CRANFIELD UNIVERSITY

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The Development of an Intelligent Decision Support Framework in the Contact Centre Environment

SCHOOL OF APPLIED SCIENCES

PhD Thesis

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December 2007

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The Development of an Intelligent Decision Support Framework in the Contact Centre Environment

Supervisors: Prof. Rajkumar Roy and Dr. Ashutosh Tiwari
December 2007

This thesis is submitted in partial fulfilment of the requirements
for the degree of Doctor of Philosophy

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Abstract

In a time of fast growing technology and communication systems, it is very important for the industry and the corporations to develop new contact centre environment technologies for better customer contact requirements. The integration of contact centre (CC) into day-to-day organisational operations represents one of the most promising trends in the 21st century economy. Whatever the nature or point of contact, customers want a seamless interaction throughout their experience with the company. Customers receive more personalised experience, while the company itself can now provide a consistent message across all customer interactions.

Based on the literature studies and the research carried out within the contact centre industry through the case studies, the author identified the customer and advisor behavioural attributes along with demographic, experience and others that later are used to derive the categories. Clustering technique identified the categories for customers and advisors. From the initial set of categories, fuzzy expert system framework was derived which assigned a customer or advisor with the pre-defined set of categories.

The thesis has proposed two novel frameworks for categorisation of customer and advisor within contact centres and development of intelligent decision support framework that displays the right amount of information to the advisor at the right time. Furthermore, the frameworks were validated with qualitative expert judgement from the experts at the contact centres and through a simulation approach. The research has developed a novel Soft Computing based fuzzy logic categorisation framework that categorises customer and advisor on the basis of their demographic, experience and behavioural attributes. The study also identifies the behavioural aspects of customer and advisor within CC environment and on the basis of categorisation framework, assigns each customer and advisor to that of a pre-defined category.

The research has also proposed an intelligent decision support framework to identify and display the minimum amount of information required by an advisor to serve the customer in CC environment. The performance of the proposed frameworks is analysed through four case studies. In this way this research proposes a fully tested and validated set of categorisation and information requirement frameworks for dealing with customer and advisor and its challenges. The research also identifies future research directions in the relevant areas.

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This thesis is dedicated to my lovely ma, whom I lost in middle of the pursue of my doctorate studies.

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Acknowledgements

I would like to express my thanks and deepest gratitude to Prof. Rajkumar Roy, my supervisor and my “Sarthi” (hindu word for one who guides you to the right direction). His support, advice, and encouragement have always provided me with new perspectives. Special thanks to Dr. Ashutosh Tiwari for being a constant source of inspiration to me and for being a good friend.

I am most thankful to my industrial sponsor, Prof. Ben Azvine, and my industrial supervisor, Dr Basim Majeed who provided me the resources and case study for the contact centre design. All their extraordinary help is greatly appreciated. I am thankful for the financial support for this research, which was provided through a sponsorship from Engineering and Physical Science Research Council (EPSRC) and BT. Special thanks to all the staff and collegues at Contact Centres at Milton Keynes, Birmingham, London, Glasgow and Croydon for their help and support throughout the initial stages of the project.

It was a great pleasure to work with my colleagues in the Decision Engineering Group at Cranfield University. It is impossible to list all of them but particular thanks to Dr Ashutosh Tiwari, David Baxter, Dr. Patrick Oduguwa and Dr. Victor Oduguwa. Thanks also to all the staff of the School of Applied Sciences and formerly Enterprise Integration at Cranfield for their support. Special thanks to Ms. Emanuela Pennetta and Ms. Teresa Bandee (SAS) at Cranfield University for their kind words and support during the time of submission.

My greatest thanks to my parents Dr. Ramesh Shah and Mrs Kokila R. Shah for the wonderful opportunities they have given me in life. I thank their support and special thank you to my mother who initiated the idea of the doctorate degree in the first place and to whom I dedicate this thesis. Without their moral and financial support this would would not have been possible.

This work would not have been completed without the most precious person in my life. Her everyday patience, love, and care is the motivating force for all my accomplishments. I express my deepest love to my wife Mrs Kalgi Shah and to our little angel daughter Sachi.

Above all, I give thanks to the Almighty God for the wonderful gifts He bestows on me.

