same name. The “authenticate()” method will check if the username, password combination is valid by calling a database function to attempt to get the user details.

The “User” class helps the system to recognize the type of the user (administrator, instructor, student or visitor) for a better cooperation between system and database. It also retrieves information of the system’s database about the system’s users. This class contains a number of attributes and methods. The attribute login represents the user’s username and it should be string. The attribute password represents the user’s password and it should be string as well. The system will number the four types of users in order to retrieve the user name and password from the database. For this reason it will contain the attributes administrator, instructor, student and visitor that should all be integer. The “User()” method will be used as a constructor and it will store two parameters, user name and password, in the object. The “getUserType()” method will be used to return a constant to indicate the type of user. The “getUserLogin()” method will be used to return the users username. The “getUserPassword()” method will be used to return the users password. The “setLogin()” methods will be used to set the username and the “setPassword()” method will be used to set the password. After that, the “checkIdentify()” method will use this username and password to find the user in the database.

The “AdministratorView”, “InstructorView”, “StudentView” and “VisitorView” class are the main class for the Administrator, Instructor, Student and Visitor account respectively. Each of the above accounts will be displayed when this class will be called from the system’s main class. Each of the above classes obviously will contain a main method with the same name and other methods that will relate with the account facilities.

The “SystemCookies” class is a class that is called from the “UserLogin” class in order to pass user’s information to the cookies. It also could be called from any other class in order to pass specific information to the cookies. This class can also be seen in other class diagrams, where it will also be linked with other classes.

### Administrator Class Diagram

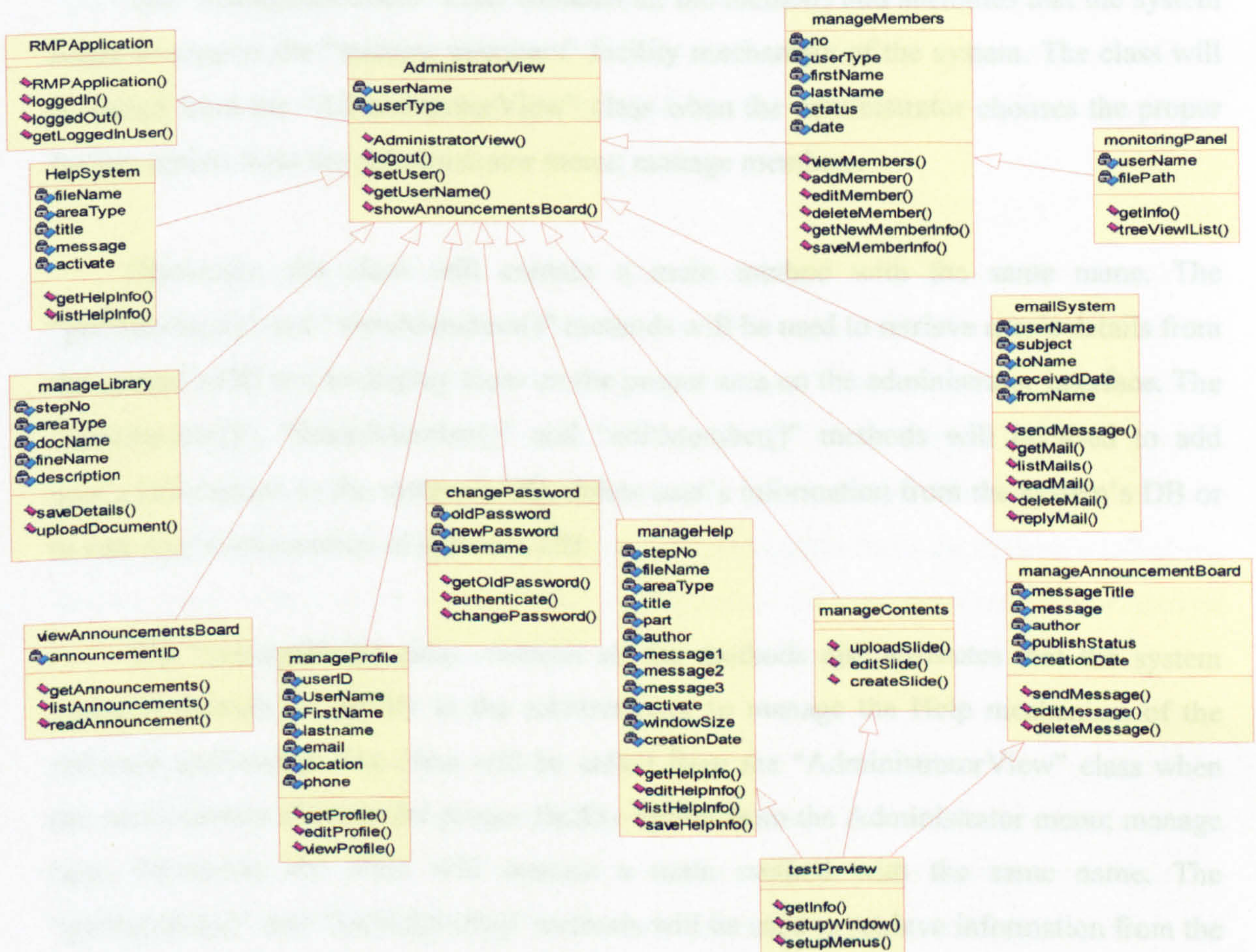


Figure 49: Administrator Class Diagram

Figure 49 illustrates the class diagram for the administrator account. After the login screen the system will display the administrator screen from an administrator account after checking if his/her user name and password are correct and the type of the user is the administrator.

Each of the above class is used from the main class “AdministratorView” to create the mechanism in the system for each tool that the administrator account provides. For example the class “manageLibrary” is used for the tool that will allow the Administrator to manage the online system’s library. This class will open a new screen that the Administrator will use for this activity.

The “manageMembers” class contains all the methods and attributes that the system needs to support the “manage members” facility mechanism of the system. The class will be called from the “AdministratorView” class when the administrator chooses the proper facility option from the Administrator menu; manage members.

Obviously, the class will contain a main method with the same name. The “getMembers()” and “viewMembers()” methods will be used to retrieve user’s details from the system’s DB and to display them on the proper area on the administrator interface. The “addMember()”, “deleteMember()” and “editMember()” methods will be used to add user’s information to the system’s DB, delete user’s information from the system’s DB or to edit user’s information of system’s DB.

The “manageHelp” class contains all the methods and attributes that the system needs to provide the ability to the administrator to manage the Help mechanism of the software application. The class will be called from the “AdministratorView” class when the administrator chooses the proper facility option from the Administrator menu; manage help. Obviously the class will contain a main method with the same name. The “getHelpInfo()” and “listHelpInfo()” methods will be used to retrieve information from the system’s DB about help and to display them on the proper area on the administrator interface. The “editHelpInfo()” method will be used to edit help information to the system’s DB.

The “manageAnnouncementBoard” class contains all the methods and attributes that the system needs to provide the ability to the administrator to manage the Announcement board of the system. The class will be called from the “AdministratorView” class when the

administrator chooses the proper facility option from the Administrator menu; manage announcement board. The class obviously will contain a main method with the same name. The “sendMessage()” method will be used from the system when the administrator will create a new message and send it to the announcement board. This method will store all the message details to the system’s DB. The “editMessage()” method will be used to edit message details from a chosen message and restore it to the system’s DB. The “deleteMessage()” methods will be used to delete a message from the announcement board and from the system’s DB if the administrator wants to, otherwise the message will be deleted only from the announcement board and it will be saved to the archive area of the system’s DB.

The “manageProfile” class contains all the methods and attributes that the system needs to provide the ability to the administrator to change his profile (personal details). The class will be called from the “AdministratorView” class when the administrator chooses the proper facility option from the Administrator menu; manage profile. The class obviously will contain a main method with the same name. The “getProfile()” and “viewProfile()” methods will be used to retrieve information from the system’s DB about administrator profile and to display them on the proper area on the administrator account interface. The “editProfile()” method will be used to edit administrator profile information and save them to the system’s DB.

The “changePassword” class contains all the methods and attributes that the system needs to provide the ability to the administrator to change his security password. The class will be called from the “AdministratorView” class when the administrator chooses the proper facility option from the Administrator menu; change password. The class obviously will contain a main method with the same name. The “getOldPassword()” and “authenticate()” methods will be used to retrieve the current administrator password from the system’s DB and to match it with the given current password in order to proceed to the change password process. The “authenticate()” method improves the security of the system. The “savePassword()” method will be used to save the new password to the system’s DB.

The “manageContents” class contains all the methods and attributes that the system needs to provide the ability to the administrator to manage the learning area mechanism of the software application. The class will be called from the “AdministratorView” class when the administrator chooses the proper facility option from the Administrator menu; manage contents. The class obviously will contain a main method with the same name. The “uploadSlide()” method will be used to upload from outsource environment a created slide of teaching material to the system. The proper information will be saved to the system’s DB. The “createSlide()” method will be used to provide the ability to the user to create online a teaching material slide and store the information in the system’s DB. The “getSlide()” and “viewSlide()” methods will be used to retrieve information from the system’s DB about the slides already placed in the system and to display them on the proper area on the administrator interface. The “editSlide()” method will be used to edit teaching material slide information and save them to the system’s DB.

The “testPreview()” methods will be called from the “manageHelp”, “manageContents” or “manageAnnouncementBoard” classes when the administrator choose the proper facility option from the “manage help menu” or “manage contents menu” or “manage announcement board menu” on the proper screen. The “testPreview” method will be used to provide the ability to the administrator to preview the changes on the help information or the changes on the teaching material or the announcement message before that will be published and it will be available to the other system’s users. The “setupWindow()” and “setupMenus()” methods will be used to create the proper testing environment, a duplication of the original one, and the “getInfo()” method will add the potential changes on it in order for the administration to have a preview of the changes before the final action; publication.

### Instructor Class Diagram

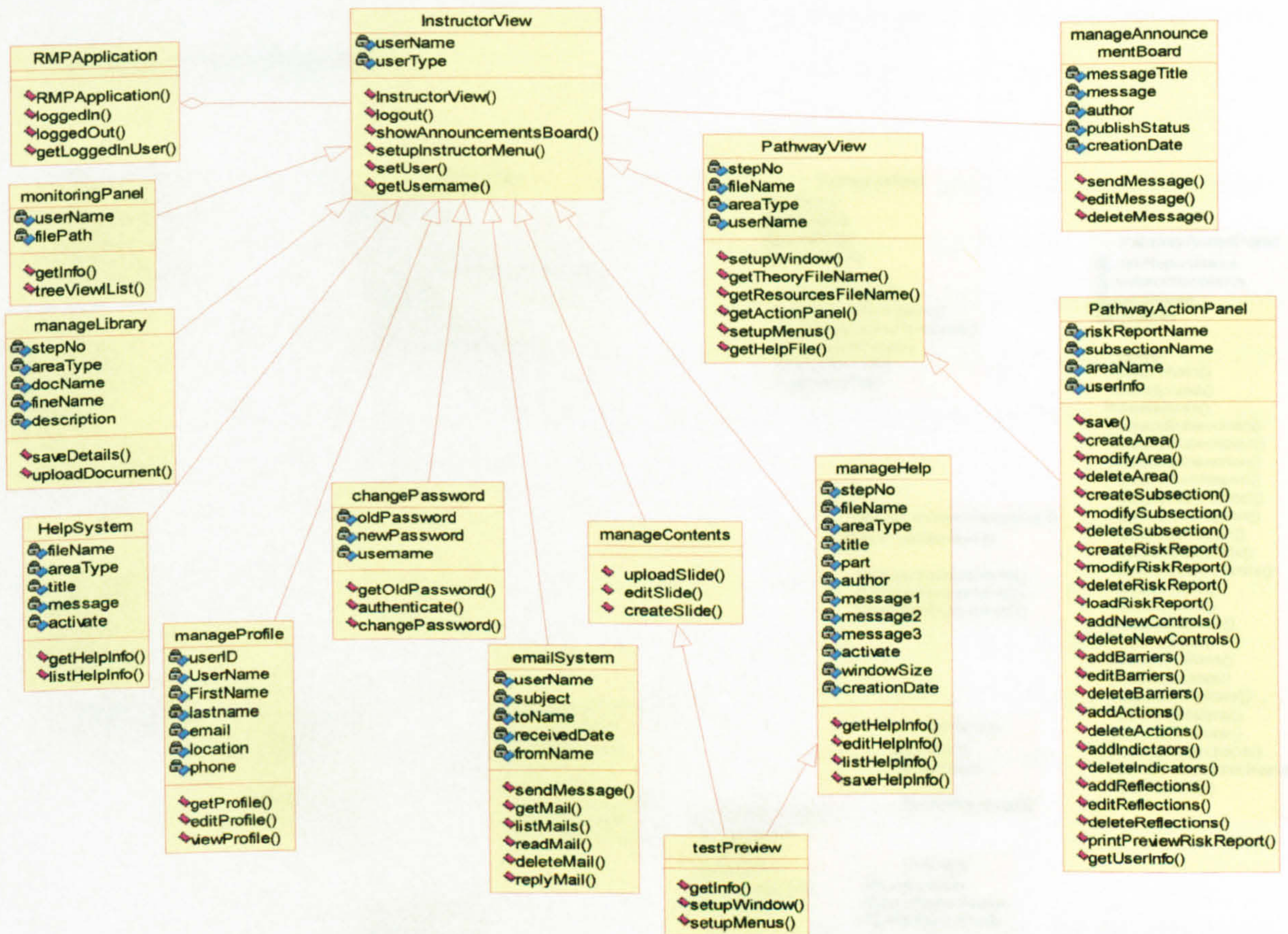


Figure 50: Instructor Class Diagram

Figure 50 illustrates the class diagram for the Instructor account. After the login screen the system will display the instructor screen from an instructor account after checking if his/her user name and password are correct and the type of the user is instructor. The instructor class diagram is similar with the administrator class diagram. As the instructor needs to act as sub-administrator of the system, he/she should have the same facilities with the administrator. The only change is that the instructor should have access to the “pathway” facility, the learning area of the system, and for this reason the “PathwayView” and the “PathwayActionPanel” classes have been added to the class diagram. The classes that will support the administrator facilities in the system have been described above. A separate class diagram for the “pathway” facility will be provided and



discussed on “Pathway Activities Class Diagram” section, as it is the most important part of the system.

### Student Class Diagram

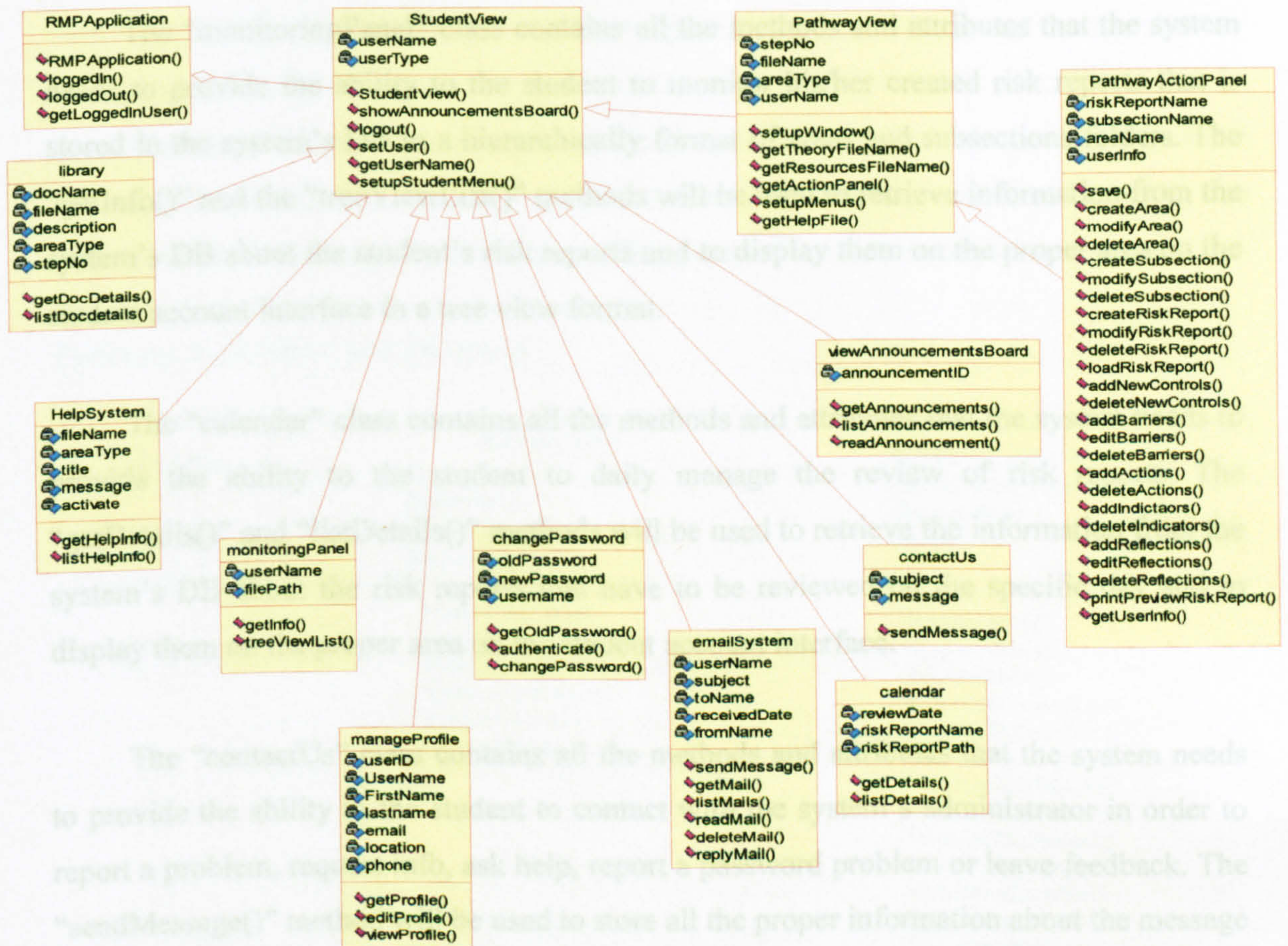


Figure 51: Student Class Diagram

Figure 51 illustrates the class diagram for the Student account. After the login screen the system will display the student screen from a student account after checking if his/her user name and password are correct and the type of the user is student.

The “library” class contains all the methods and attributes that the system needs to provide the ability to the student to have access to the online system’s library in order to download documents related with the teaching material (theory, resources etc) or related

with the system's functionality (user manual, help etc). The "getDocDetails()" and "listDocDetails()" methods will be used to retrieve information from the system's DB about the documents in the library and to display them on the proper area on the student account interface.

The "monitoringPanel" class contains all the methods and attributes that the system needs to provide the ability to the student to monitor his/her created risk reports that is stored in the system's DB in a hierarchically format of areas and subsections folders. The "getInfo()" and the "treeViewList()" methods will be used to retrieve information from the system's DB about the student's risk reports and to display them on the proper area on the student account interface in a tree view format.

The "calendar" class contains all the methods and attributes that the system needs to provide the ability to the student to daily manage the review of risk reports. The "getDetails()" and "listDetails()" methods will be used to retrieve the information from the system's DB about the risk reports that have to be reviewed on the specific day and to display them on the proper area on the student account interface.

The "contactUs" class contains all the methods and attributes that the system needs to provide the ability to the student to contact with the system's administrator in order to report a problem, request info, ask help, report a password problem or leave feedback. The "sendMessage()" method will be used to store all the proper information about the message to the system's DB.

The "viewAnnouncementsBoard" class contains all the methods and attributes that the system needs to provide the ability to the student to read the announcement messages from the announcement board. The "getAnnouncements()" and "listAnnouncements()" methods will be used to retrieve the information about the announcements from the system's DB and to display them on the proper area, announcement board, on the student account interface. The "readAnnouncement()" method will be used to retrieve information from the system's DB for the selected announcement message and to display them on the

proper format on the proper area of the student account interface in order for the student to be able to read the announcement message.

The “manage profile”, the “change password” and the “email system” facilities are provided to all system’s users. So the “manageProfile”, “changePassword” and “emailSystem” have been discussed on the “Administrator Class Diagram” section above.

The visitor class diagram is exactly the same with the student diagram as the visitor is a student with limited access. The system should provide the visitor with exactly the same facilities as a student, with the only different the limitation to use them.

### Pathway Activities Class Diagram

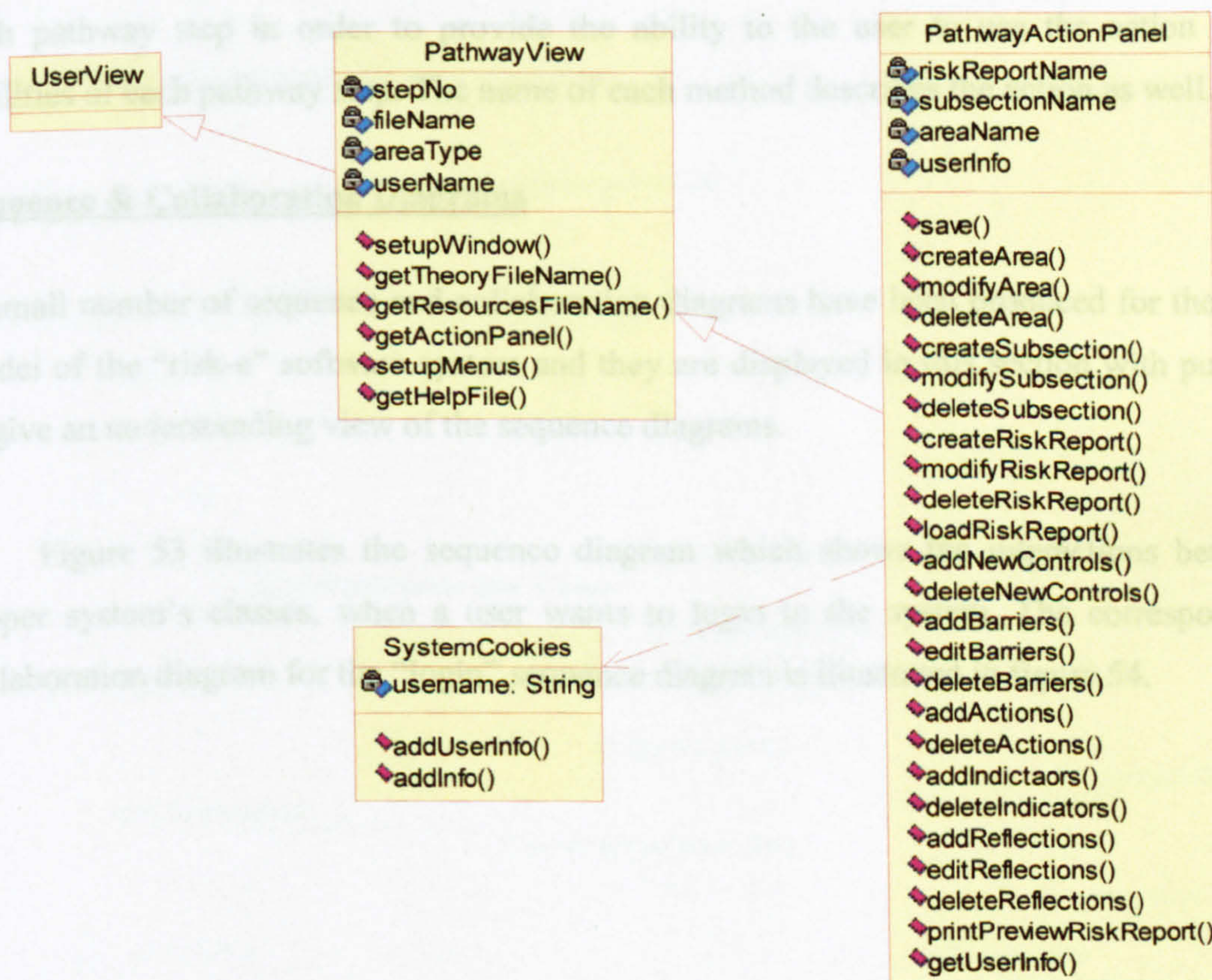


Figure 52: Pathway Activities Class Diagram

Figure 52 illustrates the class diagram for the pathway activities. The system will transfer the user (instructor, student or visitor) to the learning area of the system, pathway, when the user selects the option pathway from the account menu. The “PathwayView” class is the main class of the learning area of the system. The class contains all the methods and attributes that the system needs to retrieve proper information of the system’s DB in order to assemble the learning area of the system. The learning area of the system will contain 6 steps and each of them will be divided into 3 areas; theory, resources and action panel.

The “PathwayActionPanel” class will be called from the “PathwayView” class when the user will visit the action panel of any pathway step. The class contains all the methods and attributes that the system needs to support the pathway action panel mechanism from each pathway step in order to provide the ability to the user to use the action panel facilities of each pathway step. The name of each method describes the action as well.

### **Sequence & Collaboration Diagrams**

A small number of sequence and collaboration diagrams have been produced for the pilot model of the “risk-e” software system and they are displayed in this section with purpose to give an understanding view of the sequence diagrams.

Figure 53 illustrates the sequence diagram which shows the interactions between proper system’s classes, when a user wants to login to the system. The corresponding collaboration diagram for the “login” sequence diagram is illustrated in figure 54.

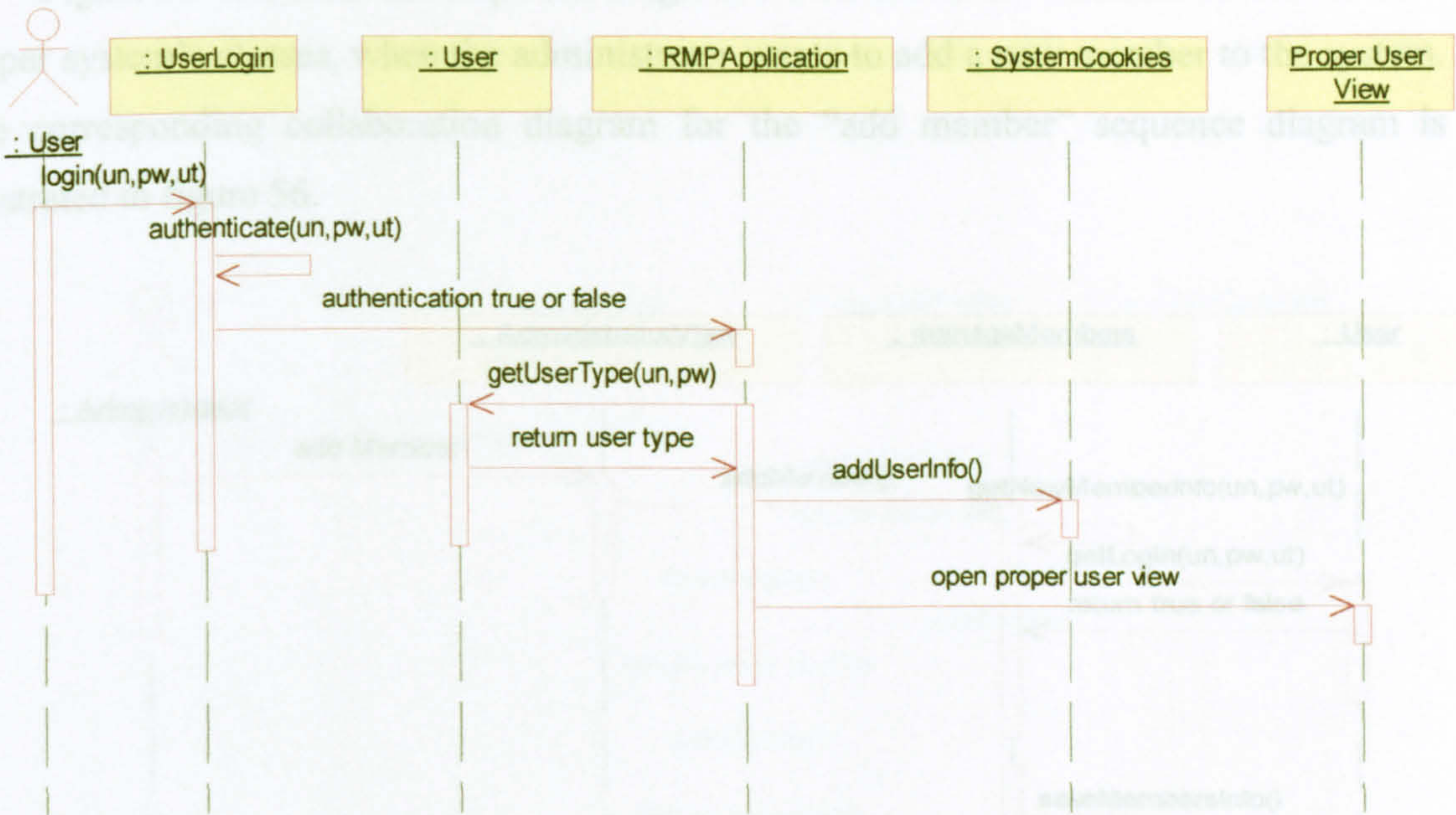


Figure 53: The Login sequence diagram of system.

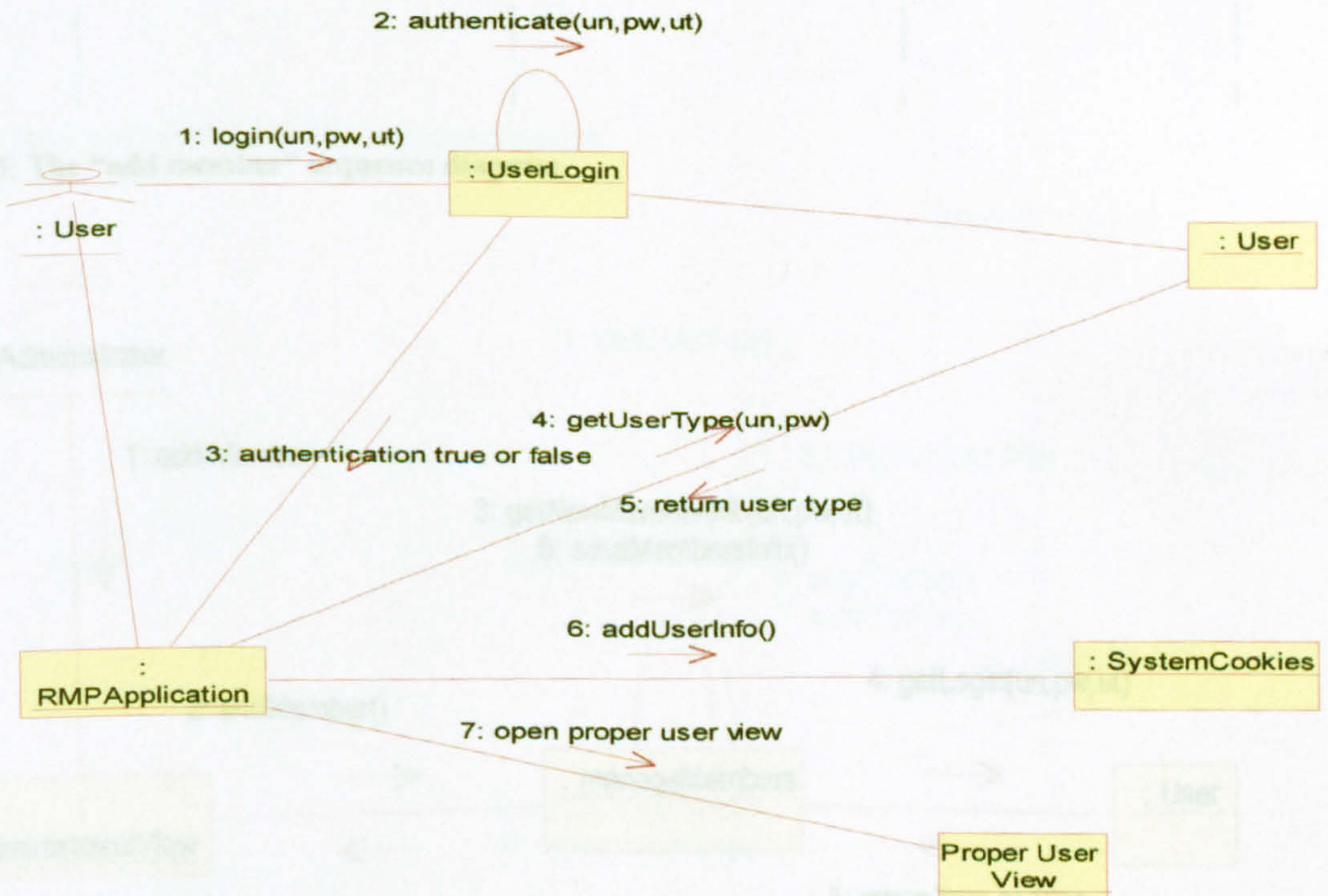


Figure 54: The Login collaboration diagram of system.

Figure 55 illustrates the sequence diagram which shows the interactions between the proper system's classes, when the administrator wants to add a new member to the system. The corresponding collaboration diagram for the "add member" sequence diagram is illustrated in figure 56.

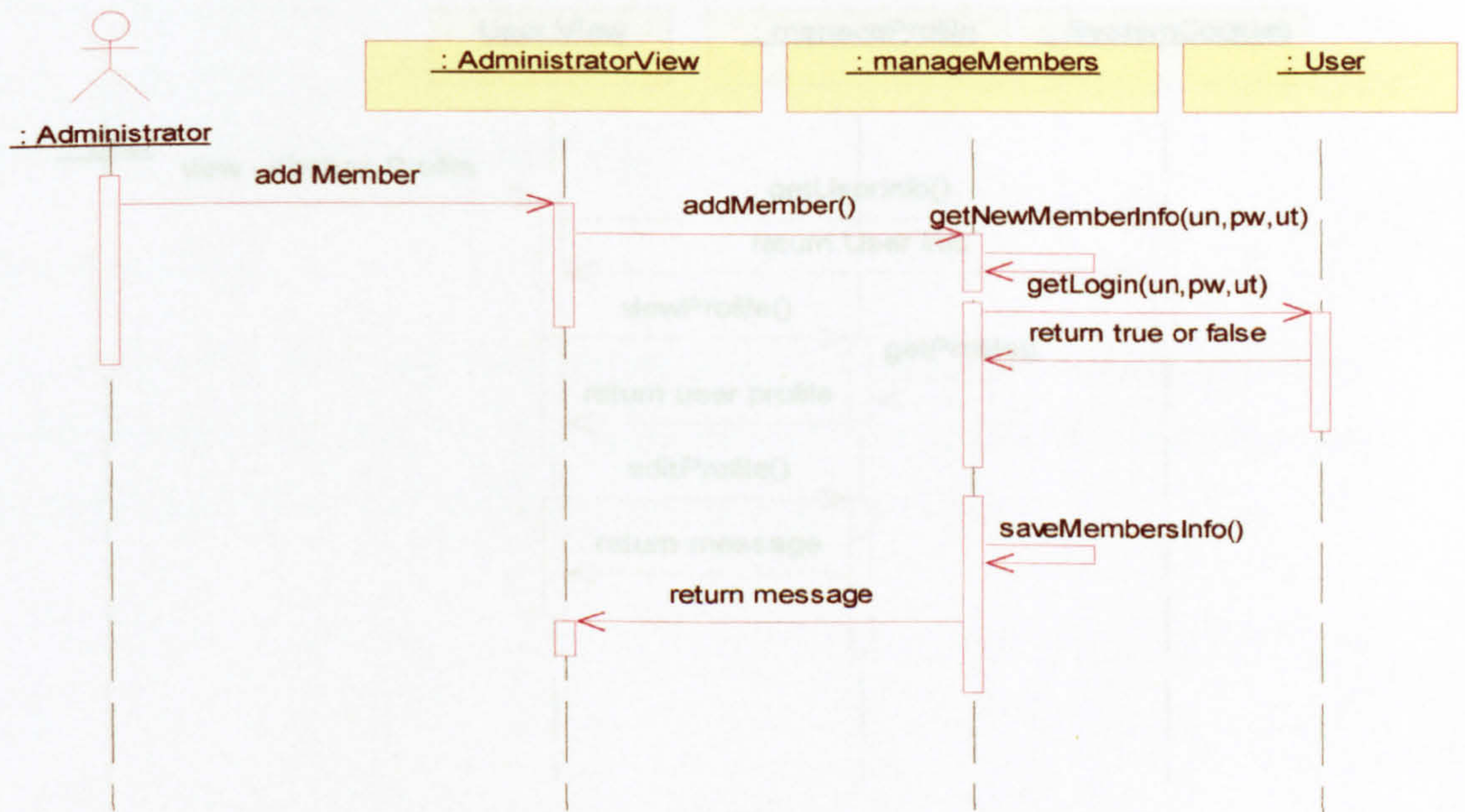


Figure 55: The "add member" sequence diagram

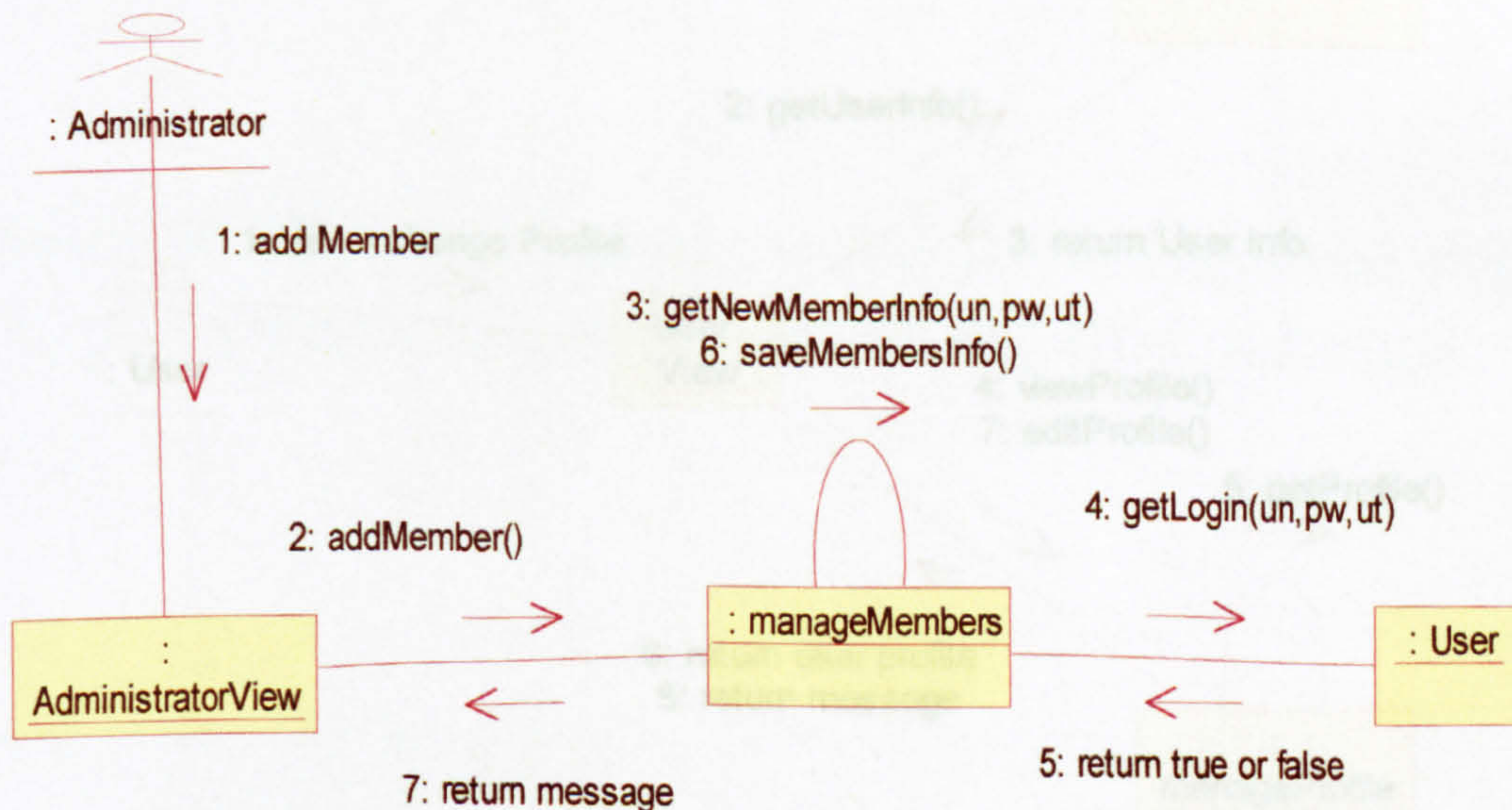


Figure 56: The "add member" collaboration diagram

Figure 57 illustrates the sequence diagram which shows the interactions between the proper system's classes, when a user wants to view and edit his/her profile. The corresponding collaboration diagram for the "view/edit profile" sequence diagram is illustrated in figure 58.

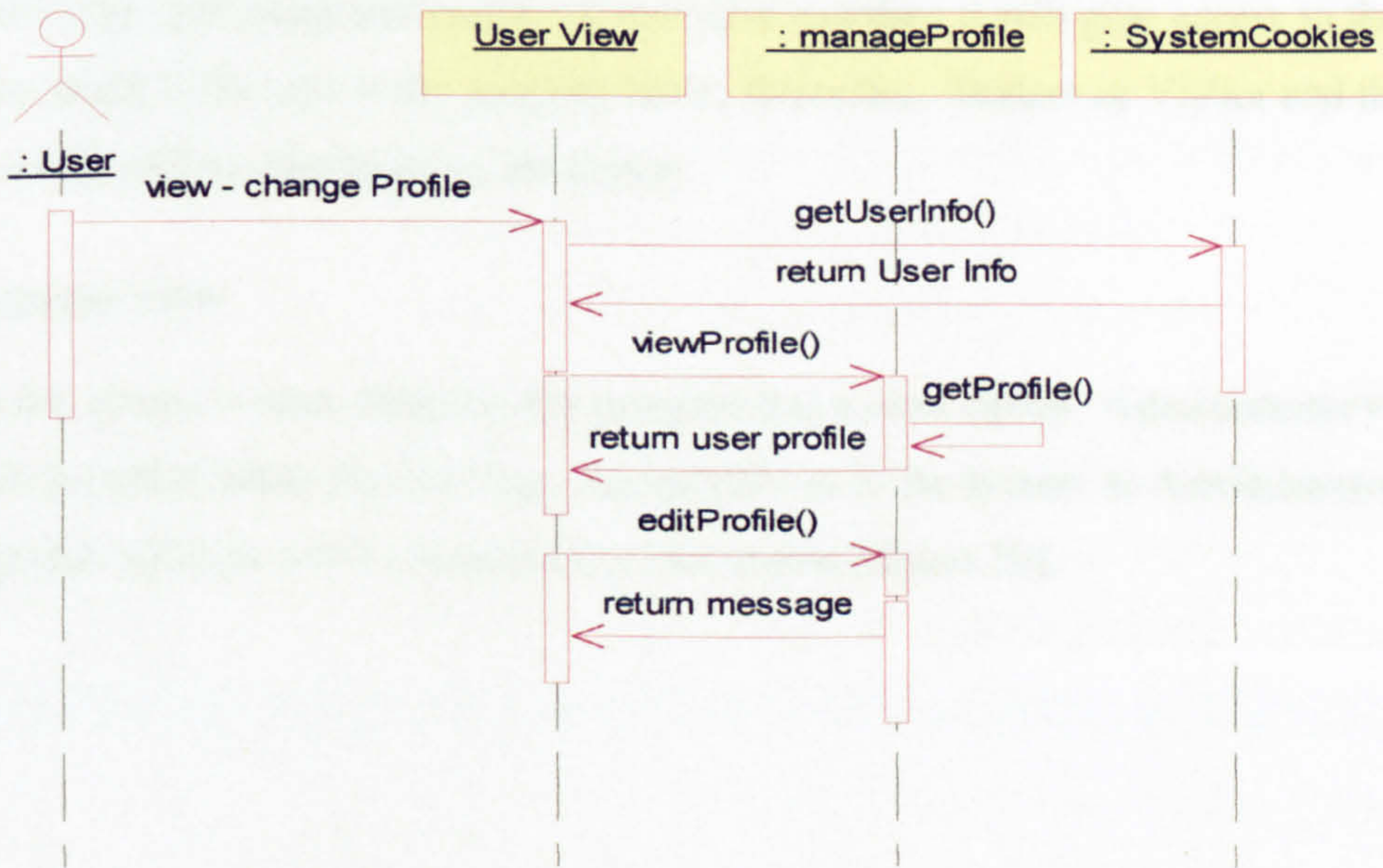


Figure 57: The "view/edit profile" sequence diagram

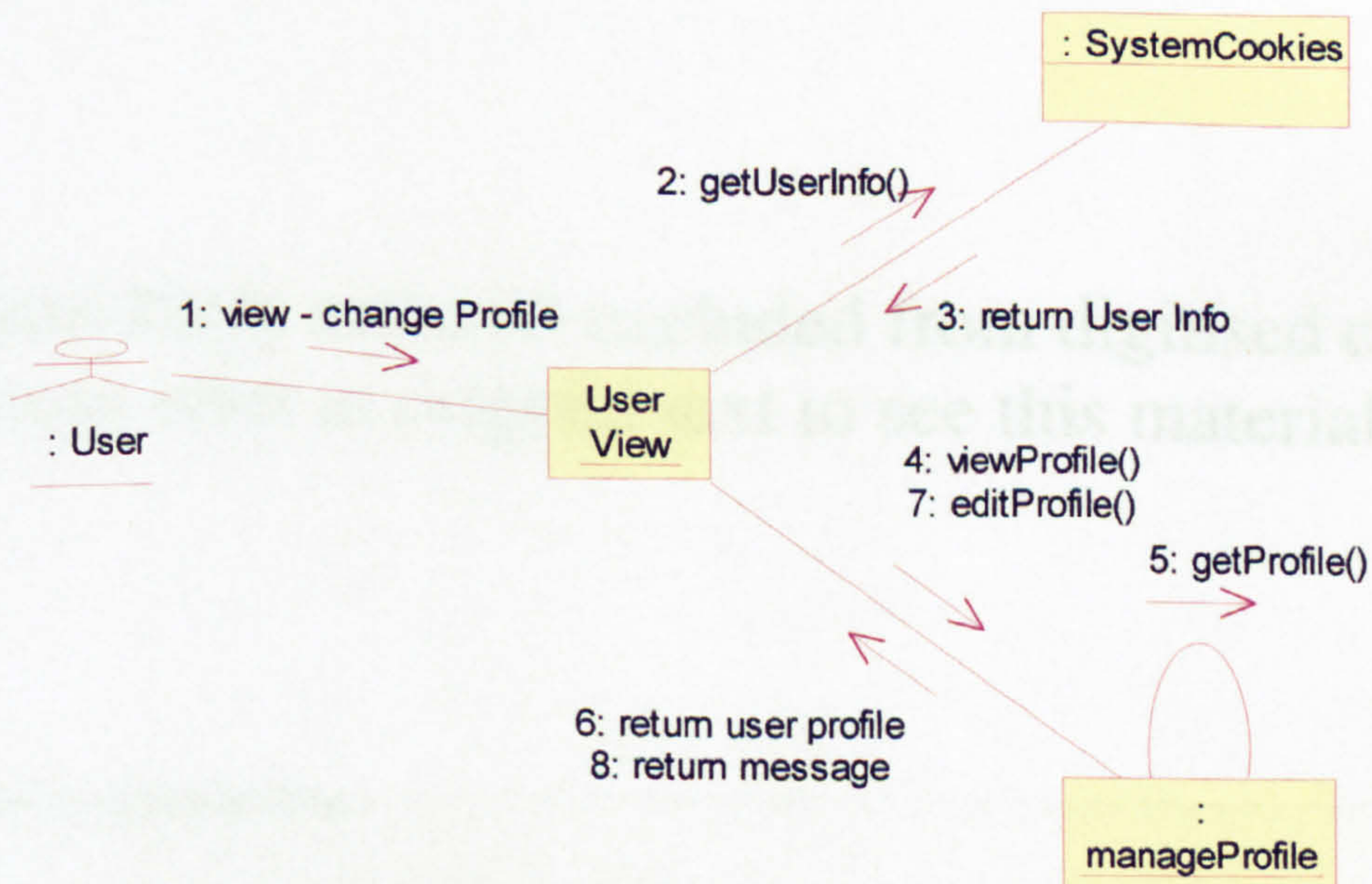
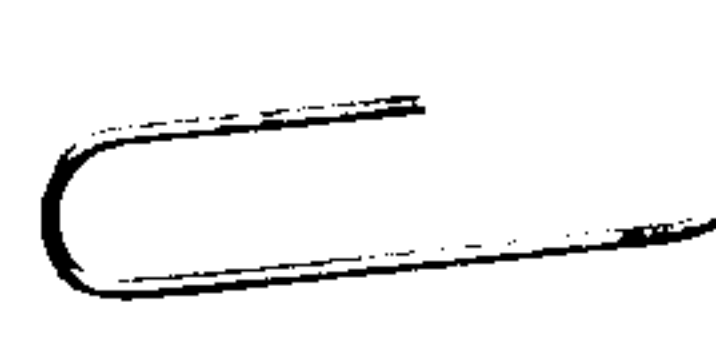



Figure 58: The "view edit profile" collaboration diagram



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desktop account has deferent design, colour and role identification icon. The administrator's desktop account is a grey colour and the role identification icon is: .

The summary of the above menu options and their use are presented below:

### ***Admin Account Main Menu***

<b>Option</b>	<b>Description</b>
Home	This option returns the user to his/her account main screen
Profile	Opens the user's profile management area
Password	Opens the user's password management area
E-Mail	Opens the e-mail system
Members	Opens the system's members management area
Announcement Board	Opens the announcement board management area
Pathway Contents	Opens Pathway Contents management area
Library	Opens system's online library management area
Help Contents	Opens Help Contents management area
Help	Opens system's online help
About Pathway	Displays the version number of the system
Logout	Logs the user out of the system

### **Home**

This option returns the user to his/her account main screen. This option plays a navigation role in the system. Any time the user can use it in order to return to the desktop view.

### **Profile**

This option opens the user's profile management screen. This option allows the administrator to change his/her personal details such as first name, last name, email, location and phone number, online at any time. For print screen please see Appendix 7.1.

### **Password**

This option opens the user's password management screen. The administrators are also able to change their password online and at any time. For security reasons, the system asks

them to provide the old password before they will proceed to the password change. For print screens please see Appendix 7.2.

### *e-mail*

This option opens the e-mail system, part of the communication with other users. For security reasons the administrators have to login again and the session will be locked after 10 minutes of idle status. The system is a proper email system with the basic facilities; inbox where the admin can manage their email (read, reply or delete), compose a new email message and address book, which will help the admin to find all the system's users contact details. For print screens please see Appendix 7.3.

### *Members*

This option opens the system member's administration screen. This facility gives the ability to the administrator to manage the users in the system. The administrator can add a new user to the system by filling in an online form and submit it to the DB. The system member's administration screen displays a list of all member accounts (active or inactive) in the system with the options of edit details or delete user or view the DB for each member account. The student's folder and the user's profile will be created or deleted automatically from the system when the administrator uses this option to create or delete a student or other user account. For print screens please see Appendix 7.4.