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List of Publications

- Shah, S., Roy, R., and Tiwari, A. Human Behaviour Modelling in Contact Centres: An Overview of Techniques. International Journal of Services Marketing, 2007: (*Submitted Sep 2007*).
- Shah, S., Roy, R., and Tiwari, A., Majeed, B. Categorisation of Customer and Advisor in Contact Centres. Journal of Computational Intelligence Research, Vol 3, No 3, pp 193-204, July 2007.
- Shah, S., Roy, R., and Tiwari, A. Development of an Intelligent Customsied Service System for Contact Centres, Proceedings of WSEAS DNCOCO: 2006 WSEAS Data Networks, Communications and Computers Multi Conference. 2006. Bucharest, Romania, 14-18 Oct 2006.
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- Shah, S., Roy, R., and Tiwari, A.. Customised Customer Support using a Soft Computing Approach, 2005 IEEE International Conference on Computational Intelligence in Modelling, Control and Automation. 2005. Vienna, Austria.
- Shah, S., Roy, R., and Tiwari, A. Development of Fuzzy Expert System for Customer and Service Advisor Categorisation in Contact Centres, CDROM Proceedings of the 10th Online World Conference on Soft Computing in Industrial Applications (WSC-10). 2005. England.

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Nomenclature

ACD	Automatic Call Distribution
BKS	Behaviour Knowledge Space
BT R,&D	British Telecom Research and Development
CBR	Case Based Reasoning
CCC	Customer Contact Centre
CC	Contact Centres
CIM	Customer Interaction Management
CLI	Calling Line Identification
CRM	Customer Relationship Management
CSA	Customer Service Advisor
CSS	Customer Service System
CTI	Computing Telephone Integration
DNIS	Dialled Number Information Service
FCM	Fuzzy Cognitive Maps
GUI	Graphical User Interface
IVR	Interactive Voice Response
JNI	Java Native Interface
KCI	Keeping Customer Informed
MAS	Multi Advisor System
NSQ	Non Sales Queries
RPC	Right Party Connects
RWE	Real World Enquiry
SC	Soft Computing
UML	Unified Modelling Language
VOIP	Voice over IP
VM	Virtual Machine
WBTS	Welcome Back to Service

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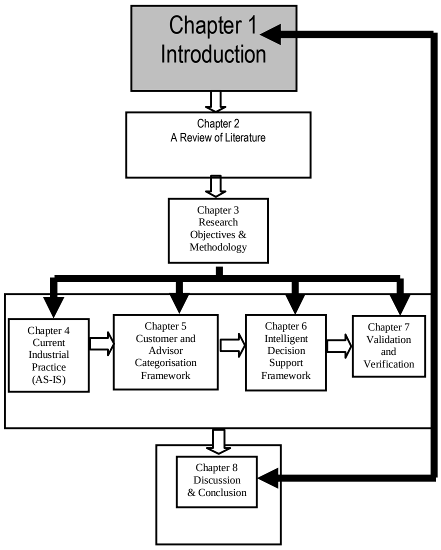
1. INTRODUCTION



Most companies strive have to find, develop, and then retain their customers. Any interaction that turns out to be frustrating or unproductive could easily become the customer's last contact with the company. Many companies now recognise the need for a stronger focus on the customer at any and every point of contact. Customer service is crucial to the success of an enterprise. Traditional single function, inbound, telephone based call centre is no longer able to service today's customers, and companies must either adopt multifunction, multidirectional and multimedia Contact Centre or risk falling in behind the market.

The new business environment requires organisations to rethink their approach to dealing with their customers. This requires a deeper understanding of all points of customer interaction, whether the contact is inbound from the customer, or outbound from the organisations, through mail, telephone, web, email, or a combination of all. Whatever the point of contact, customers want a continuous interaction throughout their experience with the company. Each contact with the customer is an opportunity for that organisation to develop a better understanding of its customer base. Understanding the customer's capabilities and needs is a necessity when transitioning to a multi channel environment. The role of the CSA (customer service advisor) is also evolving with the changes taking place around them. Interactions with the CSA have been transaction based; modern day CSA's are dealing with far more complex and varying customer issues. The ability of a CSA to provide effective voice service does not guarantee their ability to provide effective email or web chat service and support. A contact centre (CC) must both anticipate and react to customers changing needs and demands to achieve strategic customer care. This is turn, has major implications for the kinds of skills, knowledge and competencies of all CCC (customer contact centre) staff, the systems and the management. The overall goal of this research is to provide an information requirement framework that can enable any advisor to deal with any category of customer. Therefore, this chapter introduces the thesis and the context of the research study carried out to the overall aim.