### *Announcement Board*

This option opens the announcement board management screen. The system provides the administrators, tutors, students and visitors with the announcement board in order to keep them informed about any change, upgrade or maintenance of the system. This option gives the ability to the admin to send messages to the board or to delete messages from the board or to edit and rearrange messages on the announcement board. For print screens please see Appendix 7.5.

### Pathway Contents

This option opens the Pathway Contents administration screen. The administrator has the ability to update the studying materials; theory and resources (examples, background info and how to tasks). Pathway Contents administration screen provides the administrator with the tools in order to be able to create new slides of studying material or to edit the current one. He/she can also to remove a studying material slide of any section or transfer it between sections. Furthermore, he/she can change the order of the slides in the theory area of each step. For print screens please see Appendix 7.6.

### Library

This option opens system's online library management screen. The system provides the administrator with the ability to manage the online system's library. They can add documents in the correct section or delete documents from a selected section in the library. They should also be able to edit or update document's details. For print screens please see Appendix 7.7.


### Help Contents

This option opens the help contents management screen. The system provides the administrator with the ability to manage the help system contents. The administrator can change the information on the online active help system for each part of the system. He/she can activate or deactivate help screens of the help system. For print screens please see Appendix 7.8.

### Help

This option opens the online help facility for the system. The administration can find information about the facilities of the administrator account, troubleshooting information and general information about the system's functionality.

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The instructor's desktop account is a grey colour as the administrator's account, because the instructor has a sub-administrator role in the system. The instructor role identification icon is: .

The summary of the instructor's menu options and their use are presented below:

### *Instructor Account Main Menu*

<b>Option</b>	<b>Description</b>
Home	This option returns the user to his/her account main screen
Pathway	Opens the learning area
Profile	Opens the user's profile management area
Password	Opens the user's password management area
E-Mail	Opens the e-mail system
Pathway Contents	Opens Pathway Contents management area
Library	Opens system's online library management area
Student's Risk Reports	Opens instructor's monitoring panel
Help	Opens system's online help
About Pathway	Displays the version number of the system
Logout	Logs the user out of the current module

Many options of the instructor's account menu are the same with administrator's account menu because the instructor has a sub-administrator role in the system. These options have been described above (see Administrator View). "Pathway" and "Student's Risk Reports" are extra options in the instructor's account.

### *Pathway*

This option opens the e-learning area of the system. The students have access to the pathway system (e-learning area) in order to be able to produce risk reports (action plans) for their organization according to the provided method. Functionality of this part has been extensively explained in chapter 6 as it was the main functionality of the prototype model.

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The summary of the student's menu options and their use are presented below:

### *Student Account Main Menu*

<b>Option</b>	<b>Description</b>
Home	This option returns the user to his/her account main screen
Pathway	Opens the learning area
Profile	Opens the user's profile management area
Password	Opens the user's password management area
E-Mail	Opens the e-mail system
Calendar	Opens the student's calendar
Monitoring Panel	Opens student's monitoring panel
Library	Opens system's online library
Contact Us	Opens the "contact us" form
Help	Opens system's online help
About Pathway	Displays the version number of the system
Logout	Logs the user out of the current module

### Home

This option returns the user to his/her account main screen. This option plays a navigation role in the system. Any time the user can use it in order to return to the desktop view.

### Pathway

This option opens the e-learning area of the system. The users have access to the pathway system (e-learning area) in order to be able to produce risk reports (action plans) for their organization according to the provided method. Functionality of this part has been extensively explained in chapter 6 as it was the main functionality of the prototype model.

### Profile

This option opens the user's profile management screen. This option allows the student to change his/her personal details such as first name, last name, email, location and phone number, online at any time. For print screen please see Appendix 7.1.

### Password

This option opens the user's password management screen. The students are also able to change their password online and at any time. For security reasons, the system asks them to provide the old password before they will proceed to the password change. For print screens please see Appendix 7.2.

### e-mail

This option opens the e-mail system, part of the communication with other users. For security reasons the students have to login again and the session is locked after 10 minutes of idle status. The system is a proper email system with the basic facilities; inbox where the admin can manage their email (read, reply or delete), compose a new email message and address book, which will help the admin to find all the system's users contact details. For print screens please see Appendix 7.3.

### Calendar

This option opens the student's personal calendar. Students are able to view their personal calendar in order to know when the next risk report review date is. The personal calendar is linked with the pathway system through the system's DB. For print screens please see Appendix 7.11.

### Monitoring Panel

This option opens the monitoring panel for students where they can check their risk reports at any time. They can view a report in a separate window, which provides them with the print out option as well. For print screens please see Appendix 7.12.

### Library

This option opens system's online library. The system provides the students with an online library that provides 24/7 access to online collection of the studying material and supporting documents about risk management. The students can also have the ability to download them. For print screens please see Appendix 7.13.



### Contact Us

This option opens the “contact us” form. By using this form the student can contact directly with the system’s administration in order to report a problem, to request info, to ask for help, to report a password problem, to leave feedback or for any other matter. For print screens please see Appendix 7.14.

### Help

This option opens the online help facility of the system. The students can find information about the facilities of the student account, troubleshooting information and general information about the system’s functionality. For print screens please see Appendix 7.15.

### About Pathway

This option opens a screen that displays information about the version of the system, the name of the developer and the copyright information. For print screens please see Appendix 7.9.

### Logout

This option logs the student out from his/her account and returns him/her to the login screen.

### **Visitor View**

Based on the system’s architecture and design, when the user is the Visitor the system redirects the user to the appropriate account after the successful login. The following figure illustrates the Visitor account interface which looks similar to the student account.

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Help	Opens system's online help
About Pathway	Displays the version number of the system
Logout	Logs the user out of the current module

The visitor's account menu is the same with student's account menu as the system treats the visitor as a potential student and it provides him/her with the same facilities. Based on the system's requirements, limitations have been applied to the visitor's facilities. The menu options have been explained above (see Student View).

### 8.3.4 System's Database and Security

Prototype's model database design is applied to the pilot model as well. The same XML data store and SQL data store mechanism, as discussed in chapter 6, is used from pilot model for storing sensitive data from different parts of the system in the main system's DB. However, more new different parts has been developed and added to the pilot model which interacts with the database. The following table shows which system's facilities interaction with the system's database and which new facilities have been provided from the pilot model. All the system's users interact with the system's database by storing or retrieving information or both.

System Version	System's Facilities interact with Database		User: Student - Visitor		User: Admin - Instructor	
			Store	Retrieve	Store	Retrieve
Pilot Model	Desktop facilities	E-mail	✓	✓	✓	✓
		View/Edit Profile	✓	✓	✓	✓
		Announcement Board		✓	✓	✓
		Change Password	✓	✓	✓	✓
		Calendar		✓		
		Monitoring Panel		✓		
		Library		✓	✓	✓
		Contact Us	✓			✓
		Manage Members			✓	✓
		Help		✓	✓	✓
Prototype Model	Pathway facilities	Theory		✓	✓	✓
		Resources		✓	✓	✓
		Action Panel	✓	✓	✓	✓

Table 12: System's Facilities interact with Database (Pilot)

System's security is still remaining a very serious concept for this project as sensitive data will be transfer in the system's network. A very secure environment has been developed during the prototype model development life cycle, chapter 6, and the same piece of work is integrated with the pilot model functionality as well.

## **8.4 Pilot Model Testing**

In this stage the pilot model of the "risk-e" system is tested from potential students in order important and useful information to be collected. A face-to-face session was organised in Newport, with 15 risk managers from NHS hospitals in Wales and 2 e-learning software applications experts. The functionality of the system was presented to them at the beginning of the session and they had the opportunity to use the system for 5 hours as well. At the end they had to complete a number of questionnaires.

The pre intervention questionnaire contains general questions about each participant's computing experience and e-learning background. This allows an average participant profile to be built against which subsequent data collection can be evaluated. The profile of the e-learning experts will be treated as expertise opinion. The post intervention questionnaire contains more specific questions about the "risk-e" pathway in relation to the main characteristics and sub-characteristics of the software system, specifically its functionality, efficiency, usability, reliability, portability and maintainability. As the sample is small the answers of the e-learning experts does not effect the evaluation results at this stage. However, their answers form their experienced evaluation will be valuable for the future implementation of the system. The questionnaires can be found in Appendix 1 and their diagrammatic data analysis can be found in Appendix 8.

### **Respondent General Experience**

All the participants have strong computing experience. Most of the respondents are using PC (desktop or laptop) several times a day at work or at home. Most of them (65%) rate their current computer skills as "good" and they were confident that they can learn how to use computers in order to improve their computer skills. 59% of the respondents are using

the internet every day or every two days and 65% of them are using the internet to get information to support their work. 60% of them rate their current internet skills as “very good” and 35% rate as “good”. These results prove that the NHS risk managers are able to adapt quickly a new IT system as most of them have good computer skills.

65% of the respondents believe that e-learning can be an effective method of learning and 53% of them were involved with e-learning as students. All the respondents involved with e-learning, acquired knowledge through e-learning that affected their professional life and they had a positive learning experience. Finally they are happy to use e-learning in the future but 78% of them are confident to use e-learning tool for their work. These results are very important for this study because the NHS risk managers will not treat the “risk-e” system as another expensive IT software system which will add more daily tasks.

So, based on the above results, the average participant’s profile is a person with good computer/internet skills and experience, average e-learning experience but happy to use e-learning in the future even during his work. A group of participants with this average profile is definitely acceptable sample to evaluate the pilot model system and to provide useful results for the future. Furthermore, the e-learning experts, who are participating to the evaluation, will cover any critical and significant part of the evaluation by providing information based on their strong experience.

### **Respondent “risk-e” Experience**

The findings show that most of the respondents agreed or strongly agreed that they were able to complete their work effectively, efficiently and fast by comfortably using the system. However, the percentage of undecided respondents is significantly high, 29%. Also, 6% of the respondents disagreed with that statement.

Nearly all of the participants (94%) believed that they will become more productive with further use of the “risk-e” software application. However, only 82% believed that they became quickly productive when they used the software, 18% believed that they did not become productive quickly. These results show that even if the system is easy to use,

something is stopping the students to be quickly productive. These results should be highlighted for future investigation as the same findings are explored from the prototype product evaluation with the participation of potential instructors.

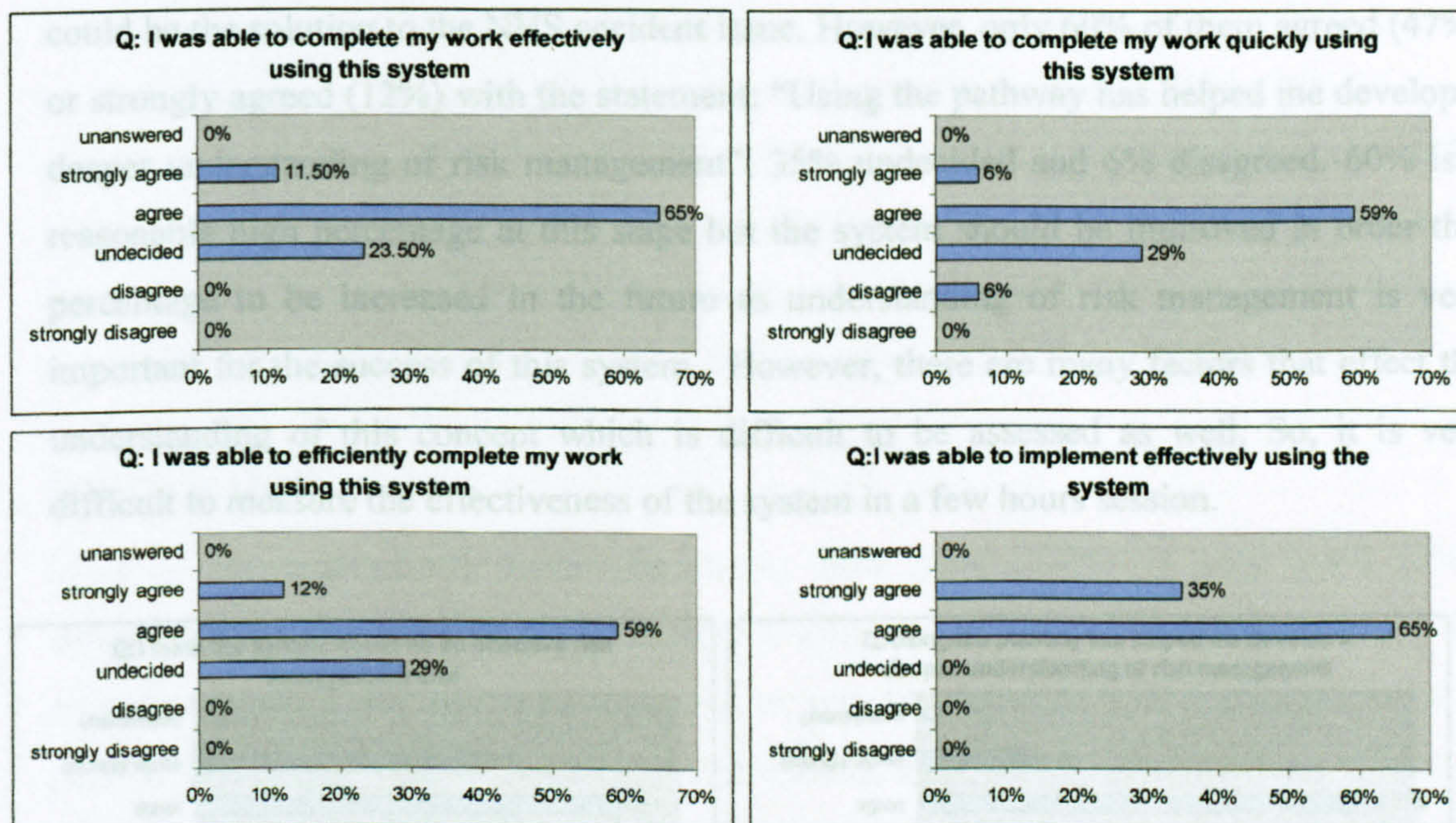


Figure 63: Users were able to complete their work effectively, efficiently, and fast with comfort

All respondents found the information provided by the system easy to understand. However, only 88% found the information effective in helping them to complete the action plan, 12% were not sure but at least they did not disagree. 100% of the respondents found the overall look of the system pleasant. Furthermore, 88% of them agreed that the system's page load was loaded quickly. The system's speed is based on the network (internet connection) speed and the hardware's specifications. The day when the session took place the network provided a top speed and the hardware's specifications were average. Obviously the findings of this evaluation about the system's speed were better in comparison to the results of the previous evaluation (prototype product) because the speed of the network connection was better.

Most of the respondents agreed or strongly agreed that the system could be an effective risk management tool and that the system will be a useful tool for learning about and managing risks in their work environment. There are also 12% of them, which were not decided. These results prove that this project produced a risk management tool which could be the solution to the NHS accident issue. However, only 60% of them agreed (47%) or strongly agreed (12%) with the statement: "Using the pathway has helped me develop a deeper understanding of risk management", 35% undecided and 6% disagreed. 60% is a reasonable high percentage at this stage but the system should be improved in order this percentage to be increased in the future as understanding of risk management is very important for the success of this system. However, there are many factors that effect the understanding of this concept which is difficult to be assessed as well. So, it is very difficult to measure the effectiveness of the system in a few hours session.

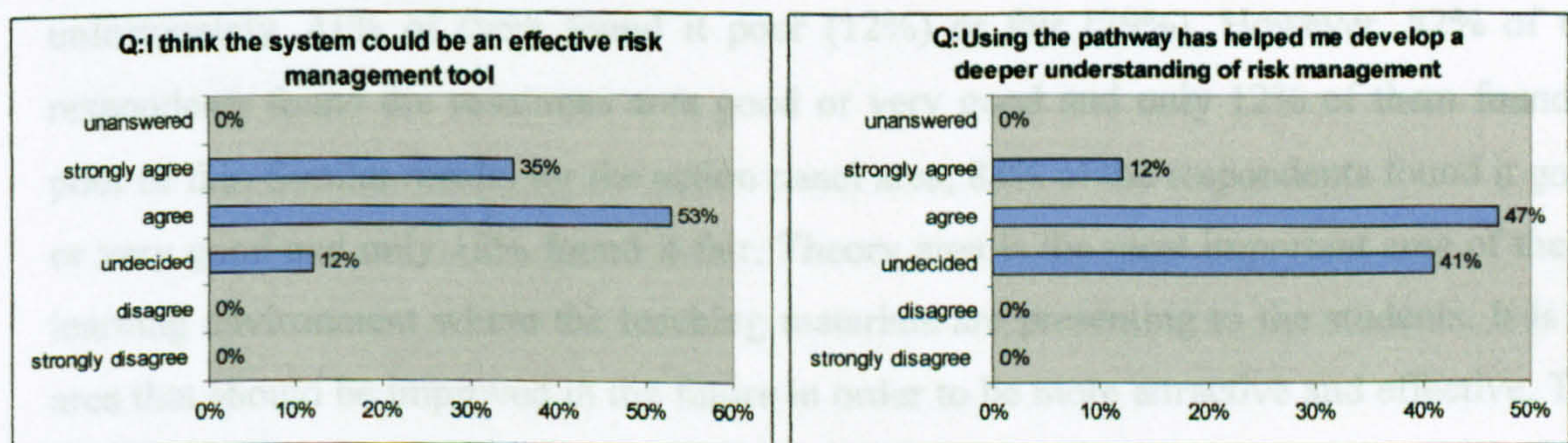


Figure 64: Effective risk management tool with a pleasant look

94% of the respondents found the system's error messages useful (88% agreed and 6% strongly agreed) and 88% of them found the information (such as online help, on-line screen messages, and other documentation) provided with the system clear. However, only 82% of the respondents recovered easily and quickly whenever they made a mistake using the system, 18% answered undecided and 0% did not recover whenever they made a mistake, or they recovered with difficulties. Clearly, based on these results, "risk-e" has been improved since the last evaluation, where only 62% of the respondents recovered easily and quickly whenever they made a mistake using the system. Furthermore, most of the respondents found the organization of information on the system screens clear and they

agreed or strongly agreed that the system has all the functions and capabilities they would expect it to have.

Respondents have been asked for their opinion about the benefit of using “risk-e” and the results were very positive. 94% of them agreed or strongly agreed with the benefit of having access to risk management theory and access to resources. Also, 88% of them agreed or strongly agreed with the benefit of having access to the online library and 100% of them agreed or strongly agreed with the 24/7 operation of the system. These results show that the system can be very beneficial in the future and it can provide an effective service. Finally, most of the respondents (88%) were overall satisfied with the system.

### Specific facilities

Most of the respondents found the theory area good (53%) or very good (6%), unfortunately, 41% of them found it poor (12%) or fair (29%). However, 82% of the respondents found the resources area good or very good and only 12% of them found it poor or fair. Similar results for the action panel area, 88% of the respondents found it good or very good and only 12% found it fair. Theory area is the most important area of the e-learning environment where the teaching materials are presenting to the students. It is an area that should be improved in the future in order to be more attractive and effective. The findings show that the respondents were very satisfied with the monitoring panel, online library, announcements board and profile management facilities. More than 90% of the respondents found these facilities good or very good. On the other hand, only 64% of the respondents found the calendar facility good (59%) or very good (6%) and 45% found it poor (12%) or fair (23%). Similar results for the e-mail facility; only 71% of the respondents found the e-mail system good (65%) or very good (6%) and 29% found it fair. Clearly the system provides each user with a list of appropriate advanced tools that help them to perform their tasks based on their role in the system. Furthermore, these findings prove that the successful development of these tools with high level of usability and efficiency.



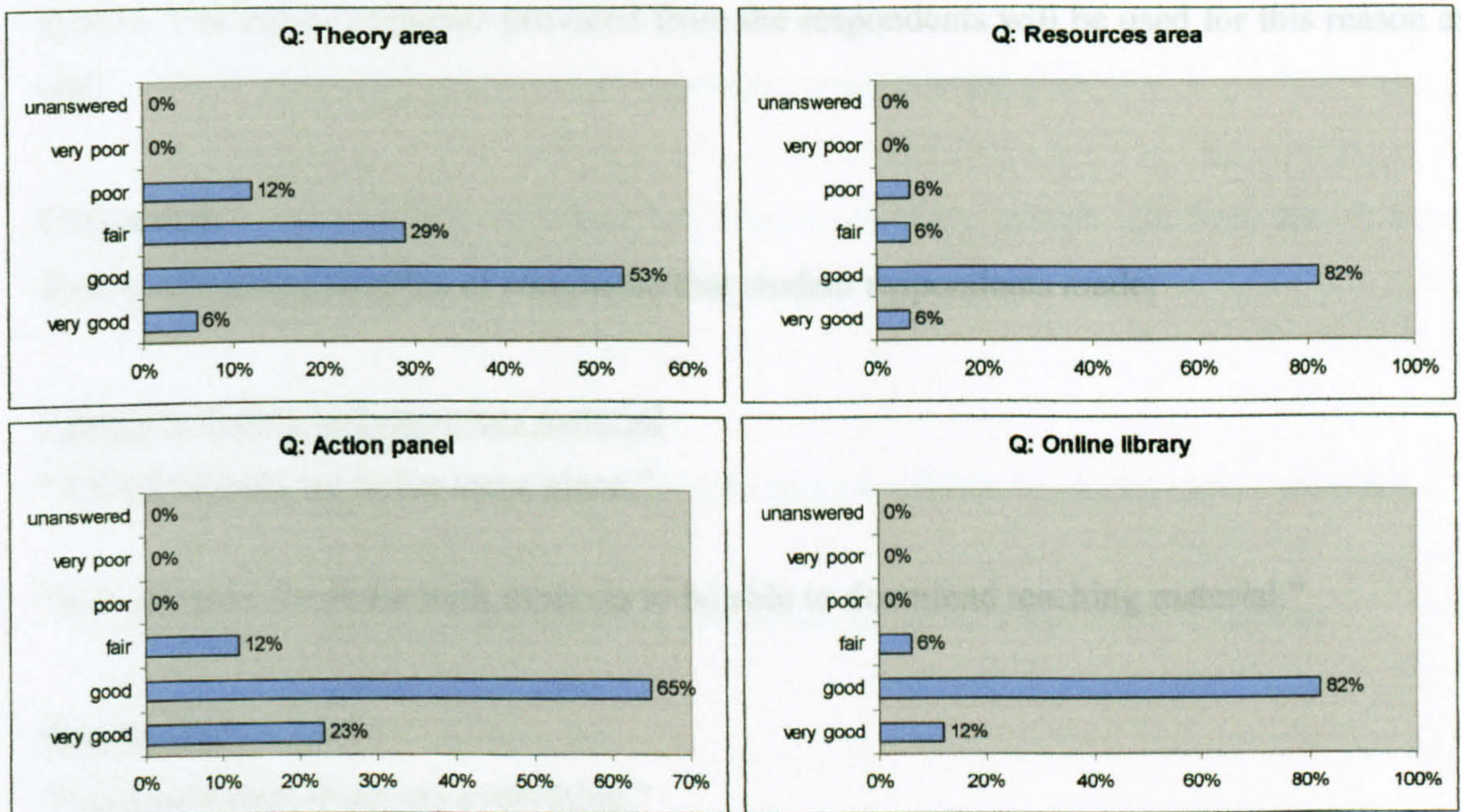


Figure 65: System facilities

### System interface

82% of the respondents generally found the system ease to use. However, only 76% of the respondents found system's page instructions and online help good or very good; 24% of them found it fair or poor. Furthermore, an impressive 94% of the respondents found the overall visual design/layout, the general flexibility and the system's interface error messages good or very good. Visual design and layout are very important for the usability of the system and it is directly related with the effectiveness of the e-learning environment. This percentage shows that the system's visual design/layout has dramatically improved since the last evaluation (prototype product). Only 62.5% of the respondents found the system's visual design/layout good or very good in the prototype product evaluation. Finally, all of the respondents found the task layout / task flow (e.g. action panel) good (82%) or very good (18%).

Overall the findings of the questionnaires helped the identification of the problematic system areas that need improvements, based on potential student's experience. These set of findings can be used in the future in order to start a new SDLC process, where the requirements will be reviewed and the pilot system will be transformed into a commercial

system. The extra comments provided from the respondents will be used for this reason as well.

### **Comments**

Below are some examples of comments that student respondents made:

#### Access to theory and resources material

“All documents are in the same place.”

“It is essential for those with dyslexia to be able to download teaching material.”

#### Easy to use

“It is really easy to access everything.”

“It is easy to use the system if you understand the whole philosophy.”

#### Flexible access (anything, anywhere)

“risk-e is a great way to access a vast amount of information about risk management and to create proper action plans for risks in the organisation at any time. It also means I can check what is going on from home, which is a vital plus for reading, planning and revision.”

#### Communications and discussions

“It is a good way to communicate with the system’s administrator and with the instructors but definitely it will be an extra benefit to have the ability to share risk reports and ideas with other users of the system.”

“Communication with other students could be better.”

### Better Organisation

“risk-e will help to organise my risk reports in a very familiar way.”

“risk-e calendar will help revising risk reports on time, which will help me to better organise my work.”

### Overall Effectiveness

“It makes learning more accessible and I feel more confident to identify and treat risks.

“I am feeling more confident to create risk action plans with this kind of support.”

## **8.5 Conclusions**

A new more advanced version of the “risk-e” software system has been developed based on the test and evaluation findings of the prototype. The experience from the prototype development life cycle has been used also in the pilot development life cycle stages. The same processes, best practices, methodologies, technologies and IT infrastructure have been applied for this development as for prototype development.

Functional and non-functional requirements are gathered by evaluating the prototype model system in a face-to-face session with eight WRP assessors. Based on their experience in the health care risk management field they evaluated the prototype of the “risk-e” system and they provided valuable information which has been transformed into a new list of requirement. The list of functional requirements describes a more complete functionality that WRP assessors (potential instructors) in NHS in Wales are expecting from an online learning risk management tool for health care professionals. The requirements have been analyzed and the improvements have been highlighted.

New system architecture has been created in order to support the new requirements. The new architecture, as the old one, conforms to the principles of interoperability, user-friendly interactivity and flexibility. The UML notation has been used and the new requirements has been translated and transformed into a number of diagrams which

describes the system functionality. The improvements and the additional functionality have been clearly highlighted into these diagrams. The most significant additional functionality is the creation of desktop environment with a list of tools for each user based on their role in the system. The user desktop account provides the users with a list of tools which will help them to perform organize and manage their tasks in the learning environment. It is a supportive layer to the e-learning area which has been built as a prototype system. This new functionality has been implemented based on e-learning standards and usability principles, as the prototype, in order to be used for e-content authoring and management but also to be accessible and usable from everyone. Furthermore, the same data store and security mechanism has been used to the pilot system as well.

At the end of the system's pilot model implementation all the systems' modules have been tested and all the encountered problems have been solved. The testing strategy which has been used to test the prototype model it has been used to test the pilot model of "risk-e" system as well. Accessibility and usability also has been tested by using a number of free tools, which are provided mainly by W3C.

Finally, the pilot model has been evaluated by potential students in a real environment. A quantitative method (questionnaires) was used to evaluate "risk-e". The findings of the pilot model's test and evaluation can be used for the implementation of the commercial product. The evaluation results are very positive and show that this system can be an effective risk management and it can be used as solution to the medical error issue in NHS. Furthermore, the research part of this chapter provides much useful information about how risk managers in the NHS in Wales (potential students) react on this innovation and what kind of functionality they are expecting from an application like this in their sector. These findings show that the system will be easily adapted from risk managers as they found this innovation very useful in their daily duties. Finally, the evaluation results highlight a number of significant improvements which transform the product into a commercial powerful risk management tool for health care professionals.

## **Chapter 9**

### **Conclusions**

#### **9.1 Summary**

Annual NHS clinical negligence expenditure is rising every year. The overarching NHS clinical governance strategy aims at a reduction in adverse incidents in the health service. However, adverse incidents in the health service continue to rise and in NHS hospitals these account for 10% of admissions (in excess of 850,000 per year) and cost an estimated £2 billion in additional hospital stays alone. The adverse incidents in the health service became one of the biggest issues in the NHS as it damages its reputation and it also costs millions of pounds every year.

The aim of this work was to develop an appropriate and advantageous solution for the NHS to reduce the frequency of adverse incidents in hospitals. A solution that will help NHS staff to gain deep learning about risk management with minimal distraction from their daily duties. The work also aimed to identify an appropriate educational platform and pedagogy which will support this solution. The research addressed the complexity and multidimensional nature of the risk management e-learning development approach in the health care environment. Throughout the research a deeper understanding of variety of concepts and aspects in different fields has been gained. The research has been carried to meet a number of objectives of the research.

Firstly, the work provided information about the medical errors in NHS, which cost money to the NHS, damage its reputation and, in some cases, cost human lives. Most of the errors are human mistakes and, based on the statistical figures, the number of accidents in the NHS dramatically increased over the last 10 years. The study also provides information about the size of the NHS, history of the NHS and the main aim for the NHS existence in order to emphasize the difficulties of any action (research, evaluation, etc) in the organization against problems, the importance of these problems and the need of an immediate effective solution. This was the reason that the research focus on the NHS in

Wales which is a reasonable size in comparison with NHS in England, Scotland and Northern Ireland.

The study argued that there are a number of ways to overcome human error and the importance of constant evaluation of tasks to identify and manage risks. In 1995 clinical risk management had been the essential prerequisite, for each health authority and NHS Trust to adopt, in reducing incidents in hospitals. The study provides an overview of risk management in the NHS in order to make the way that the risk management subject is applied in the NHS more understandable. It provides a risk management strategy general model based on the evaluation of 40 different risk management strategies of 40 different NHS Trusts in the UK. It also describes the whole risk management process and the risk assessment tools that could be used in order to manage risks. The risk management process is based on the Australian and New Zealand Risk Management Standard because it is recognized as international best practice with regard to risk management. The effectiveness of this process is strongly related with the level of knowledge on risk management subject and based on the research of this study NHS knowledge level on this subject is very low. Furthermore, the study provides information about the other two solutions that have been used from the NHS in order to solve the problems with the accidents in hospitals; the design of WRP self-insurance scheme and the use of risk management software applications. Based on the latest statistics, both of them did not have the expected results because both of them do not provide the users with the appropriate knowledge on risk management.

A unique software application was developed during this study, based on a development methodology and a customized software development life cycle model. The system is a combination of web based e-learning and database management tool. The system provides the educational material and the tools that students need in order to manage the database, where risk action plans will be saved.

The student as a user of the system has to follow 6 steps in order to report a risk in his organization. During each step the student will add the proper information to the risk

action plans. Each step provides the students with educational materials, resources, examples, exercises and the database management tools. The student has to read the educational materials for each step and based on them he/she will add the proper information to the action plan using the management tools.

This pedagogy strategy is a combination of individual learning, case study learning and problem based learning. Moreover, it blends theory and practice, which is one of the most effective learning ways for most people, especially in risk management. This strategy will help the NHS staff to gain deeper knowledge and understanding on risk management by practicing in real working environment with minimal distraction of their duties.

Two products of the system have been developed during this study; the prototype product and the pilot product. Both of them have been tested based on the testing strategy, testing process and testing technique that have been identified for this study. WRP assessors have participated in the product testing in order for the system's requirements to firstly be confirmed and accepted, and secondly for useful information to be collected, where they used the system as instructors. NHS risk managers have participated in the pilot product testing in order for important and useful information to be collected from a real time situation. A face-to-face session was used for both evaluations, where the participants had the opportunity to use the software for 5 hours and participate to the research by filling in a number of questionnaires. The findings for both evaluations helped the development of the software to follow the correct direction and effective software application has been developed. Furthermore, the whole study is giving a huge range of subjects for future development and research.

## **9.2 Implications of the Findings**

There are several implications of the findings of this study. It provides information about relative topic areas that could be combined in order to produce solutions for the current issues in NHS. The study also creates a software development environment including

methodologies, strategies, technologies and models that could be a framework for future software development in the NHS.

Annual NHS clinical negligence expenditure was just £1 million in 1974-75 (£6.33 million at 2002 prices). This figure rose to £446 million in 2001-02 only in England. Based on these figures, coming from the NHSLA (NHS Litigation Authority), responsible for the negligence claims made against NHS bodies in England, NHSLA dealt with nearly 7,000 claims for clinical negligence in 2002/2003. Similar is the situation with NHS in Wales. The annual cost of clinical negligence to the NHS in Wales is considerable and rising. In 1999-2000 total cash payments made by the NHS in Wales on clinical negligence cases were £26.9 million, an increase of 42 per cent compared with the previous year (Bourn, 2001).

Based on the last statistical figures, the NHS tried to solve the issue with many different solutions, which unfortunately did not have the expected results. NHS staff, especially employees with many years experience in NHS, are not positive towards a potential new solution to be applied in the NHS, which will affect the organisation's culture. The study provides NHS organisation with a developed and tested risk management software application, called "risk-e", which is a web based online learning platform with database management facilities, supported by a provided pedagogy. The implication of this software application development, and especially its promotion in the NHS, will kick off a sequence of reactions in the organisation. These negative reactions can create a negative environment for the risk-e application, which will affect its adaptation from the NHS or even the decision for ethical approval of further research and system's testing in the NHS.

The in-depth analysis during each stage of the SDLC that has been used for this development, revealed issues that have not been widely discussed in the literature – thus being another contribution to the literature. Some of these issues include how the type of workforce complicates issues of access and willingness to learn (for example, volunteers); how the type of job or the amount of daily duties can be a major barrier to e-learning; how



learner readiness problems can be minimised by requiring them to do some e-learning and providing support mechanisms so that they can become more comfortable, willing, and skilled in using computers; how NHS environment can adopt another “solution” for this issue; and does the use of this software application effect the organisation culture.

In the end, it is important to know that the effectiveness of an e-learning system is based on the effectiveness level of different components of it; software application (technology), resources, mode of delivery, context, learners and support (instructors). Furthermore, the design and planning plays vital role to the effectiveness level for all the above components. The implementation of a well designed and effective software application to support e-learning environment does not ensure learning success. It is just one component of an overall complex process (Rosenberg, 2001).

### **9.3 Scope and Limitations of the Research**

Several methodological and conceptual limitations have been identified with this study. The first limitation is regarding the size of various groups that were used for this study.

First, a group of three people with significant experience in this field participated in the process of gathering the requirements for the system. Although this could be classed as a small sample set, the information they provided was valuable to generate the requirements. Furthermore, it is extremely difficult to practically arrange meetings with these people, and having more people involved may have generated more conflicting requirements that may have inhibited the study rather than enhance the work.

Second, the work used eight WRP assessors to evaluate the prototype evaluation. The contribution from these eight assessors was extremely valuable and necessary for the completion of the project. The use of eight assessors represents the majority of assessors in Wales, thus it does provide an appropriate representation. However, this can be considered a small sample size considering the whole of the. In addition, the use of those assessors solely in Wales could be discussed as being un-representational. On the one hand, these

assessors may have specific knowledge and apply Wales specific criteria to this evaluation, and consequently the information may be viewed as not being an appropriate sample, and that the results need to be viewed in this light. However, on the other hand the assessors should be professional, and thus assessors whether from Wales, England, or any part of the UK should have similar skills, knowledge and experience, and would make professional judgements wherever they are; consequently by choosing assessors solely from Wales would not have a detrimental effect on the results, and as such the information can be used and expanded to other areas or countries.

Finally, the sample size of the participants in the pilot product evaluation phase consisted of 15 NHS staff and 2 e-learning experts. Again, the use of 15 staff is comparable to with the number of risk managers in NHS in Wales but perhaps, again, this is a very small subset of people in comparison with the NHS staff in Wales, who are relating daily with risk management issues. Thus, if this tool was to be used in daily activities then further research and validation would be required to confirm and re-affirm the results of this thesis.

Another limitation is with the background and related research. For security reasons only NHS staff have access to the DATIX and Safeguard software applications. Thus, this project had limited access to risk management software applications (DATIX & Safeguard), which are already used by NHS. So their evaluation is based on the information, which has been collected from their official web sites and the NHS staff who already used the applications.

As with any PhD thesis, time is a limiting factor. Time limitation applies to the choice of research instruments in the prototype and pilot product evaluation phases. Interviews with more people relate to risk management in NHS in various positions and with different responsibilities would have resulted in a more holistic view of the evaluation but time constraints were the limiting reason to this.

One overall limitation of choosing a combination of qualitative and quantitative, exploratory research design for this study, is that findings may not be generalised to a larger population of organisations. However, the aim has not been to generalise, but mainly to develop an effective risk management software application, which will be help to reduce accidents in hospitals and to explore some factors that NHS or researchers may want to research further or even assess them.

Finally, another serious limitation was the geographic location of NHS staff in relation with risk management combined with their time limits and budget. More testing sessions could be organised online or offline if the above limitations could be managed. As a result of that, more testing results would be explored, which would help the quality of the system to be improved as well as its effectiveness.

#### **9.4 Recommendations for Future Research**

“risk-e”, risk management pathway software application, is a bespoke software for the NHS, in order to deal with the accidents in hospitals issue. At the end of this study and after a lot of research, planning and developing, a pilot software product has been implemented. The very next step will be the transformation of that pilot product into a commercial one and this study provides a completed preparation for that process, based on the SDCL model that has been created during the study. Of course work remains to be done, and all these procedures have to be reviewed and more research and testing should occur. This study can definitely be called as a “blue sky” because it can be implemented in the future following many different directions based on new aims, and more new or old technologies can come on board to support the new implementations. Some of these directions will be discussed later in this section.

Many different and interesting subjects are involved in this study. Some of them relate with technology other with strategies and other with methodologies. All of them have been discussed and analysed during this study in order for useful information to be retrieved and used for the study. Undeniably, there is much more to be explored about those subjects during a separate individual deeper research of each of them which could

support the future implementation of the “risk-e” system. For example, a further research about risk management in NHS sounds a very interesting subject and the findings could positively or negatively affect the structure or methods of the NHS as an organisation. Other subjects for research could be e-learning effectiveness, e-learning readiness, software accessibility/usability and one million other subjects relating with the NHS or with the current study. Furthermore, the “risk-e” future implementations, which are discussed earlier, can provide many subjects for research and the findings will be a useful part of the implementations. Some of these subjects could be:

Compatibility with existed software systems in NHS. NHS invested and still is investing reasonable amount of money on new IT systems. It invested on risk management software systems, such as DATIX and Safeguard System from Ulysses. Many Trusts around the UK are already using those two software applications and massive databases with very sensitive, important and useful data have been built. Access to those databases will definitely be beneficial for the users of the “risk-e” software application and for the whole NHS. Further research about the existed IT systems on NHS will provide useful information about their functionality. This information will help the development of a software solution in order the “risk-e” system to interact with the existed IT systems in the NHS. Finally, this additional “risk-e” system functionality will be another reason for success in NHS environment.

Extension to other sectors. The use of pathways in other sectors, such as social care or sectors related to risk management is a big area for research. There is evidence that similar pathway processes are used in different sectors on different subjects. Furthermore, e-learning can be applied in any sector by providing the appropriate information with effective pedagogy. So, “risk-e” system could easily be used, with the appropriate changes, in other sectors.

Evaluation of Design Guidelines. In May 2007, World Web Consortium (W3C) published the new version of Web Content Accessibility Guidelines 2.0 (WCAG 2.0) (WCAG 2.0). The latest recommended accessibility guidelines could improve the design of “risk-e”

application or even the system's effectiveness. An evaluation and further research on the software design guidelines is an area that could provide very significant and valuable results for the future implementation and improvement of the "risk-e" system.

## **9.5 Future Implementation – Extensibility**

As it mentioned earlier the study can definitely be called as a "blue sky" because it can be implemented in the future following many different directions. Some future implementation of the "risk-e" system could be:

### *Automated pathways implementation*

The term "pathway" is very practical in the NHS. It is used in many areas in healthcare and it is very useful in the healthcare sector, as many processes are described as a sequence. For example the clinical care pathway, which is a documented sequence of effective clinical interventions. There is also national patient pathway, integrated care pathway, medicine care pathway etc.

The current version of "risk-e" software application can be used as a prototype and a bigger environment can be built around it. A sophisticated algorithm can be implemented, which will give the ability to the users to create their own pathway(s). It can be applied to any content, any organisation, in any sector. It should be an extremely flexible software; the user will have the ability to choose the number of steps, the study materials, the resources and the actions for the pathway. The system should provide a very friendly and easy to use environment; the user could, with a few clicks, give his/her preferences in the system and the system will automatically develop the personalised pathway environment. Most of the tools and information that will be needed for this implementation has already been discussed and provided in this study. Of course some areas should still be researched in order for goals and targets to be identified.

### Resolution Centre

Based on statistics and daily evidence of accidents in the NHS, it is obviously that lessons are not always learnt from incidents in hospitals. This means that the same mistakes are made more than once. An online resolution centre that can provide solutions about risk treatment based on real evidence will be a huge benefit for the NHS. The system could transform user's risk reports (action plans), which are used successfully to treat a specific risk, into a case study (issue-solution), which will be uploaded in the resolution centre under a specific category. The centre will be created based on the experience of thousands of hospital employees linked to the system. Of course the requirements of that implementation should be very carefully discussed before the implementation and subjects such as security, ethics, accuracy etc should be studied and analysed.

### Online risk management assessment centre

The incorporation of WRP standards can be another future implementation for the risk-e software application. The system will be an online risk assessment environment for the use of the WRP and the Trusts in Wales. Of course that can only be the beginning, in the future, the system can be used from the NHSLA and the Trusts in England. The Trust could create the portfolio of evidence about risk management online based on the WRP standards, which will be provided online as well. It could also submit it online and the WRP assessors could run the whole assessment process online, where they could provide feedback to the Trust. An implementation like that will give speed, flexibility and automation to the current assessment process and it will save quite a reasonable amount of money to the WRP.

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## Appendix 1 - Questionnaires

### Pre-questionnaire for the system's Instructors

#### IT (pre-questionnaire)

##### Computing expertise

1. How often do you use desktop or laptop computers?  
(If you answer "Never" to this question, go to question 3).

- Never
- A few times a month or less
- Once a week
- Every day or two
- Several times a day

2. Where do you have access to a computer? (Please tick as many as apply)

- No computer access
- Work
- Home
- Work and home
- Library
- Community centre
- Other, please specify

.....

3. How would you rate your current computer skills?

- Very poor
- Poor
- Fair
- Good
- Very Good

**Please indicate how much you agree or disagree with the following statements.**

- |  |                   |   |   |   |   |   |                |     |
|--|-------------------|---|---|---|---|---|----------------|-----|
| 4. I am very confident that I can learn how to use computers | Strongly disagree | 1 | 2 | 3 | 4 | 5 | Strongly agree | N/A |
| 5. I am very confident that I can improve my computer skills | Strongly disagree | 1 | 2 | 3 | 4 | 5 | Strongly agree | N/A |

#### Internet

6. How often do you use the Internet / World Wide Web?

- Never
- A few times a month or less
- Once a week
- Every day or two
- Several times a day

7. How would you rate your current Internet or Web skills?

- Very poor
- Poor
- Fair
- Good
- Very Good

8. How much do you use the Internet to get information to support your work?

- Never
- A few times a month or less
- Once a week
- Every day or two
- Several times a day

**Software**

9. Overall how would you rate your experience of using the following software

	<b>Excellent</b>	<b>Good</b>	<b>Average</b>	<b>Some</b>	<b>Never used</b>
<b>Microsoft Word</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>Microsoft Excel</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>Any Presentation software (e.g. Microsoft Powerpoint)</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>Any Desktop publishing software (e.g. Pagemaker, Quark, etc.)</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>Any Database software (e.g. Microsoft Access)</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>Any e-Mail system (e.g. Microsoft Outlook, Outlook Express, or Eudora)</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>Using Windows 2000/NT/XP Operating System</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**E-learning Background Info**

When we speak of e-learning we mean learning supported through the use of computers

10. Do you think e-learning can be an effective method of learning?

- Yes
- No

Please provide reasons for your answer

11. Have you ever used any of the following before? (please tick as many as apply)

- Computer-based training (CBT)
- Educational CD-ROMs
- Online learning / e-learning
- Training / educational websites
- Online bulletin boards / discussion forums
- None of the above

**(If you answered 'None of the above', please skip to question 19)**

12. Which best describes your involvement with e-learning (Please tick as many as apply)

- student
- lecturer (using materials prepared by others)
- lecturer and producer of e-learning materials
- e-learning developer
- e-learning adviser
- manager of e-learning within your institution
- other

13. Which e-learning platform did you use or do you currently use (Please tick as many as apply)

- Blackboard
- Lotus LearningSpace
- Granada Learnwise
- WebCT Campus Edition
- WebCT Vista
- FirstClass
- Moodle
- other Virtual Learning Environment (VLE), please specify: \_\_\_\_\_
- Websites, please specify: \_\_\_\_\_
- Bulletin boards, please specify: \_\_\_\_\_
- Other, please specify: \_\_\_\_\_

14. Was e-learning an effective way for you to learn?

- Yes
- No

Please provide reasons for your answer

15. Was it positive or negative learning experience?

- Positive
- Negative

Please provide reasons for your answer

16. Did the knowledge you acquired through e-learning effect your

- Personal life
- Professional life
- Both
- None

**Please indicate how much you agree or disagree with the following statements.**

17. I am happy to use e-learning in the future	Strongly disagree	1	2	3	4	5	Strongly agree	N/A
18. I am very confident to use an e-learning tool for my work	Strongly disagree	1	2	3	4	5	Strongly agree	N/A

**Thank you for your time**

**Pre-questionnaire for the system's Students**

**IT (pre-questionnaire)**

**Computing expertise**

19. How often do you use desktop or laptop computers?  
(If you answer "Never" to this question, go to question 3).

- Never
- A few times a month or less
- Once a week
- Every day or two
- Several times a day

20. Where do you have access to a computer? (Please tick as many as apply)

- No computer access
- Work
- Home
- Work and home
- Library
- Community centre
- Other, please specify

.....

21. How would you rate your current computer skills?

- Very poor
- Poor
- Fair
- Good
- Very Good

**Please indicate how much you agree or disagree with the following statements.**

22. I am very confident that I can learn how to use computers	Strongly disagree	1	2	3	4	5	Strongly agree	N/A
23. I am very confident that I can improve my computer skills	Strongly disagree	1	2	3	4	5	Strongly agree	N/A

**Internet**

24. How often do you use the Internet / World Wide Web?

- Never
- A few times a month or less
- Once a week
- Every day or two
- Several times a day

25. How would you rate your current Internet or Web skills?

- Very poor
- Poor
- Fair
- Good
- Very Good

26. How much do you use the Internet to get information to support your work?

- Never
- A few times a month or less
- Once a week
- Every day or two
- Several times a day

**Software**

27. Overall how would you rate your experience of using the following software

	<b>Excellent</b>	<b>Good</b>	<b>Average</b>	<b>Some</b>	<b>Never used</b>
<b>Microsoft Word</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>Microsoft Excel</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>Any Presentation software (e.g. Microsoft Powerpoint)</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>Any Desktop publishing software (e.g. Pagemaker, Quark, etc.)</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>Any Database software (e.g. Microsoft Access)</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>Any e-Mail system (e.g. Microsoft Outlook, Outlook Express, or Eudora)</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<b>Using Windows 2000/NT/XP Operating System</b>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

**E-learning Background Info**

When we speak of e-learning we mean learning supported through the use of computers

28. Do you think e-learning can be an effective method of learning?

- Yes
- No

Please provide reasons for your answer

29. Have you ever used any of the following before? (please tick as many as apply)

- Computer-based training (CBT)
- Educational CD-ROMs
- Online learning / e-learning
- Training / educational websites
- Online bulletin boards / discussion forums
- None of the above

**(If you answered 'None of the above', please skip to question 19)**

30. Which best describes your involvement with e-learning (Please tick as many as apply)

- student
- lecturer (using materials prepared by others)
- lecturer and producer of e-learning materials
- e-learning developer
- e-learning adviser
- manager of e-learning within your institution
- other

31. Which e-learning platform did you use or do you currently use (Please tick as many as apply)

- Blackboard
- Lotus LearningSpace
- Granada Learnwise
- WebCT Campus Edition
- WebCT Vista
- FirstClass
- Moodle
- other Virtual Learning Environment (VLE), please specify: \_\_\_\_\_
- Websites, please specify: \_\_\_\_\_
- Bulletin boards, please specify: \_\_\_\_\_
- Other, please specify: \_\_\_\_\_

32. Was e-learning an effective way for you to learn?

- Yes
- No

Please provide reasons for your answer

33. Was it positive or negative learning experience?

- Positive
- Negative

Please provide reasons for your answer

34. Did the knowledge you acquired through e-learning effect your

- Personal life
- Professional life
- Both
- None

**Please indicate how much you agree or disagree with the following statements.**

35. I am happy to use e-learning in the future	Strongly disagree	1	2	3	4	5	Strongly agree	N/A
36. I am very confident to use an e-learning tool for my work	Strongly disagree	1	2	3	4	5	Strongly agree	N/A

**Thank you for your time**



**Post-questionnaire for the system's Instructors**

**IT (post-questionnaire)**

How many hours in total did you use the risk-e pathway? \_\_\_\_\_

**Please indicate how much you agree or disagree with the following statements in relating to the risk-e pathway.**

	Strongly disagree	←-----→			Strongly agree
	1	2	3	4	5
1. It was simple to use	1	2	3	4	5
2. I was able to complete my work effectively using this system	1	2	3	4	5
3. I was able to complete my work quickly using this system	1	2	3	4	5
4. I was able to efficiently complete my work using this system	1	2	3	4	5
5. I feel comfortable using this system	1	2	3	4	5
6. With further use I think I will become more productive using this system	1	2	3	4	5
7. I believe I became productive quickly using this system	1	2	3	4	5
8. I was able to implement effectively using the system	1	2	3	4	5
9. Overall the look of this system is pleasant	1	2	3	4	5
10. The pages load quickly	1	2	3	4	5
11. It was easy to use the system	1	2	3	4	5
12. I think the system could be an effective risk management tool	1	2	3	4	5
13. The system gives useful error messages	1	2	3	4	5
14. Whenever I make a mistake using the system, I recover easily and quickly	1	2	3	4	5

- |  |   |   |   |   |   |
|--|---|---|---|---|---|
| 15. The information (such as online help, on-line screen messages, and other documentation) provided with this system is clear | 1 | 2 | 3 | 4 | 5 |
| 16. It was easy to find the information I need in order to use the system effectively  | 1 | 2 | 3 | 4 | 5 |
| 17. The system provided me with clear navigation all the time  | 1 | 2 | 3 | 4 | 5 |
| 18. This system has all the functions and capabilities I would expect it to have   | 1 | 2 | 3 | 4 | 5 |
| 19. Overall, I am satisfied with this system   | 1 | 2 | 3 | 4 | 5 |

20. In general how would you rate the following technical design of the

System Facilities	Very Good	Good	Fair	Poor	Very Poor
Theory area					
Resources area					
Action panel					
Online Library Management					
Profile Management (e.g. change personal details, password)					
Pathway Contents Management					
E-mail					
Calendar					
Announcement Board					
User's Risk Reports Monitoring Panel					

System Interface	Very Good	Good	Fair	Poor	Very Poor
Overall visual design / layout					
Page instructions / Online help					
Error messages					
General ease of use					
General flexibility of the tool					

21. Please list the most **negative** aspect(s):

1

2

3

22. Please list the most **positive** aspect(s):

1

2

3

Additional comments

**Thank you for your time**

**Post-questionnaire for the system's Students**

**IT (post-questionnaire)**

How many hours in total did you use the risk-e pathway? \_\_\_\_\_

**Please indicate how much you agree or disagree with the following statements in relating to the risk-e pathway.**

	Strongly disagree	←-----→				Strongly agree
	1	2	3	4	5	
23. It was simple to use	1	2	3	4	5	
24. I was able to complete my work effectively using this system	1	2	3	4	5	
25. I was able to complete my work quickly using this system	1	2	3	4	5	
26. I was able to efficiently complete my work using this system	1	2	3	4	5	
27. I feel comfortable using this system	1	2	3	4	5	
28. With further use I think I will become more productive using this system	1	2	3	4	5	
29. It was easy to learn to use this system	1	2	3	4	5	
30. I believe I became productive quickly using this system	1	2	3	4	5	
31. The information provided by the system is easy to understand	1	2	3	4	5	
32. The information is effective in helping me complete the action plan	1	2	3	4	5	
33. I was able to implement effectively using the system	1	2	3	4	5	
34. Overall the look of this system is pleasant	1	2	3	4	5	
35. The pages load quickly	1	2	3	4	5	
36. It was easy to use the system	1	2	3	4	5	

37. I think the system could be an effective risk management tool	1	2	3	4	5
38. The system will be a useful tool for learning about and managing risks in my work environment	1	2	3	4	5
39. Using the pathway has helped me develop a deeper understanding of risk management	1	2	3	4	5
40. The system gives useful error messages	1	2	3	4	5
41. Whenever I make a mistake using the system, I recover easily and quickly	1	2	3	4	5
42. The information (such as online help, on-line screen messages, and other documentation) provided with this system is clear	1	2	3	4	5
43. It was easy to find the information I need in order to use the system effectively	1	2	3	4	5
44. The system provided me with clear navigation all the time	1	2	3	4	5
45. The organisation of information on the system screens is clear	1	2	3	4	5
46. This system has all the functions and capabilities I would expect it to have	1	2	3	4	5
47. Benefits of using pathway system are:					
i. Having access to risk management theory	1	2	3	4	5
ii. Access to resources	1	2	3	4	5
iii. Online library	1	2	3	4	5
iv. 24/7 operation	1	2	3	4	5
48. Overall, I am satisfied with this system	1	2	3	4	5

49. In general how would you rate the following technical design of the

System Facilities	Very Good	Good	Fair	Poor	Very Poor
Theory area					
Resources area					
Action panel					
Online library					
Profile Management (e.g. change personal details, password)					
Calendar					
E-mail					
Monitoring panel					
Announcement Board					

System Interface	Very Good	Good	Fair	Poor	Very Poor
Overall visual design / layout					
Task layout / Task flow (e.g. action panel)					
Page instructions / Online help					
Error messages					
General ease of use					
General flexibility of the tool					

50. Please list the most **negative** aspect(s):

1

2

3

51. Please list the most **positive** aspect(s):

1

2

3

Additional comments

**Thank you for your time**

## Appendix 2

### Interview Explanatory Statement - Consent Form



## **risk-e**

### **“risk management pathway”**

### **e-learning tool for healthcare professionals**

The purpose of the interview is to gather functional and non-functional requirements in order to design and implement the “risk-e” system. The “risk-e” system will be a web based e-learning software application that tries to enhance an organisation’s ability to manage risk. The “risk-e” is intended for use by members of staff who have a role in managing risk of any nature.

1. I agree to be participated for the purposes of the project named above.
2. The purpose and nature of the project has been explained to me.
3. Any questions that I asked about the purpose and nature of the research have been answered to my satisfaction.
4. I have been ensured that the identities of all people who participate will remain anonymous and will be kept confidential.

Name of interviewee \_\_\_\_\_

Signature of interviewee \_\_\_\_\_

Date \_\_\_\_\_



## Appendix 3

### Explanatory statement for instructors and students



**risk-e**  
**“risk management pathway”**  
**e-learning tool for healthcare**  
**professionals**



The risk-e pathway is a prototype web based e-learning software application that tries to enhance an organisation's ability to manage risk. The “risk-e” is intended for use by members of staff who have a role in managing risk of any nature.

The objective of the “risk-e” is to develop the skills and provide the resources and guidance needed to manage all areas of risk in the work place. It draws on best practice, current legal and policy requirements and guidance issued by the relevant bodies.

It is not designed to be a prescriptive tool, deviations from the pathway are encouraged, should the user see an improved method to carry out their risk management.

Currently the “risk-e” is in its second phase of development, and we are tracking the pathway structure, its usefulness and acceptability. Changes will be made as a result of continuing research into both the literature surrounding best practice and the feedback we receive from the users.

It is imperative that no person using the “risk-e” system inputs confidential or sensitive data of any kind. It is designed for training purpose only and does not use a secure site for the storage of data. Hypothetical case studies and examples must be used for the inputting of data the action panel at all times.

Anyone using the system must agree to become involved in the research surrounding the development of the system. The “risk-e” pathway system is currently subject to copyright law.

Before you use the system you must agree to the above conditions.

I agree

.....

**Consent Form**

**risk-e**  
**“risk management pathway”**  
**e-learning tool for healthcare professionals**



1. I agree to be participated for the purposes of the project named above.
2. The purpose and nature of the project has been explained to me, and I have read the explanatory statement as provided.
3. Any questions that I asked about the purpose and nature of the research have been answered to my satisfaction.
4. I have been ensured that the identities of all people who participate will remain anonymous and will be kept confidential.

Your participation in this research is voluntary. You are free to refuse to take part. You may refuse to answer any questions and may stop taking part in the study at any time.

I have read this consent form and the explanatory statement.

Name of participant \_\_\_\_\_

Signature of participant \_\_\_\_\_

Date \_\_\_\_\_

## Appendix 4 – Interviews Scripts

### Interview 1

**Q: Based on the last statistical figures, NHS is currently facing a serious issue of increasing number of accidents in the Trusts. What is your comment on that?**

Yes, that is true, the statistical figures every year shows that the number of accidents in NHS is increased since 1990 and that cost to NHS millions if not billions of pound now. As you know, WRP is responsible only for Trusts in Wales. WRP promotes and maintains high quality risk management using audit to measure compliance with WRP standards. The first year of WRP operation was very productive and promising as well. In the period 1999-00 NHS paid out near 26m and the period of 2000-01 (first year of WRP operation) NHS paid out near 10m. This is very significant for the NHS and the public health. An effective solution has to be found and it should be developed from the beginning because currently there are many corrective actions are applied but without significant results. I also believe that any solution will be difficult to be applied based on the size of the NHS and for this reason it should be applied in a small scale first. Of course, I am not expecting everything to be changed in a few days or months. Any significant change, as solution to this problem, will effect the culture of the organization and definitely we need years to see the real results.

**Q: There are no evidences that proofs the number of accidents reduction in the period 2000-01 (first year of WRP operation). Does the legal bill have been increased and that was the reason why the NHS paid out less?**

Of course the operation of a new organisation such WRP affected the whole procedure and delayed many cases which affected the legal bill. But the statistical figure of the period 2000-01 shows that the accidents reduced as well in the hospitals. Unfortunately, next year, 2001-02, the number of accidents has been increased again and it is continue to be increased every year since.

**Q: What do you think was the reason for that?**

We are not 100% sure by evaluating the assessment results of previous years, we found out that there are lack of risk management knowledge between people in NHS who are responsible of risks in NHS. This is also one of the reasons why we found inaccurate or lack of information on their portfolio during the assessments.

**Q: NHS is spending a lot of money for training programmes. Does NHS spend money for specific risk management training in order to deal with that issue?**

Currently, there is no training provision for healthcare risk management that has a traditional and virtual delivery anywhere in the UK. At the moment, education and training for staff in Wales is provided by external consultants (which are costly) on an ad hoc basis with no strategic quality assured provision available.

**Q: So, that is the main reason of your decision to create your own training strategy?**

WRP assessors discovered that most of NHS staff responsible for risk in Trust knows how to typical identify and report a risk. Also most of them know the Trust process for risks but unfortunately 85-90% of them do not know how to treat and manage risks in Trust in order to avoid accidents and that is the reason of the same accidents to be occurred.

**Q: Do you think e-learning could help WRP to develop and provide the proper services to NHS in order to reduce accidents in hospitals?**

We had a few discussion in the past with experts in the training field and we be aware for the e-learning benefits (and negatives) as solution for this issue. We strongly believe that e-learning could be a very strong potential solution for this issue. The most important is that e-learning is the cheapest solution and for an organisation such NHS with millions of employees the saving could be millions of pounds. The main concern is about the level of IT Knowledge of NHS employees and the cost (time, money, etc) for the improvement.

**Q: Do you have experience of be a member of any e-learning course as student or as tutor in the past?**

No, but I attend to a presentation of an e-learning software application and it was impressive. J. has been enrolled as student to an e-learning course in the past.

**Q: So, how do you imagine the WRP e-learning environment will work?**

The students have to fill in a risk report with relevant information about a risk that they identified in their organisation. That is part of the most risk management strategies in the Trust but also it is part of the WRP standards. So, I would like the system to teach them how to fill in this report with the correct, accurate, proper and most useful information about the risk. I would like also the system to provide the students with relevant information that will help them to gain more advanced knowledge about risk management and the same time they will be able to apply this knowledge during their work.

**Q: Do you like to apply an action learning approach to the system then?**

Exactly, I would like the students to learning by acting in real time under their real job conditions. I would like to see students (NHS employees) from one side learn and from the other side act based on the knowledge.

**Q: Is this approach risky for the current situation? I mean, how do you think to monitor and control the quality of the student's work? How WRP will monitor the effectiveness of the system?**

I assume that the instructors, WRP assessors with many years experience in the field of risk management in NHS, will have the ability to review the student's risk report and provide feedback.

**Q: I know that any information on the risk report is sensitive. Any security levels for the users in need?**

The risk reports will be part of the intellectual property of each Trust. Risk report could contain very restricted information. So, security matter is very important.

**Q: Do you believe that the system will improve the time for a risk report to be completed?**

I am not sure. I hope so. If the system could be able to fill in some parts of the risk report with accurate information, that will be a huge benefit. But at the moment my priority is firstly the completion of risk report with correct, accurate, proper and most useful information and secondly the NHS staff knowledge imprudent about risk management.

**Q: Who will be responsible for any additions or eliminations in a risk report?**

I guess the author of the risk report and the appropriate instructor will have access to appropriate report. But also I would like the system too keep track of the changes.

**Q: Will the instructors be able in case of an investigation for an accident to access the wanted report in order to find any restrictions/limitations/mistakes made from the particular student?**

Probably he/she should have access to a wanted report but with limitations. Otherwise people could change information at any time and for any purpose.

**Q: Does the student's risk reports will be available to other students?**

That could be a very good idea if the system could manage the access. I would like all the students have "read only" access to all risk reports but only in their department. I mean reports relevant to their roles and responsibilities. I believe it will be beneficial for the employees to use previous reports as experience.

**Q: I think the time is up and that was excellent information for me. It will help me to start the design and implementation of the first prototype version of the application. Just two last important questions. Can you provide me with a list of information which should be on a risk report? Do you want to participate on any of the prototype evaluation stages of the product?**

Yes of course to both questions. I can email you what kind of information a risk report should contain or even better, I can send you a copy (template) of an existing one including my comments. I love to participate and I look forward for that.

## **Interview 2**

**Q: Based on the last statistical figures, NHS is currently facing a serious issue of increasing number of accidents in the Trusts. What is your comment on that?**

Well, the issue of accidents in the Trusts is far too more complicate as many people are thinking. It is true that every year the number of accidents in the Trusts is higher than the previous year. It is also true that NHS in Wales or in UK if you prefer, is trying hard to deal with this issue but we need to take in account the size of NHS, as organization, and the huge number of people that it need to serve. It is not a doubt that this is a significant issue for the NHS which damages the NHS reputation, costs huge amount of money to NHS yearly and most important has big impact on public health. As I said NHS is a huge organization with many complicated processes including many people's participation. That makes the solution of this issue even harder. However, we have confidence on the risk management as a concept which can solve the problem or at least be part of the solution. As WRP, we have seen the risk management to improve the situation in some cases but we believe that we are far from significant changes and an effective solution which will reduce dramatically the accidents in the Trusts.

**Q: Do you think that maybe you need to start looking for potential solution by following different direction than risk management?**

No, definitely not. As I said risk management is the key for finding a successful solution for this issue. However, I think that we did not find the proper way to use it successfully in NHS and of course as a solution to this significant issue.

**Q: There are no evidences that proofs the number of accidents reduction in the period 2000-01 (first year of WRP operation). Does the legal bill have been increased and that was the reason why the NHS paid out less?**

2000-01 was the first year of WRP operation. We were facing many problems until the processes and procedures to be in place. I guess that caused delays to Litigation Authority but I can not be sure what else effected the legal bill in that period. However, the number of accidents reduced during this period but unfortunately increased again the following year. Definitely, the establishment of WRP and its role in NHS was looking promising in the beginning. Somewhere here I would like to make it clear that WRP has not been established as a solution of this issue. However, based on the current results the issue is still remaining but at least WRP implemented a strong basement which can be used as part of the solution for this issue.

**Q: What do you think was and still is the reason of the increasing number of accidents in NHS?**

We have strong evidences, from assessments, that lack of risk management knowledge in NHS is the main source of this issue. The main concern is that we identified lack of risk management knowledge to NHS key employees in risk management areas such as Trust risk manager.

**Q: But based on my research NHS is spending a lot of money for training programmes. Does NHS spend money for specific risk management training in order to deal with that issue?**

Training for staff in Wales is provided by external consultants and it is far too costly based on the organization's size. Furthermore, there is no training strategy in place and the training is provided on an ad hoc basis. Personal, I believe and I've seen that NHS employees are coming back from training and only the first days they are able to apply the knowledge that they gained from training. I guess that the many daily duties or the system which does not help the employees to totally adopt and use the new knowledge could be the reason for that. Of course it could be something else but apart of the reasons the result is remaining the same. For this reason WRP is looking to adopt a new training strategy which will involve a combination of learning and practice with the employees daily duties.

**Q: Do you think e-learning could help WRP to develop and provide the proper services to NHS in order to reduce accidents in hospitals?**

I am aware about e-learning benefits and I think that it is the best solution at the moment. At first it is cheap and it will help us to reduce the training cost. At second it is a very effective way to involve a combination of learning and practice with the employees daily duties. Finally I believe it is an attractive method and the employees will adopt it easily. The only concern is the employees IT knowledge background and the cost for improvements.

**Q: Do you have experience of be a member of any e-learning course as student or as tutor in the past?**

Yes, as a student. It was a very small course (4 days in total). It was a very good experience for me and I was surprised with the usability of the system. I have to admit that my IT skills are not the best. However, I found it very easy to use and to follow the training only.

**Q: So, how do you imagine the WRP e-learning environment will work?**

I believe that the system should be divided into 2 main areas; theory (with resources) and action. The first area will provide the student with knowledge and the second area will provide the student with tools to practice the theory. Using these two areas the students will fill in stages the risk report with relevant information about a risk that they identified in their organisation. So, the system will teach the students how to fill in properly a risk report and through this task the students will gain more advanced knowledge about risk management. I would like to see a system like that to be part of their daily duties. One important part of the system will be the risk report review stage where the system has to alert (organise) the review of the risk reports.

**Q: Do you like to apply an action learning approach to the system then?**

If what I've described before is called "action learning", then YES I would like to apply an action learning approach to the system. Or better I would like the system to be built based on this approach.

**Q: Is this approach risky for the current situation? I mean, how do you think to monitor and control the quality of the student's work? How WRP will monitor the effectiveness of the system?**

WRP experienced assessors will play the instructions role in the system. They can monitor and review the risk reports, they can provide help, instructions and support to the students based on their experience. I assume that the system will provide the instructors with feedback or communication facilities.

**Q: I know that any information on the risk report is sensitive. Any security levels for the users in need?**

Yes, that is correct. The risk reports will be part of the intellectual property of each Trust. Risk report contains information only specific people should be able to see them. Security is very important for WRP and NHS generally.

**Q: Do you believe that the system will improve the time for a risk report to be completed?**

It could be in due time. I don't care about the speed as much as I do care about the quality and accuracy of a risk report. Of course, speed will be an extra benefit but first thing first.

**Q: Who will be responsible for any additions or eliminations in a risk report?**

The person who created the risk report and proper instructor should have access to change the information on a risk report but I prefer the system to be able to track the changes.

**Q: Will the instructors be able in case of an investigation for an accident to access the wanted report in order to find any restrictions/limitations/mistakes made from the particular student?**

I think everyone should have "read only" access to any risk reports which is relevant with his/her responsibilities but maybe we have to identify limitations for activities like that.

**Q: I think the time is up and that was excellent information for me. It will help me to start the design and implementation of the first prototype version of the application. Just two last important questions. Can you provide me with a list of information which should be on a risk report? Do you want to participate on any of the prototype evaluation stages of the product?**

Yes I will ask from J. to help you with that. We have a current report template that we are using for our assessments and we recommend it to the Trusts. Of course I would like to participate. It will be a very good experience for me. I can help you, if you want, to organise a workshop with risk managers from Wales Trusts.



## Appendix 5

### Risk Report Layout

<b>Risk:</b>		<b>Area:</b>	
<b>Risk Lead:</b>		<b>Subsection:</b>	
<b>Acceptable risk?</b>		<b>Score:</b>	
<b>Controls</b>			
<b>Existing Controls</b>		<b>New Controls</b>	
<b>Plan - how am I going to effectively implement the changes?</b>			
<b>Actions to be taken:</b>		<b>Completion date</b>	<b>Lead person Reported to</b>
<p>If the activity selected is CANCEL, the user is returned to the main screen.</p> <p>If the activity selected is HELP, the S-2: Online Help window is performed.</p> <p><b>S-1: Save details</b></p> <p>The system saves the details to the main database and returns a proper message to the user. The use case ends.</p>			
<b>Barriers</b>			
<b>What may effect the ability to implement the changes you are planning the change you are planning</b>			
<b>Monitoring</b>			
<b>Monitoring, performance indicators:</b>		<b>Data</b>	<b>Completion date</b>
<b>L2 Main Flow</b> <p>The use case begins when the user selects the "Change Password" from the main menu on the administrator account. The system allows the administrator to change his/her password.</p> <p>The system prompts the user to select the desired activity: SAVE, RESET, CANCEL or HELP.</p>		<b>Lead person</b>	<b>Reported to</b>
<b>Reflections</b>			
<b>A diary of how the plan is progressing</b>			
<p>If the activity selected is CANCEL, returns to the main screen, the use case ends.</p> <p>If the activity selected is HELP, the S-2: Online Help window is performed.</p>			

## Appendix 6

### Flow of Events of Administrator

#### 1.0 Flow of Events for the “*Manage Profile*” Use Case

##### 1.1 Preconditions

The user should be login to the administrator account.

##### 1.2 Main Flow

The use case begins when the user selects the option “Profile” from the main menu on the administrator account. The system will display a screen with the user’s personal details.

The system prompts the user to select the desired activity: SAVE, RESET, CANCEL or HELP.

If the activity selected is SAVE, the S-1: Save the details to the system’s DB.

If the activity selected is RESET, clear the form.

If the activity selected is CANCEL, returns to the main screen, the use case ends.

If the activity selected is HELP, the S-2: Online Help subflow is performed.

##### 1.3 Subflows

###### S-1: Save details

The system saves the details to the main database and returns a proper message to the user. The use case ends.

###### S-2: Online Help

The Systems’ activates online help system. A new window appears on the screen with the online help information.

#### 2.0 Flow of Events for the “*Change Password*” Use Case

##### 2.1 Preconditions

The user should be login to the administrator account.

##### 2.2 Main Flow

The use case begins when the user selects the option “Password” from the main menu on the administrator account. The system allows the administrator to change his/her password.

The system prompts the user to select the desired activity: SAVE, RESET, CANCEL or HELP.

If the activity selected is SAVE, the S-1: Save the password to the system’s DB.

If the activity selected is RESET, clear the form.

If the activity selected is CANCEL, returns to the main screen, the use case ends.

If the activity selected is HELP, the S-2: Online Help subflow is performed.

## **2.3 Subflows**

### **S-1: Save New Password**

The system saves the new password to the main database and returns a proper message to the user. The use case ends.

### **S-2: Online Help**

The Systems' activates online help system. A new window appears on the screen with the online help information.

## **3.0 Flow of Events for the “*Manage Members*” Use Case**

### **3.1 Preconditions**

The user should be login to the administrator account.

### **3.2 Main Flow**

The use case begins when the user selects the option “Members” from the main menu on the administrator account. The system will display a screen with a list of the systems' members and some information about each of them. The system provide the administrator with a list of tools (add, delete, edit) in order to manage the members in that list.

## **4.0 Flow of Events for the “*Manage Library*” Use Case**

### **4.1 Preconditions**

The user should be login to the administrator account.

### **4.2 Main Flow**

The use case begins when the user selects the option “Library” from the main menu on the administrator account. The system will redirect the user to the library management environment where the user can find a number of tools (upload, edit, delete, organize etc) in order to manage the documents in the library for each area of the pathway.

## **5.0 Flow of Events for the “*Manage Announcement Board*” Use Case**

### **5.1 Preconditions**

The user should be login to the administrator account.

### **5.2 Main Flow**

The use case begins when the user selects the option “Announcement Board” from the main menu on the administrator account. The system will redirect the user to the Announcement Board management environment where the user can find a number of tools (send messages, delete messages, organize messages, etc) in order to manage the Announcement Board.

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## **6.0 Flow of Events for the “*Manage Contents*” Use Case**

### **6.1 Preconditions**

The user should be login to the administrator account.

### **6.2 Main Flow**

The use case begins when the user selects the option “Pathway Contents” from the main menu on the administrator account. The system will redirect the user to the pathway contents management environment where the user can find a number of tools (create, edit contents, organize, upload, publish, etc) in order to manage the contents in each area of the pathway.

## **7.0 Flow of Events for the “*Manage Help System*” Use Case**

### **7.1 Preconditions**

The user should be login to the administrator account.

### **7.2 Main Flow**

The use case begins when the user selects the option “Help Contents” from the main menu on the administrator account. The system will redirect the user to the help system contents management environment where the user can find a number of tool (create, edit contents, organize, upload, publish, etc) in order to manage the contents in the help system.

## **8.0 Flow of Events for the “*Provide Support*” Use Case**

### **8.1 Preconditions**

The user should be login to the administrator account and to the e-mail system.

### **8.2 Main Flow**

The use case begins when the user selects the option “E-mail” from the main menu on the administrator account. The system will redirect the user to a proper e-mail system where he/she can find basic tools in order to communicate with the system member and to provide support.

## **Flow of Events of Student**

### **1.0 Flow of Events for the “*Manage Profile*” Use Case**

#### **1.1 Preconditions**

The user should be login to the student account.

#### **1.2 Main Flow**

The use case begins when the user selects the option “Profile” from the main menu on the student account. The system will display a screen with the user’s personal details.

The system prompts the user to select the desired activity: SAVE, RESET, CANCEL or HELP.

If the activity selected is SAVE, the S-1: Save the details to the system’s DB.

If the activity selected is RESET, clear the form.

If the activity selected is CANCEL, returns to the main screen, the use case ends.

If the activity selected is HELP, the S-2: Online Help subflow is performed.

#### **1.3 Subflows**

##### **S-1: Save details**

The system saves the details to the main database and returns a proper message to the user. The use case ends.

##### **S-2: Online Help**

The Systems’ activates online help system. A new window appears on the screen with the online help information.

### **2.0 Flow of Events for the “*Change Password*” Use Case**

#### **2.1 Preconditions**

The user should be login to the student account.

#### **2.2 Main Flow**

The use case begins when the user selects the option “Password” from the main menu on the student account. The system allows the instructor to change his/her password.

The system prompts the user to select the desired activity: SAVE, RESET, CANCEL or HELP.

If the activity selected is SAVE, the S-1: Save the password to the system’s DB.

If the activity selected is RESET, clear the form.

If the activity selected is CANCEL, returns to the main screen, the use case ends.

If the activity selected is HELP, the S-2: Online Help subflow is performed.

## **2.3 Subflows**

### **S-1: Save New Password**

The system saves the new password to the main database and returns a proper message to the user. The use case ends.

### **S-2: Online Help**

The Systems' activates online help system. A new window appears on the screen with the online help information.

## **3.0 Flow of Events for the “*Monitor Risk Reports*” Use Case**

### **3.1 Preconditions**

The user should be login to the student account.

### **3.2 Main Flow**

The use case begins when the user selects the option “Monitoring Panel” from the main menu on the student account. The system will display a screen with a list of the user's areas (folders) and he/she will be able to explore them in order to view any risk report in the areas or subsection.

## **4.0 Flow of Events for the “*View Calendar*” Use Case**

### **4.1 Preconditions**

The user should be login to the student account.

### **4.2 Main Flow**

The use case begins when the user selects the option “Calendar” from the main menu on the student account. The system will redirect the user to the calendar area where the user can select a specific day and the system will display any available information for the selected day.

## **5.0 Flow of Events for the “*Pathway Activities*” Use Case**

### **5.1 Preconditions**

The user should be login to the student account.

### **5.2 Main Flow**

The use case begins when the user selects the option “Pathway” from the main menu on the student account. The system will redirect the user to the pathway (e-learning area).

## **6.0 Flow of Events for the “*Read Announcement Board*” Use Case**

### **6.1 Preconditions**

The user should be login to the student account..

### **6.2 Main Flow**

The use case begins when the user clicks on any of the displayed messages or on the “See all messages” of the announcement board. The selected message or a list of messages will be displayed on the screen.

## **7.0 Flow of Events for the “*Download Documents*” Use Case**

### **7.1 Preconditions**

The user should be login to the student account.

### **7.2 Main Flow**

The use case begins when the user selects the option “Library” from the main menu on the student account. The system will redirect the user to the library where the user can download any document for each area of the pathway or any other available document.

## **8.0 Flow of Events for the “*Communicate with members*” Use Case**

### **8.1 Preconditions**

The user should be login to the student account and to the e-mail system.

### **8.2 Main Flow**

The use case begins when the user selects the option “E-mail” from the main menu on the student account. The system will redirect the user to a proper e-mail system where he/she can find basic tools in order to communicate with other system’s member.

## **Flow of Events of Instructor**

### **1.0 Flow of Events for the “*Change Password*” Use Case**

#### **1.1 Preconditions**

The user should be login to the instructor account.

#### **1.2 Main Flow**

The use case begins when the user selects the option “Password” from the main menu on the instructor account. The system allows the instructor to change his/her password.

The system prompts the user to select the desired activity: SAVE, RESET, CANCEL or HELP.

If the activity selected is SAVE, the S-1: Save the password to the system’s DB.

If the activity selected is RESET, clear the form.

If the activity selected is CANCEL, returns to the main screen, the use case ends.

If the activity selected is HELP, the S-2: Online Help subflow is performed.

#### **1.3 Subflows**

S-1: Save New Password

The system saves the new password to the main database and returns a proper message to the user. The use case ends.

S-2: Online Help

The Systems’ activates online help system. A new window appears on the screen with the online help information.

### **2.0 Flow of Events for the “*Manage Profile*” Use Case**

#### **2.1 Preconditions**

The user should be login to the instructor account.

#### **2.2 Main Flow**

The use case begins when the user selects the option “Profile” from the main menu on the instructor account. The system will display a screen with the user’s personal details.

The system prompts the user to select the desired activity: SAVE, RESET, CANCEL or HELP.

If the activity selected is SAVE, the S-1: Save the details to the system’s DB.

If the activity selected is RESET, clear the form.

If the activity selected is CANCEL, returns to the main screen, the use case ends.

If the activity selected is HELP, the S-2: Online Help subflow is performed.

#### **2.3 Subflows**

S-1: Save details

The system saves the details to the main database and returns a proper message to the user. The use case ends.



**S-2: Online Help**

The Systems' activates online help system. A new window appears on the screen with the online help information.

**3.0 Flow of Events for the "View Student Risk Reports" Use Case****3.1 Preconditions**

The user should be login to the instructor account.

**3.2 Main Flow**

The use case begins when the user selects the option "Student's Risk Reports" from the main menu on the instructor account. The system will display a screen with a list of the systems' students and the instructor will have the ability to view the risk reports from any students in the list.

**4.0 Flow of Events for the "Communicate with Members" Use Case****4.1 Preconditions**

The user should be login to the instructor account and to the e-mail system.

**4.2 Main Flow**

The use case begins when the user selects the option "E-mail" from the main menu on the instructor account. The system will redirect the user to a proper e-mail system where he/she can find basic tools in order to communicate with the system member and to provide support. Instructors can also send messages to the announcement board using the email system.

**5.0 Flow of Events for the "Manage Library" Use Case****5.1 Preconditions**

The user should be login to the instructor account.

**5.2 Main Flow**

The use case begins when the user selects the option "Library" from the main menu on the instructor account. The system will redirect the user to the library management environment where the user can find a number of tools (upload, edit, delete, organize etc) in order to manage the documents in the library for each area of the pathway.

**6.0 Flow of Events for the "Manage Contents" Use Case****6.1 Preconditions**

The user should be login to the instructor account.

**6.2 Main Flow**

The use case begins when the user selects the option "Pathway Contents" from the main menu on the instructor account. The system will redirect the user to the pathway contents management environment where the user can find a number of tools (create, edit contents, organize, upload, publish, etc) in order to manage the contents in each area of the pathway.

## **7.0 Flow of Events for the “*Pathway Activities*” Use Case**

### **7.1 Preconditions**

The user should be login to the instructor account.

### **7.2 Main Flow**

The use case begins when the user selects the option “Pathway” from the main menu on the instructor account. The system will redirect the user to the pathway (e-learning area).

---

## **Flow of Events of Pathway Activities – Level 1**

### **1.0 Flow of Events for the “*View Theory*” Use Case**

#### **1.1 Preconditions**

The user should be login to the system as Instructor, Student or Visitor. The user should open the pathway environment (e-learning area).

#### **1.2 Main Flow**

The use case begins when the user selects the option “Pathway” from the main menu on the main account and the pathway environment will be opened. The use case also begins if the user selects the option “Theory”, one of the 3 tabs in any step of the pathway environment. Each time the user selects any step of the pathway, the theory of the selected step will be displayed first.

### **2.0 Flow of Events for the “*View Resources*” Use Case**

#### **2.1 Preconditions**

The user should be login to the system as Instructor, Student or Visitor. The user should open the pathway environment (e-learning area).

#### **2.2 Main Flow**

The use case begins when the user selects the option “Resources”, one of the 3 tabs in any step of the pathway environment.

### **3.0 Flow of Events for the “*Use Action Panel*” Use Case**

#### **3.1 Preconditions**

The user should be login to the system as Instructor, Student or Visitor. The user should open the pathway environment (e-learning area).

#### **3.2 Main Flow**

The use case begins when the user selects the option “Action Panel”, one of the 3 tabs in any step of the pathway environment.

---

## **Flow of Events of Pathway Activities – Level 2**

### **1.0 Flow of Events for the “*Manage Area*” Use Case**

#### **1.1 Preconditions**

The user should be login to the system as Instructor, Student or Visitor. The user should open the step 2 of the pathway environment (e-learning area).

#### **1.2 Main Flow**

The use case begins when the user selects the option “Action Panel”, one of the 3 tabs in step 2 of the pathway environment. The system will provide the user with a menu including the options create, modify and delete area.

### **2.0 Flow of Events for the “*Manage Subsection*” Use Case**

#### **2.1 Preconditions**

The user should be login to the system as Instructor, Student or Visitor. The user should open the step 2 of the pathway environment (e-learning area).

#### **2.2 Main Flow**

The use case begins when the user selects an area from the menu (load area) in the step 2 in the pathway. The system will provide the user with a menu including the options create, modify and delete subsection.

### **3.0 Flow of Events for the “*Manage Risk Report*” Use Case**

#### **3.1 Preconditions**

The user should be login to the system as Instructor, Student or Visitor. The user should open the step 2 of the pathway environment (e-learning area).

#### **3.2 Main Flow**

The use case begins when the user selects a subsection from the menu (load area) in the step 2 in the pathway. The system will provide the user with a menu including the options create, modify and delete risk report.

### **4.0 Flow of Events for the “*Load Risk Report*” Use Case**

#### **4.1 Preconditions**

The user should be login to the system as Instructor, Student or Visitor. The user should open the pathway environment (e-learning area).

#### **4.2 Main Flow**

The use case begins when the user selects a risk report from the load area of any step in the pathway. The selected risk report will be loaded to the system and the user will be able to work on the loaded risk report through all pathway steps.

## **5.0 Flow of Events for the “*Manage Leader*” Use Case**

### **5.1 Preconditions**

The user should be login to the system as Instructor, Student or Visitor. The user should open the step 3 of the pathway environment (e-learning area).

### **5.2 Main Flow**

The use case begins when the user load a risk report to the system from the step 3 or selects the step 3 but a risk report is already loaded to the system from the previous steps. The system will provide the user with a menu including the options add, edit and delete leader name.

## **6.0 Flow of Events for the “*Manage Score*” Use Case**

### **6.1 Preconditions**

The user should be login to the system as Instructor, Student or Visitor. The user should open the step 3 of the pathway environment (e-learning area).

### **6.2 Main Flow**

The use case begins when the user load a risk report to the system from the step 3 or selects the step 3 but a risk report is already loaded to the system from the previous steps. The system will provide the user with a menu including the options add, edit and delete score.

## **7.0 Flow of Events for the “*Manage Indicators*” Use Case**

### **7.1 Preconditions**

The user should be login to the system as Instructor, Student or Visitor. The user should open the step 5 of the pathway environment (e-learning area).

### **7.2 Main Flow**

The use case begins when the user load a risk report to the system from the step 5 or selects the step 5 but a risk report is already loaded to the system from the previous steps. The system will provide the user with a menu including the options add, edit and delete indicator.

## **8.0 Flow of Events for the “*Manage Controls*” Use Case**

### **8.1 Preconditions**

The user should be login to the system as Instructor, Student or Visitor. The user should open the step 3 of the pathway environment (e-learning area).

### **8.2 Main Flow**

The use case begins when the user load a risk report to the system from the step 3 or selects the step 3 but a risk report is already loaded to the system from the previous steps. The system will provide the user with a menu including the options add, edit and delete control.

## **9.0 Flow of Events for the “*Manage Acceptance*” Use Case**

### **9.1 Preconditions**

The user should be login to the system as Instructor, Student or Visitor. The user should open the step 3 of the pathway environment (e-learning area).

### **9.2 Main Flow**

The use case begins when the user load a risk report to the system from the step 3 or selects the step 3 but a risk report is already loaded to the system from the previous steps. The system will provide the user with a menu including the options add, edit and delete acceptance.

## **10.0 Flow of Events for the “*Manage Actions*” Use Case**

### **10.1 Preconditions**

The user should be login to the system as Instructor, Student or Visitor. The user should open the step 4 of the pathway environment (e-learning area).

### **10.2 Main Flow**

The use case begins when the user load a risk report to the system from the step 4 or selects the step 4 but a risk report is already loaded to the system from the previous steps. The system will provide the user with a menu including the options add, edit and delete action.

## **11.0 Flow of Events for the “*Manage New Controls*” Use Case**

### **11.1 Preconditions**

The user should be login to the system as Instructor, Student or Visitor. The user should open the step 4 of the pathway environment (e-learning area).

### **11.2 Main Flow**

The use case begins when the user load a risk report to the system from the step 4 or selects the step 4 but a risk report is already loaded to the system from the previous steps. The system will provide the user with a menu including the options add, edit and delete new control.

## **12.0 Flow of Events for the “*Manage Barriers*” Use Case**

### **12.1 Preconditions**

The user should be login to the system as Instructor, Student or Visitor. The user should open the step 5 of the pathway environment (e-learning area).

### **12.2 Main Flow**

The use case begins when the user load a risk report to the system from the step 5 or selects the step 5 but a risk report is already loaded to the system from the previous steps. The system will provide the user with a menu including the options add, edit and delete barrier.

### **13.0 Flow of Events for the “*Manage Reflections*” Use Case**

#### **13.1 Preconditions**

The user should be login to the system as Instructor, Student or Visitor. The user should open the step 6 of the pathway environment (e-learning area).

#### **13.2 Main Flow**

The use case begins when the user load a risk report to the system from the step 6 or selects the step 6 but a risk report is already loaded to the system from the previous steps. The system will provide the user with a menu including the options add, edit and delete reflection.

### **14.0 Flow of Events for the “*Print Risk Report*” Use Case**

#### **14.1 Preconditions**

The user should be login to the system as Instructor, Student or Visitor. The user should open the step 6 of the pathway environment (e-learning area).

#### **14.2 Main Flow**

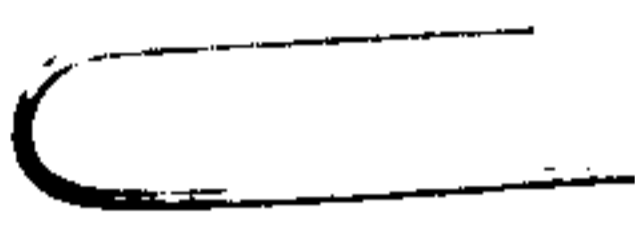
The use case begins when the user load a risk report to the system from the step 6 or selects the step 6 but a risk report is already loaded to the system from the previous steps. The system will provide the user with an option where the user can view the risk report and print it out.

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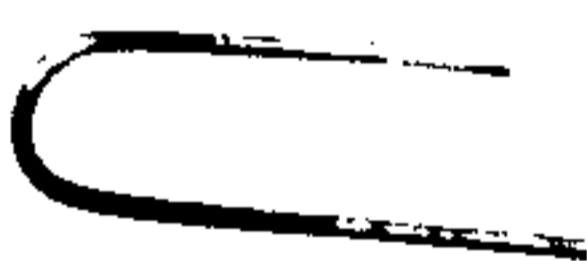
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**Appendix 7.4: Manage Members – Administrator Account**

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**Appendix 7.5: Manage Announcement Board – Administrator Account**

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**Appendix 7.6: Manage Pathway Contents – Administrator Account**

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**Appendix 7.7: Manage Library – Administrator Account**

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**Appendix 7.8: Manage Help Contents – Administrator Account**

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**Appendix 7.9: About risk-e Pathway**

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**Appendix 7.10: Students Risk Reports – Instructor Account**

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**Appendix 7.11: Calendar – Student Account**

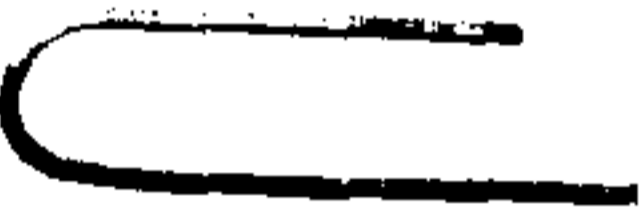
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**Appendix 7.12: Monitoring Panel – Student Account**

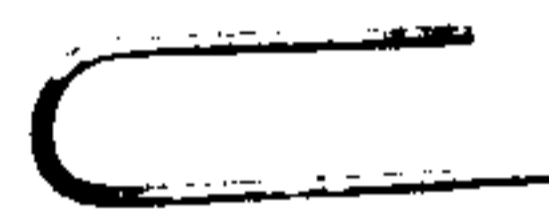
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**Appendix 7.13: Library – Student Account**

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**Appendix 7.14: Contact Us – Student Account**

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**Appendix 7.15: Help – Pathway (Step 2)**

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**Appendix 7.16: Action Panel Menu – Pathway (Step 2)**

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**Appendix 7.17: Action Panel Menu – Pathway (Step 3)**

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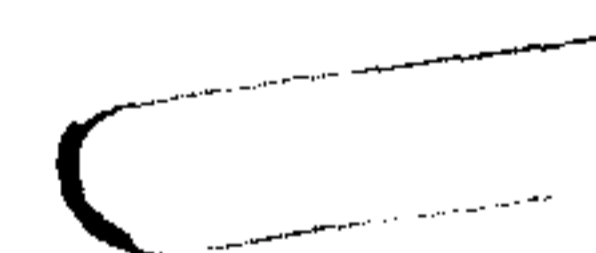
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**Appendix 7.18: Action Panel Menu – Pathway (Step 4)**

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**Appendix 7.19: Action Panel Menu – Pathway (Step 5)**

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**Appendix 7.20: Action Panel Menu – Pathway (Step 6)**