This chapter is organised as follows: Section 1.1 introduces the research context to the project. Section 1.2 introduces the basic scope of the research. Section 1.3 provides the statement of the research problem. Section 1.4 introduces the collaborating organisation and outlines the importance of the research project to the sponsoring organisation. Section 1.5 introduces the basic concepts of the soft computing methodologies including the genetic algorithm and fuzzy logic, and the chapter concludes by outlining the structure of the thesis in section 1.6.

1.1. Research Context

Contact Centres (CC) is considered as an widely known means of communication to the customers of any service industry environment. For example, (Hawkins *et al.* 2001) define contact centres as:

> "A Contact Centre can be defined as an internal or outsourced operation largely based on telecommunication and data supports whose primary role is to provide one or many relationship channels for customers, clients, employees or suppliers. This may include inbound and/or outbound, person-to-person and self-service contact capabilities that include service, sales, marketing, fulfilment or data collection."

This thesis is concerned with the 'contact centres' aspect of service sector. Within industry, contact centres are used more widely to provide service to the customers of the company on sales and service of products for business purposes. To avoid confusion, where necessary, the author describes them as sales and service activities in contact centres, and engineering activities in service sector environment.

The aim is to develop an intelligent decision support framework for effective engagement between any customer and advisor within contact centre environment. The research would also create further business opportunity through cross selling. Several companies and industries were involved during the research to provide generic results. Through information requirement modelling, the author is concerned with facilitating the capture of categorisation information for future reuse. By formalisation, the author is concerned with developing a structured and consistent process to the way in which experts use their information and judgement when customise the information to be used for business purposes. By information requirement, the author is concerned with capturing the rationale behind the decisions made by experts as they categorise their customers and advisors at the centres. In addition, expert knowledge is referred to as expert judgment a commonly used term within literature.

1.2. Scope of the Research

The research concentrates in the service industry and in information requirement modelling within contact centres. However, several companies and industries were involved during the research to provide more understanding that is generic. The author is concerned with developing a structured and consistent method with which contact centre experts and managers from commercial and engineering backgrounds can derive their categorisation of customer and advisors based on a common approach. In order to focus the study and achieve the aim set, the author limited the research to the categorisation and information requirement issues in the contact centre environment. He also interviewed other customer facing environments in order to explore the validity of his work with other service environments. The literature review and the interviews conducted with experts throughout this study have also demonstrated that it is at the information requirement stage where most confusion and misunderstandings between the customer and advisor within the environment occurs.

1.3. Problem Statement

Customer satisfaction and staff retention has been an ongoing concern for the contact centre industry since 1990. To date staff (advisor) retention problem been considered as wide growing with almost 55% of them leaving the environment within the first year of their time at the company. Therefore, there is a need to provide a framework within CC that can enable any advisor to effectively deal with any customer. This imposes severe competition into the service sector and customer facing market. The nature of such a competitive market is putting severe pressures on contact centre managers and companies are putting more pressure to ensure that the problem is controlled thus retaining the staff and providing improved customer service. In order to remain competitive, the contact centres need to be highly innovative in delivering high quality service at reduced time and cost; through continuously improve timely response to increasing complex customer demands. The need to satisfy these market requirements provides an incentive to develop state-of-the-art techniques to enable that the information and service provided to the customers are adequate.

Therefore, the aim of this thesis is to develop an intelligent decision support framework for effective engagement between any customer and advisor within contact centre environment. Data is collected through semi structured questionnaires for identifying variables for customer and advisors. Clustering analysis derives the categories used for further development of the framework described in the thesis. Fuzzy expert system development assigns each customer and advisor to that of the pre-defined category. Based on the categorisation, information requirement framework displays the necessary information required for a particular combination of customer and advisor. All the frameworks are validated with expert judgement and in simulated environment.