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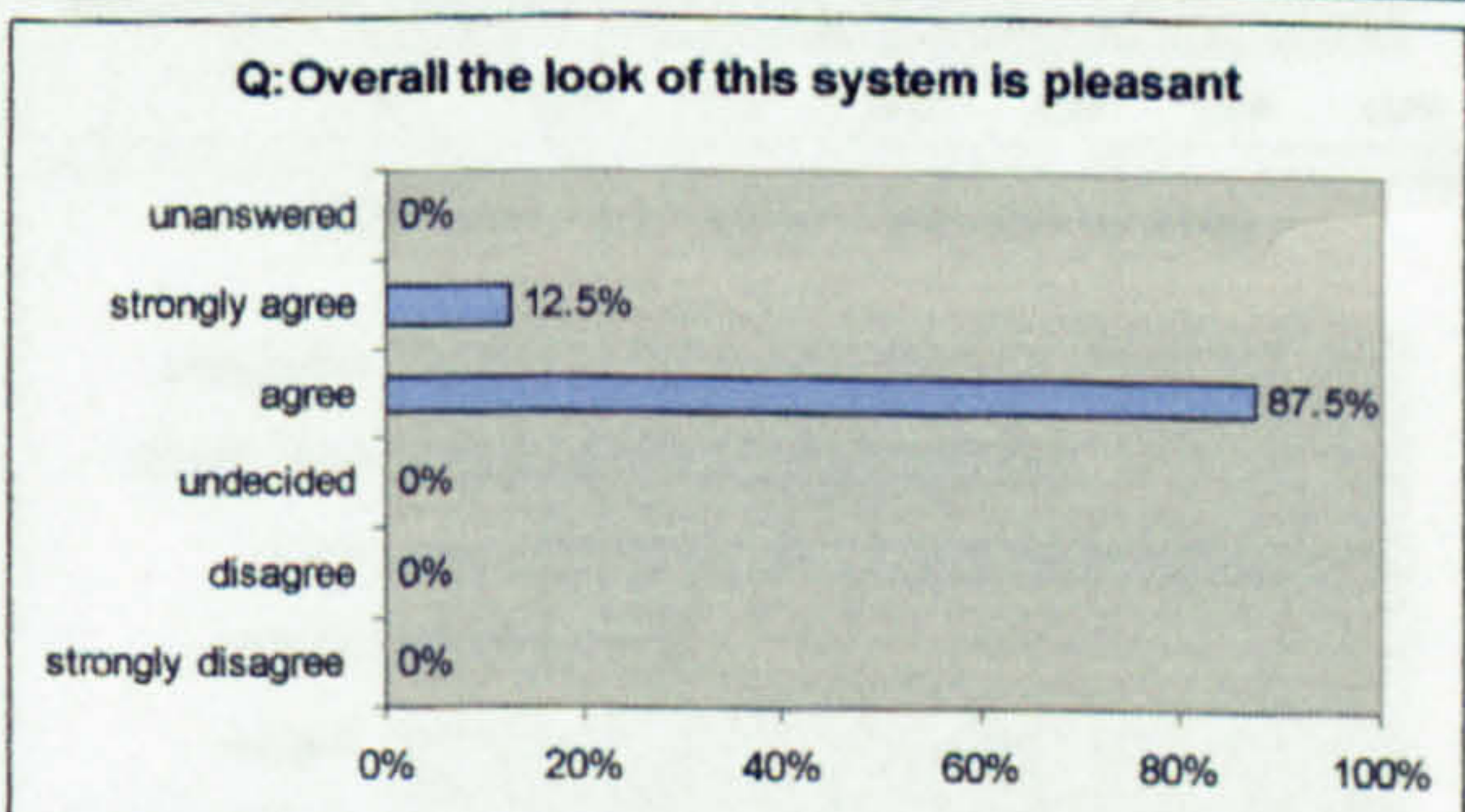
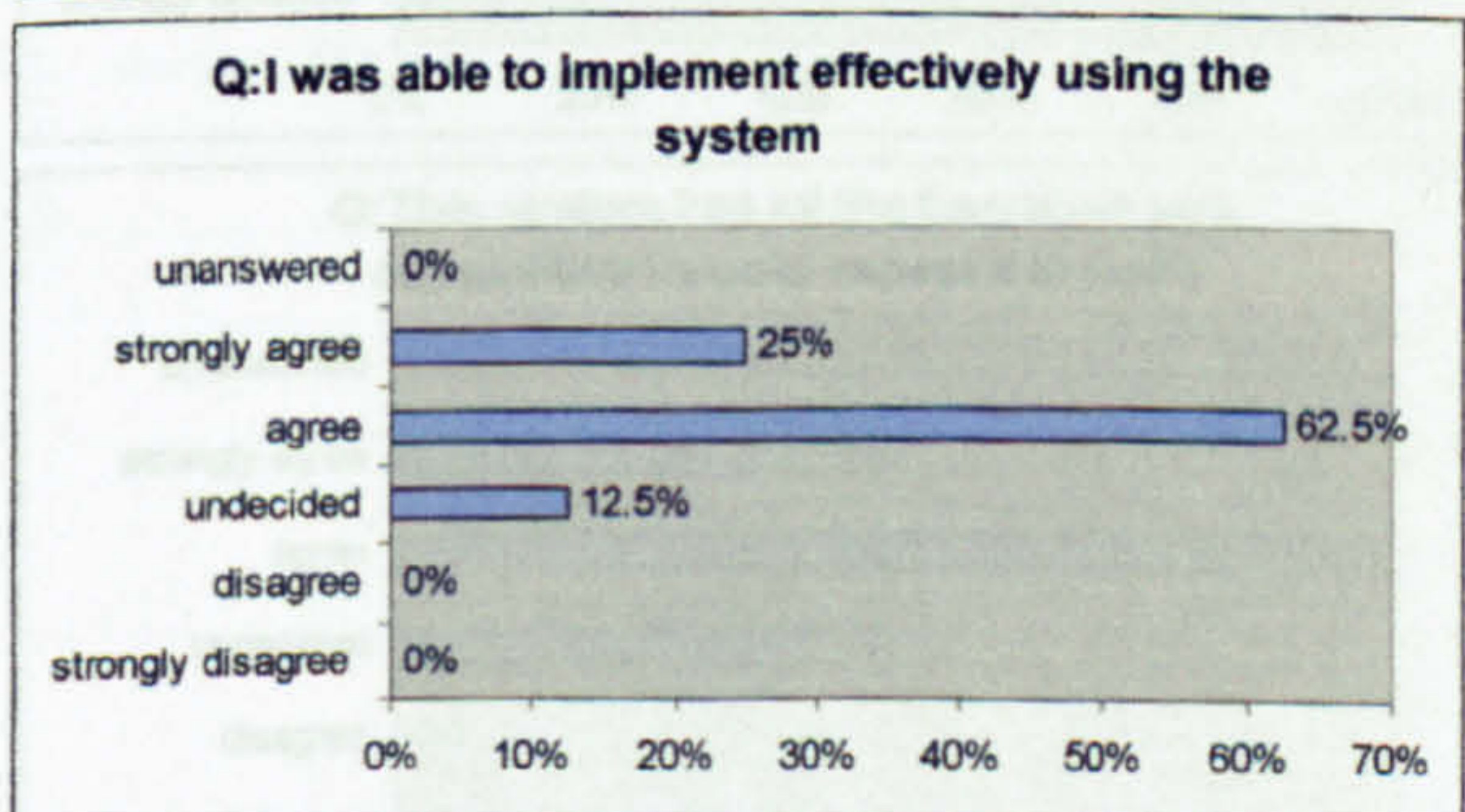
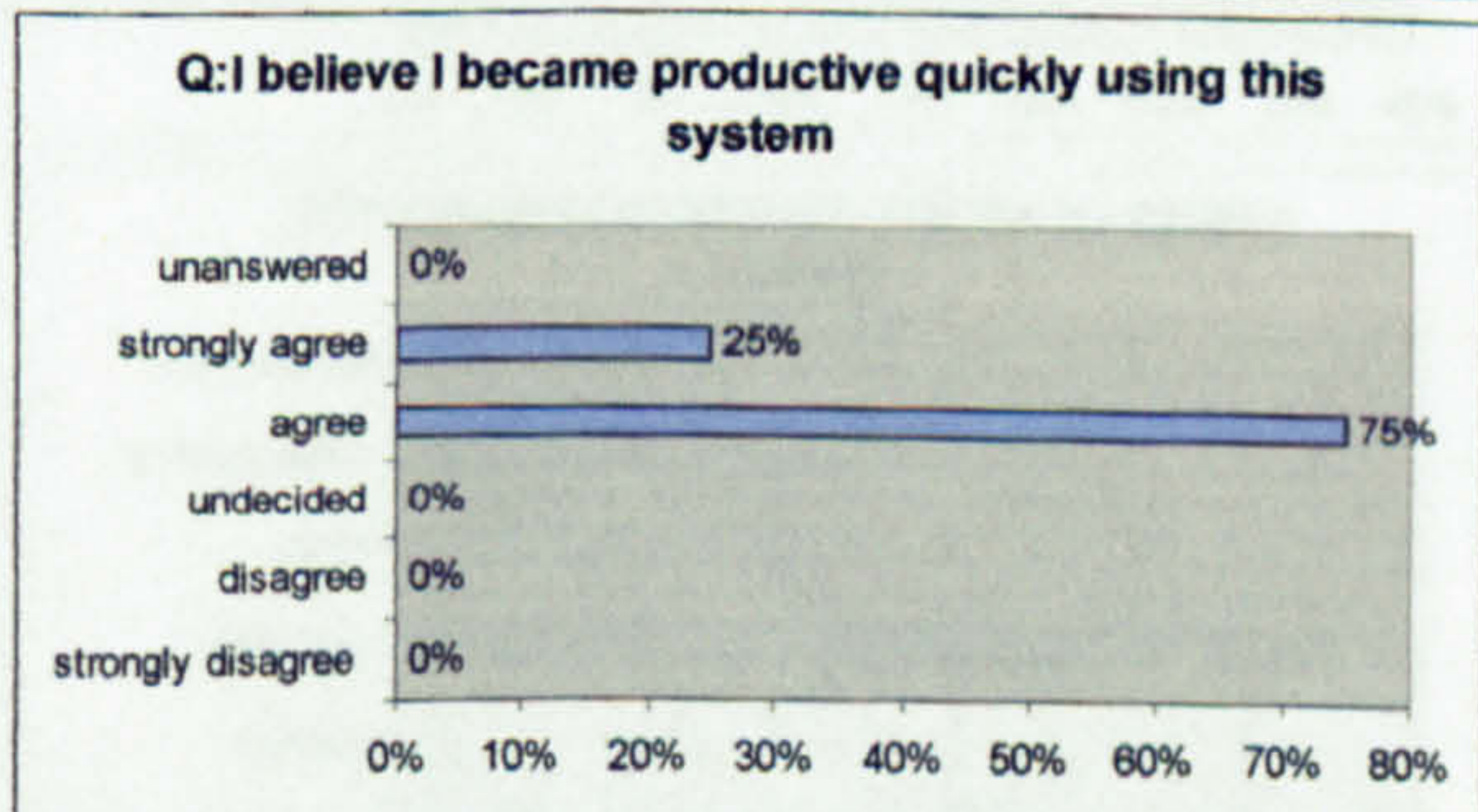
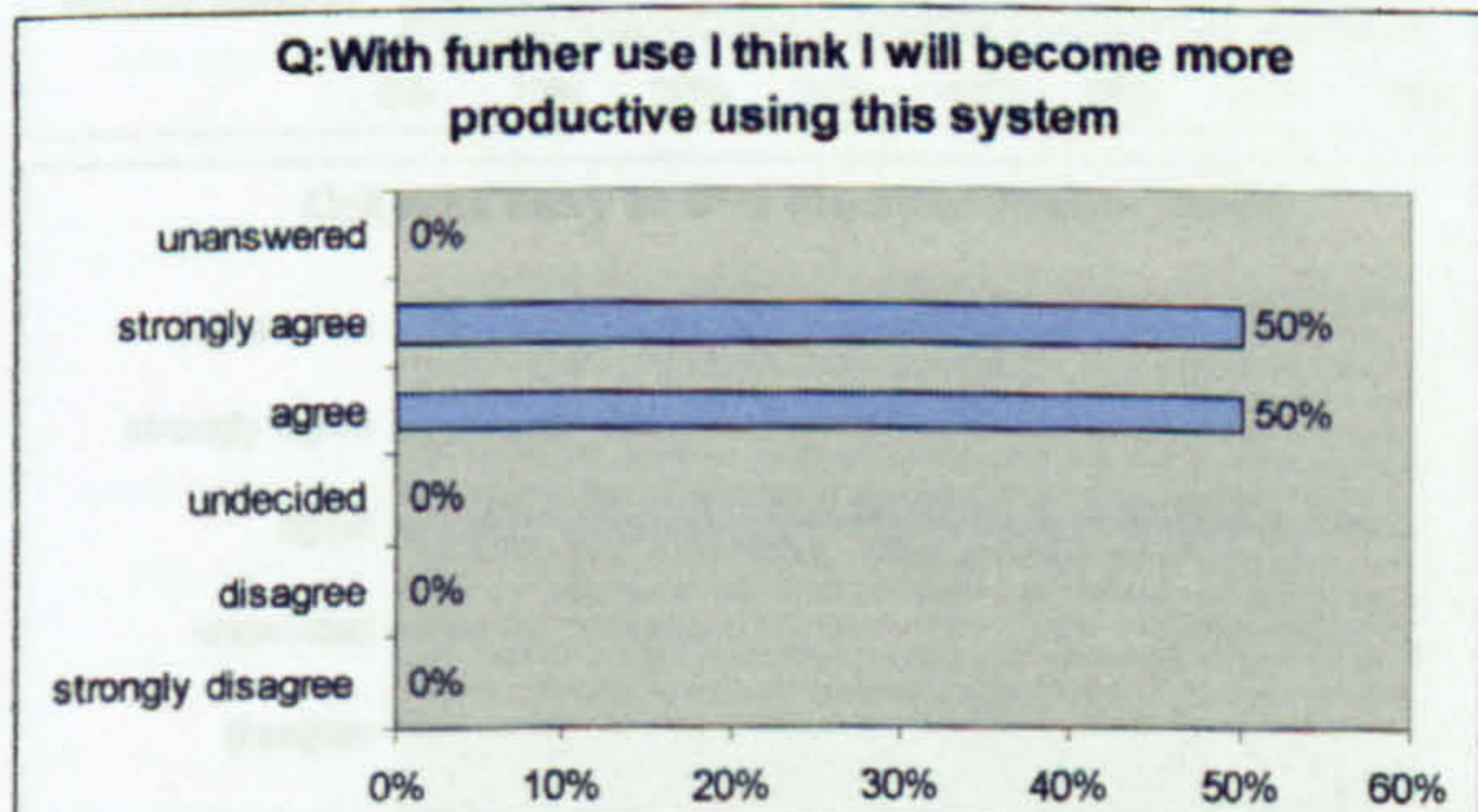
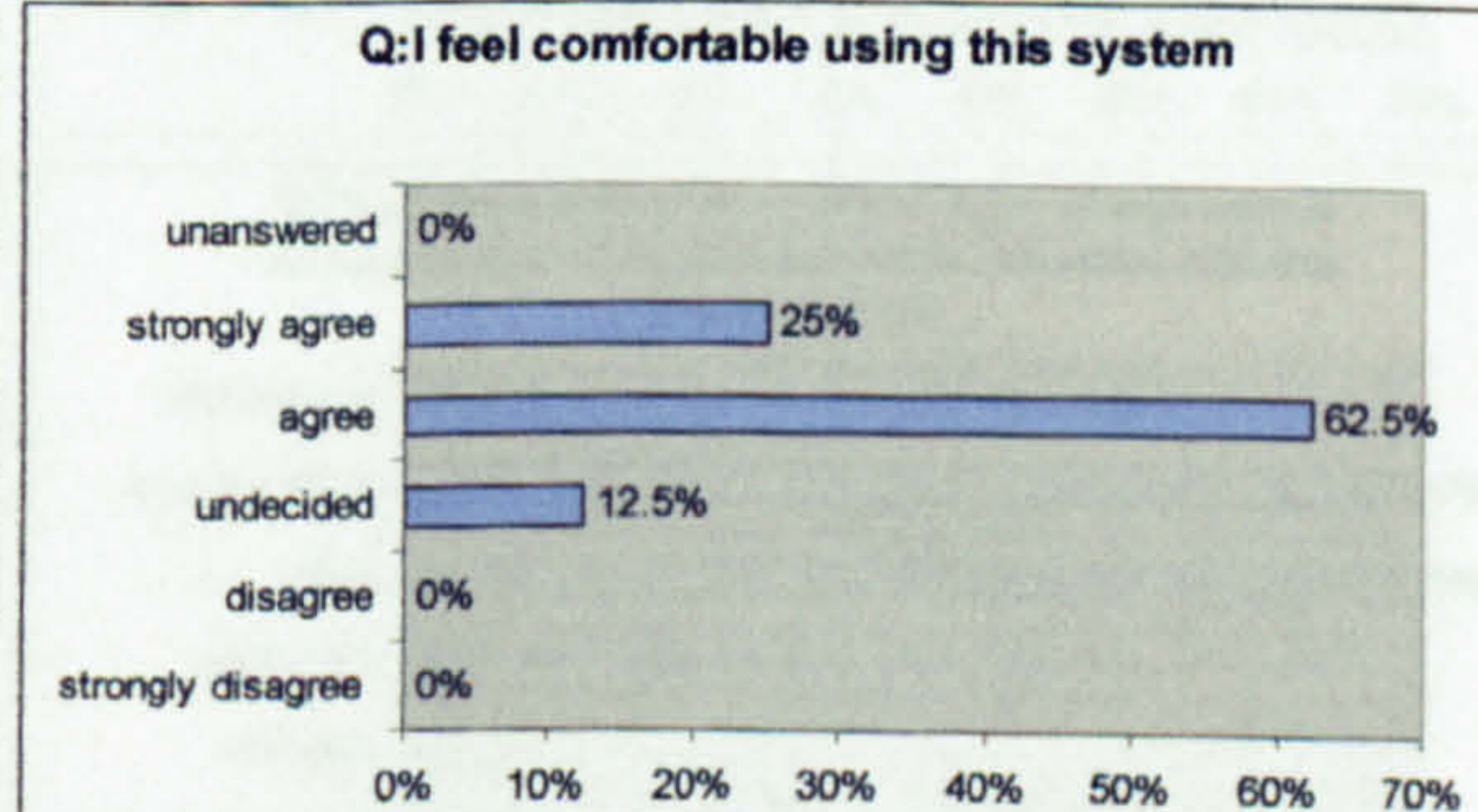
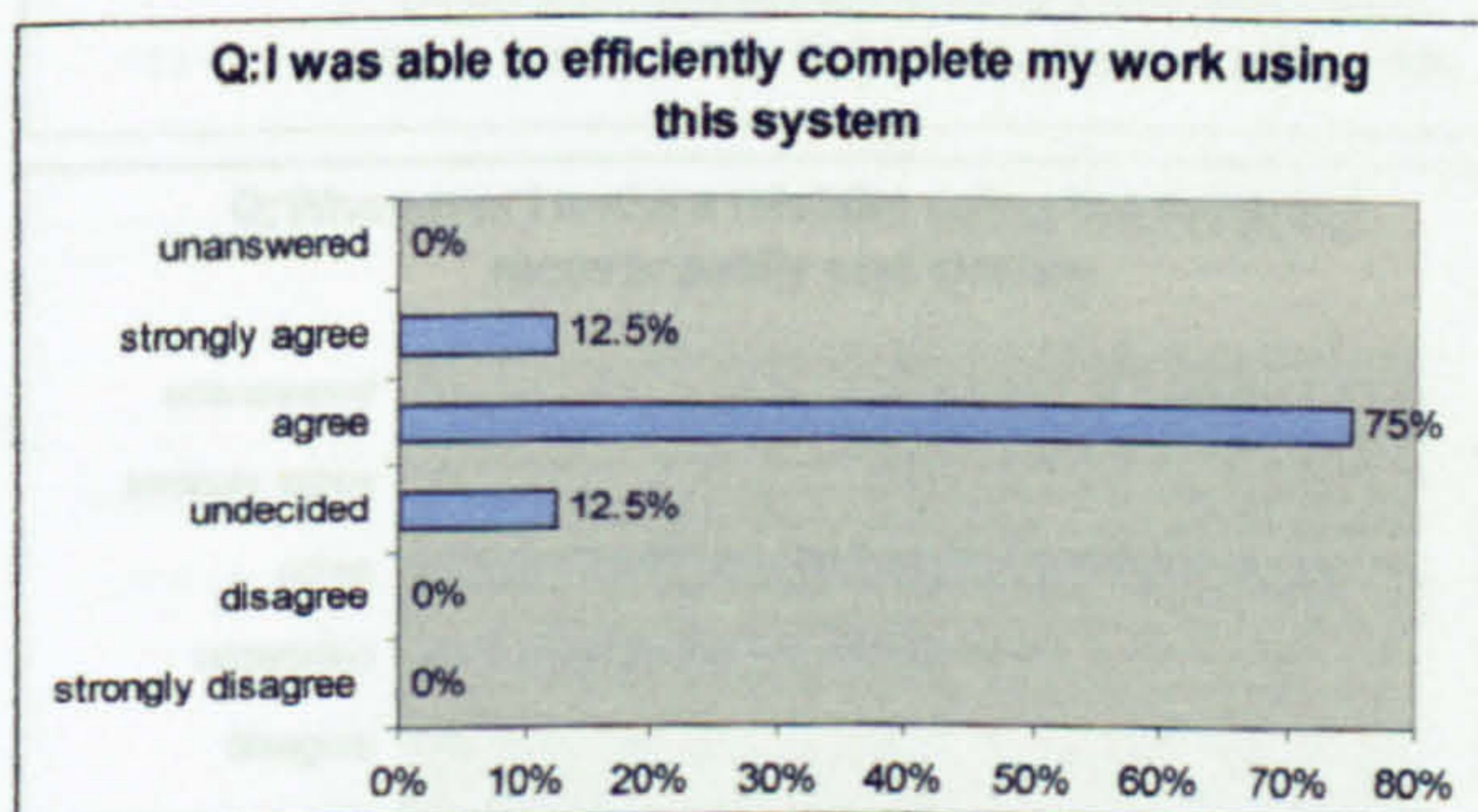
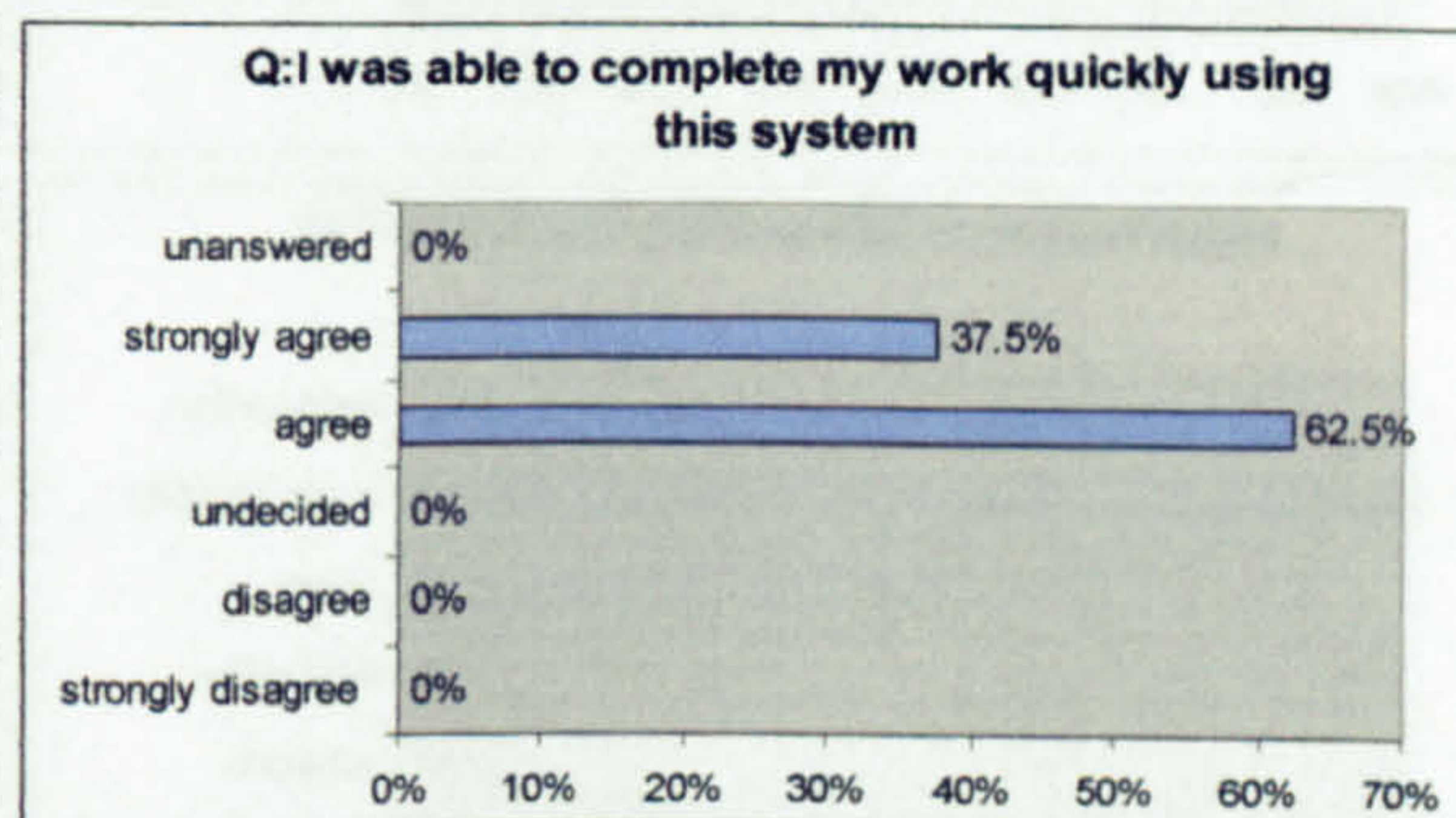
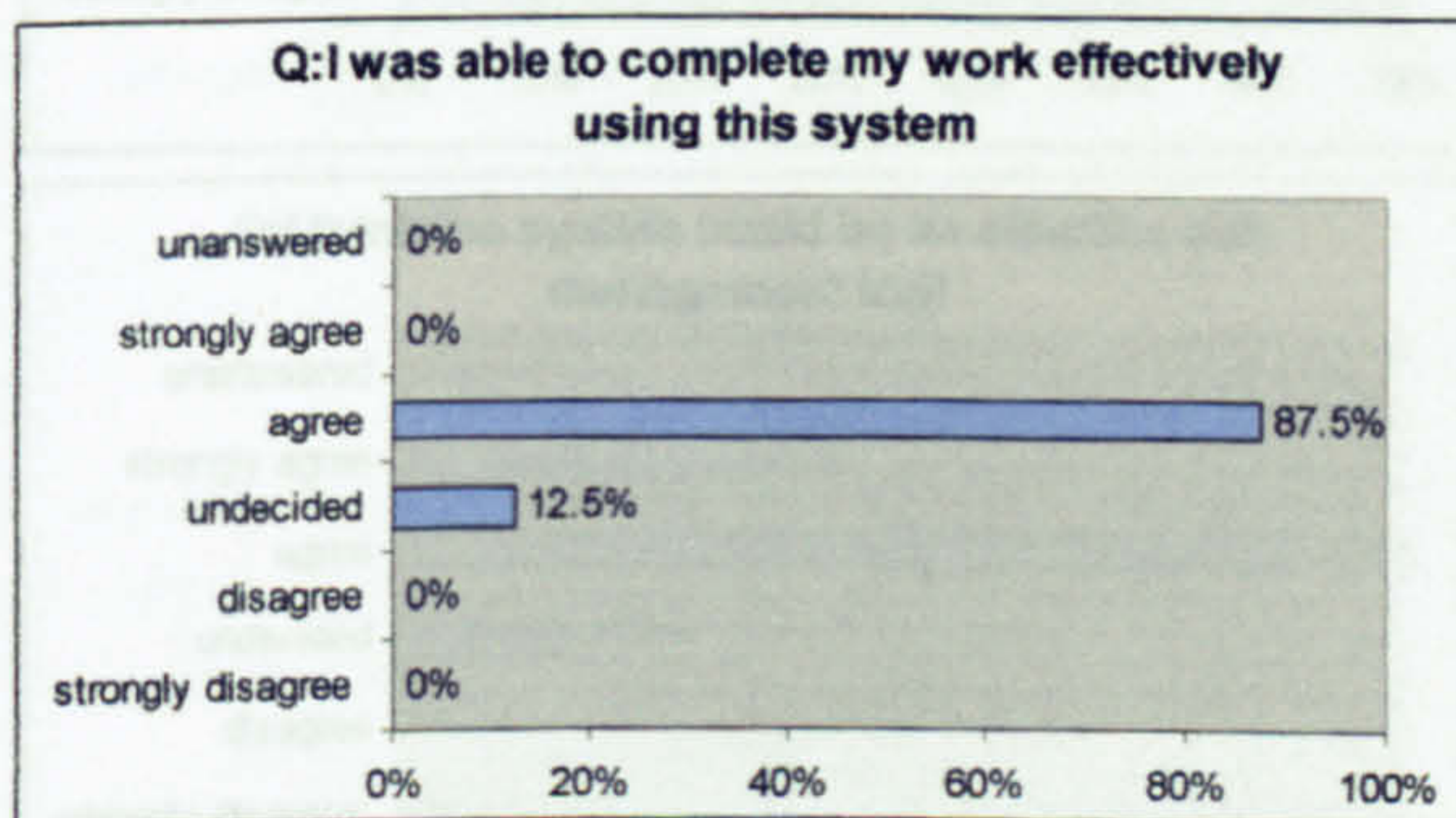


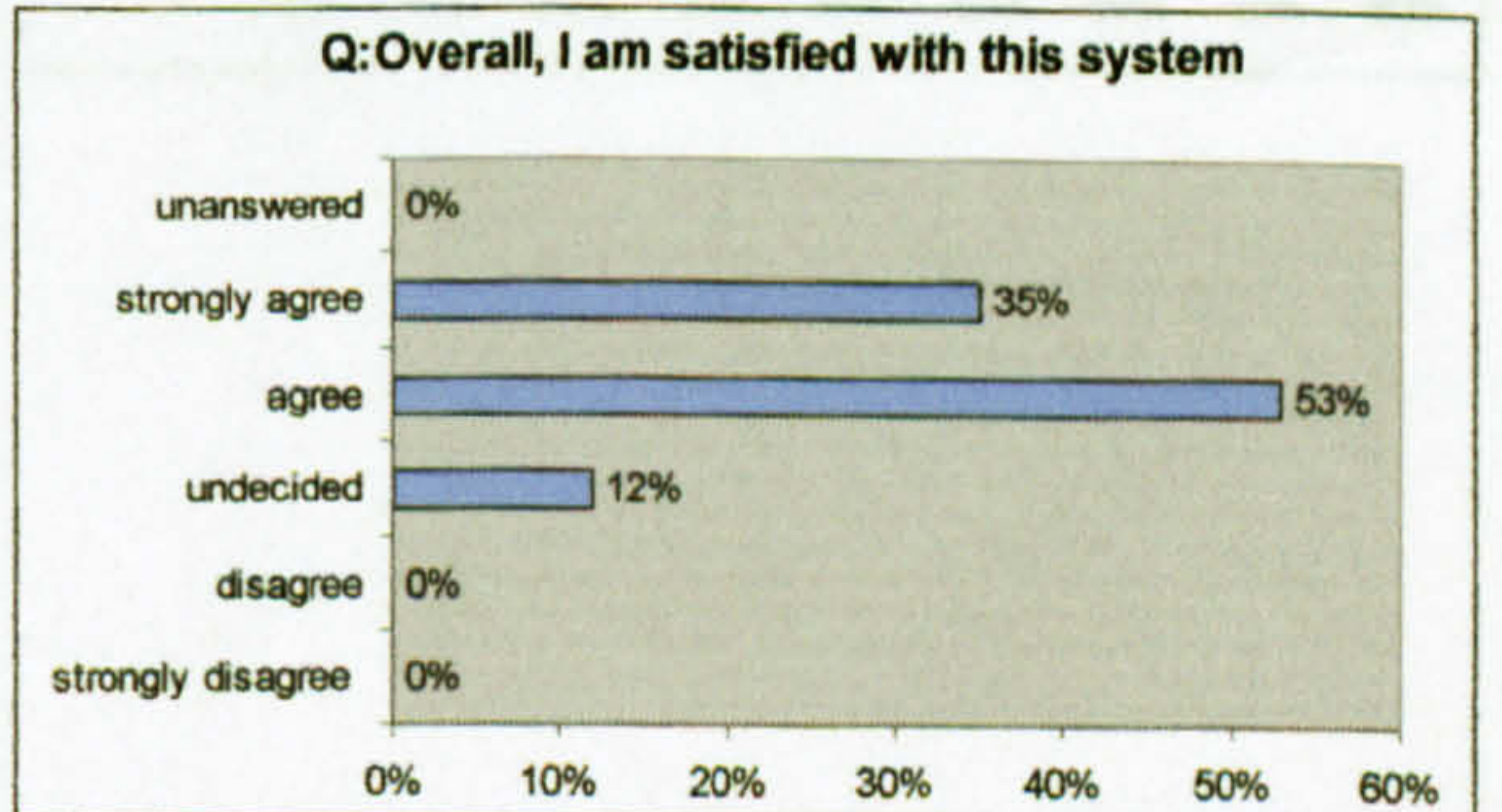
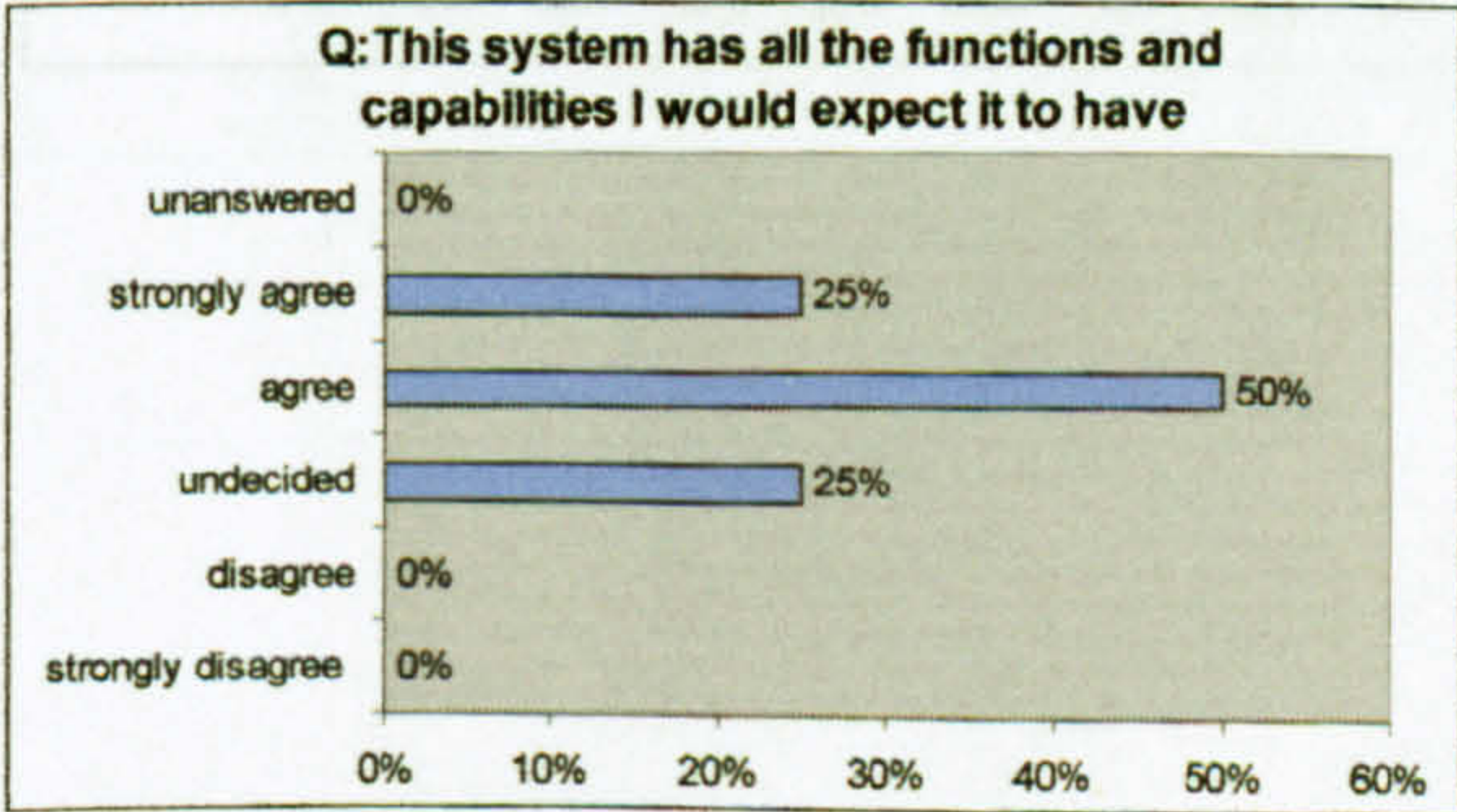
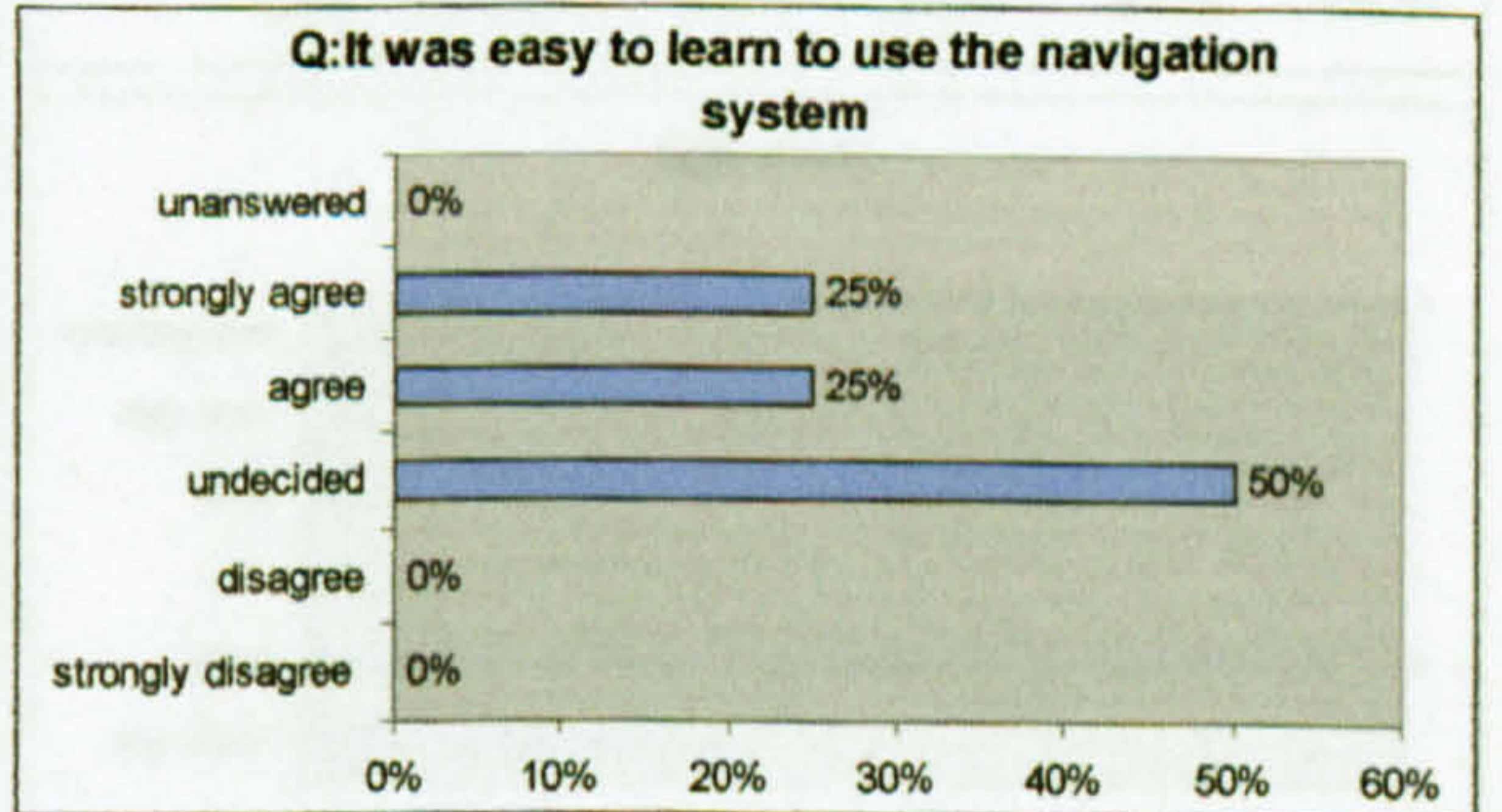
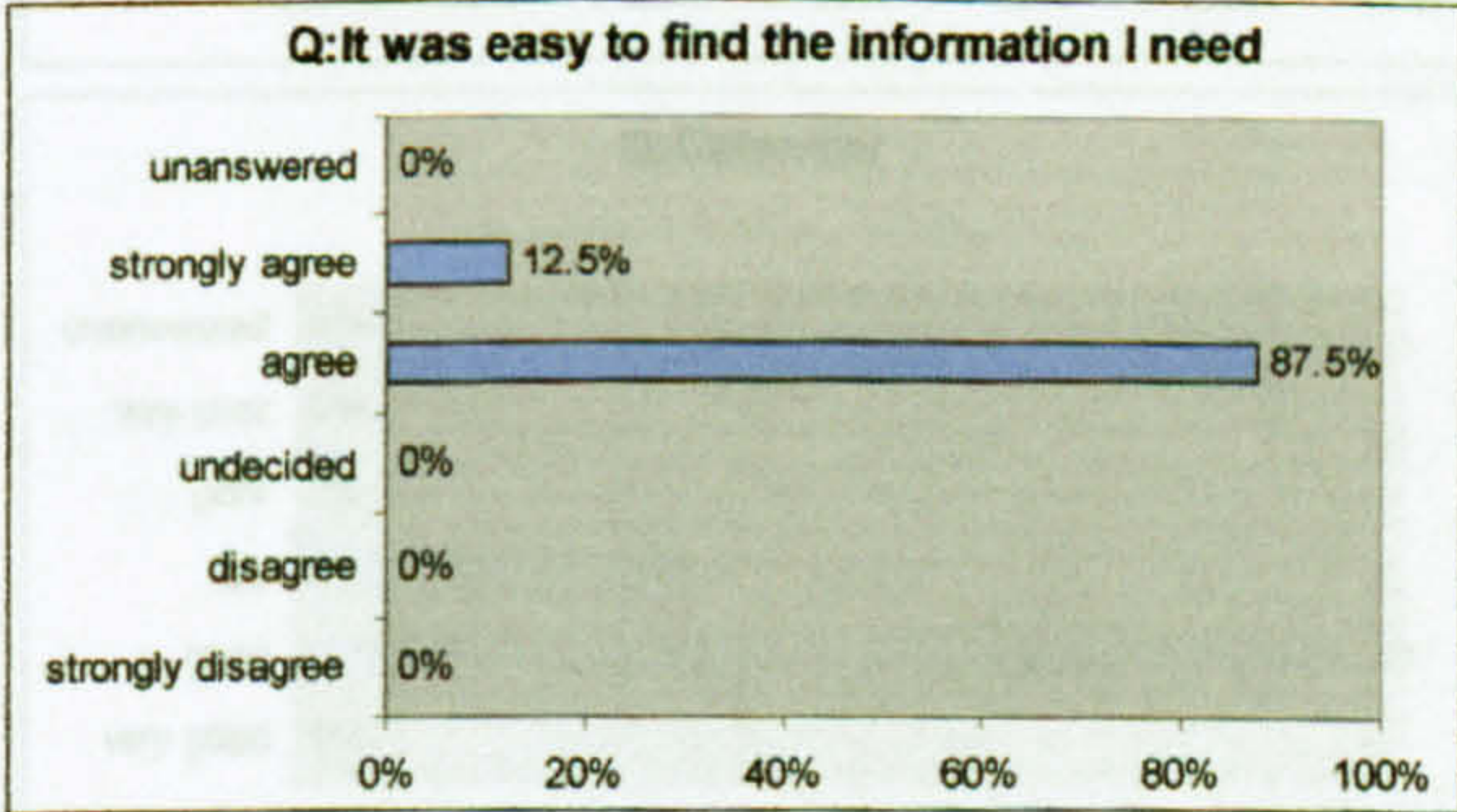
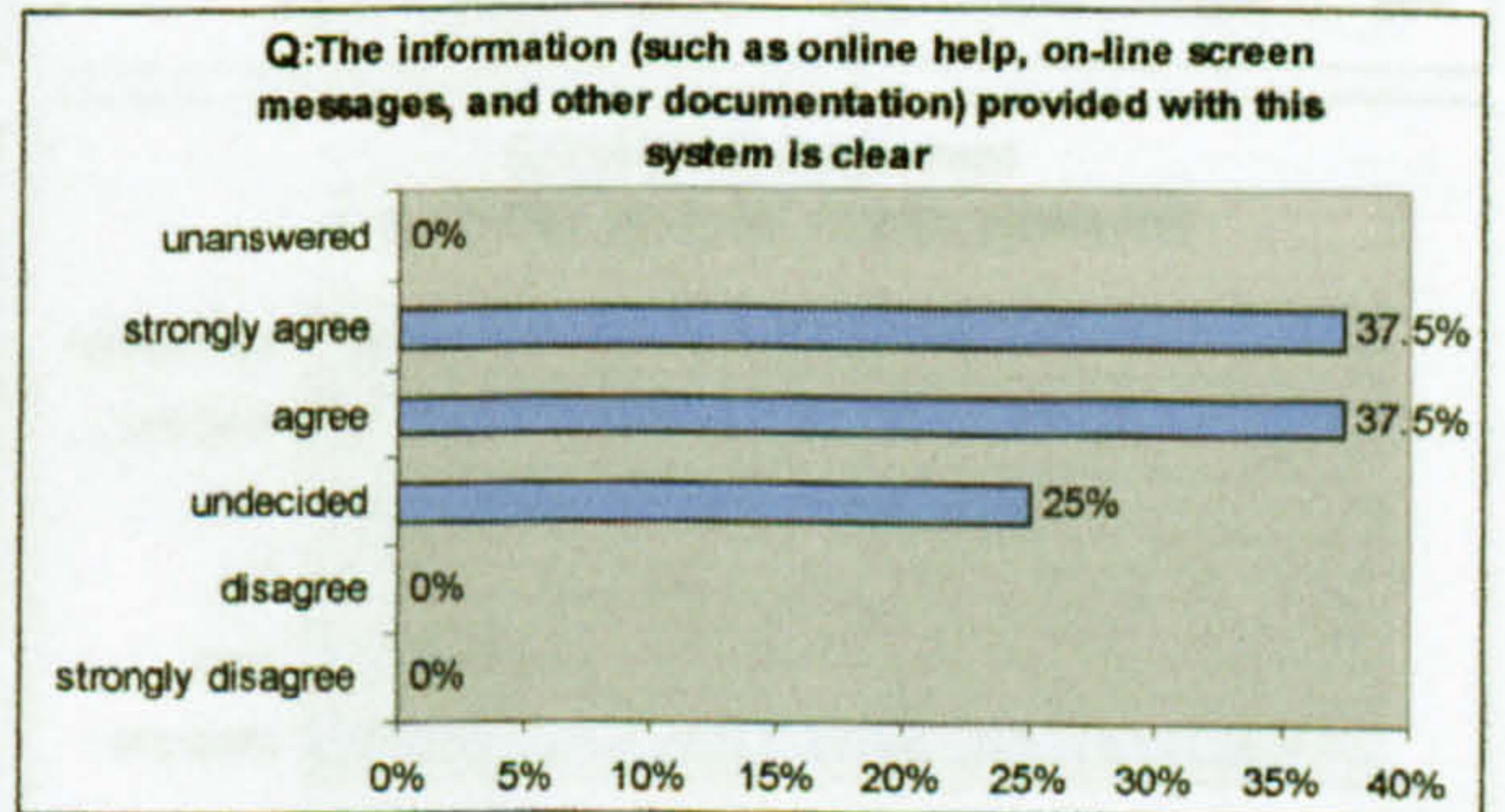
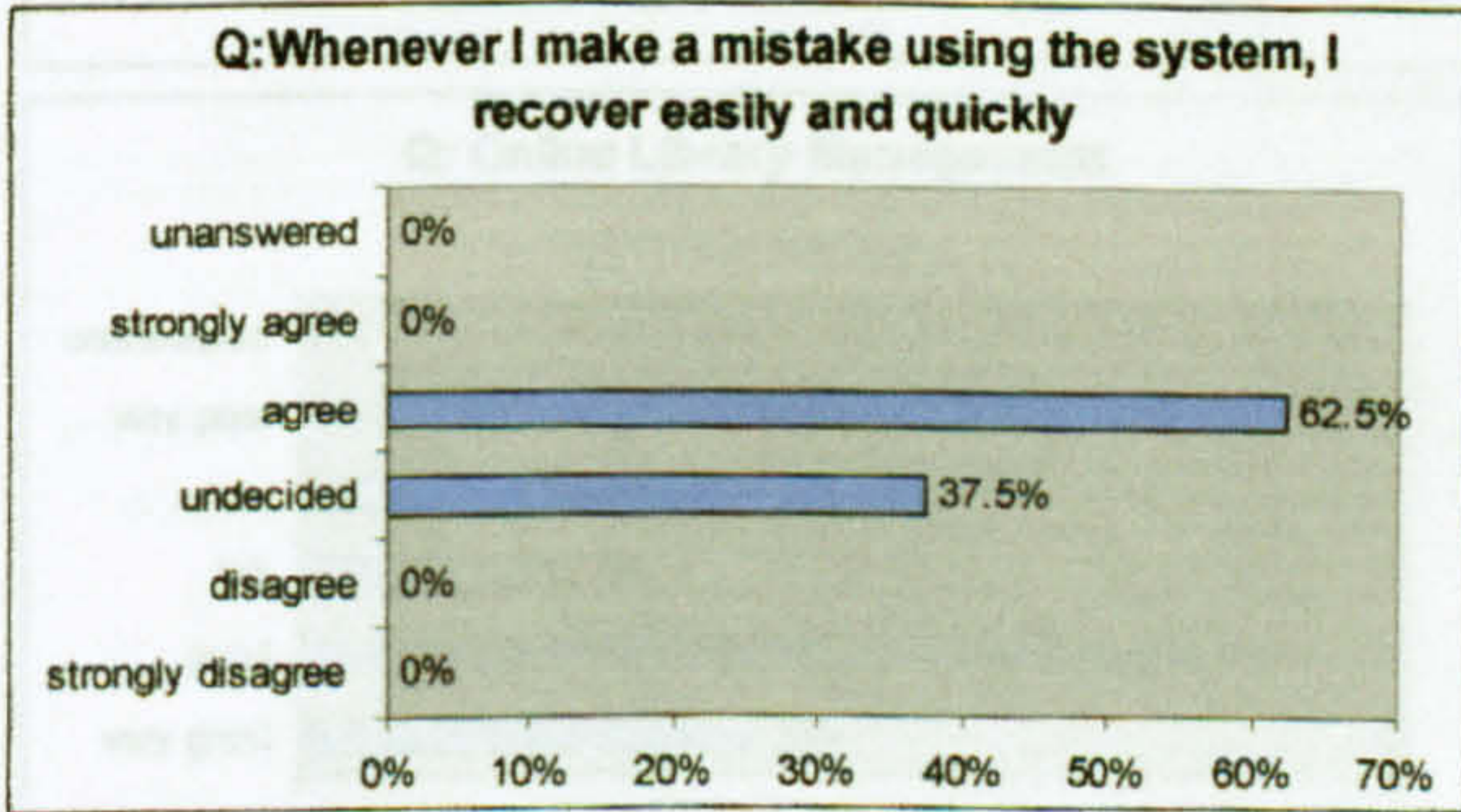
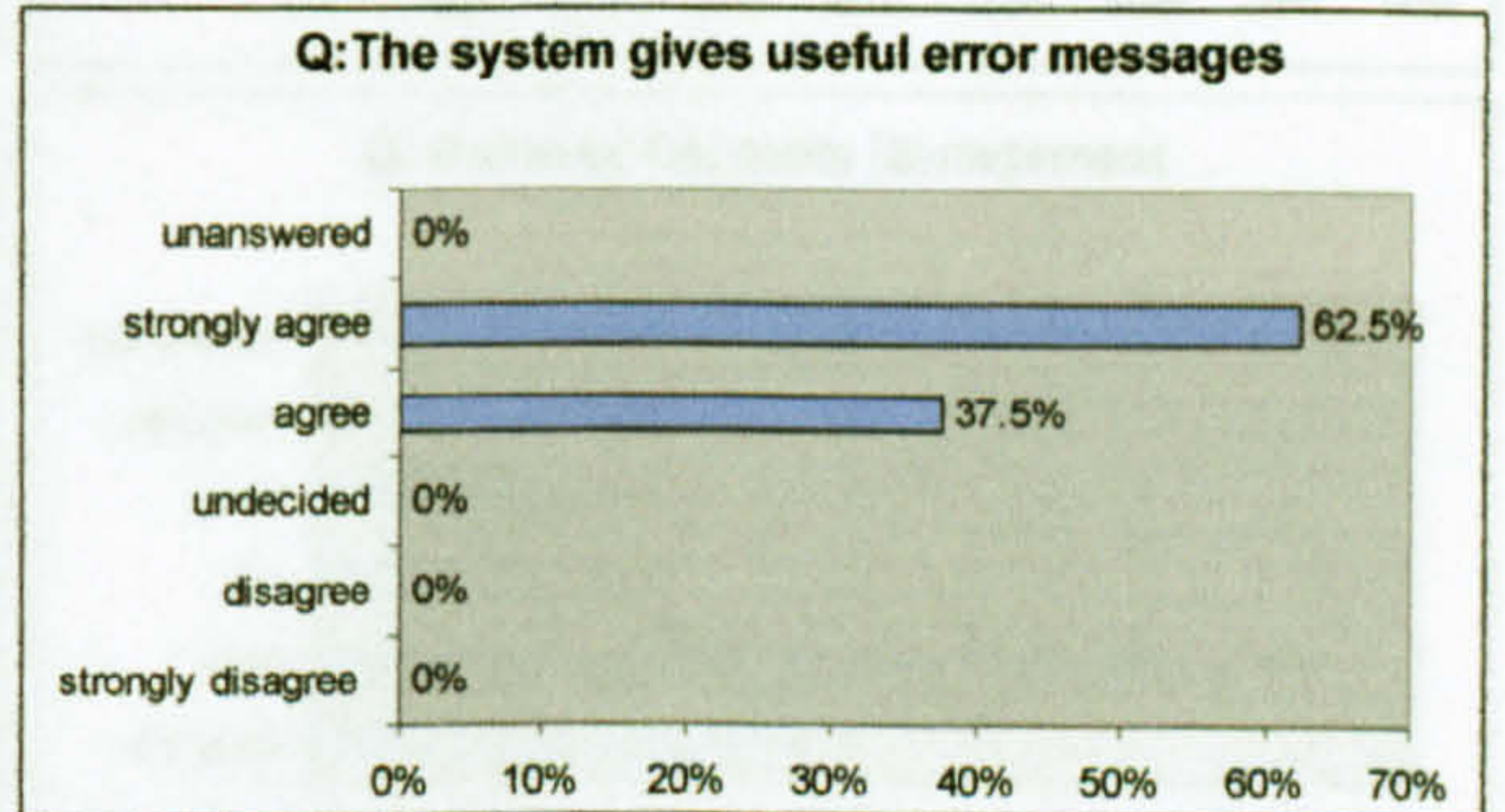
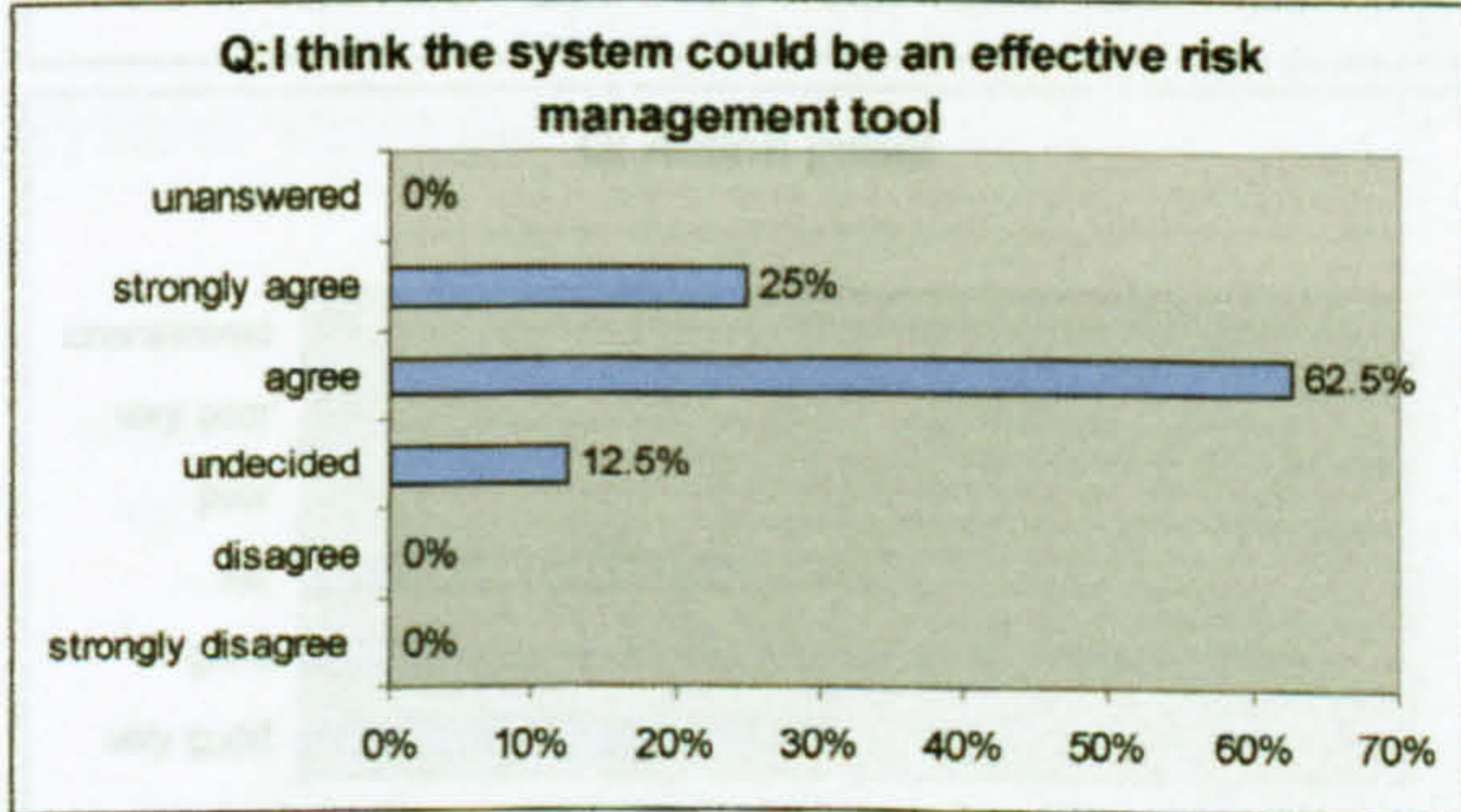
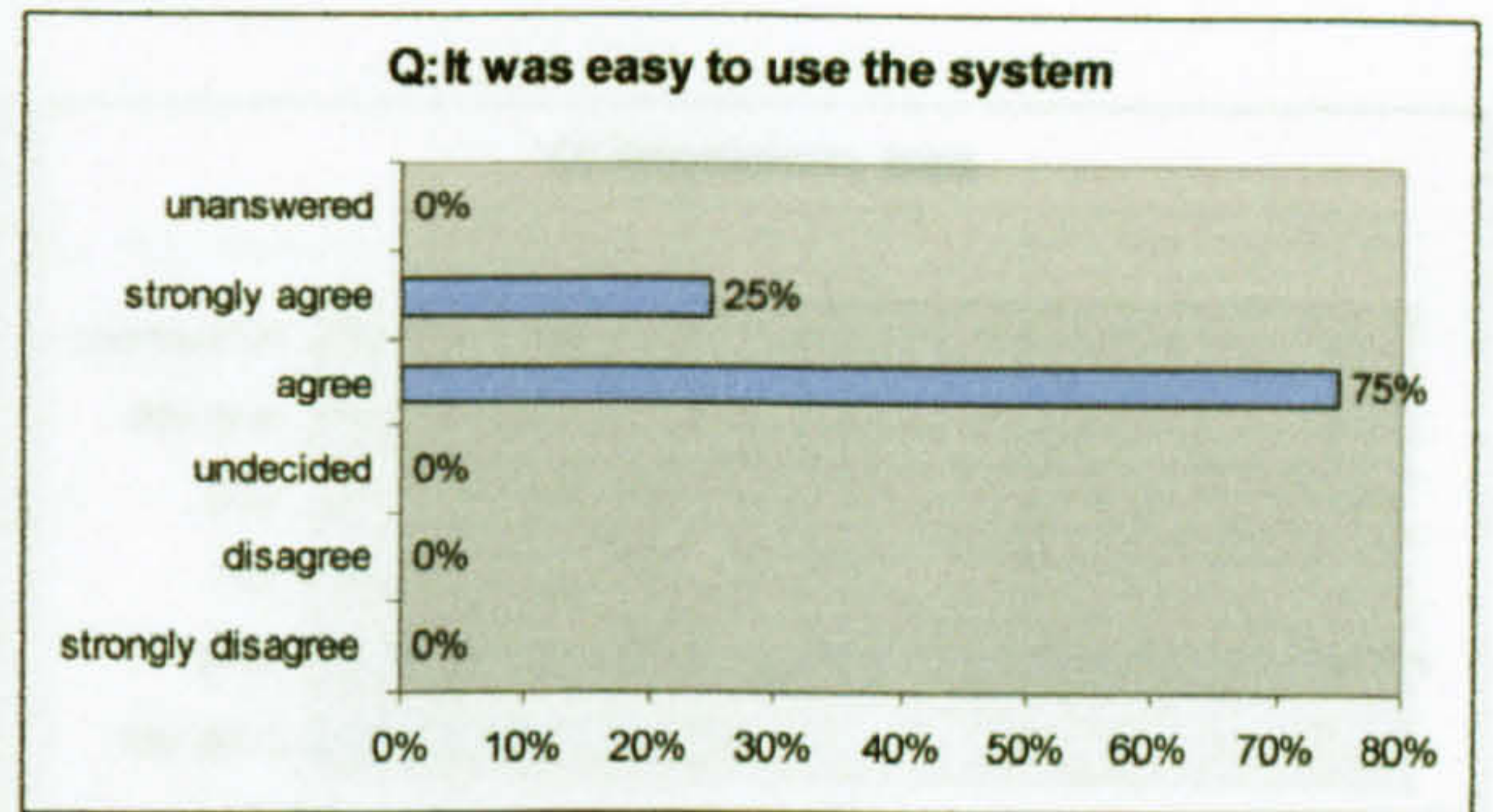
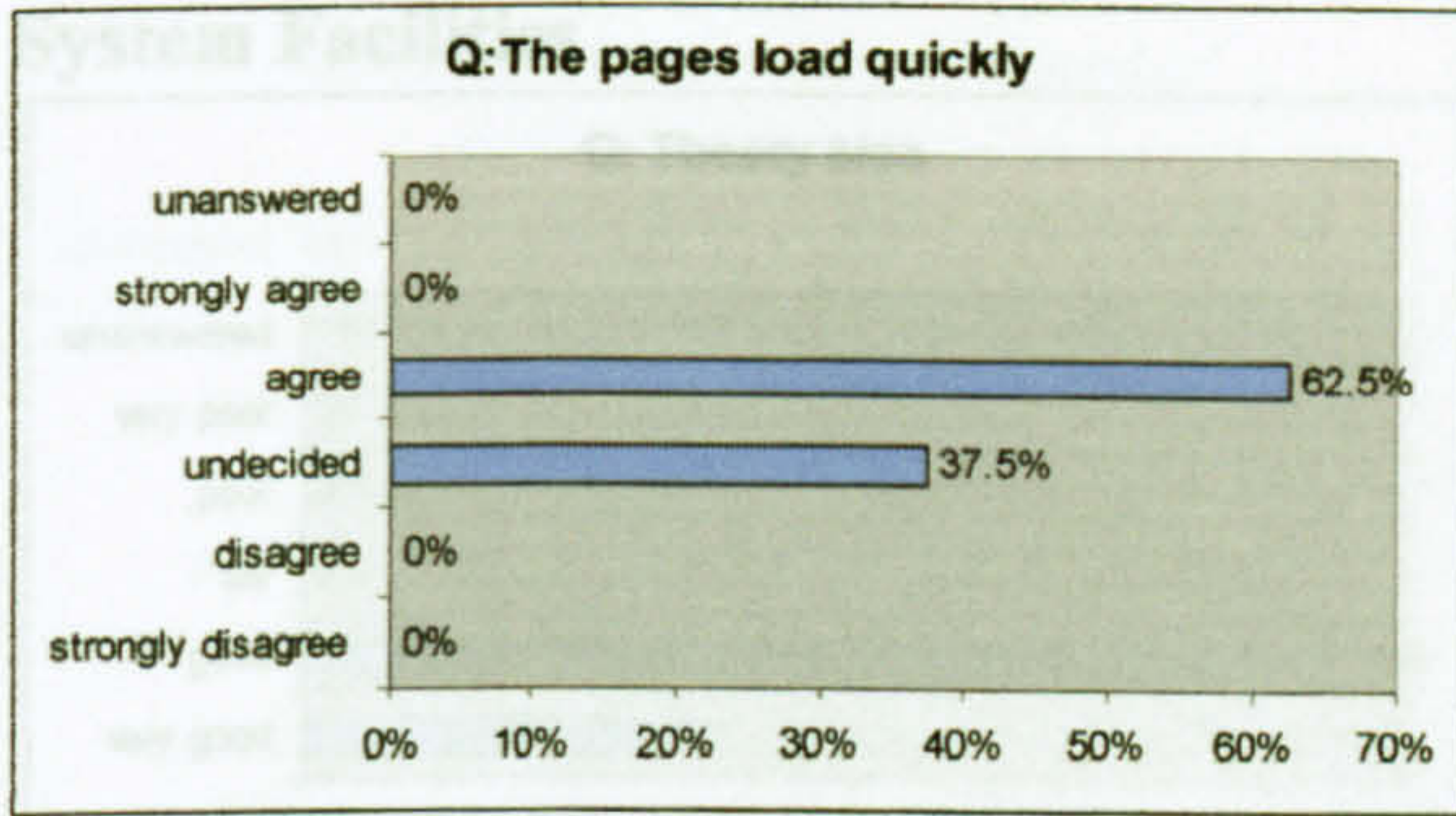
## Appendix 8

### Prototype testing

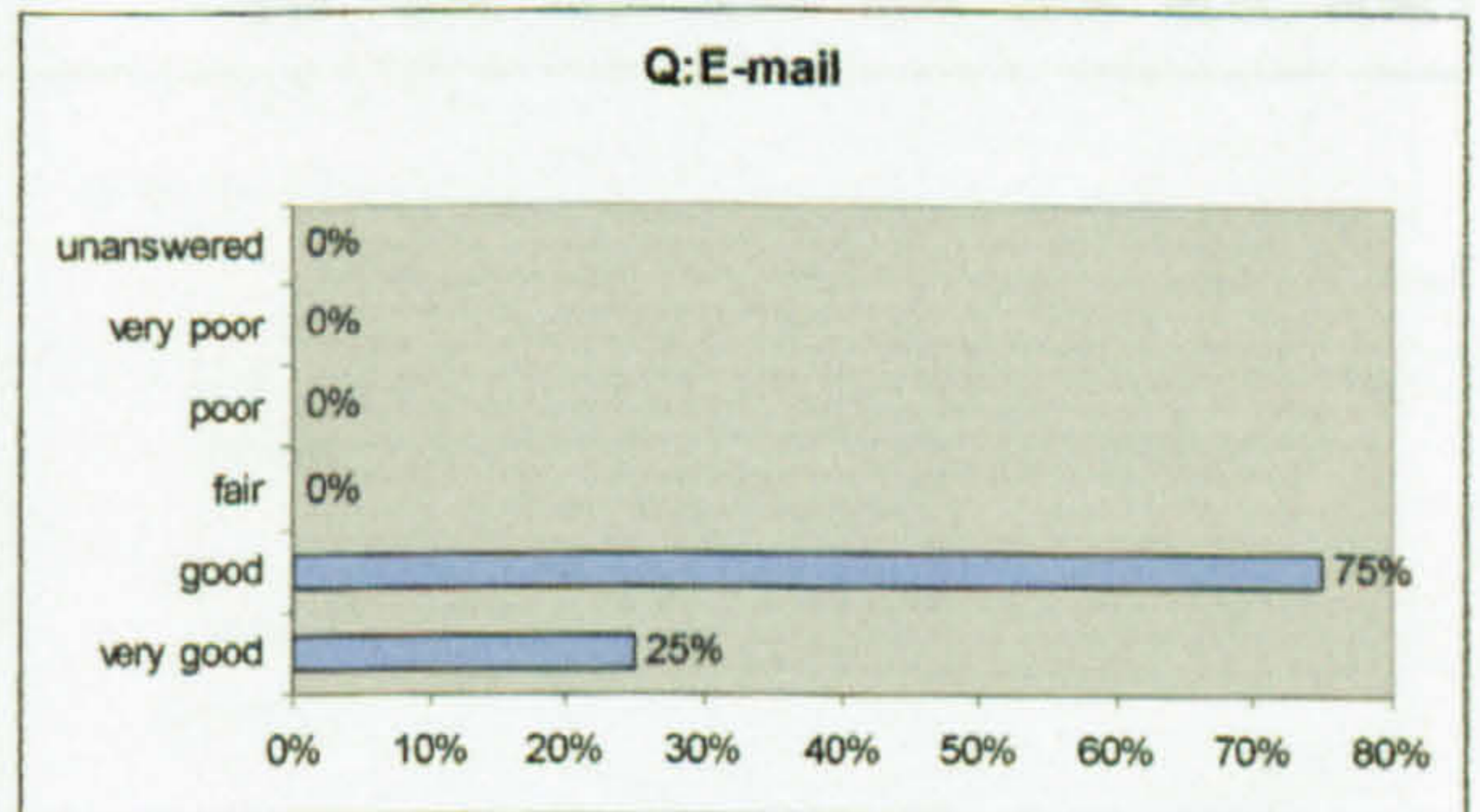
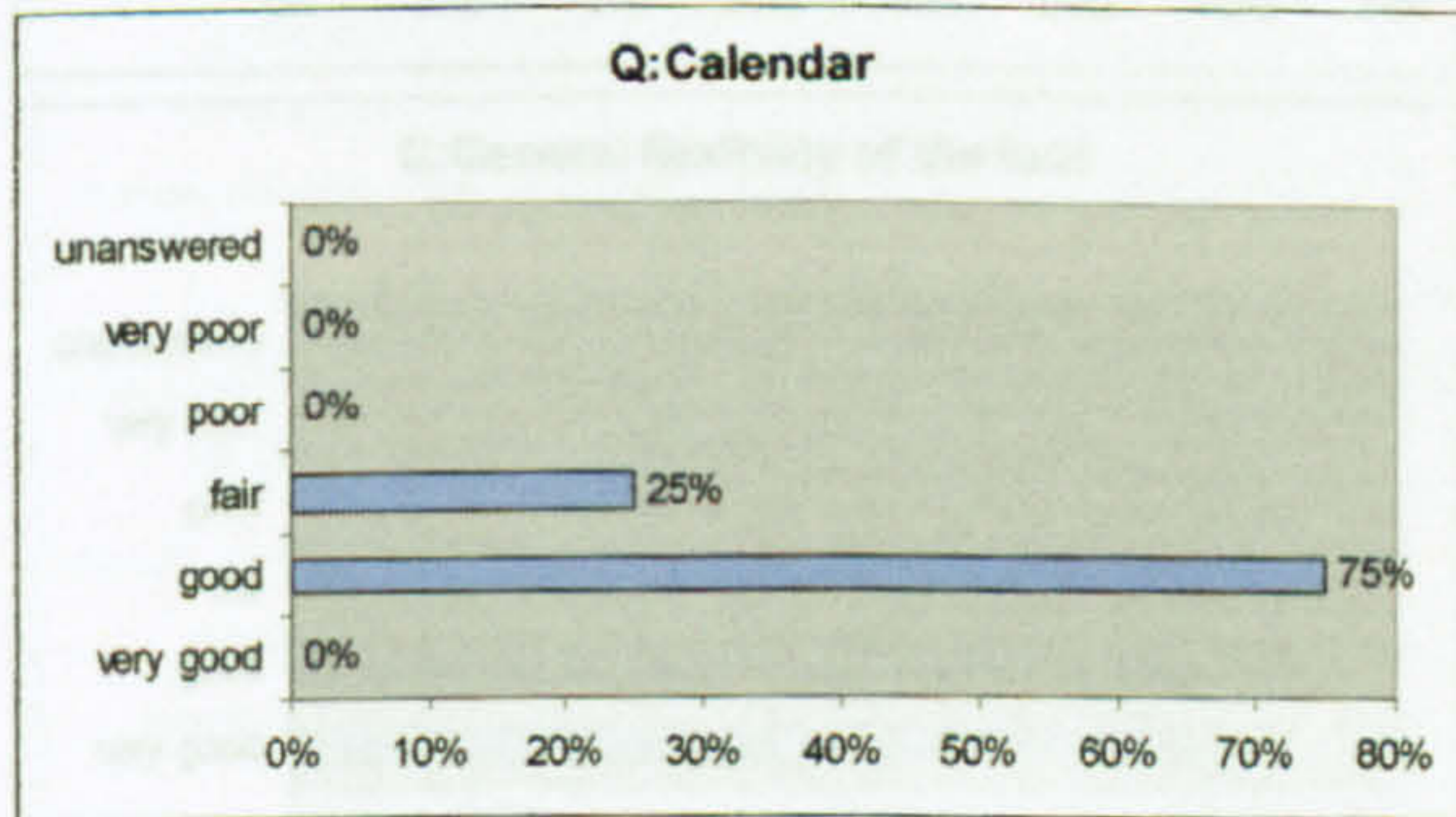
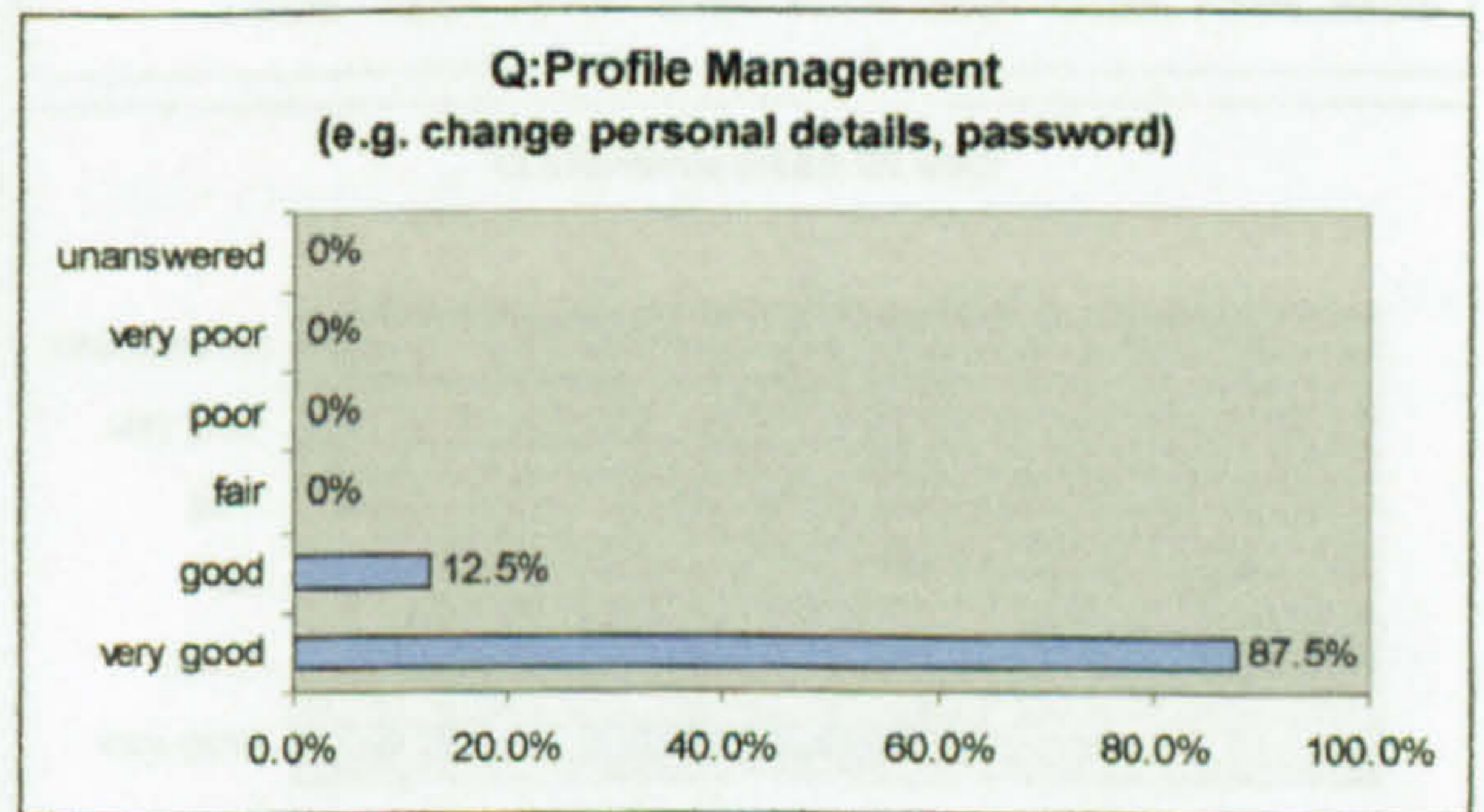
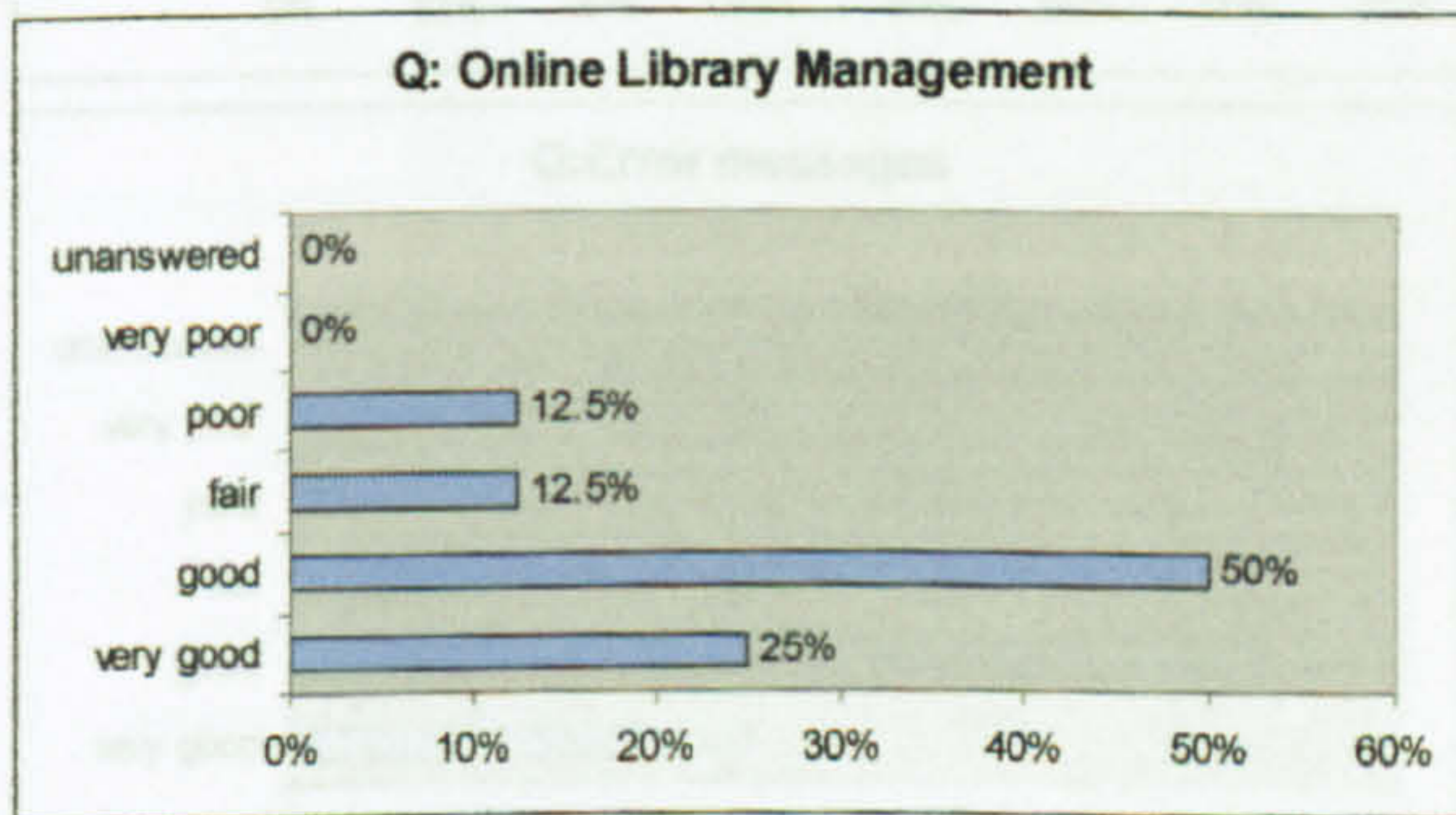
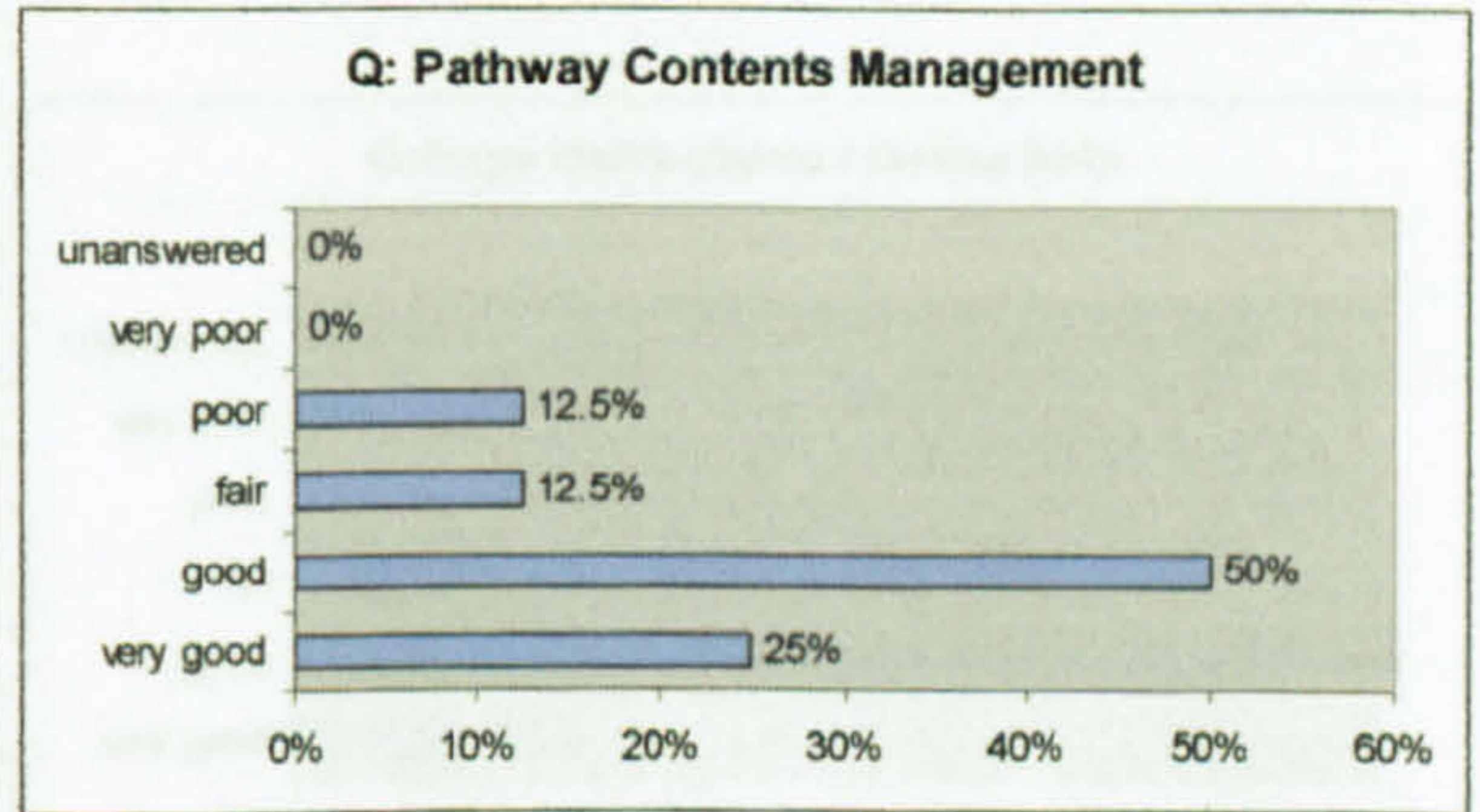
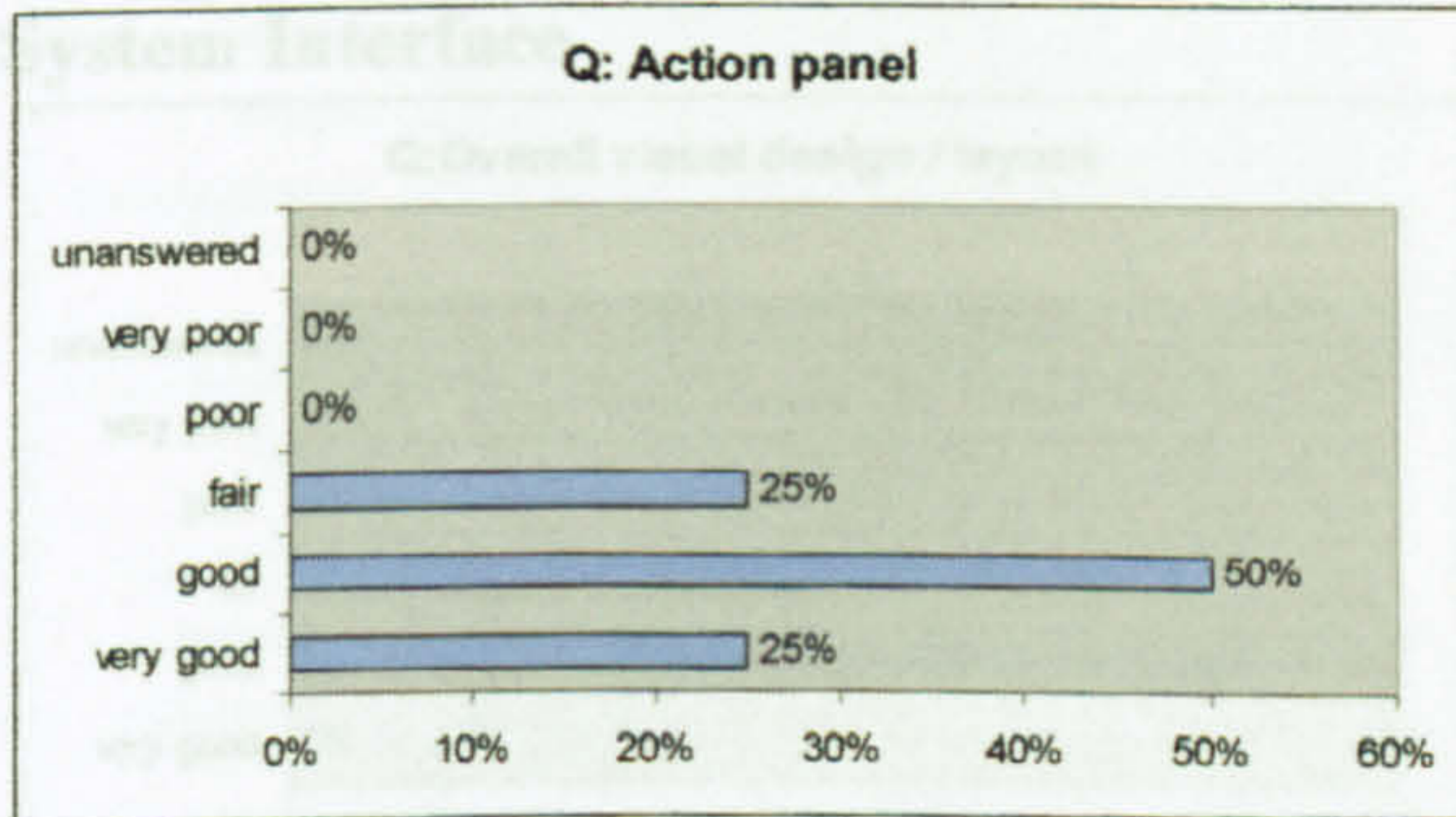
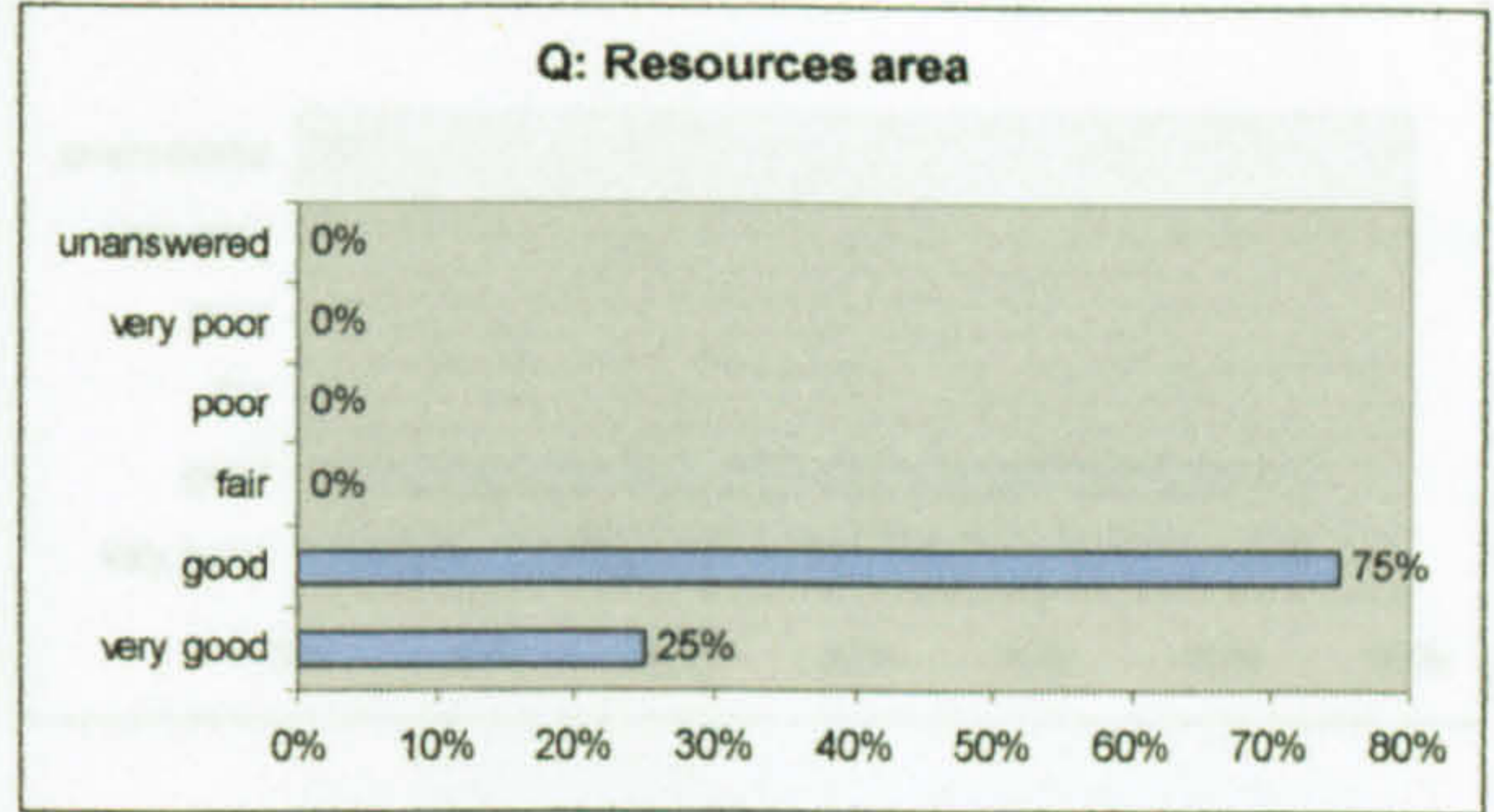
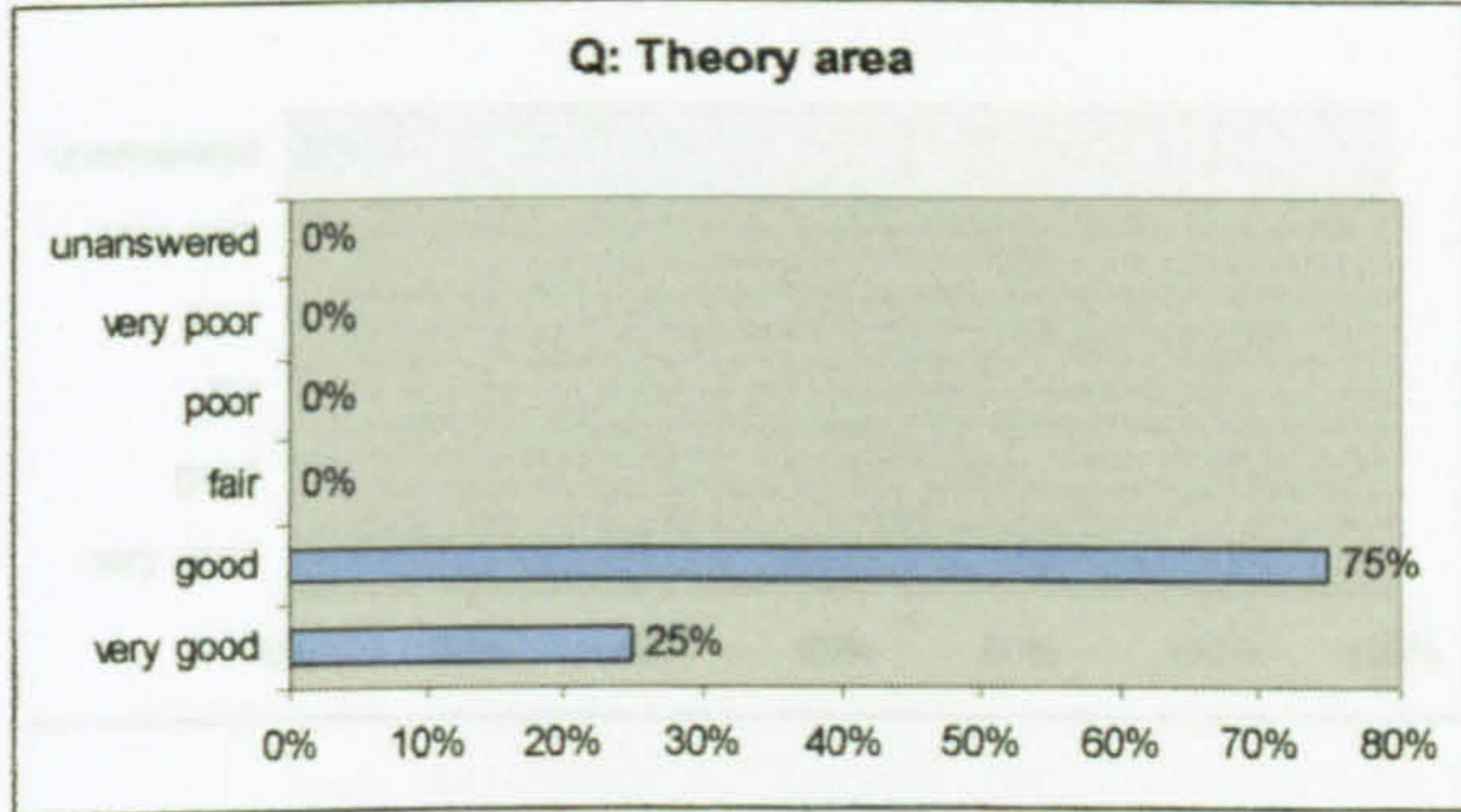
#### It was simple to use

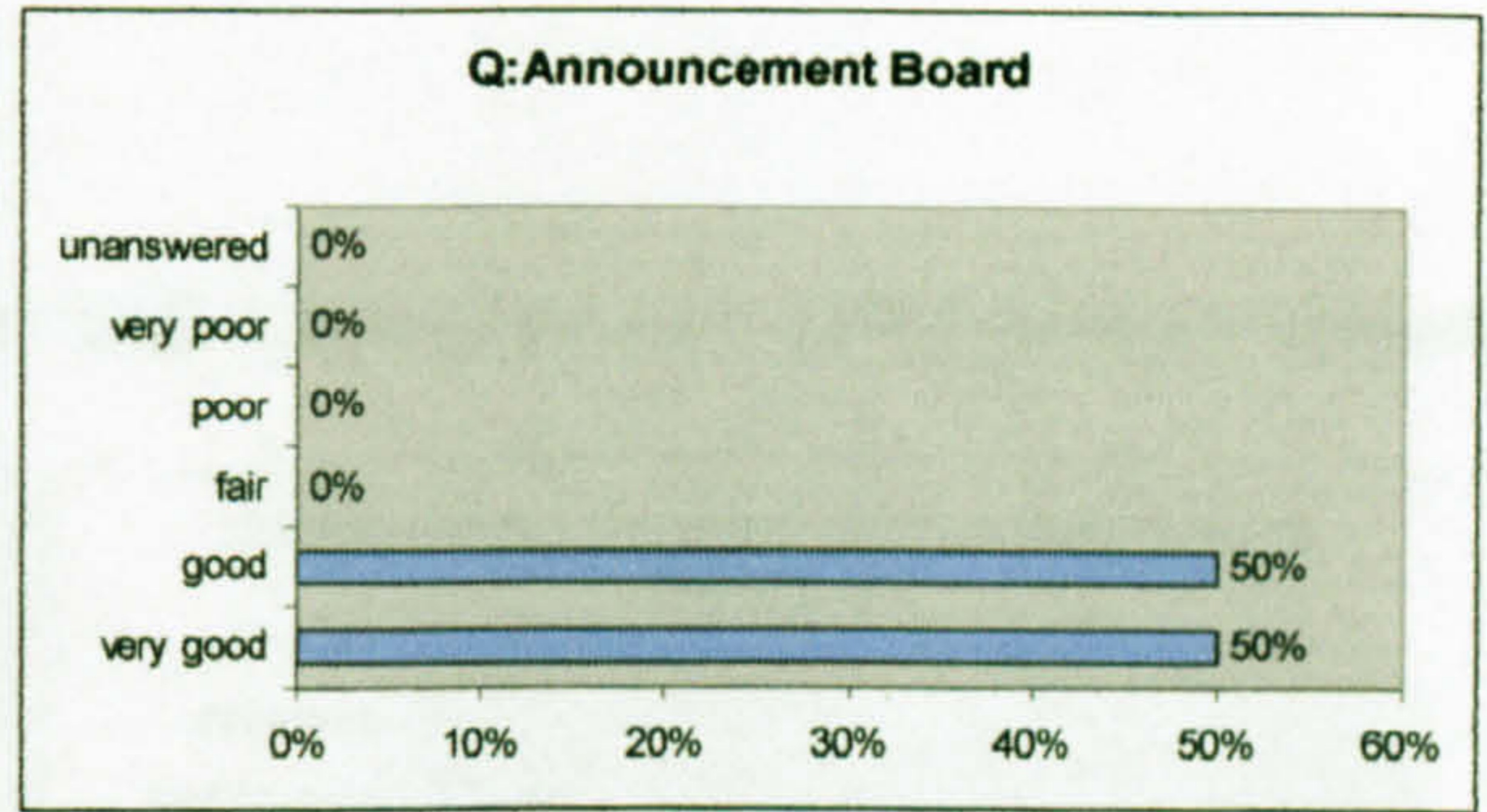
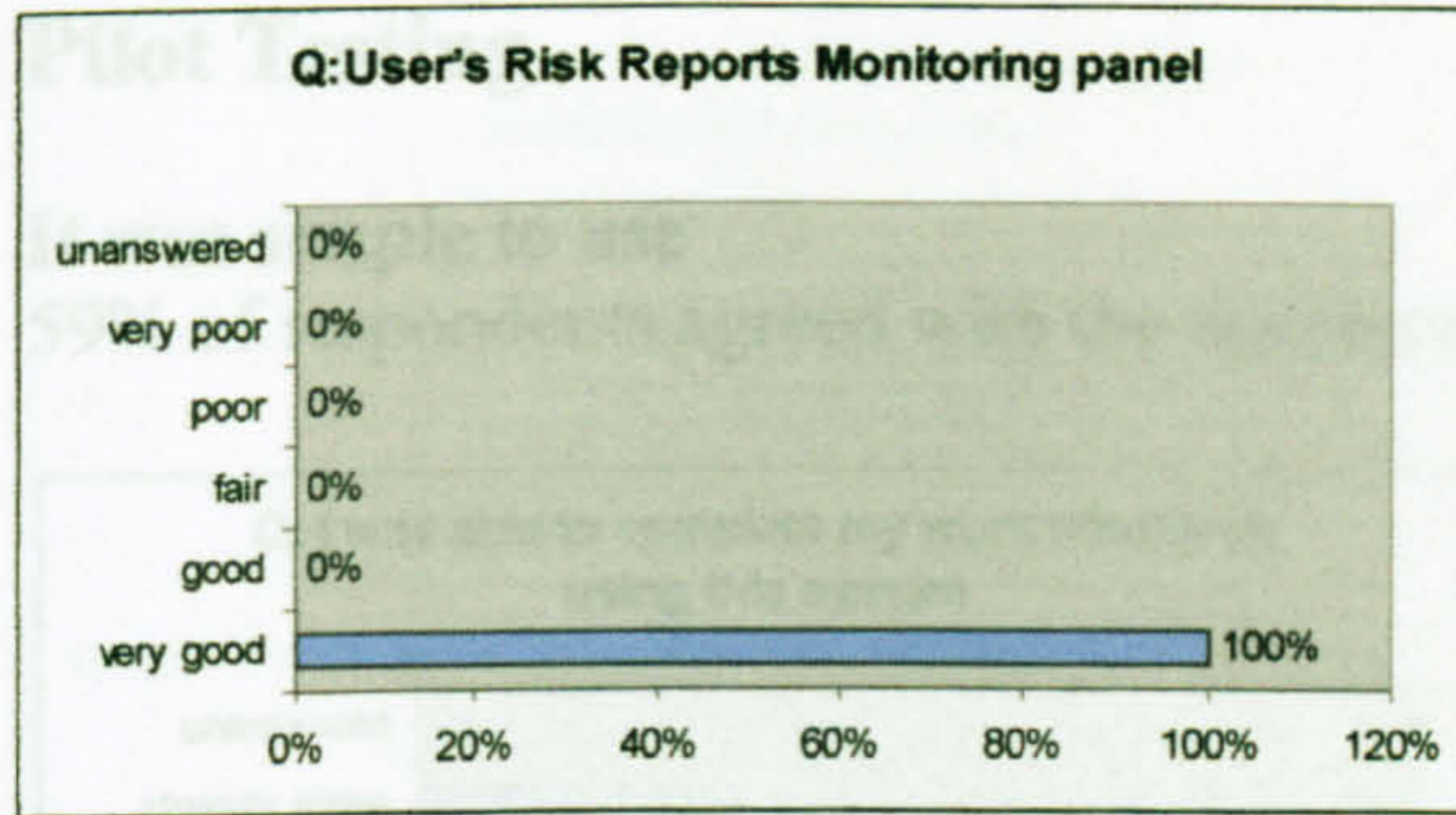
75% of respondents agreed with the statement: "risk-e is easy to use". (12.5% strongly agreed)