1.4. The Collaborating Organisation

This section explores the background and the business environment of the collaborating organisation and discusses the motivations that led to the initiation of the project. This project was carried out in collaboration with BT's Research & Development (BT R&D). BT R&D is a business unit offering support and research services to other business processes within the wider organisation of BT Group.

1.4.1. BT Group

BT is the world's oldest communications company, with a direct line of descent from the first commercial telecommunications undertaking in Europe. The Electric Telegraph Company established in 1846, was the first outside the United States to exploit leading edge telegraphy technology and introduce electrical communications to an astonished world. Within ten years an international network had been developed, making communications possible within minutes and hours instead of days and weeks. The consequences for every aspect of society were dramatic and profound. Fast forward to today and technology is more central to BT's business than ever before as it builds on the foundation of the digital era to create the information age. Innovation - the combination of technical know-how with commercial acumen - becomes even more crucial in a competitive world. Virtual markets, electronic commerce, broadband and mobility are now the watchwords which are changing radically the way companies and people do business. The successful companies of the future will be those which exploit their technology to underpin their business, generate revenues and minimise costs. For BT, the willingness to embrace new relationships, both technical and commercial, will be key to maintaining its influence on the development of the communication industry. As guardian of the UK's telecommunications legacy BT recognises and attach great value and importance to their long and rich heritage (Duxbury *et al.* 1999).

Table 1-1: Global Ranking (2005) for Telecommunications Industry Sector

Organisation	Revenues ($ millions)	Ranking in Telecoms	Global Ranking (out of 500)
Nippon Telegraph & Telephone	94.8	**1**	24
Verizon Communications	75.1	**2**	50
Deutsche Telekom	74.1	**3**	54
Vodafone	65.3	**4**	66
Frame Telecom	60.9	**5**	71
Telefonica	48.8	**6**	108
AT&T	43.8	**7**	121
Telecom Italia	39.7	**8**	141
BT	34.8	**9**	162

BT is one of the largest telecoms service producers in the world with over 38,500 employees worldwide, and has service operations in many countries. The group's prinicipal activities include networked IT services, local, national and international telecommunications services, and higher value broadband and inernet products and services. In the UK, BT serves more than 20 million business and residential customers with more than 30 million exchange lines, as well as providing network services to other licensed operators. The group is formed of different business which include BT Retail, BT Global Servies, BT Wholesale and Openreach. The group's revenue and global ranking is shown in Table 1-1 .

BT Contact Centre Environment

BT Contact Centre Service is a combination of intelligent networking and a global communications platform. This solution, which is managed by BT end-to-end, enables any number of contact centres in the UK and abroad to operate as though they were one. As a result, the provider will be able to establish a local appearance in numerous countries, provide an even better customer experience, connect callers and advisors more efficiently and benefit from economies of scale. For example, it can be able to utilise costly multilingual advisors more effectively and reduce call waiting times and lost calls by quickly routing callers to available advisors. The service can also provide advisors with information about callers as they answer them, such as contact details and buying history.

Figure 1.1 describes the contact centre environment and products offered by BT. The three major types of services offered are (1) BT Ignite Services, (2) Multimedia Contact Centre and (3) BT Contact Central services. The benefits and applications of these services are described below in figure 1.1