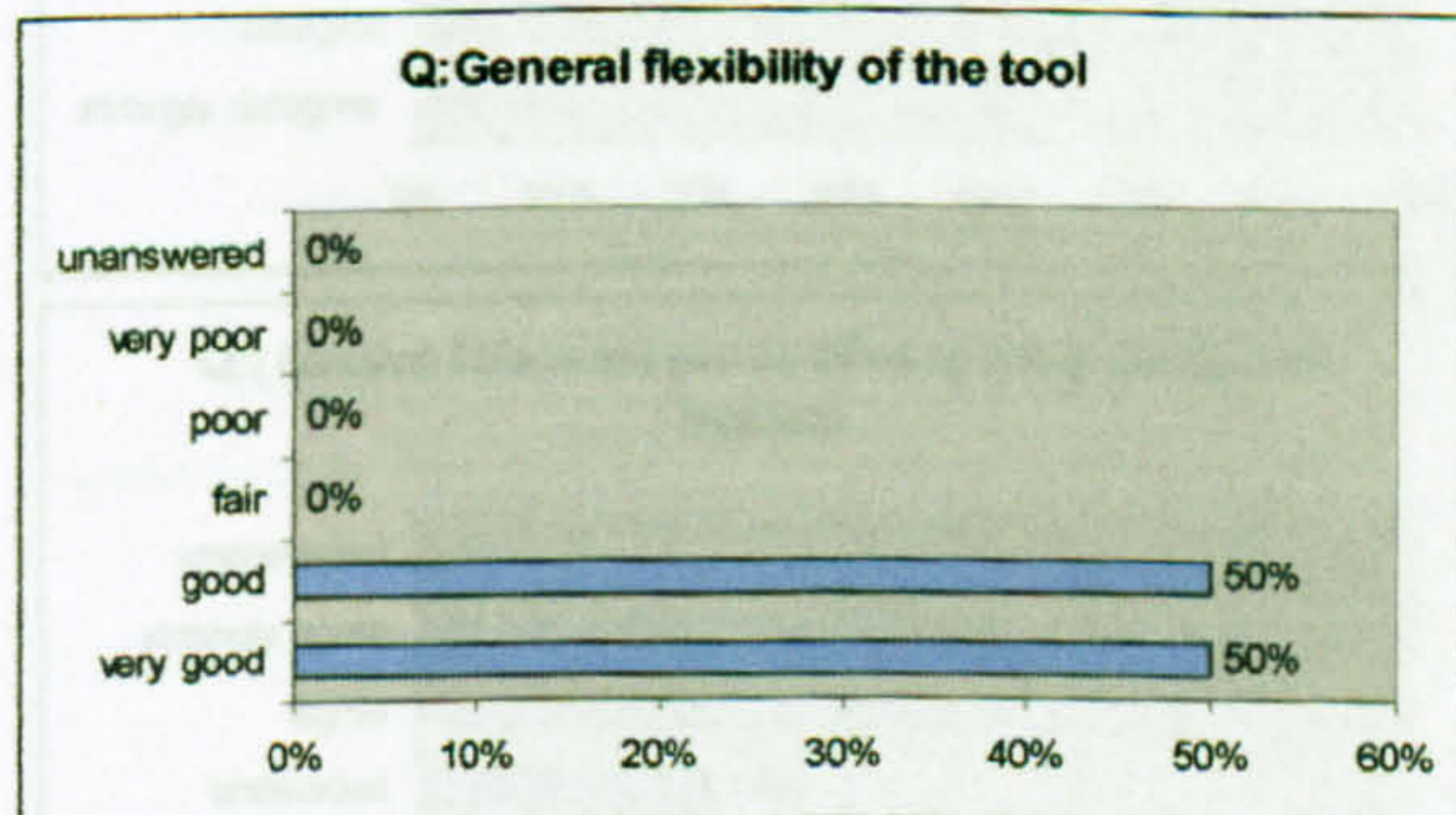
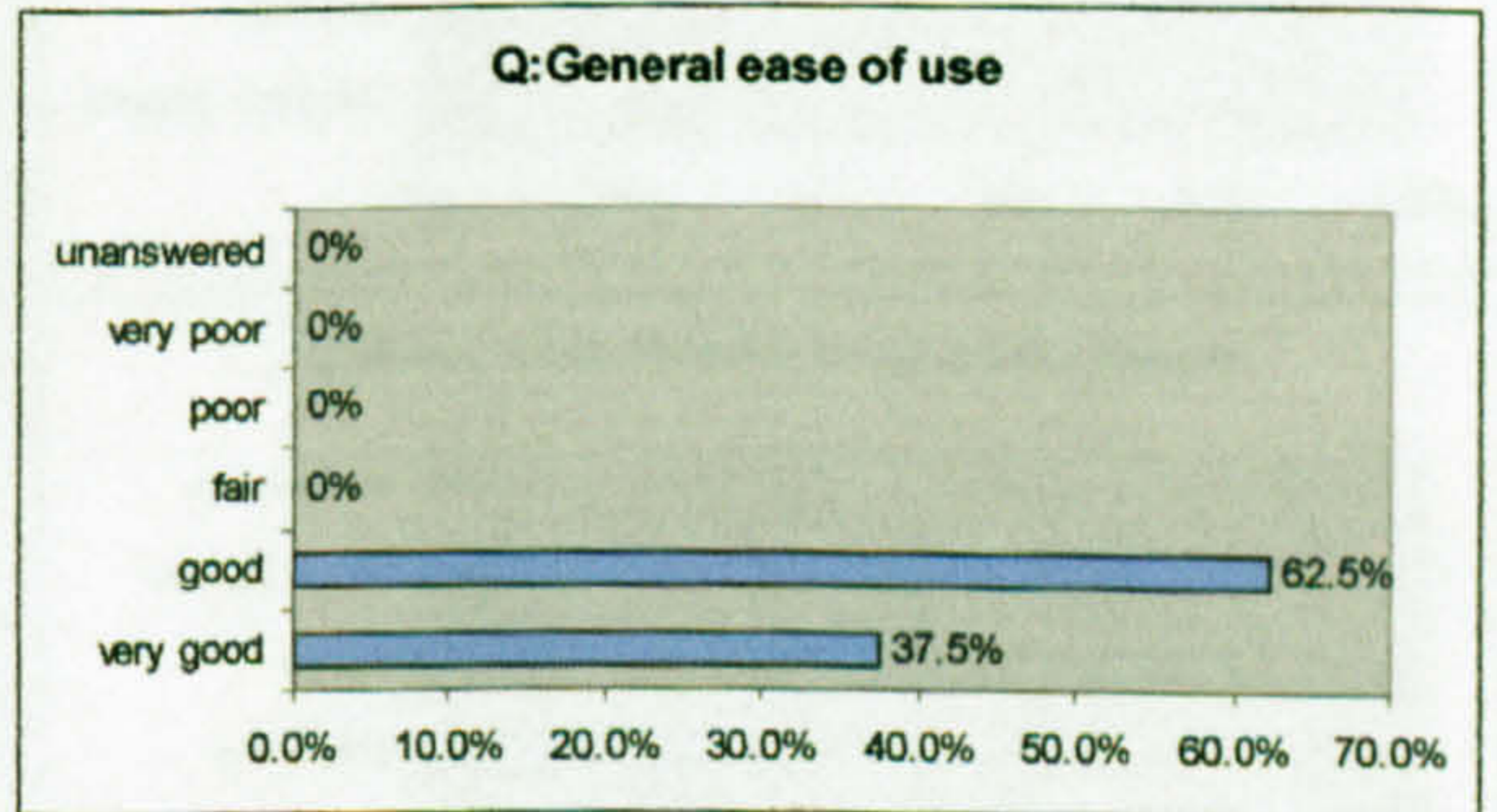
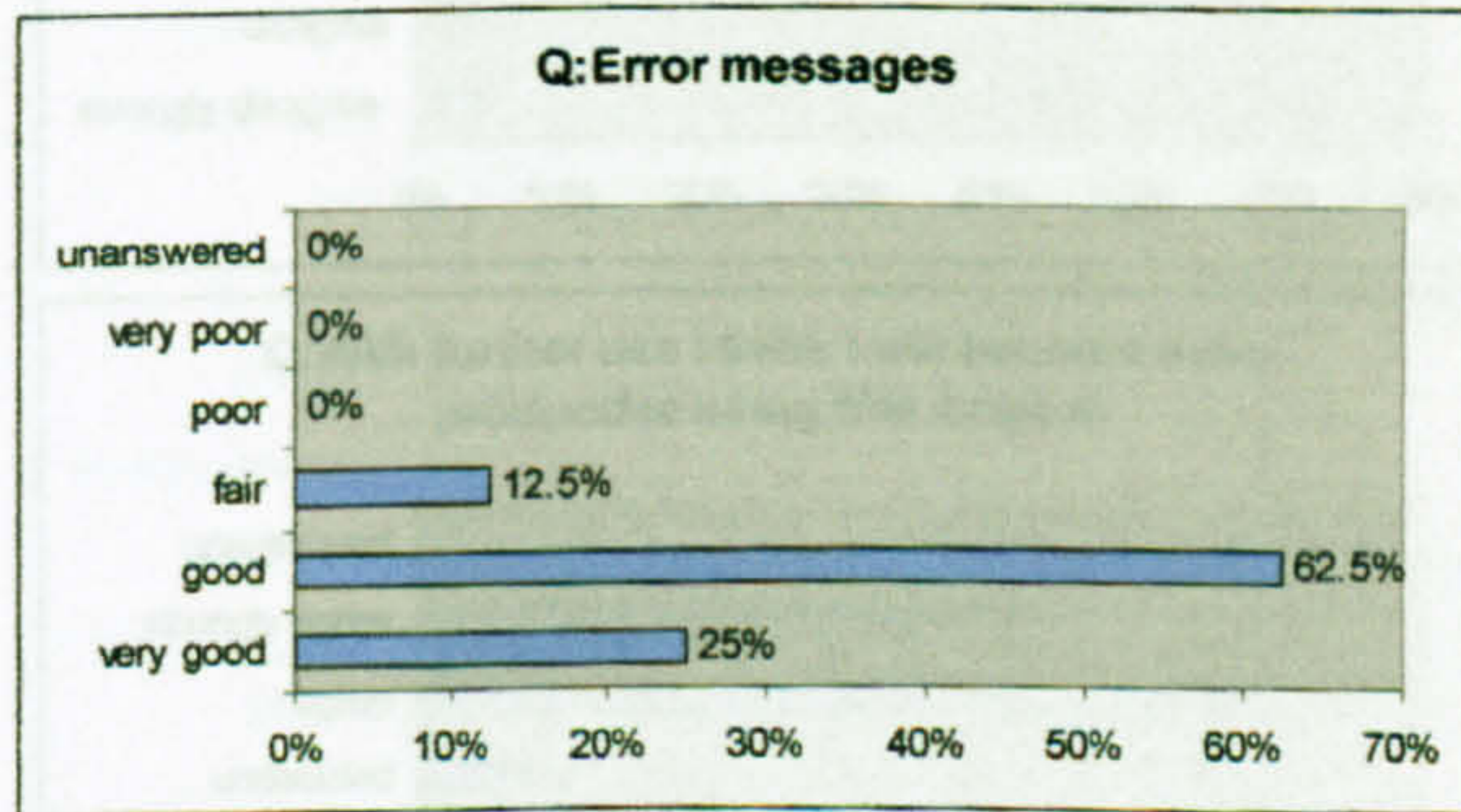
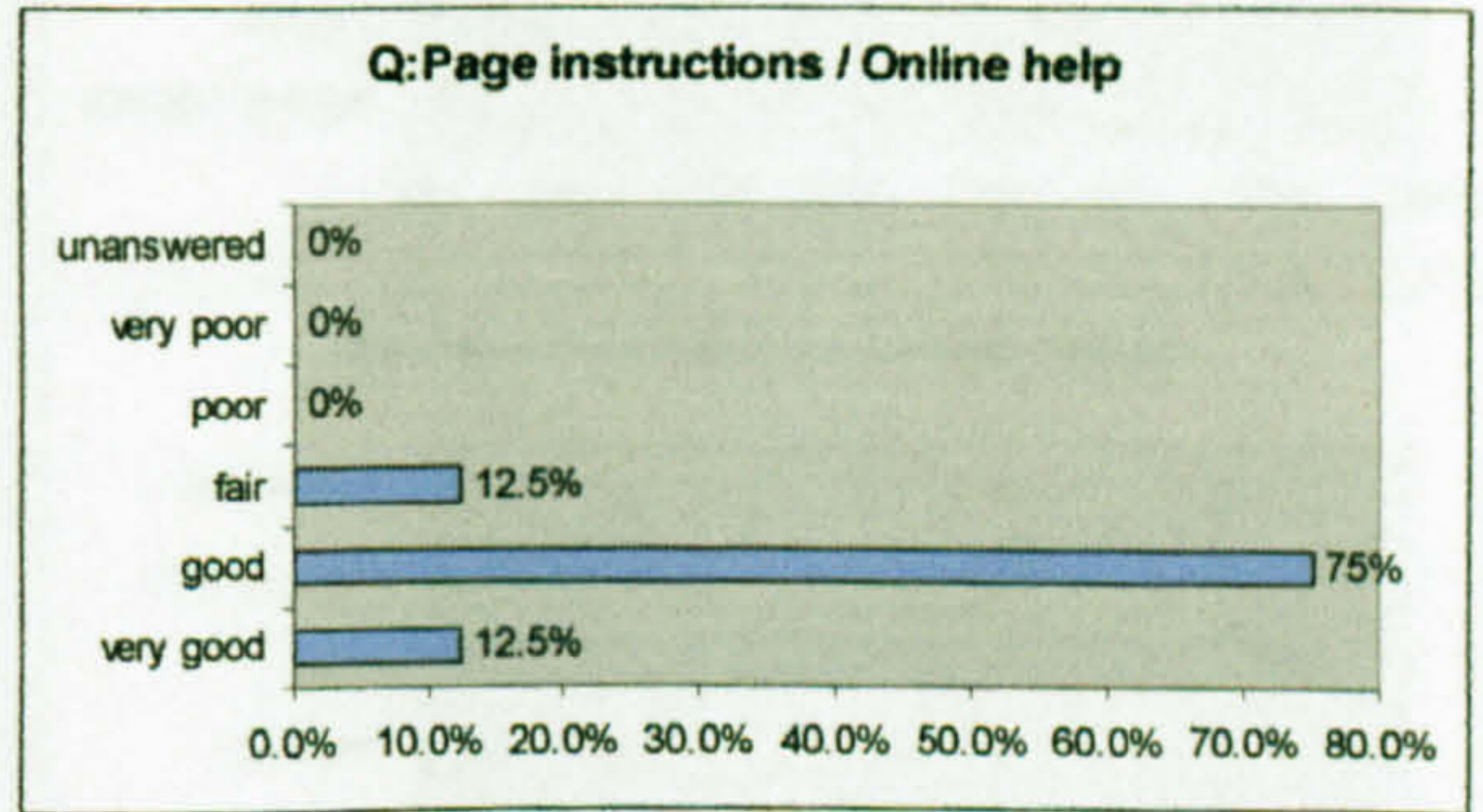
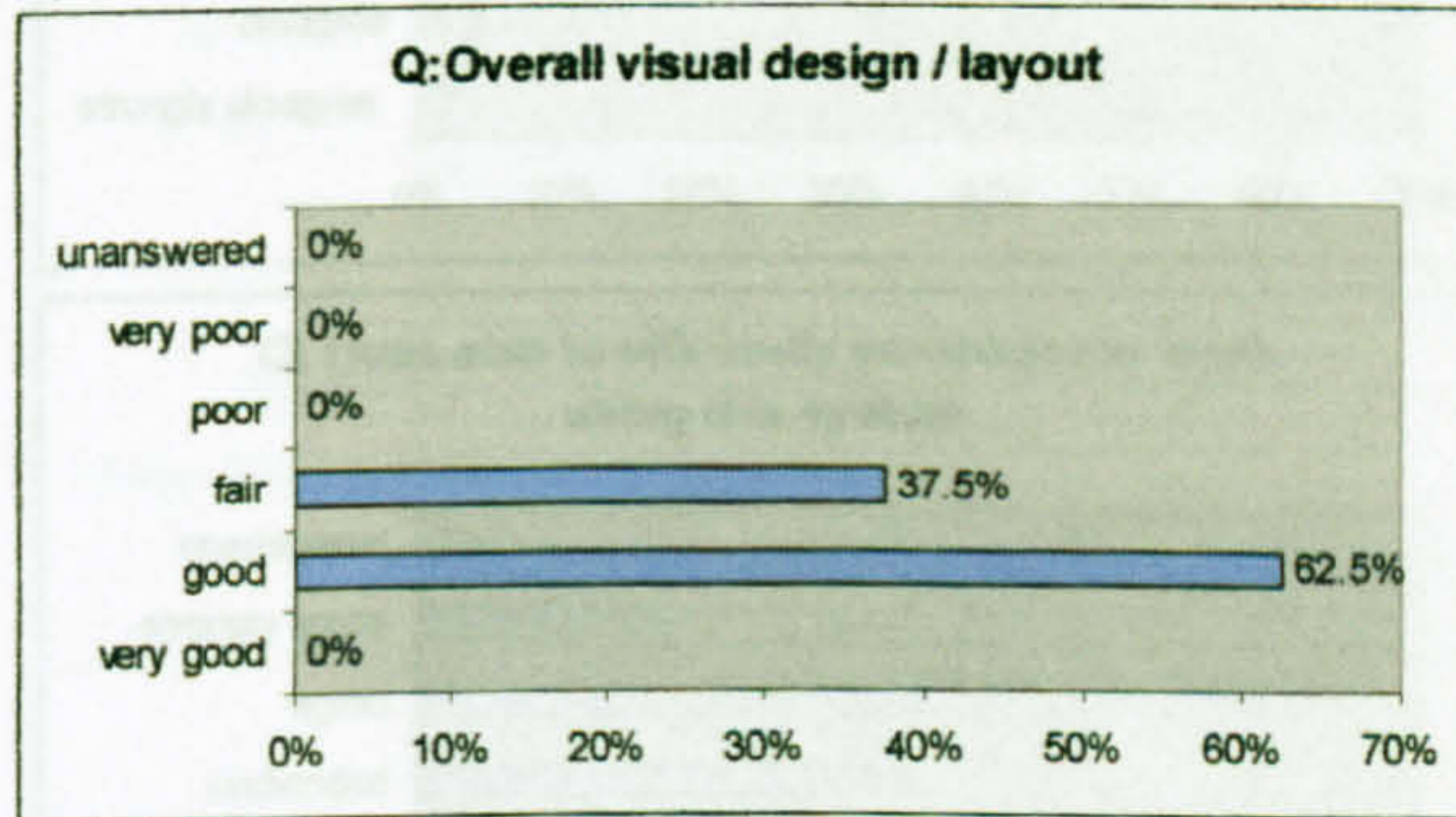


**System Facilities**





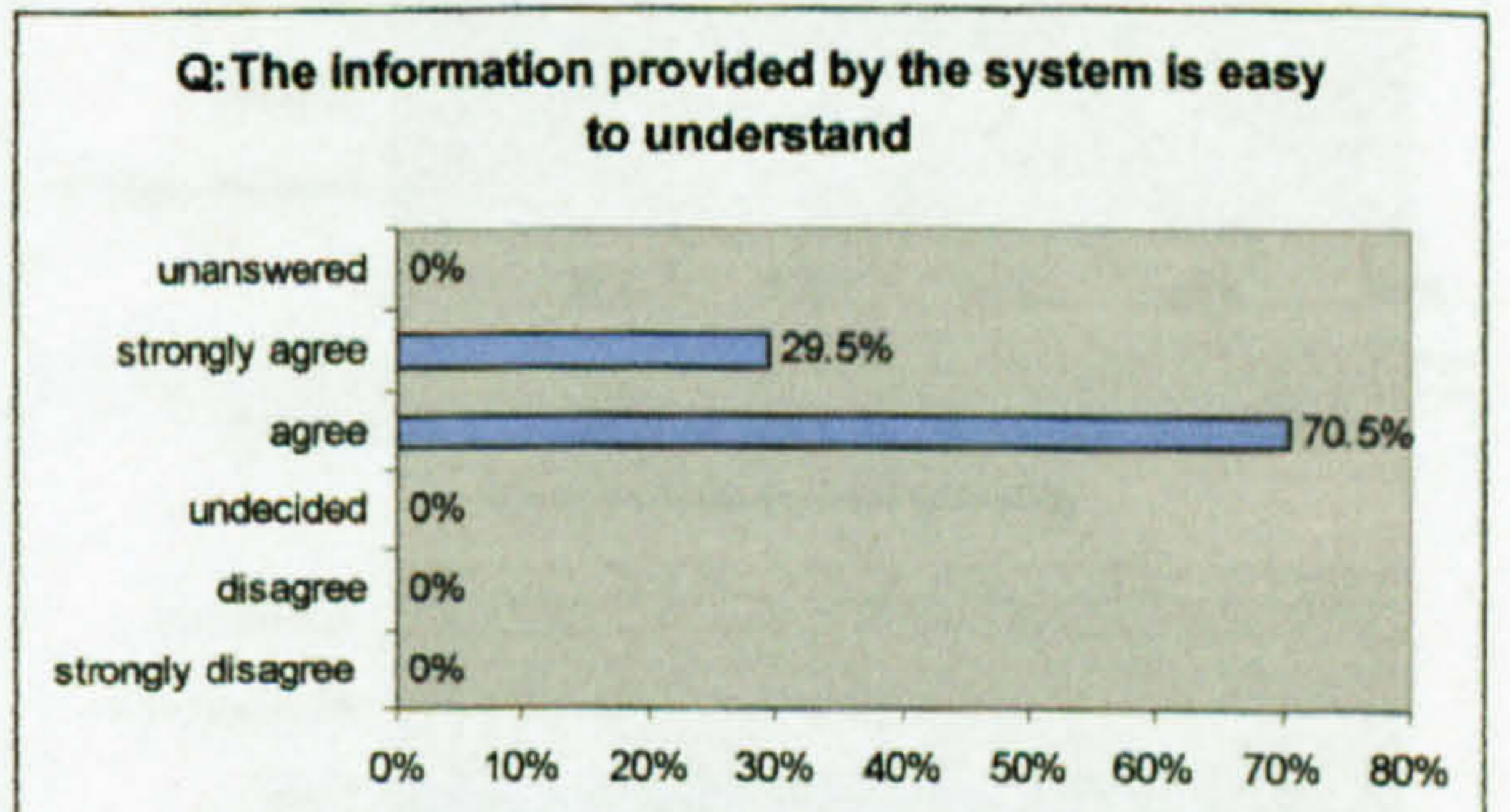
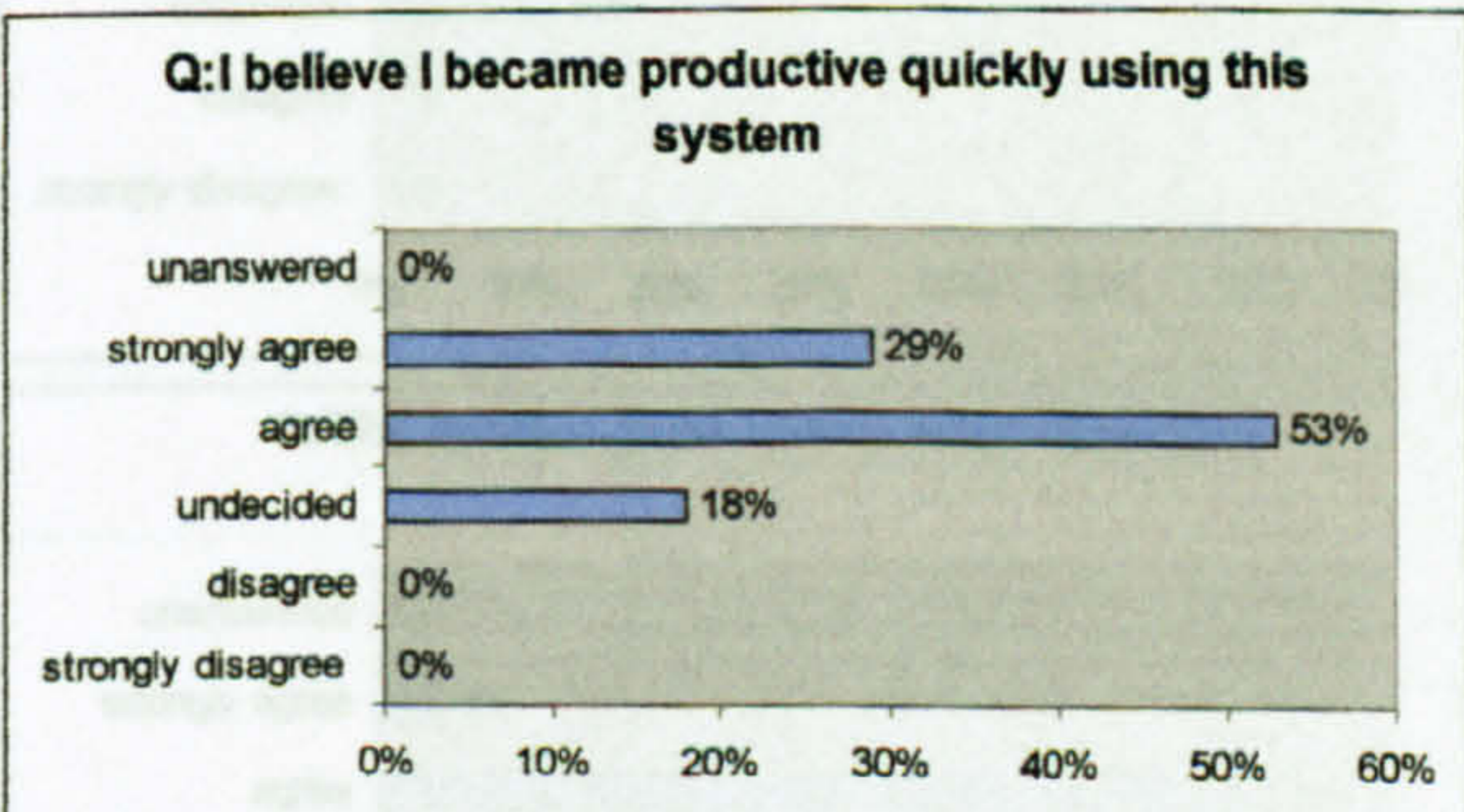
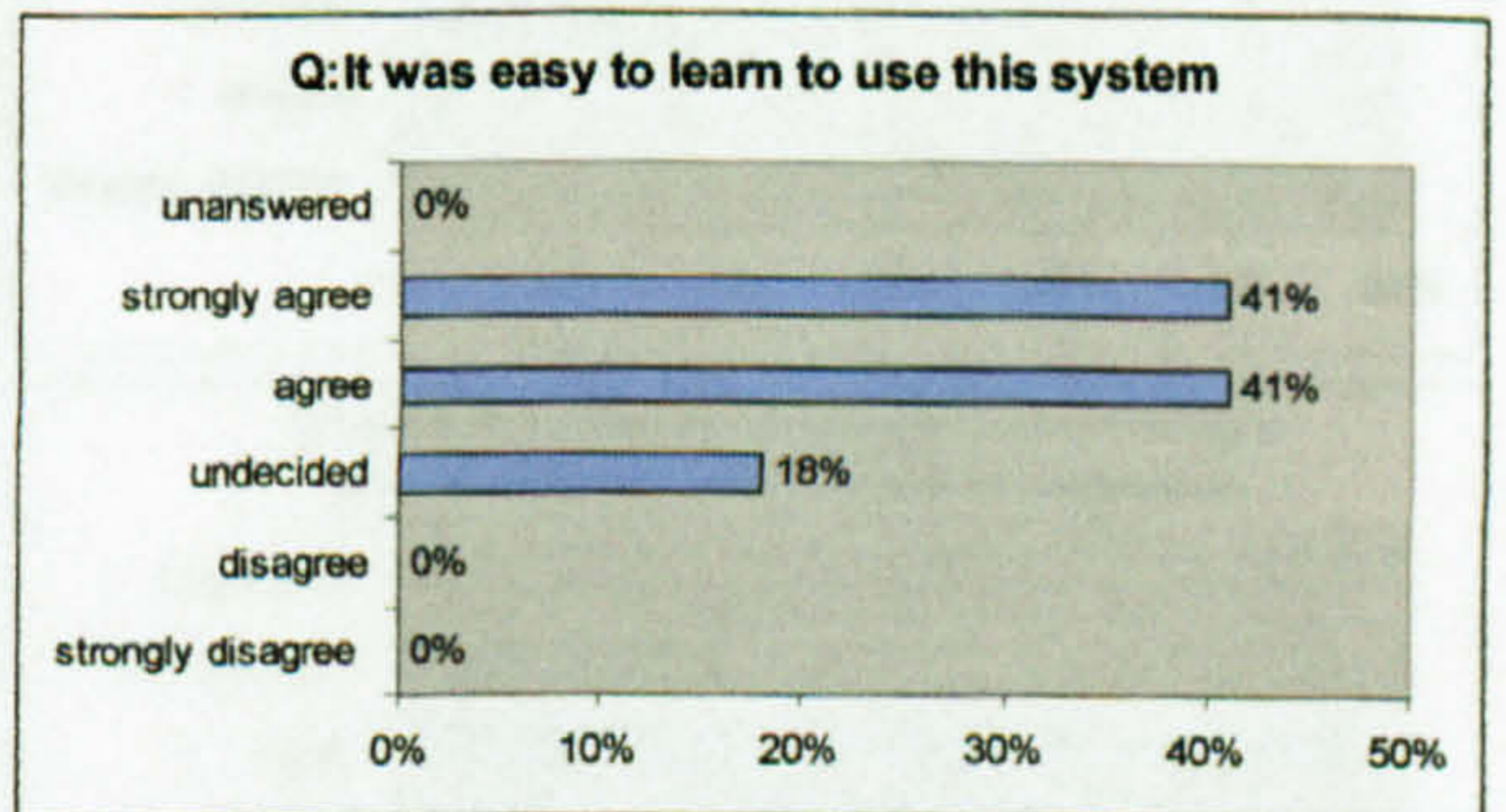
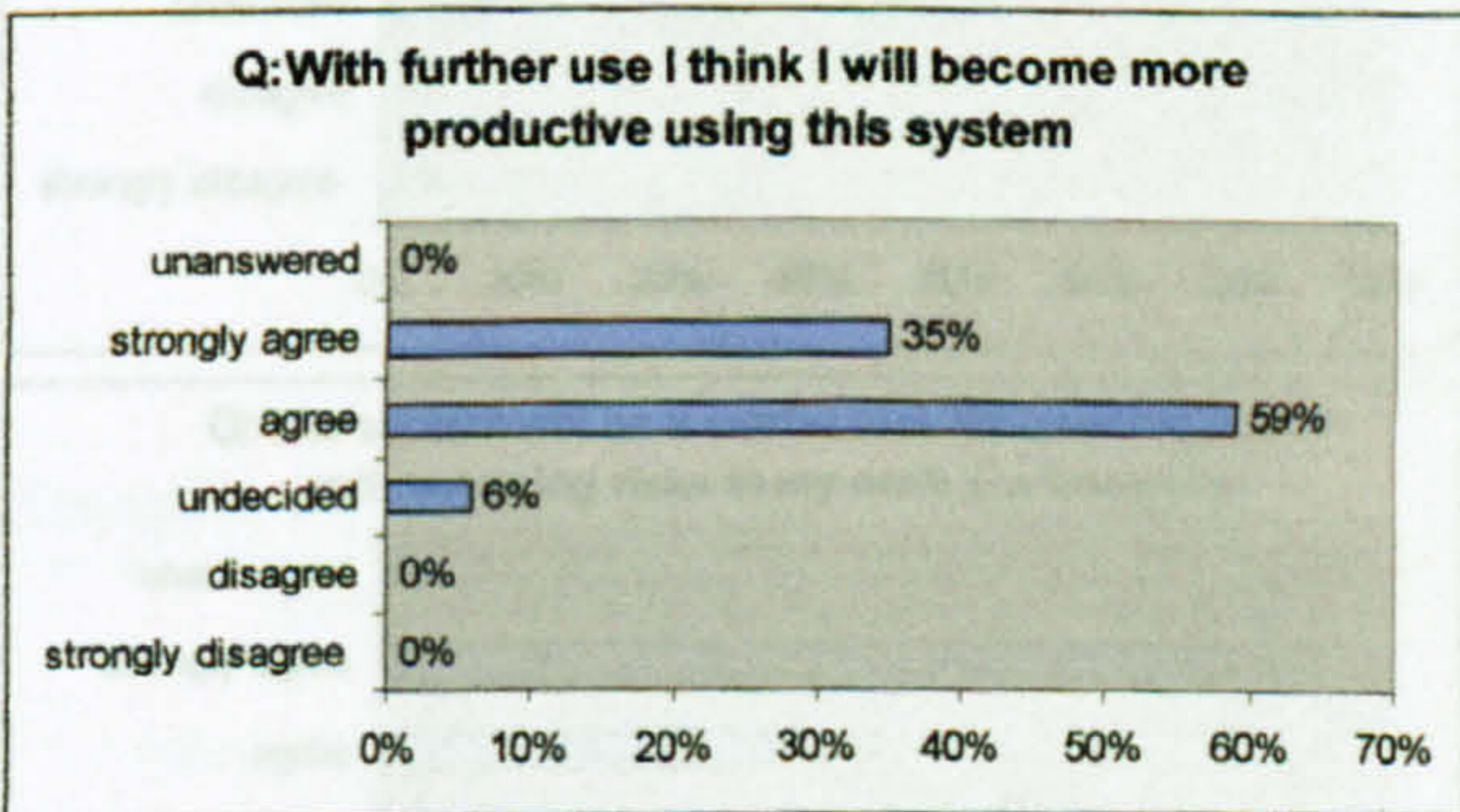
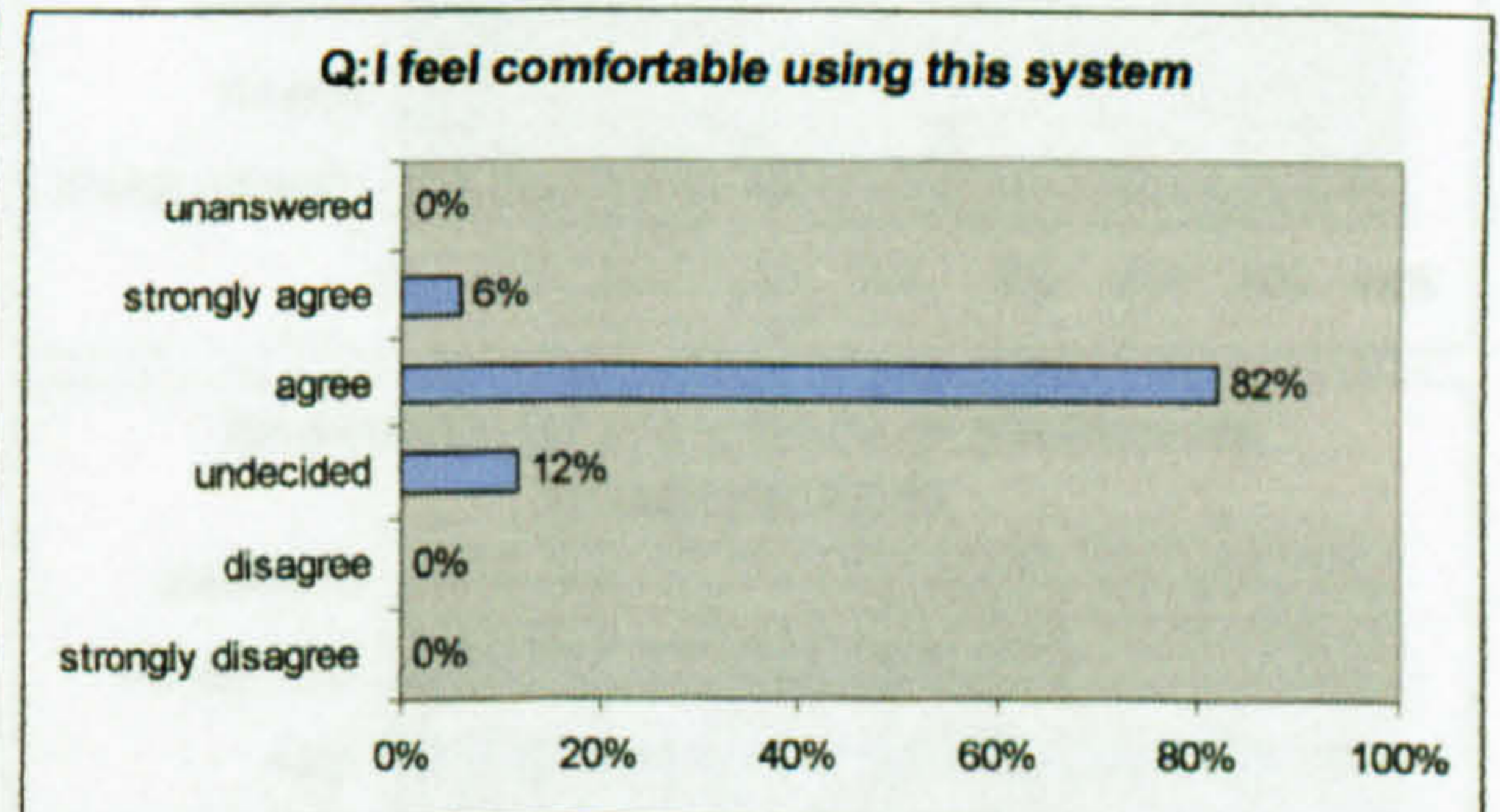
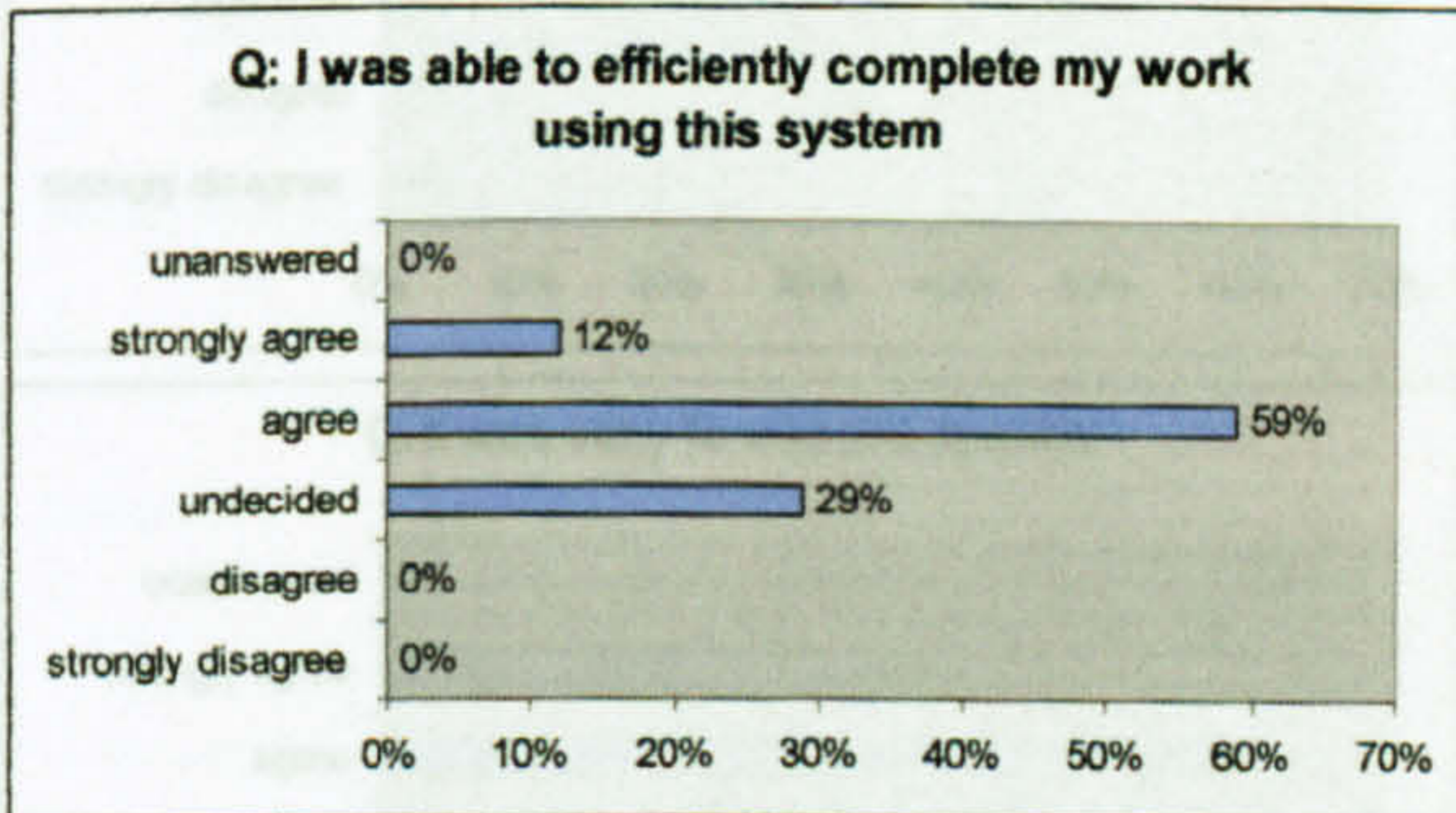
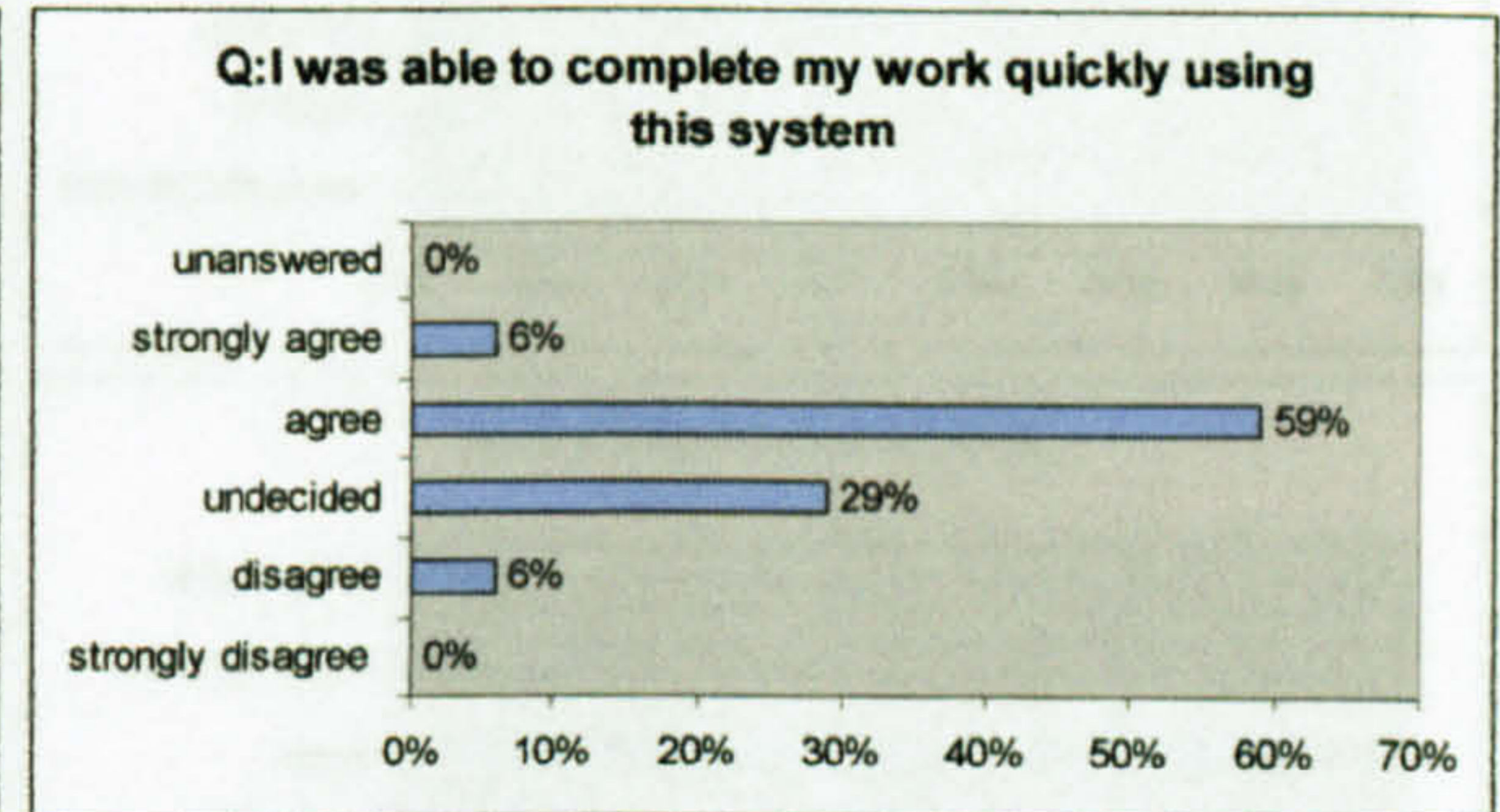
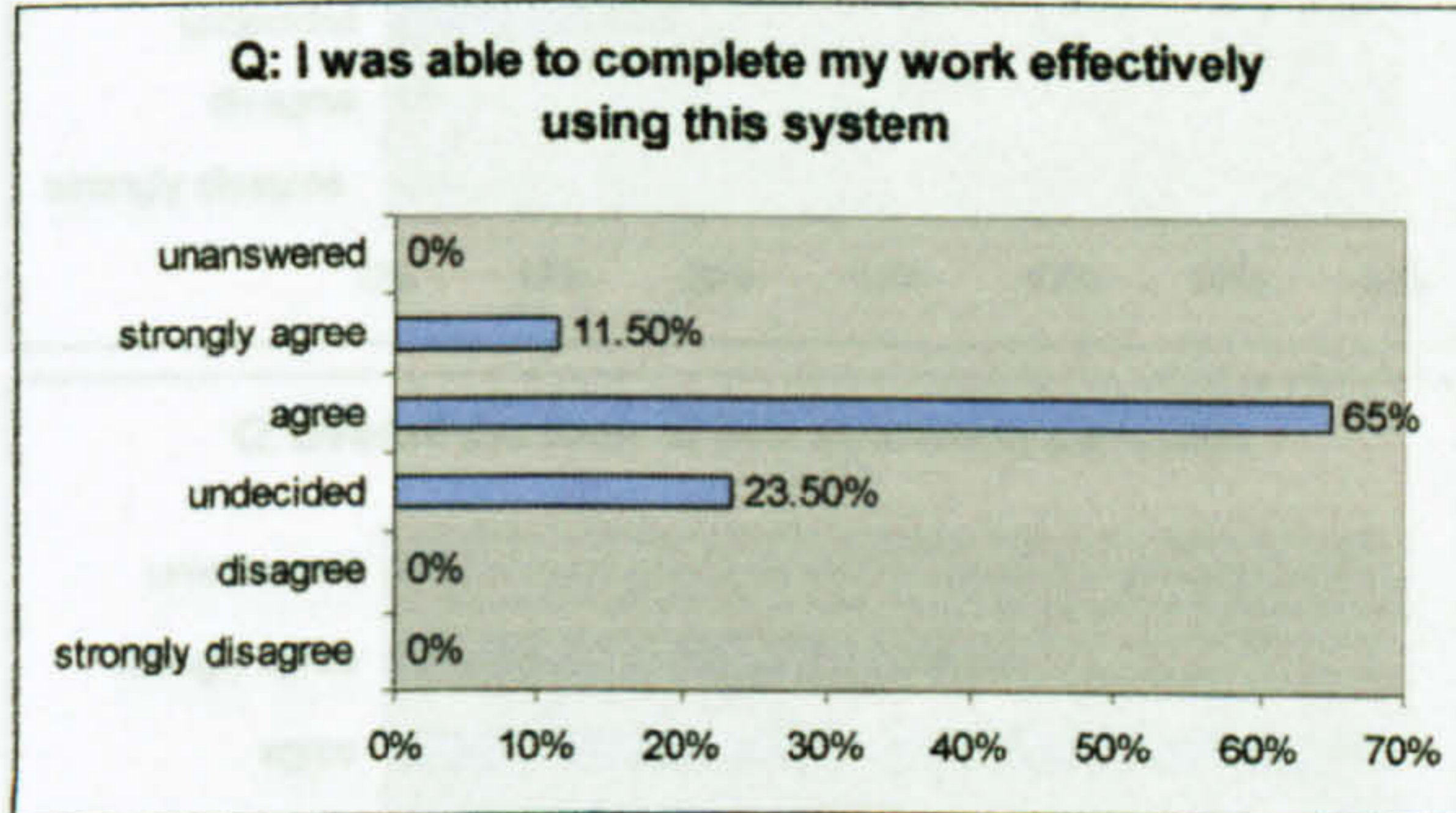
**System Interface**

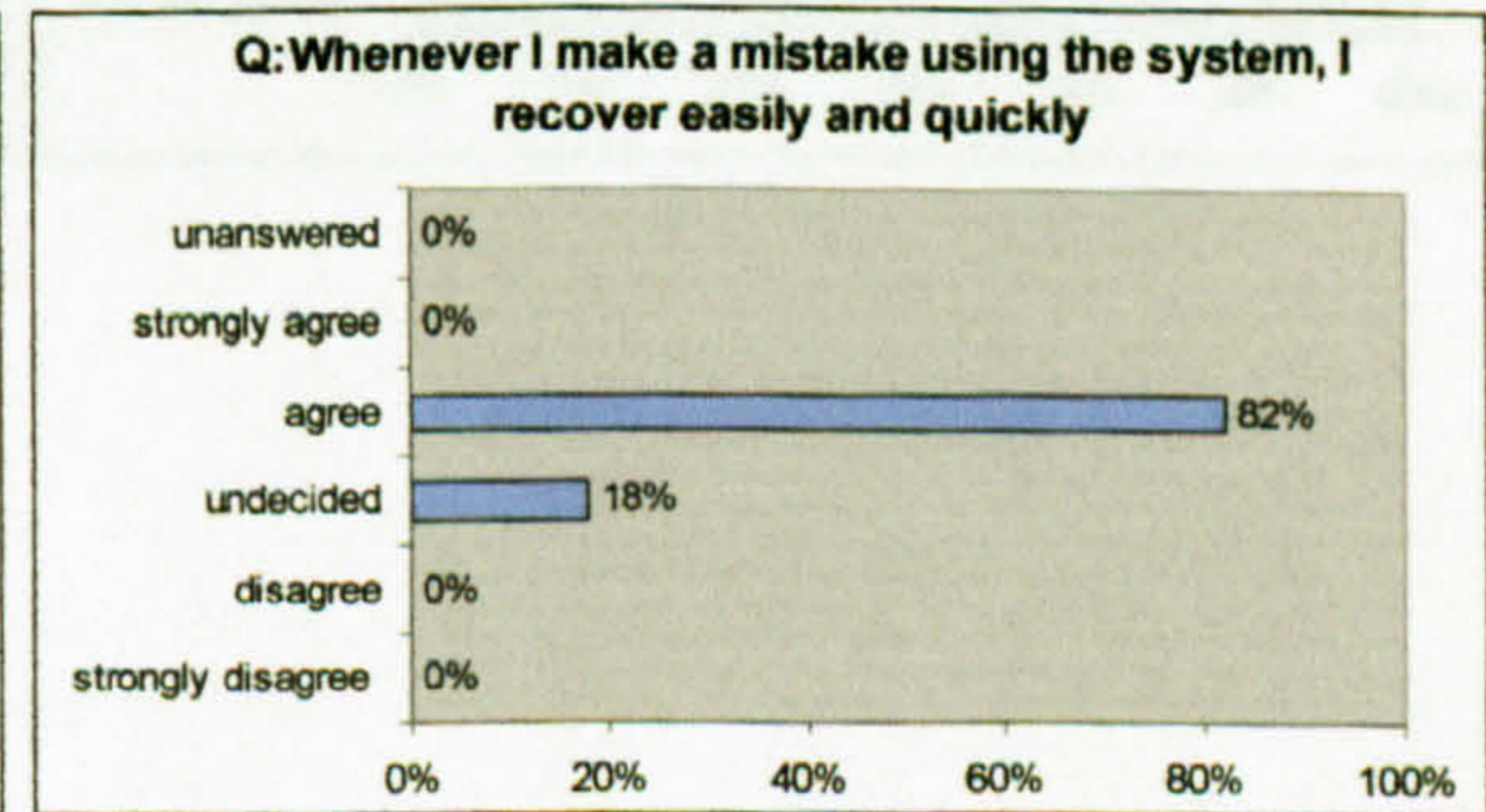
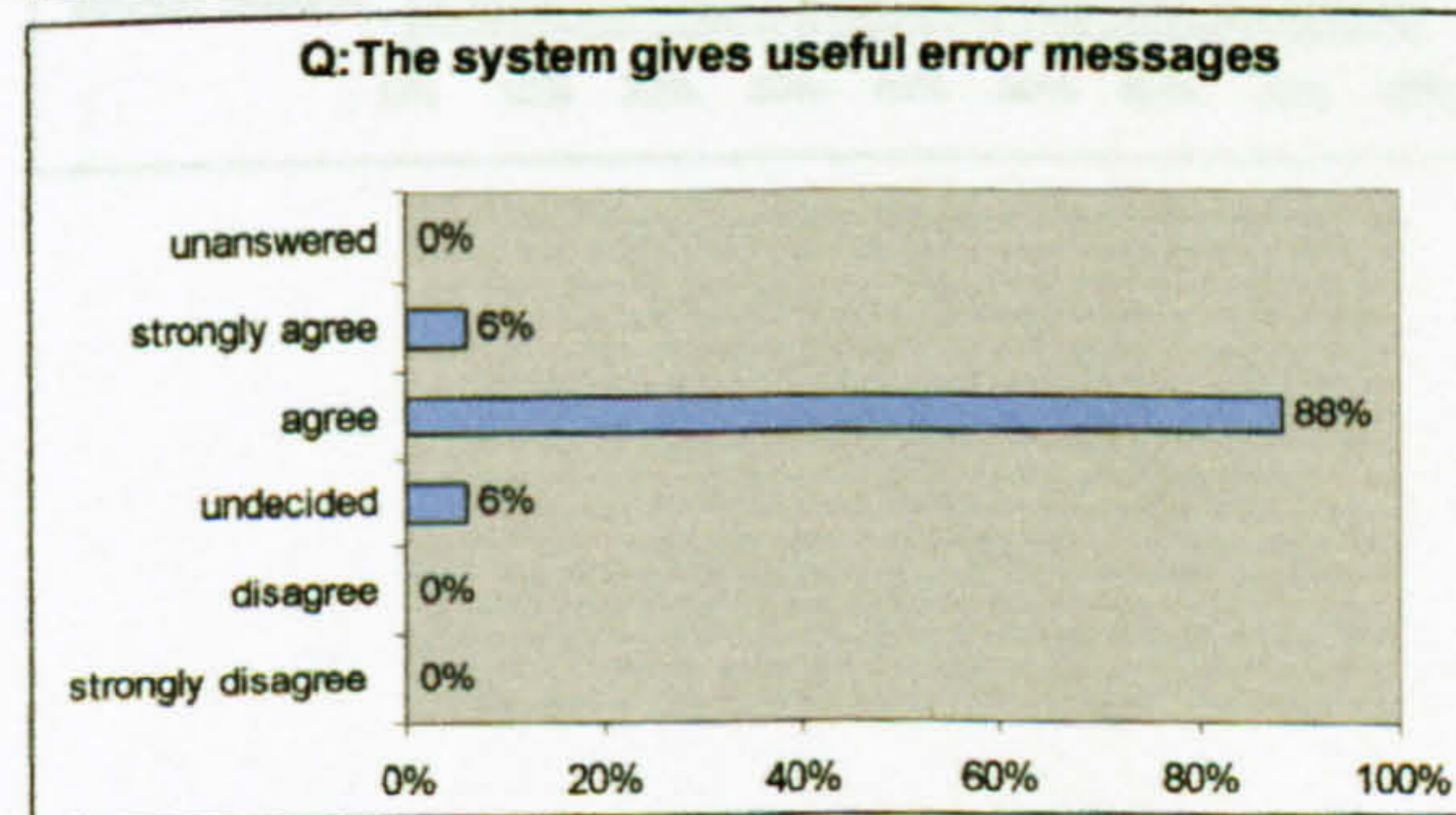
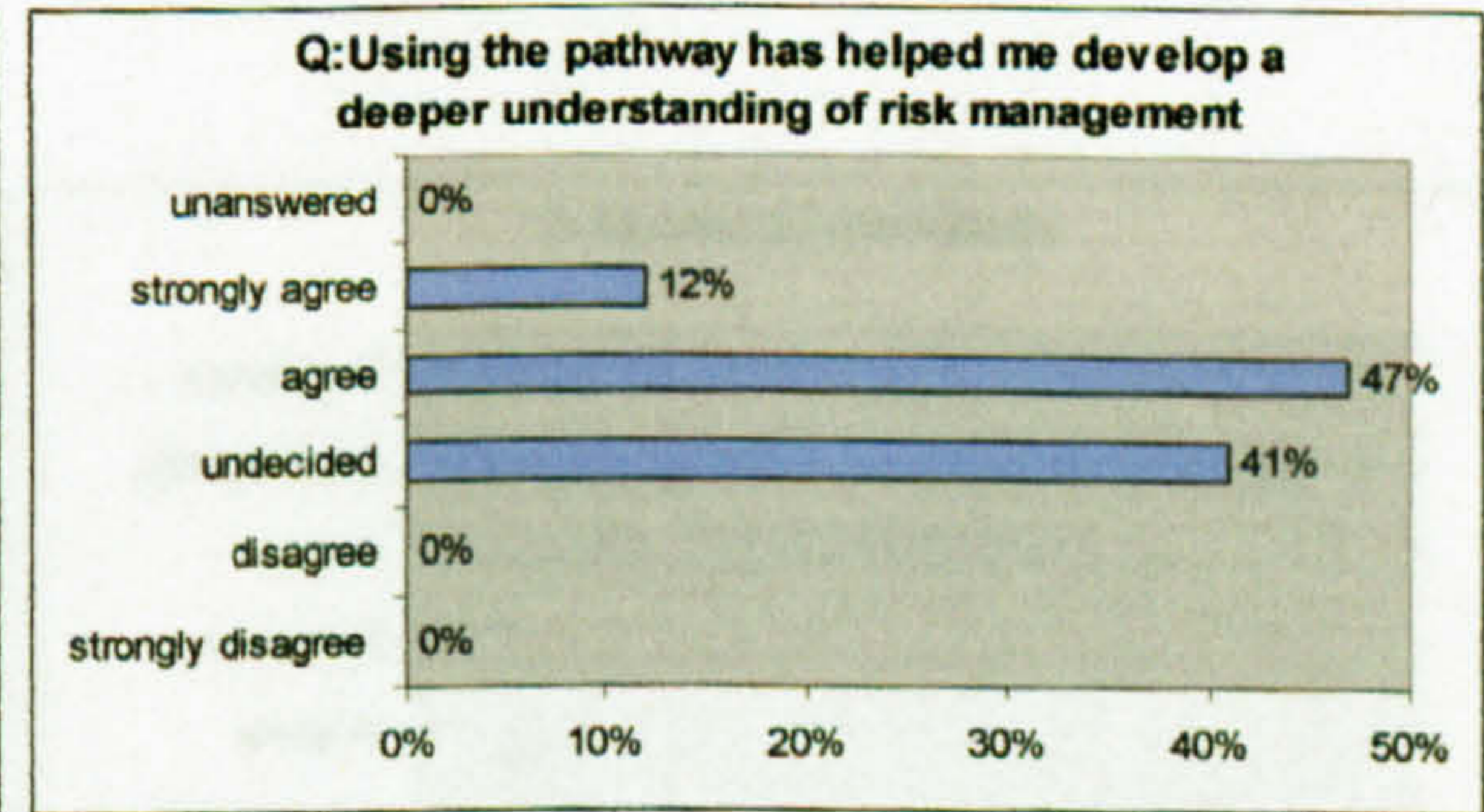
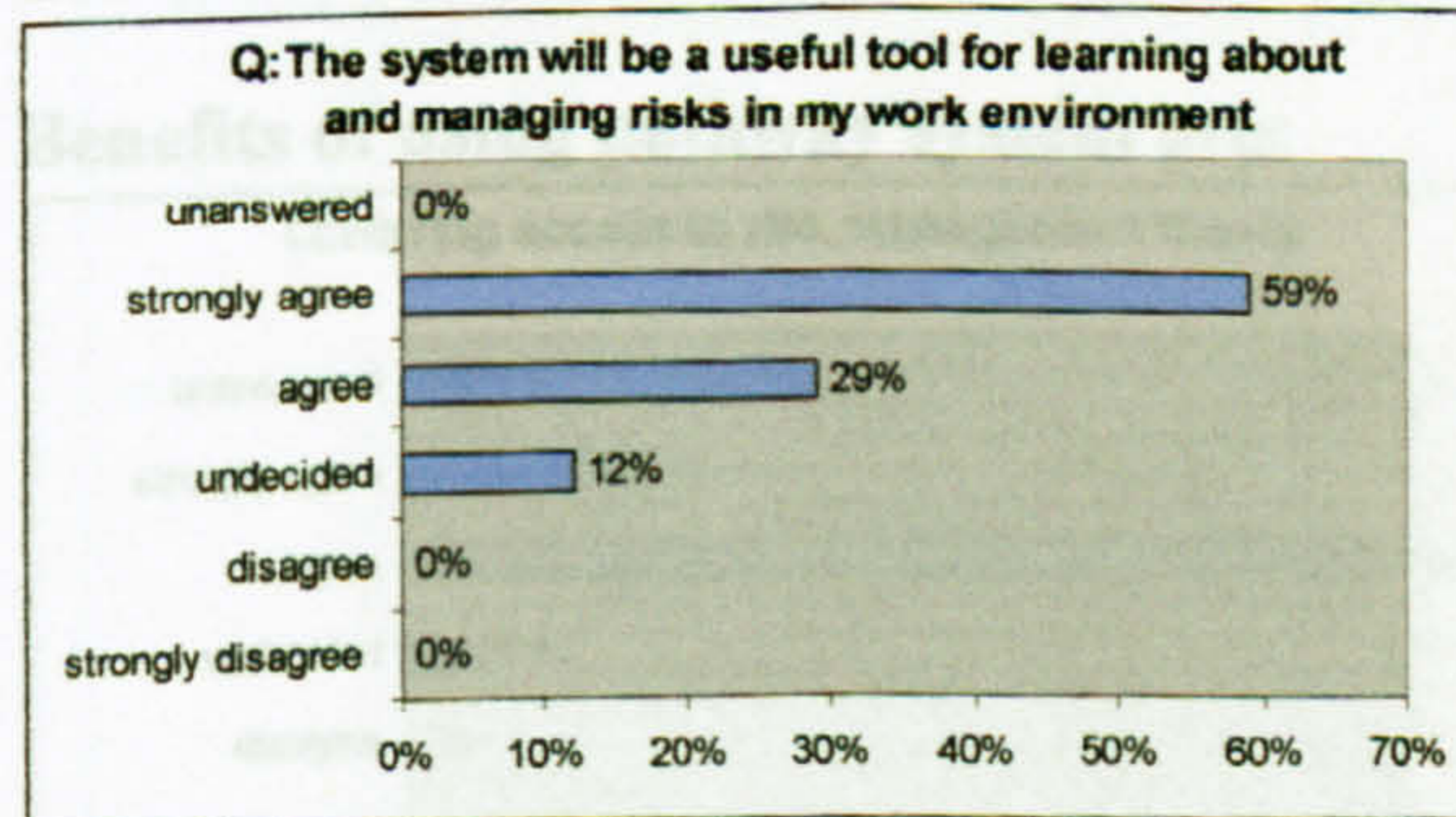
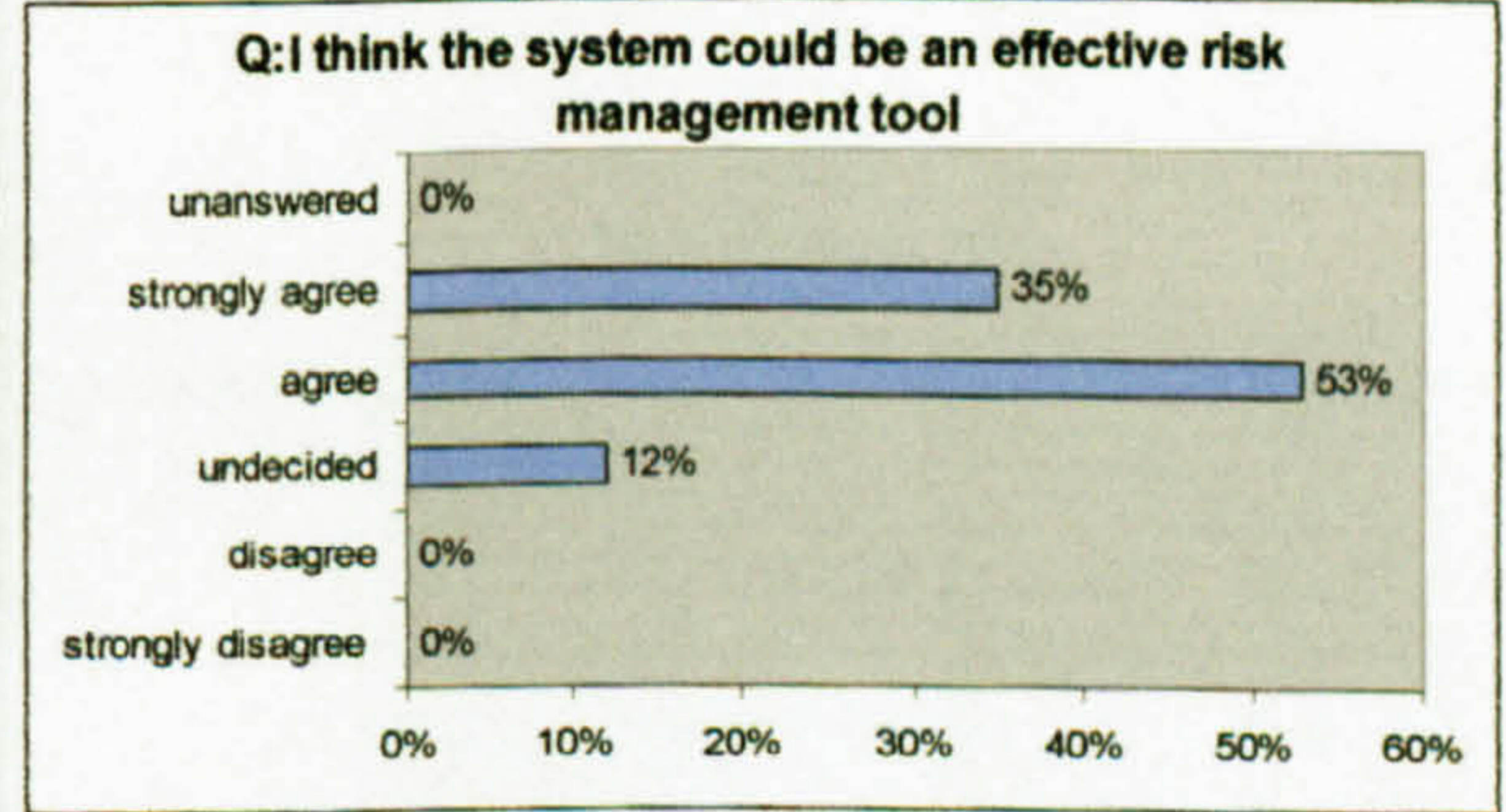
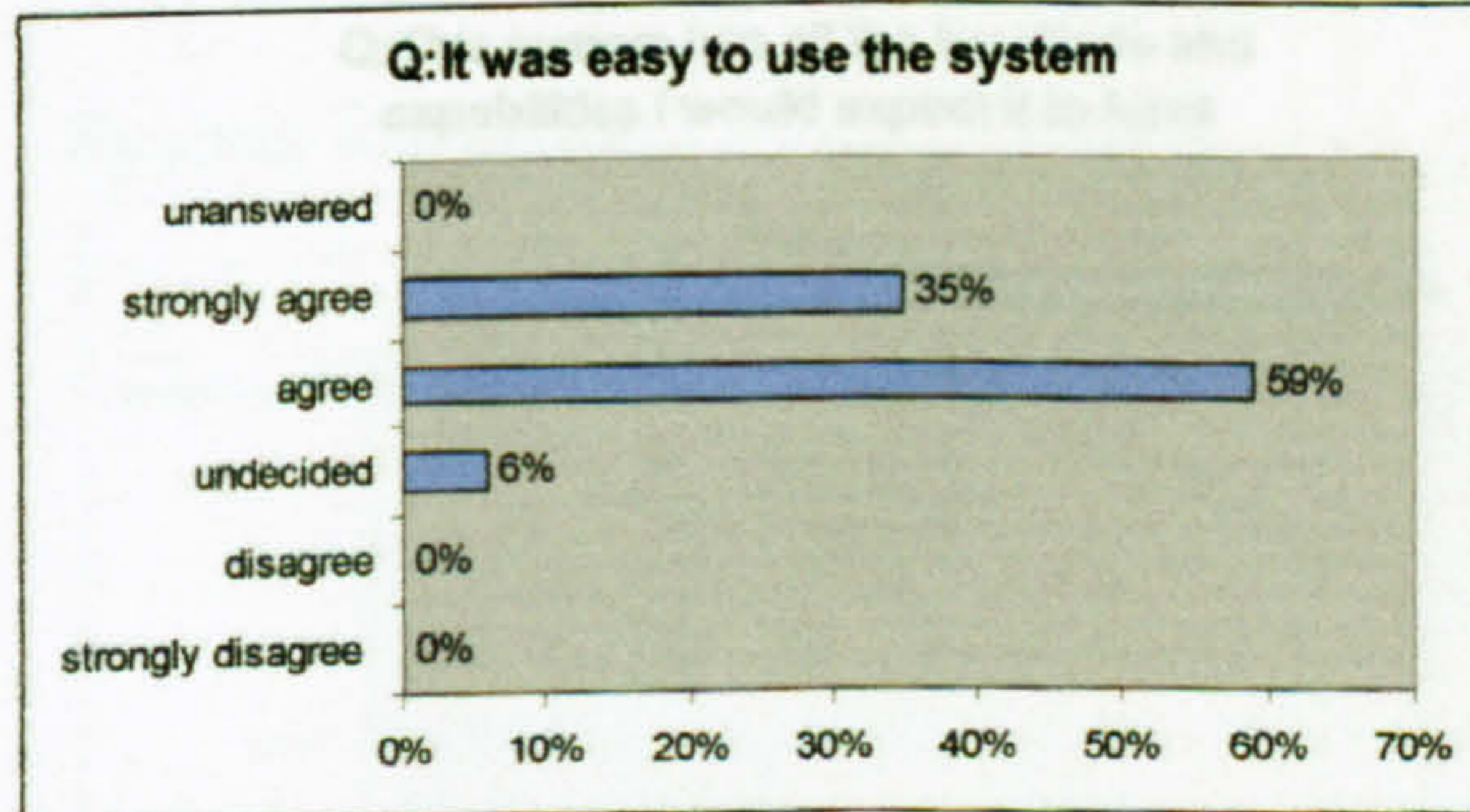
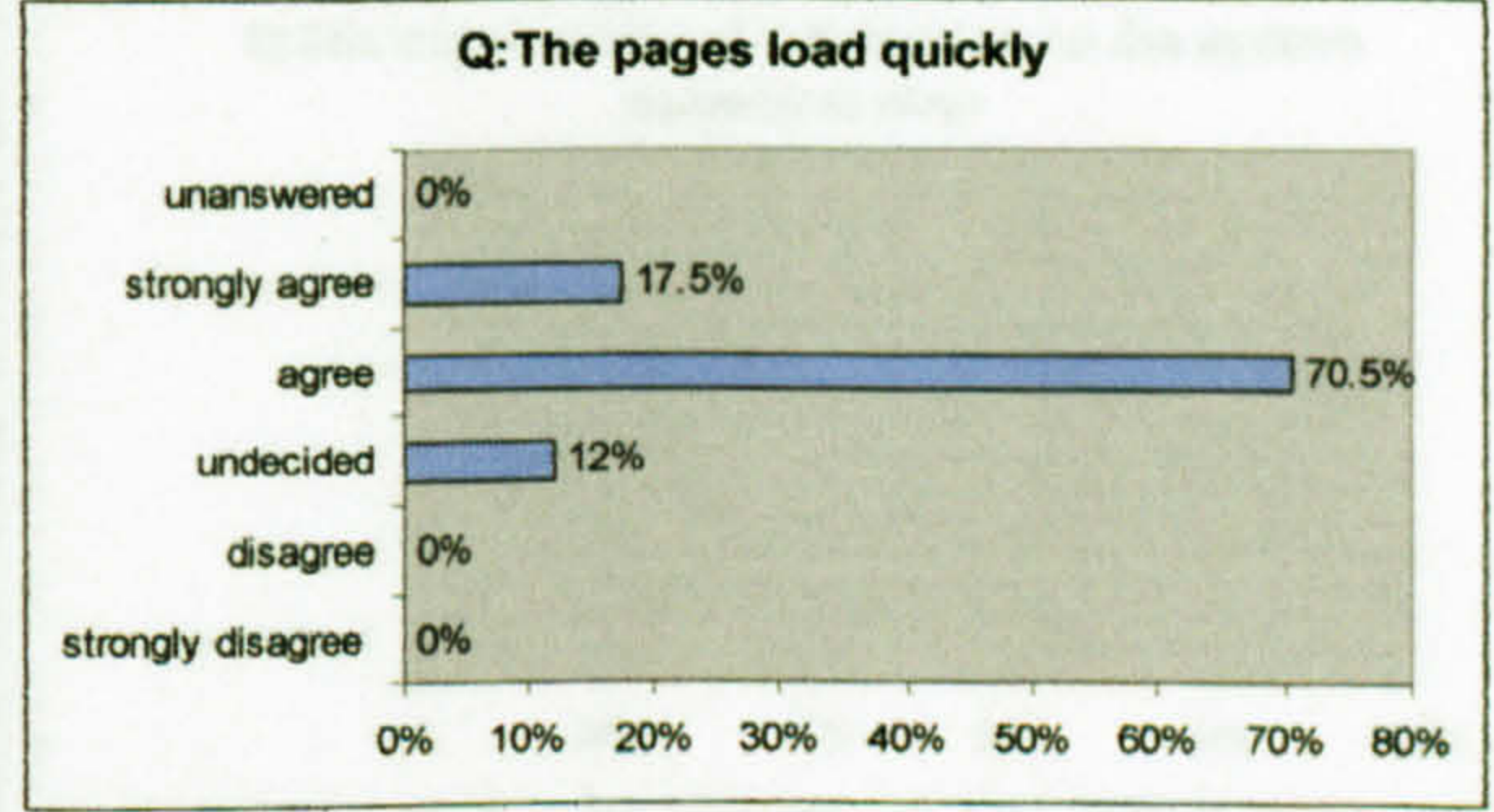
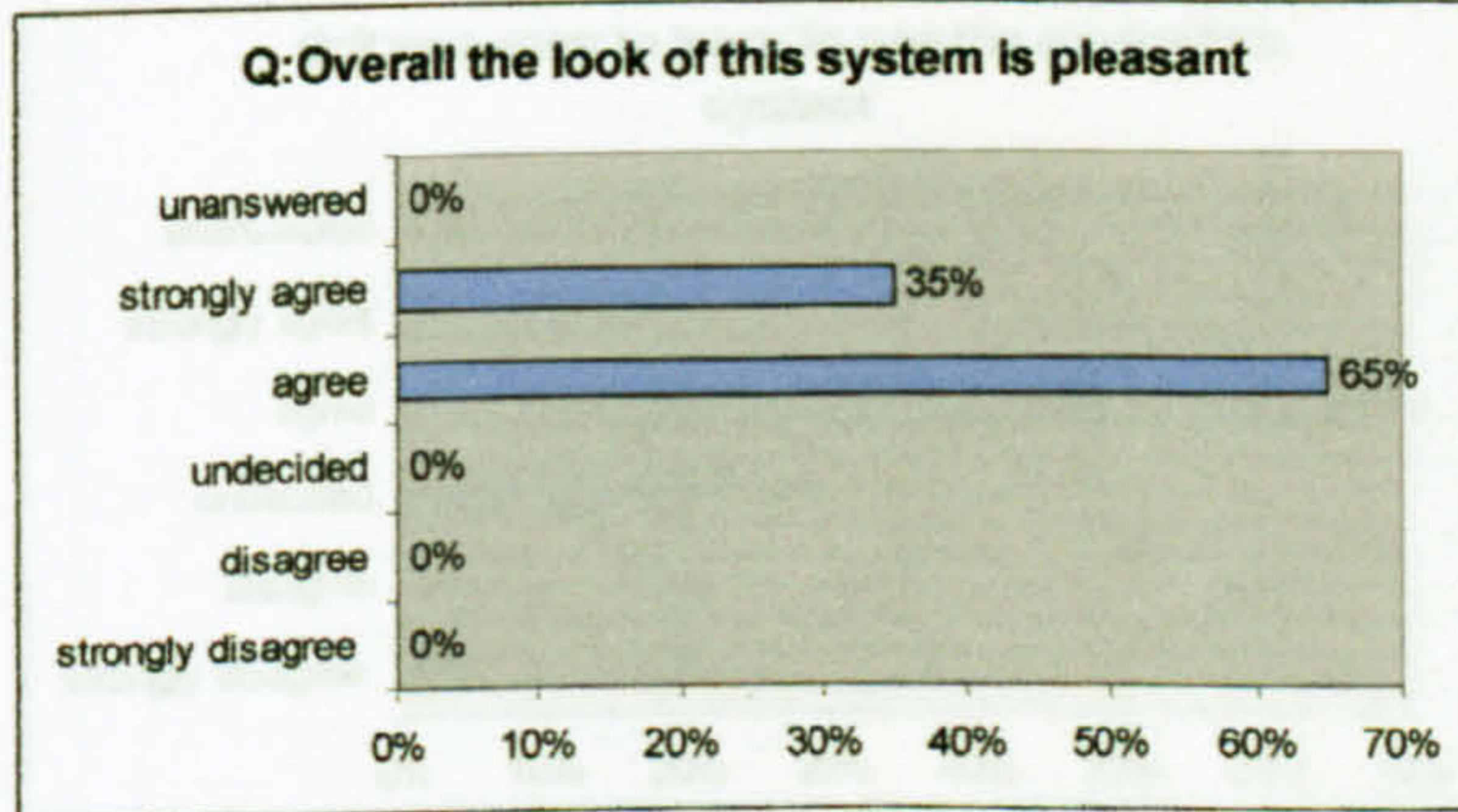
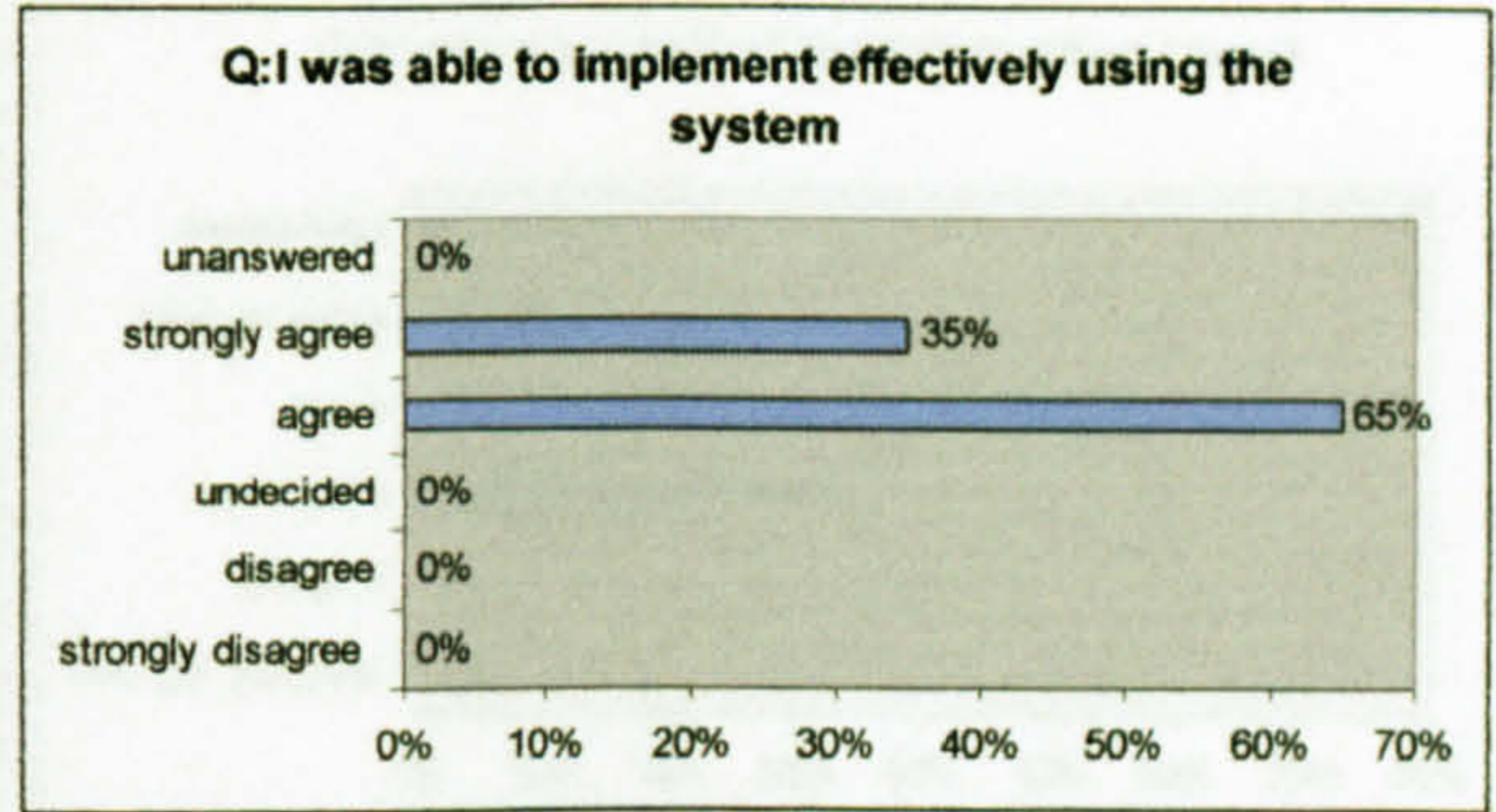
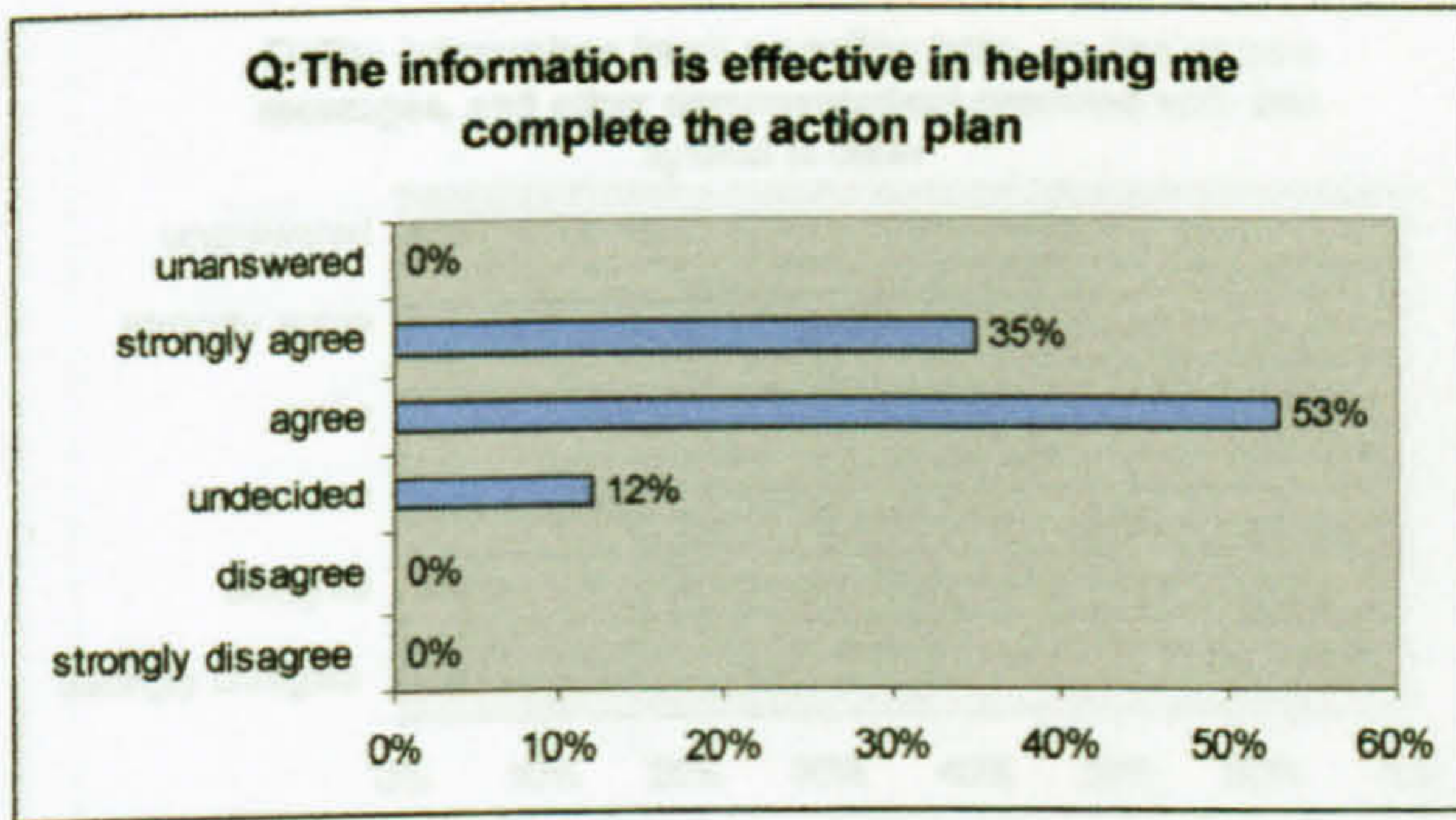


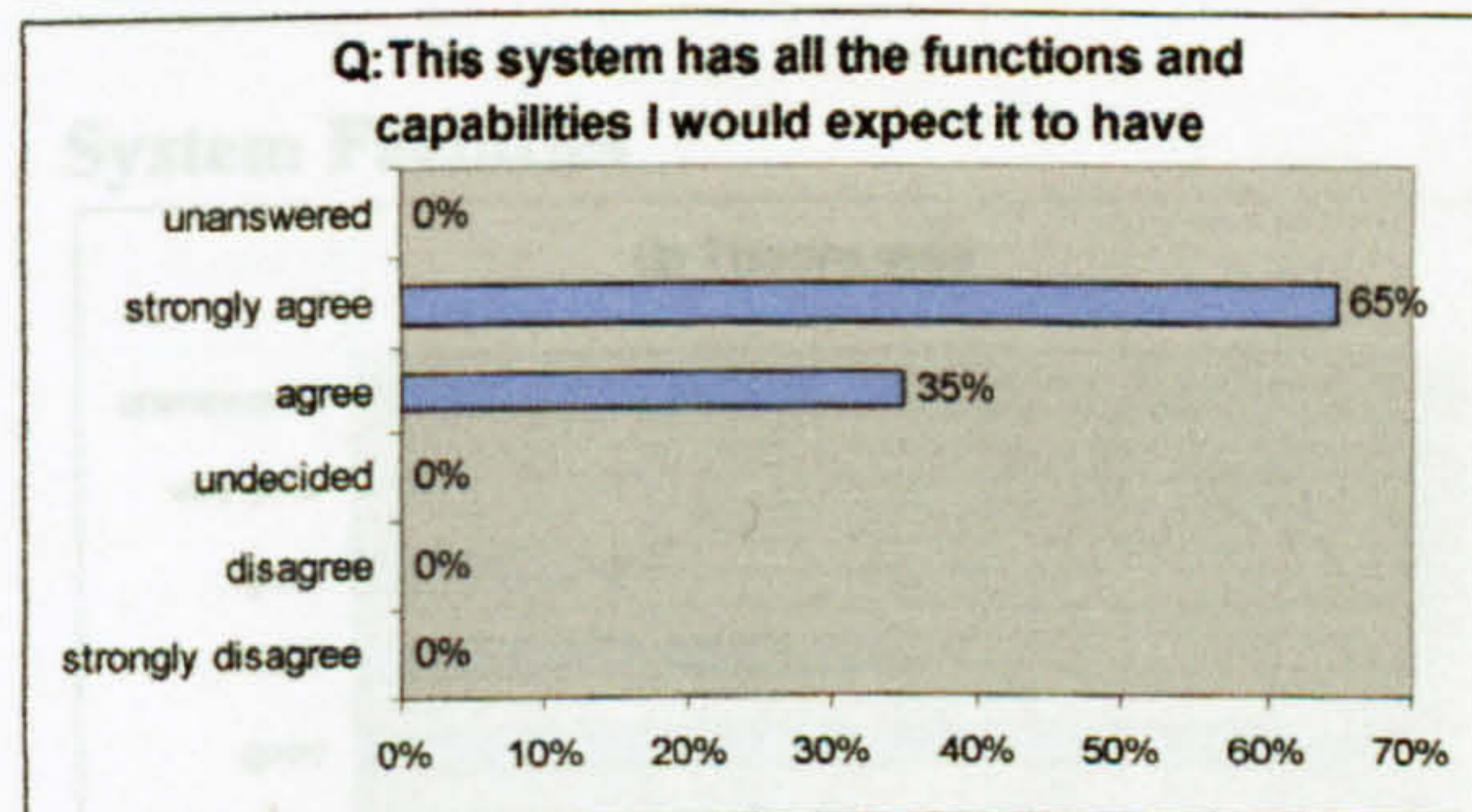
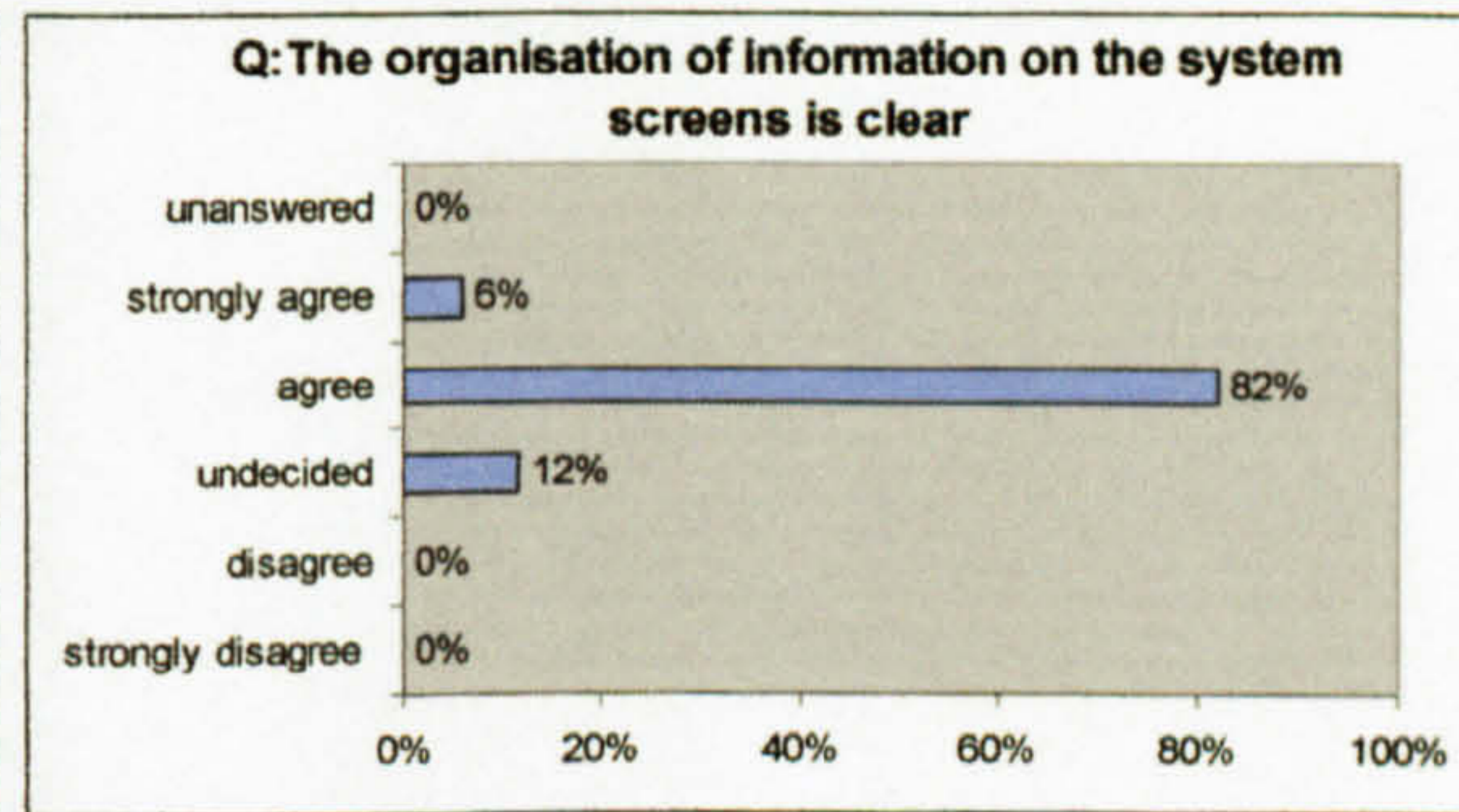
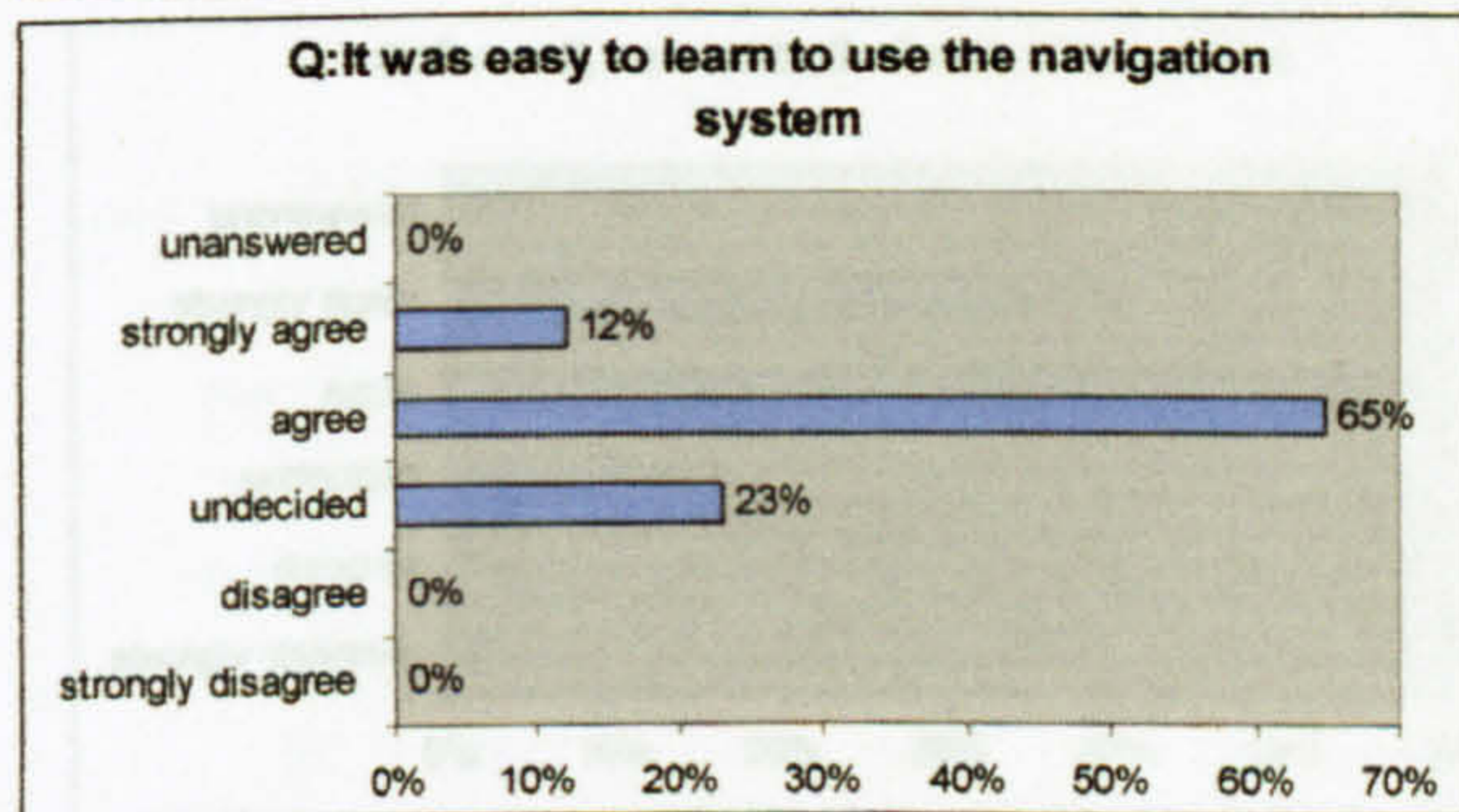
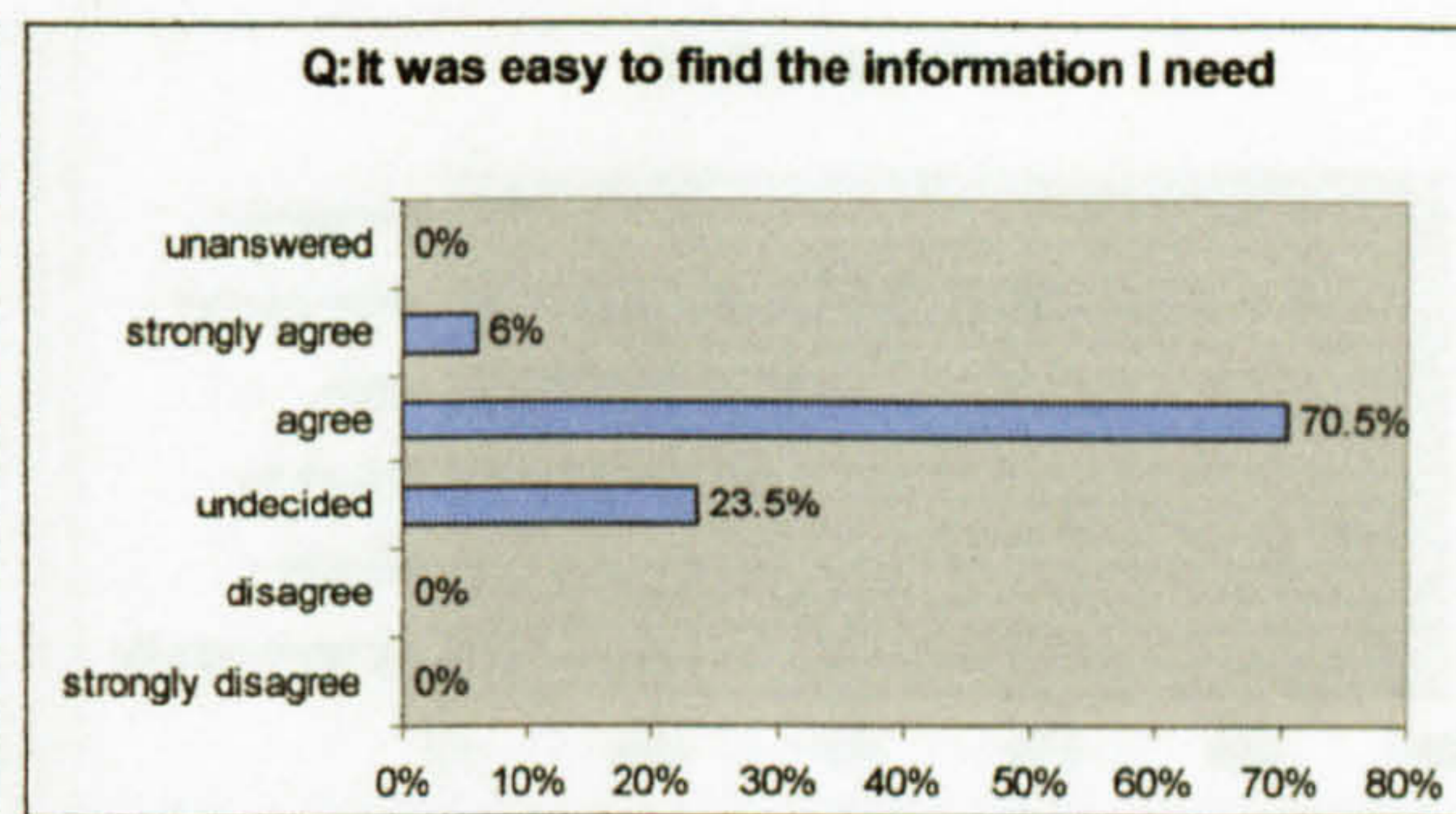
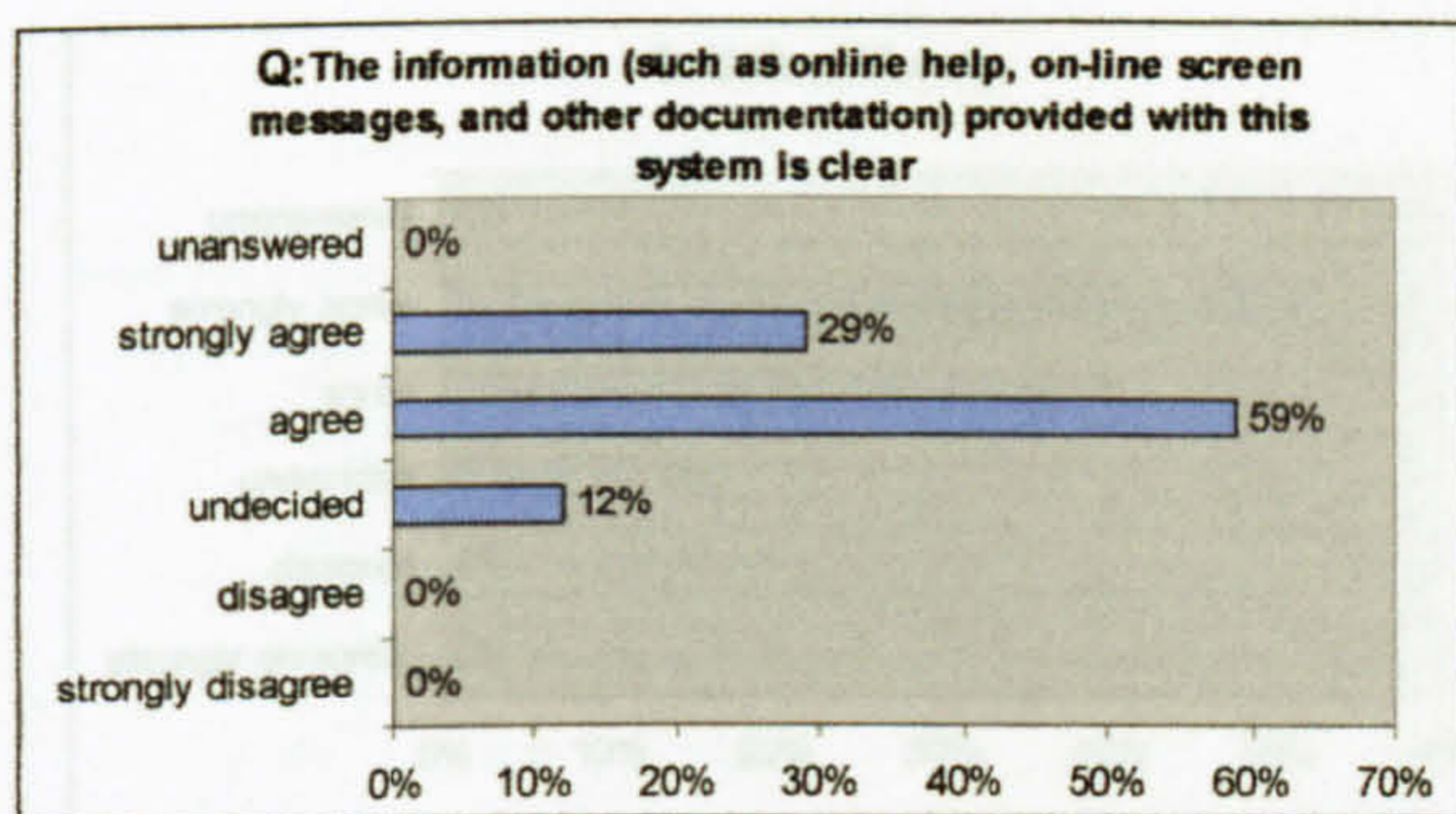
## Pilot Testing

### It was simple to use

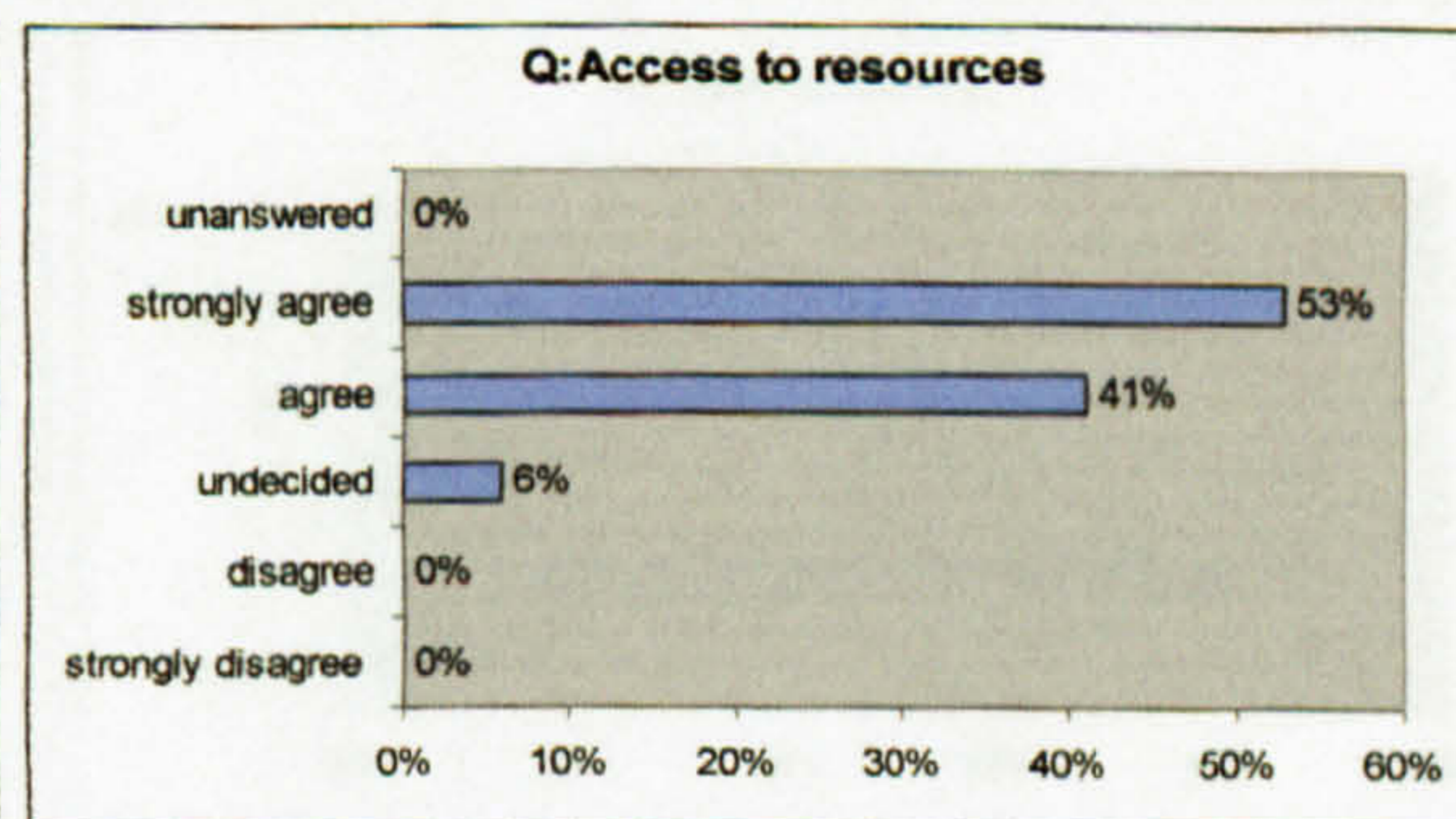
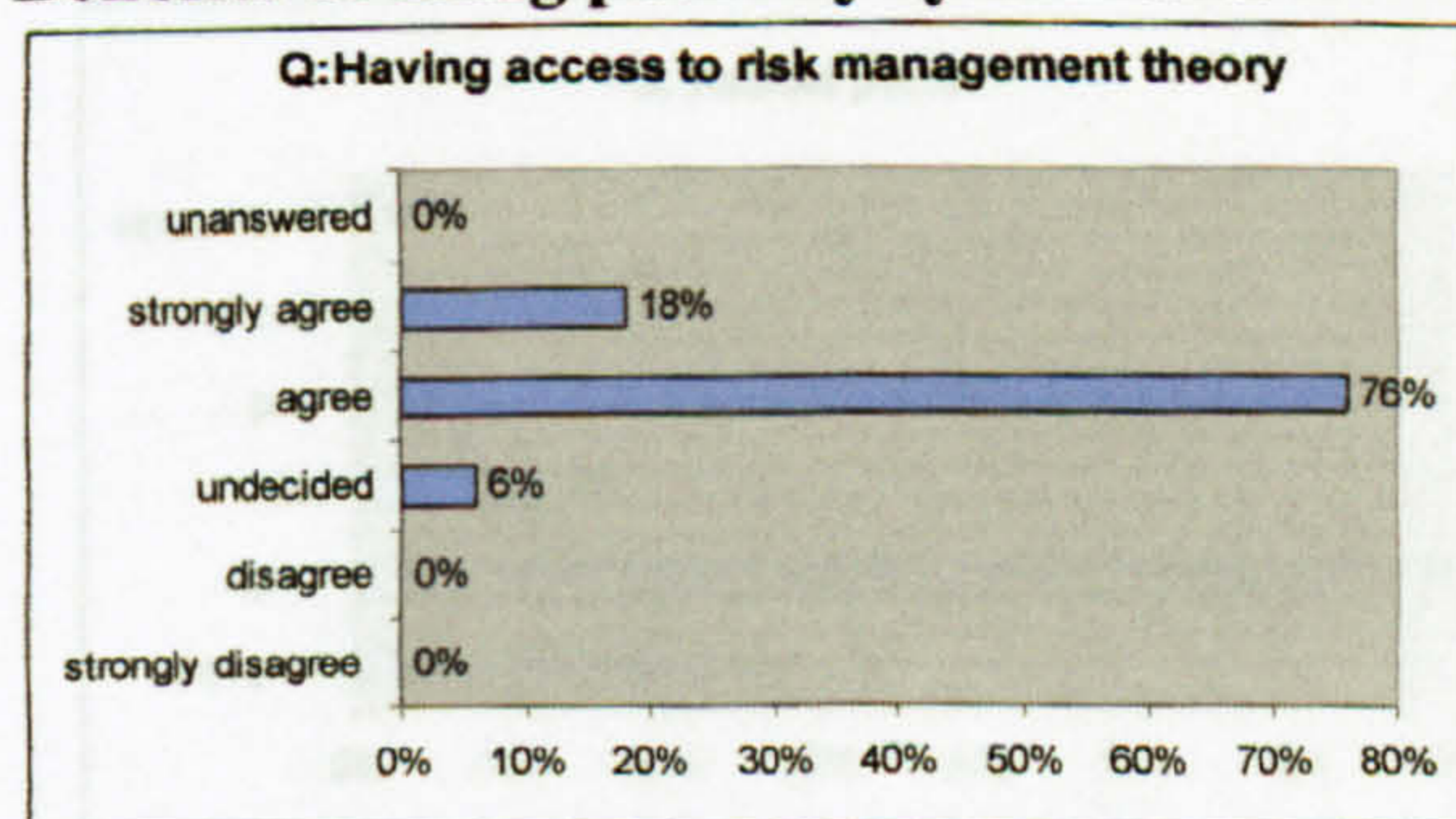
59% of respondents agreed with the statement: "risk-e is easy to use". (29% strongly agreed)