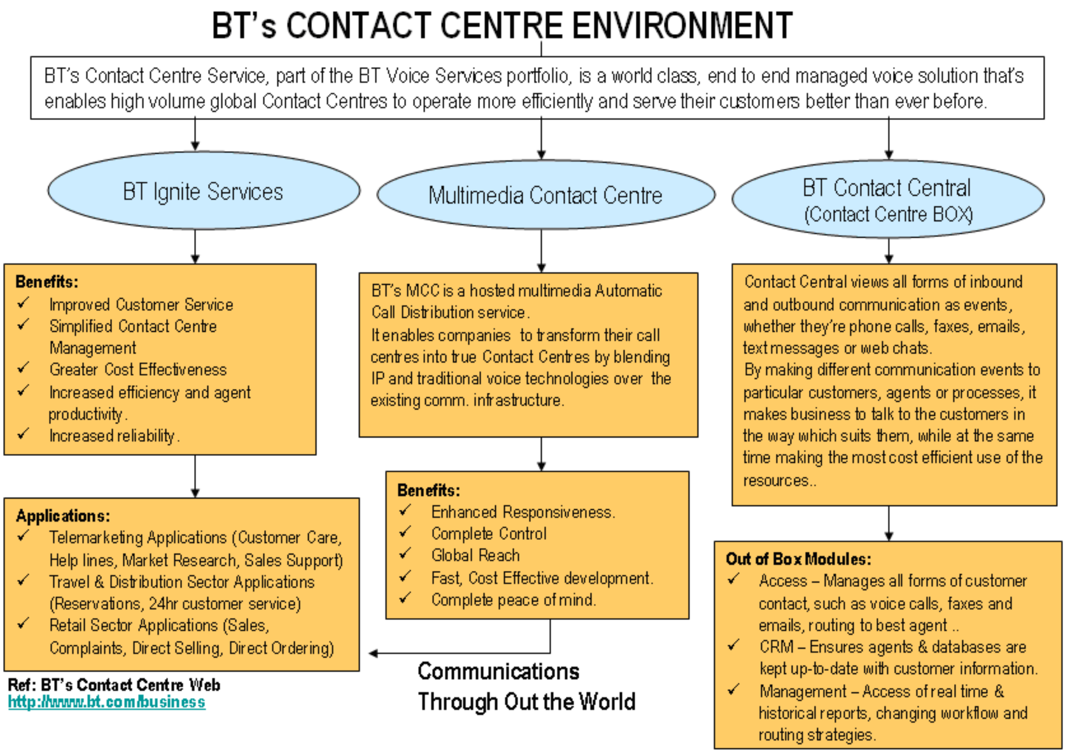


Figure 1-1: BT's Global Contact Centre Solution

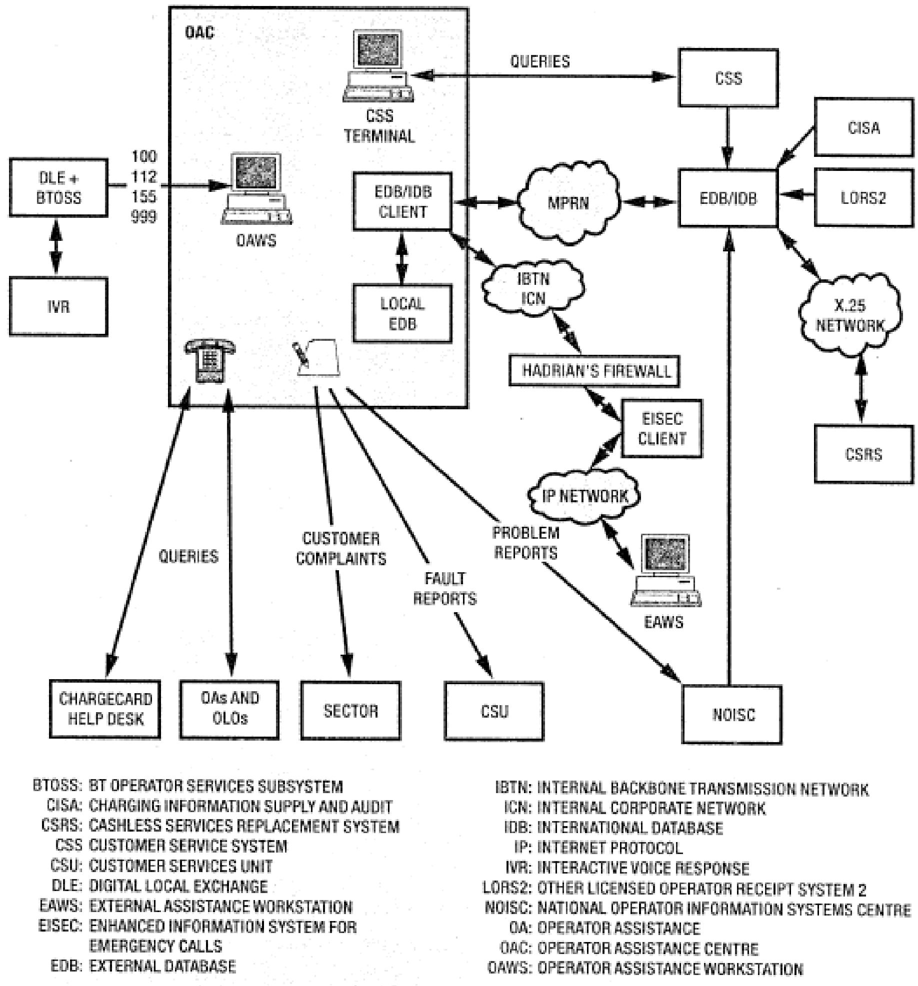


Figure 1-2: BT's Architecture of Call Centre (Duxbury *et al. 1999)*

It can additionally handle simple requests and qualify calls automatically, thus freeing up advisors to deal with more complex inquiries. Figure 1.2 shows a typical BT's call centre operator assistance architecture (Duxbury *et al.* 1999). The main benefits of using BT's customer contact centre solutions is as follows:

- Cost Effective: Even though this is a managed service, full network visibility and control can be achieved.
- Single source solution: Avoids the hassle of dealing with service providers in other countries. BT manages all aspects of global voice network operations.
- Global reach: Direct terminations are available in 24 countries in Europe, Asia Pacific and North America. Switched access is available from 150 countries, and switched terminations are available to over 240 countries

- Resilience and reliability: BT's CC does not depend on other operators for the network elements of the voice platform. The network is owned, managed and maintained by us end-to-end.
- Multiple access options: Customers can contact the company using domestic and international toll free numbers, PSTN/caller pays, shared cost and premium rate numbers.