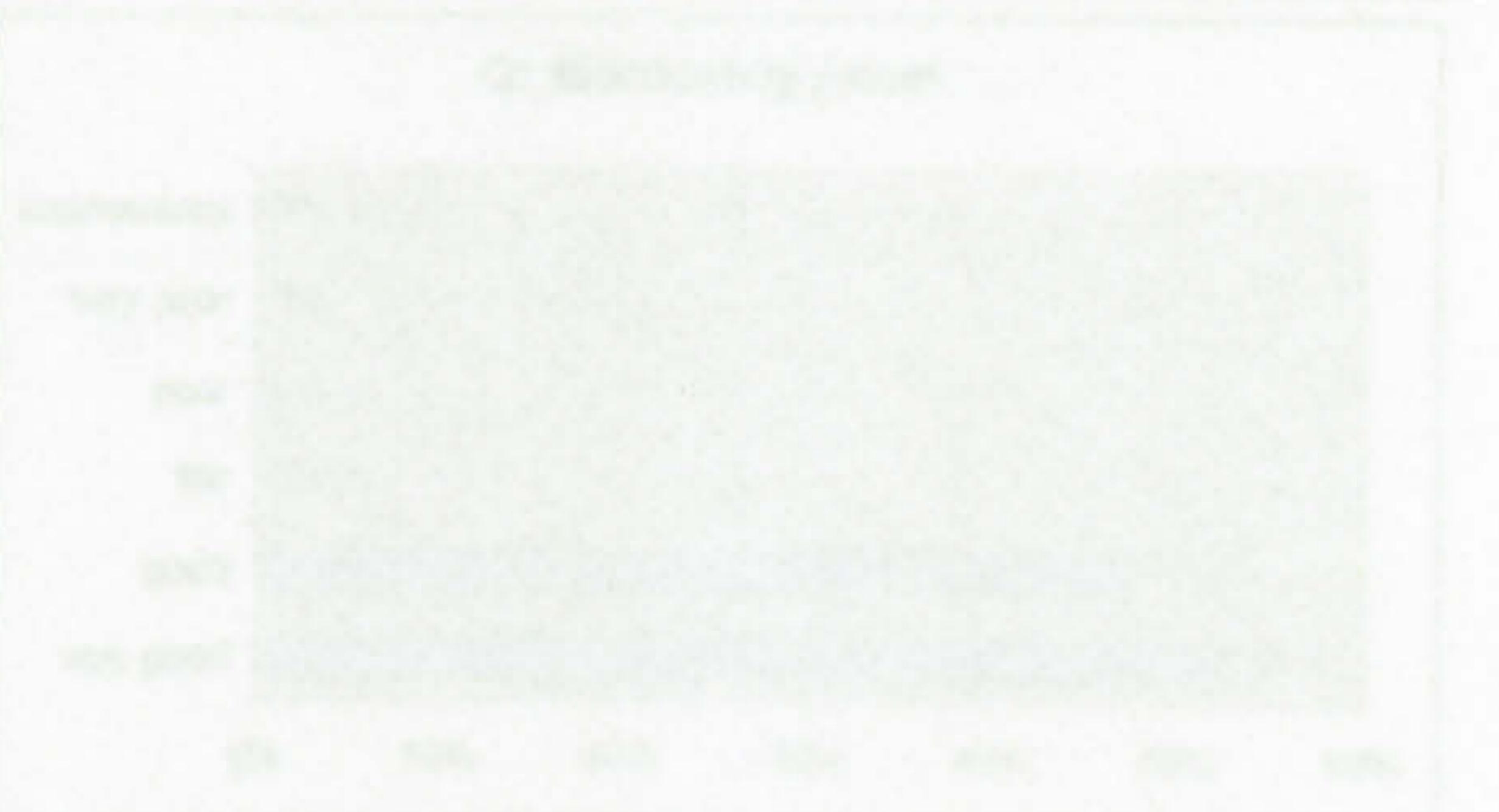
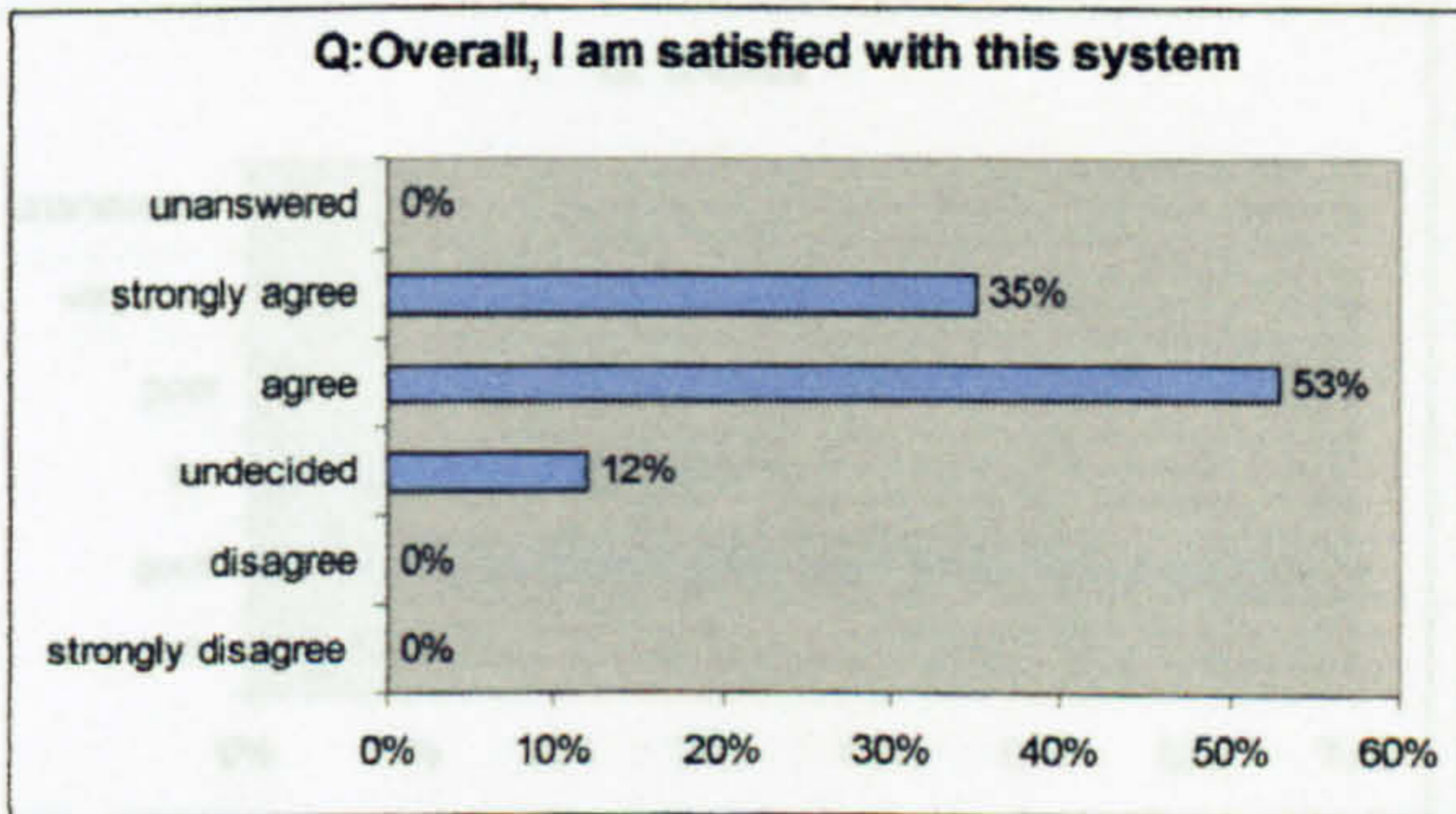
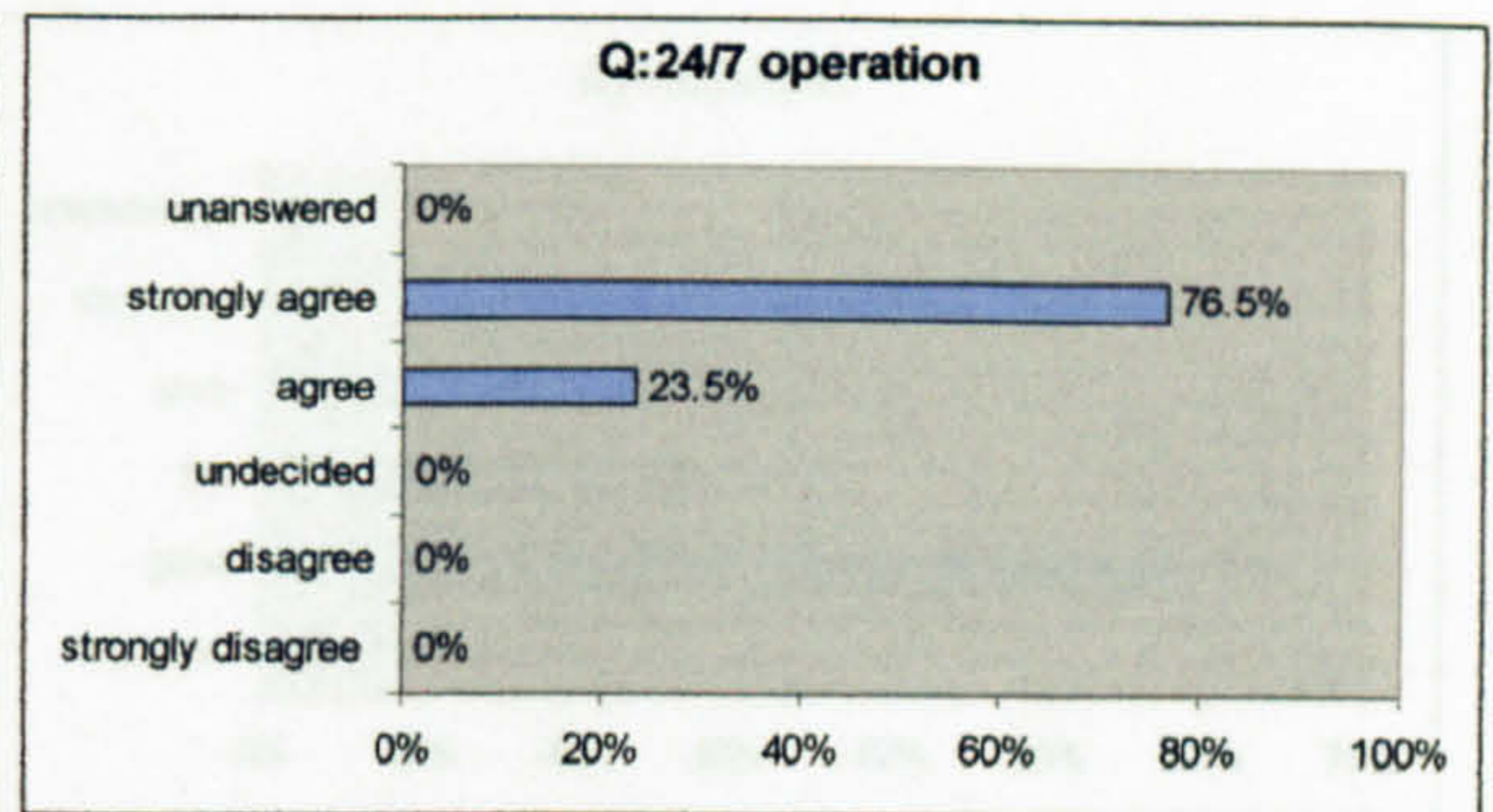
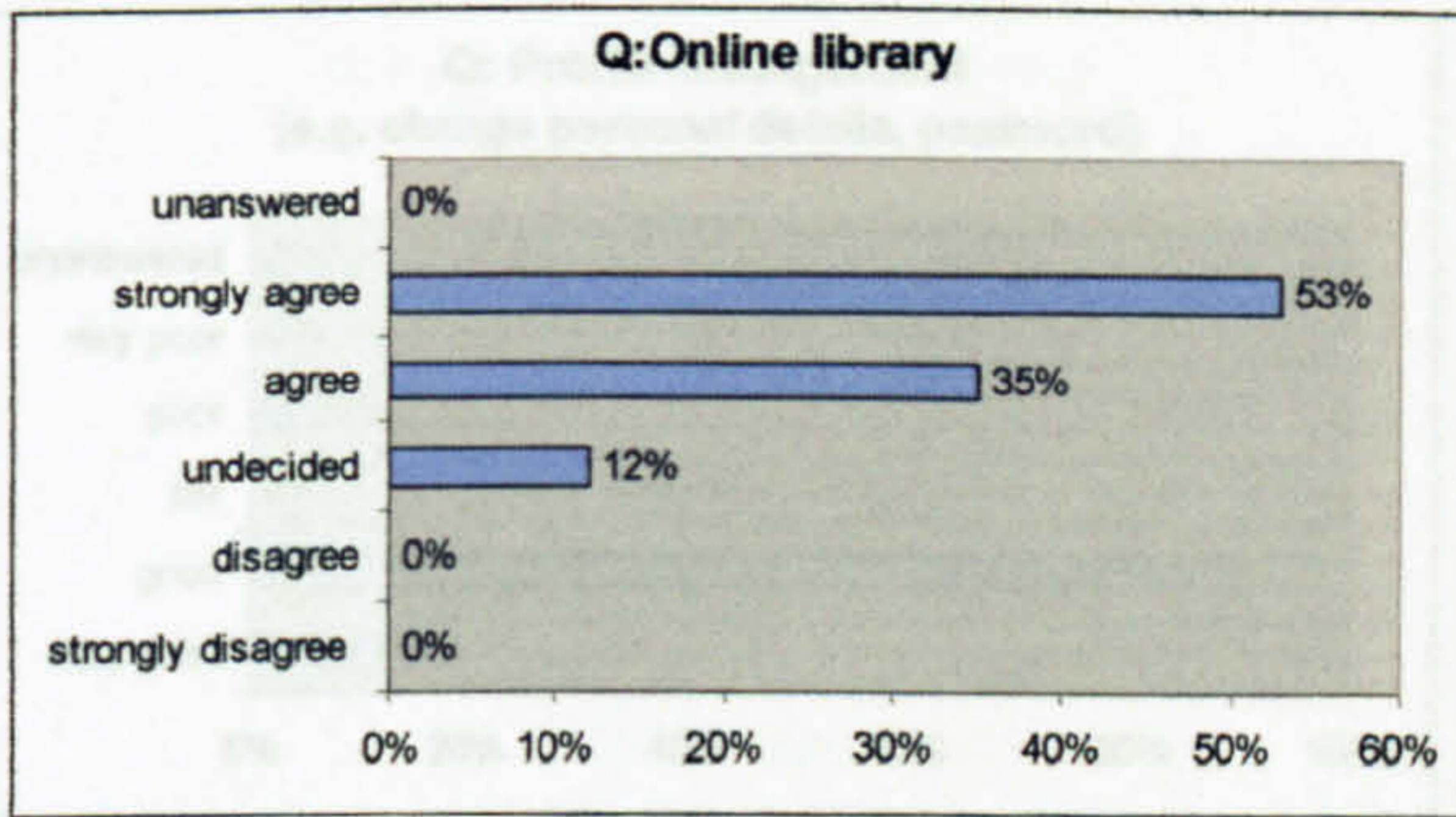




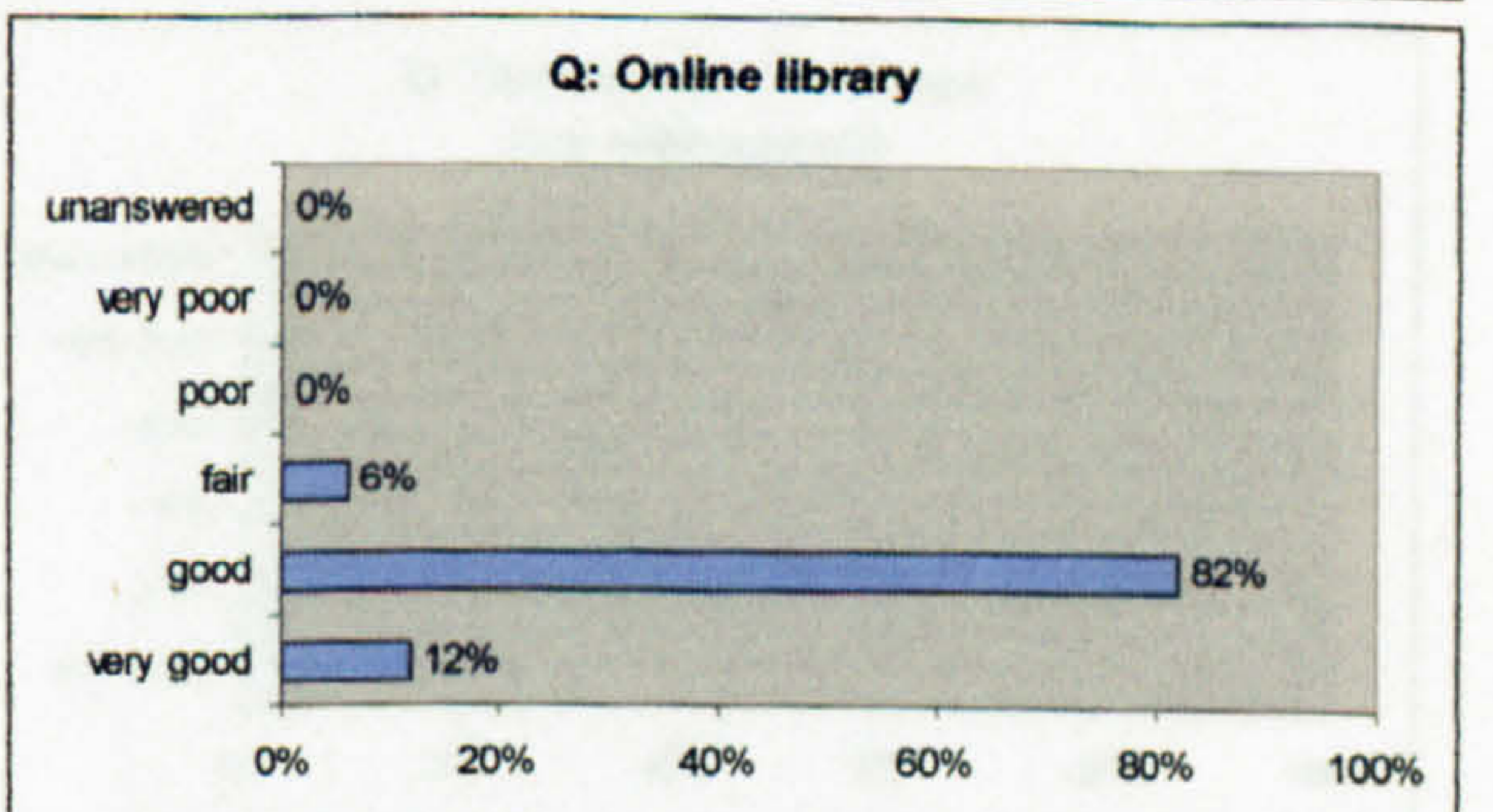
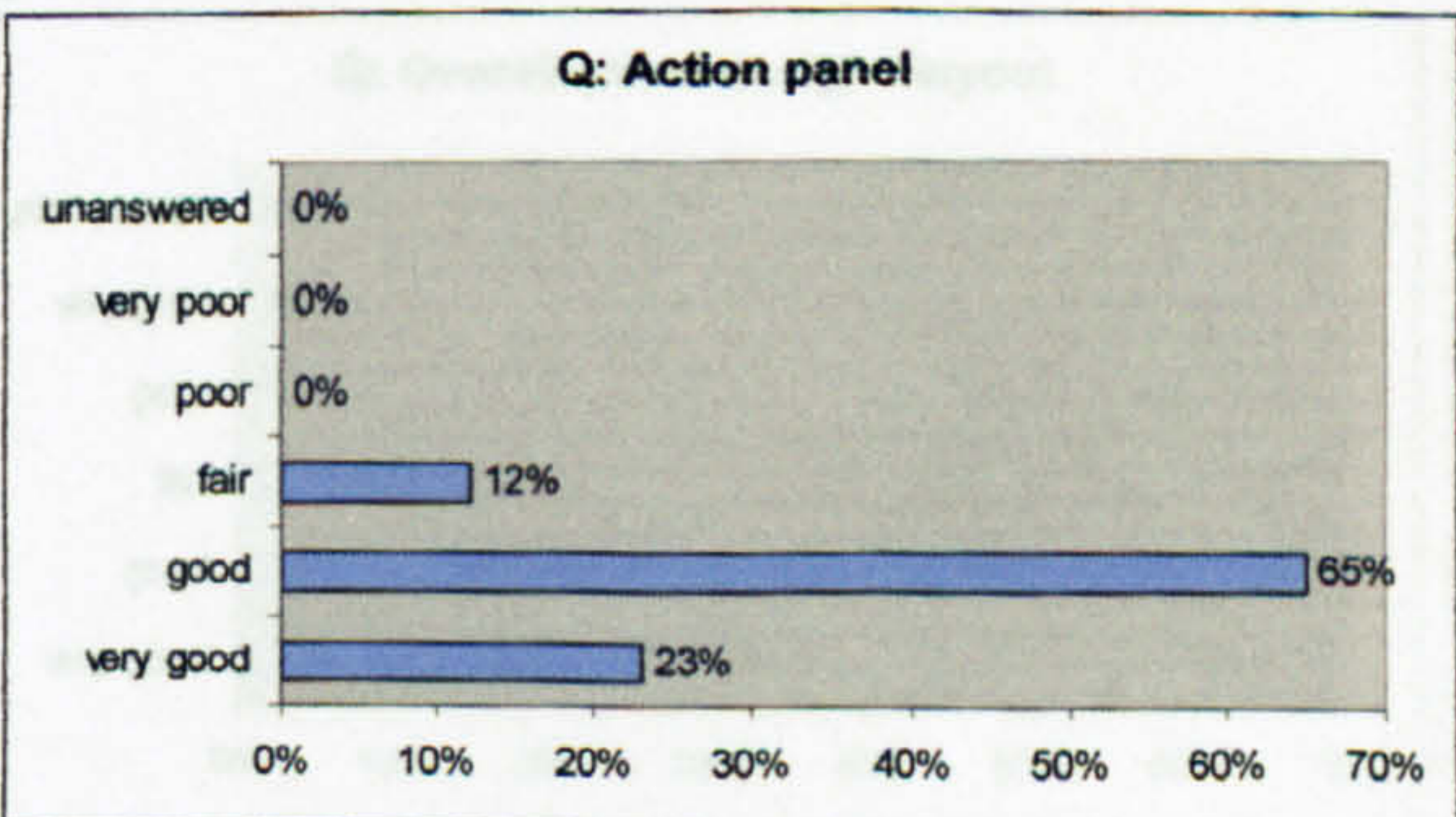
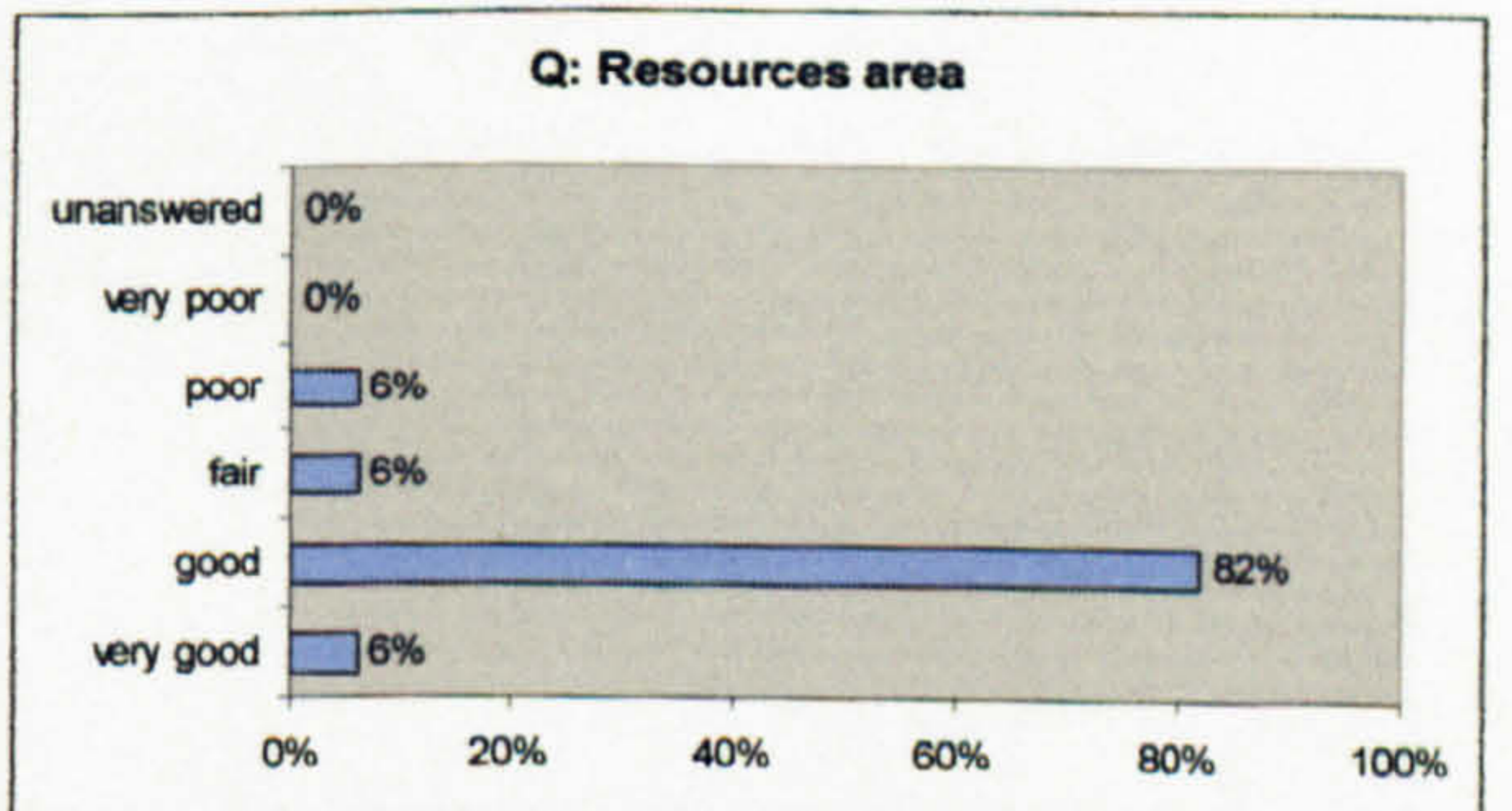
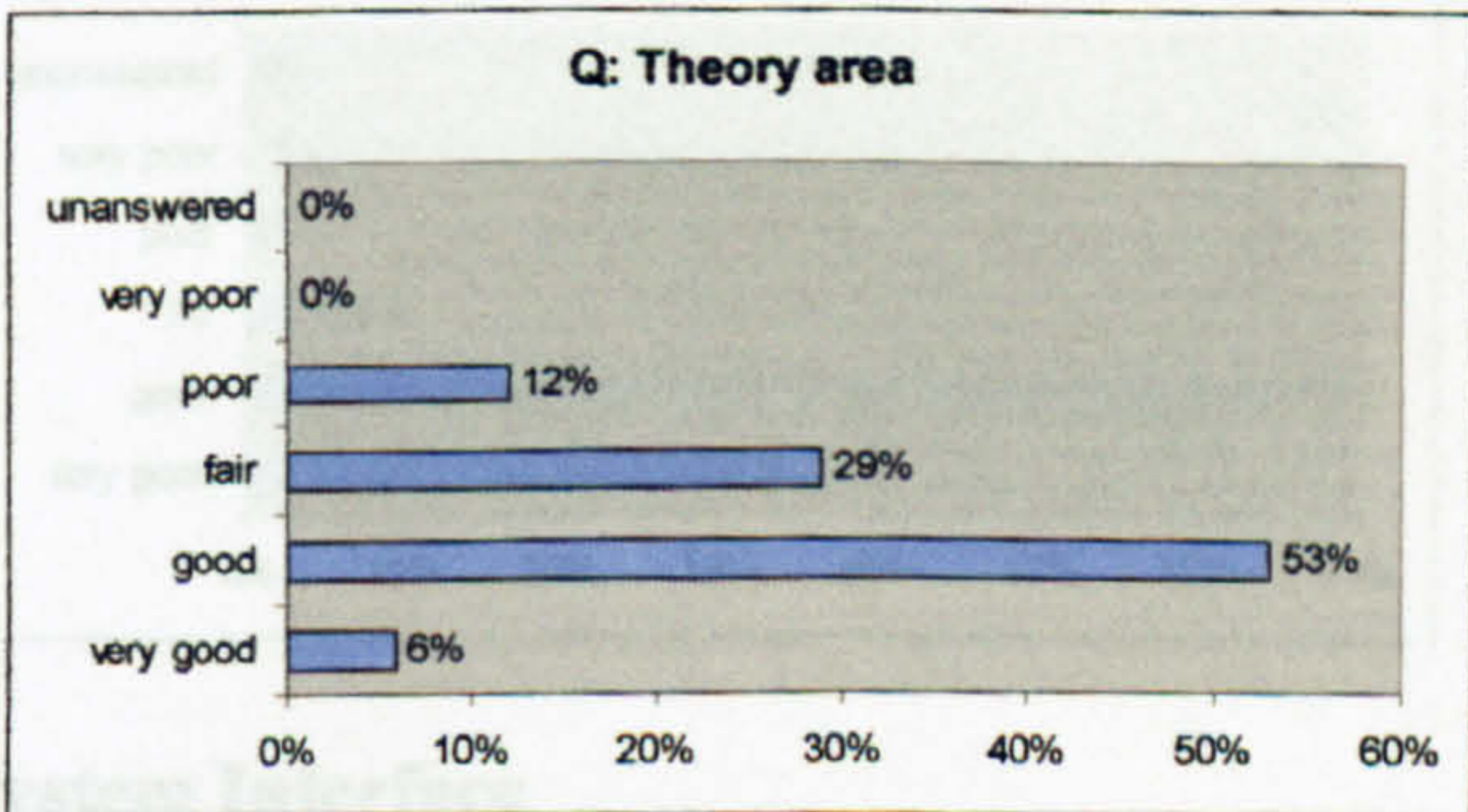


**Benefits of using pathway system are:**

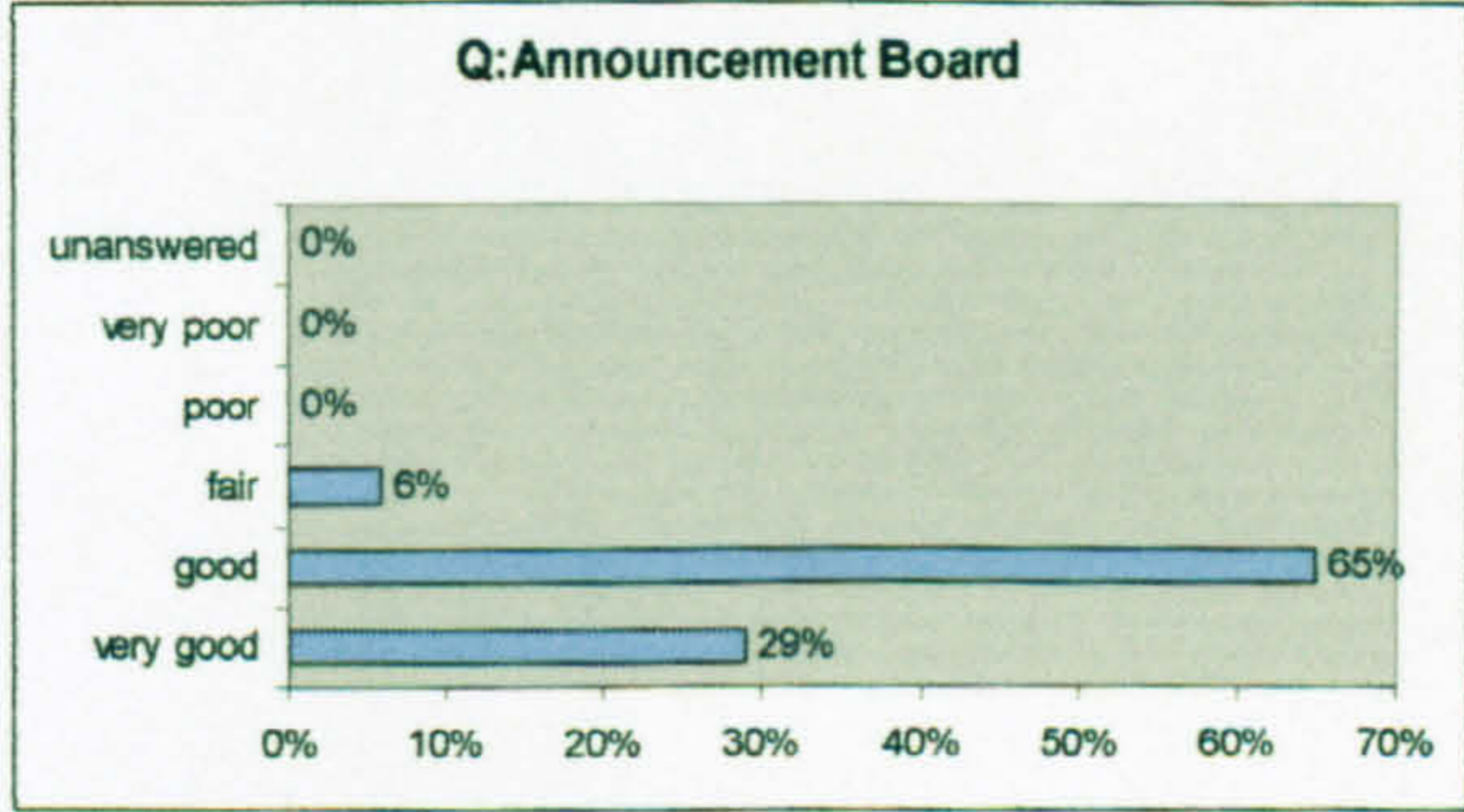
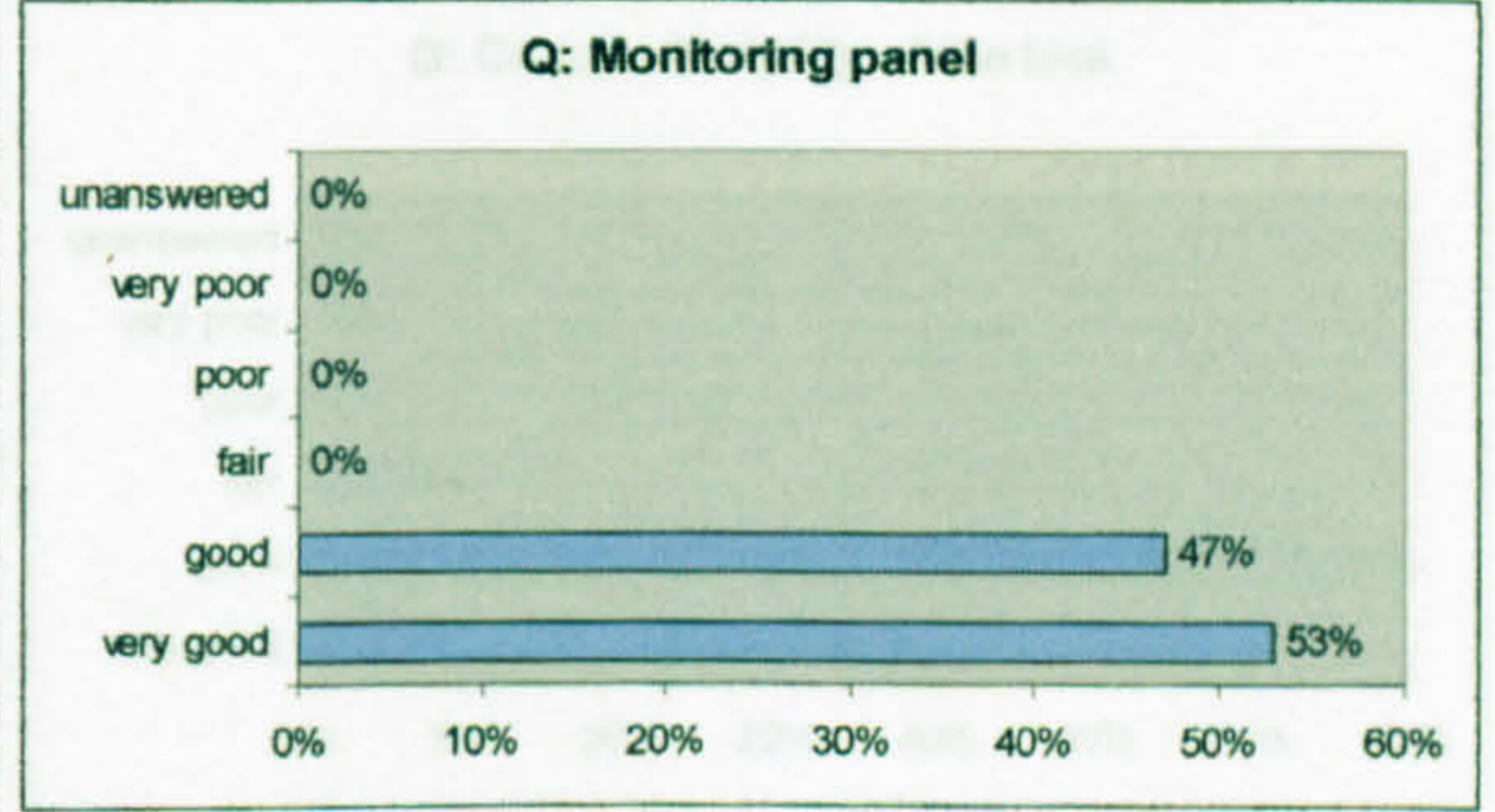
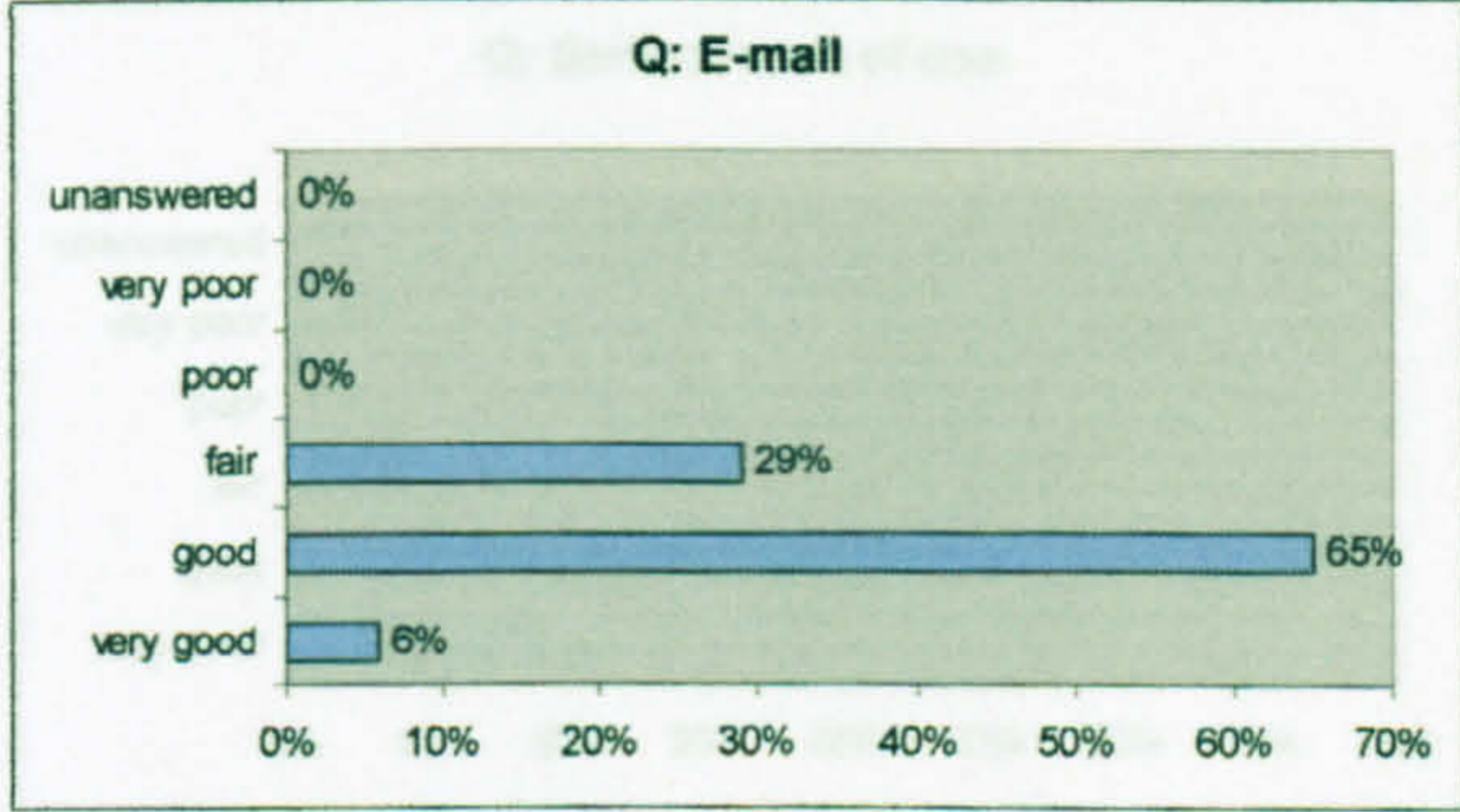
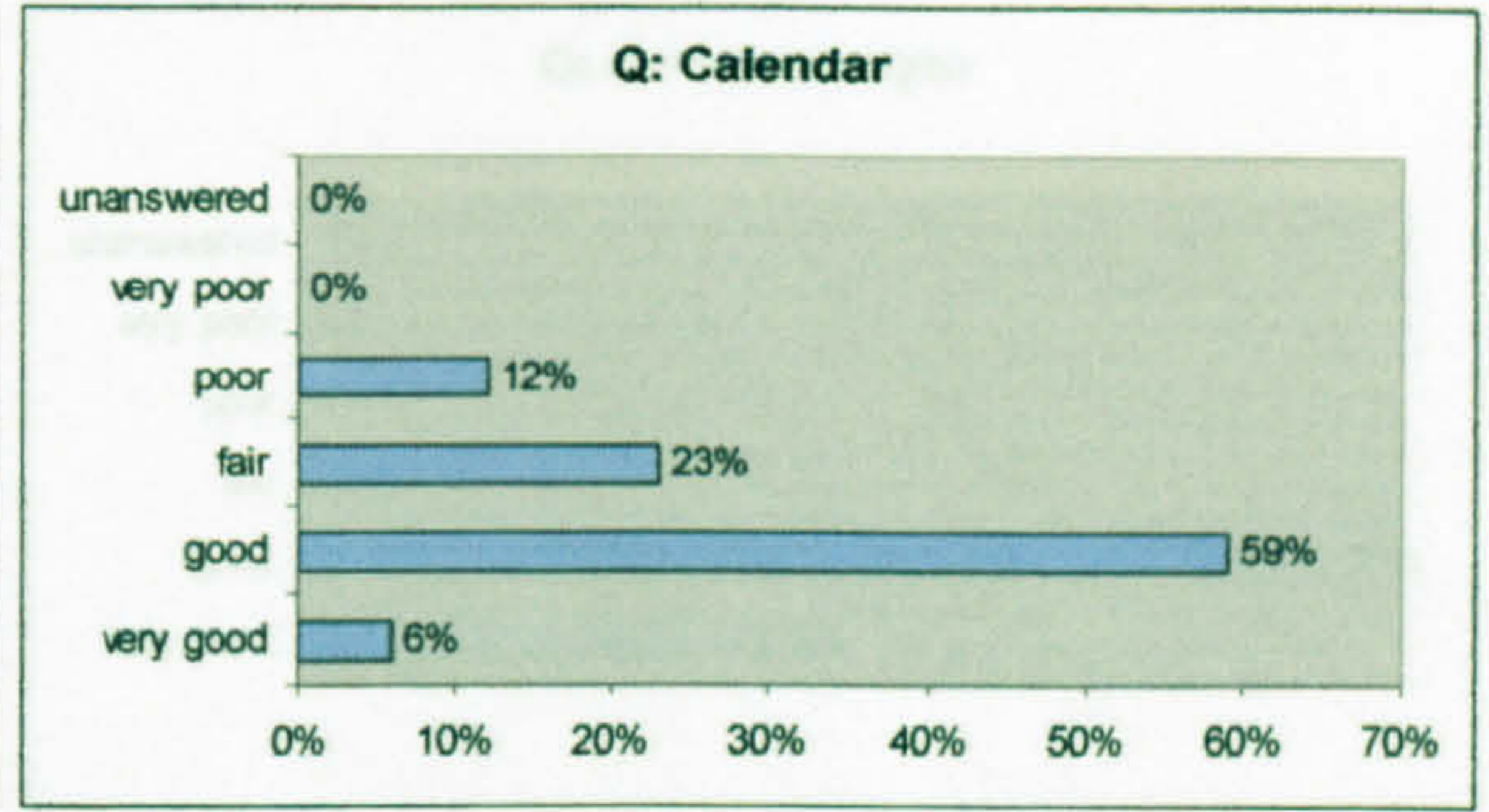
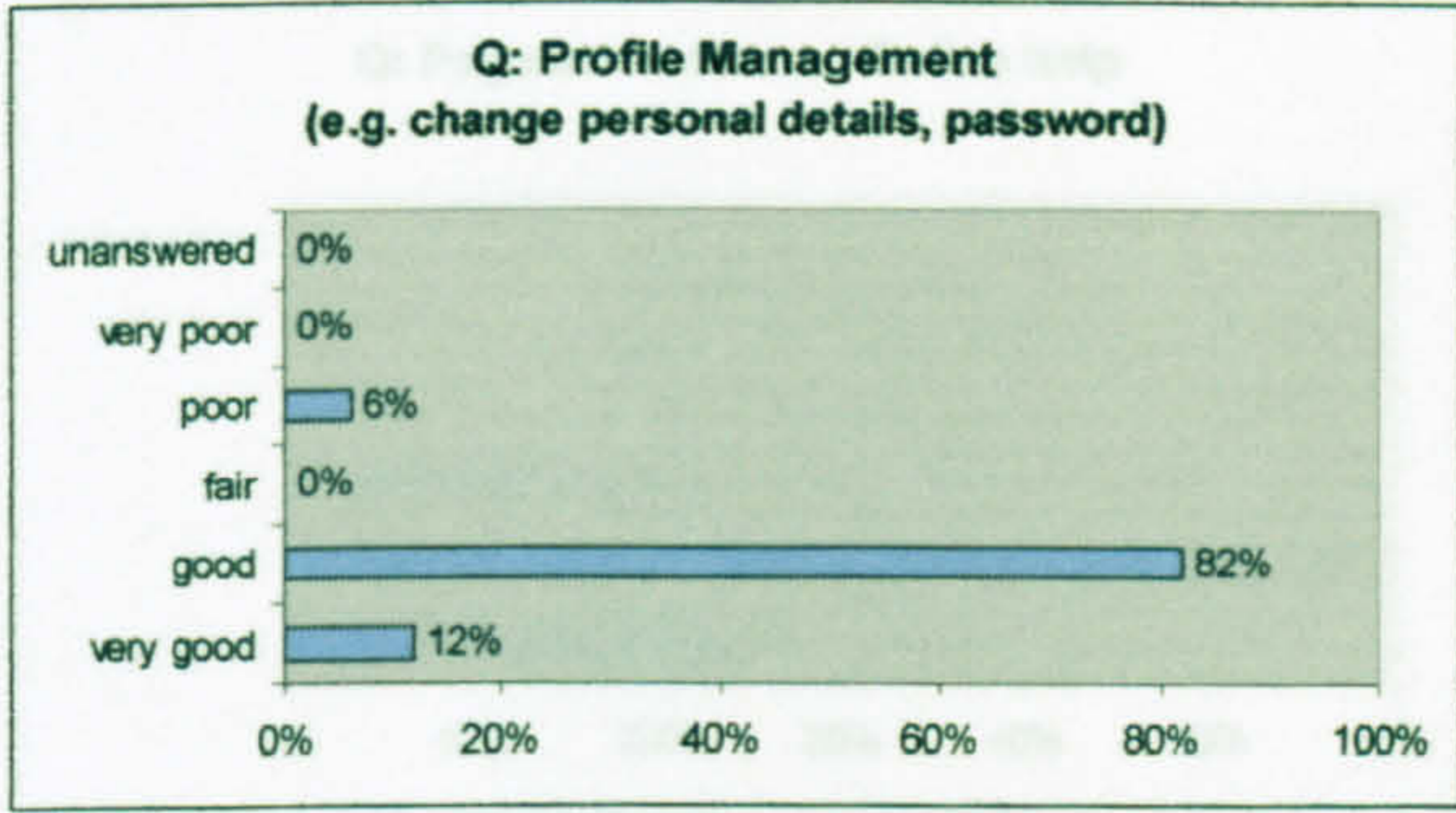




**System Facilities**







**System Interface**