- Management reporting: Web-based reporting and routing management tools make it easy for you to review the performance of your contact centres around the world from any location and make changes in real time (Boyd *et al*. 2002).

Future of Contact Centres and the European Market

Financial services organisations run the most contact centres of any business sector in the UK. This vertical market consists mainly of banks, credit card companies, insurance companies, building societies, collection agencies and credit reference agencies. The first three sub-sectors are amongst the largest users of contact centres, and many of the largest operations are within this vertical market (over 33% of 500+ advisor position contact centres are finance operations). Figure 1.3 shows the UK contact centre industry from 1995 to 2007 with the total number of centres across UK (excluding any planned or outsourced centres) (CM Insight and Contact Babel, 2004).

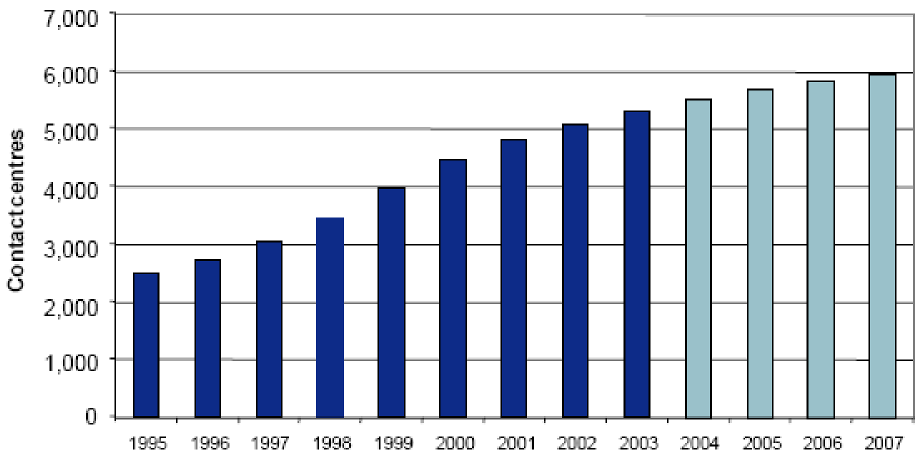


Figure 1-3: UK Contact Centre Industry (CM Insight & Contact Babbel, 2004)

Several suppliers of contact centre solutions have estimated that the finance sector provides between 40% and 50% of their total revenues. It should be noted that most of the high-profile offshoring decisions have come from finance companies, including Prudential, Abbey, HSBC, GE Capital and American Express. The retail and distribution sector has the second-largest number of contact centre operations. This vertical market includes catalogue/direct mail retailers (which tend to be the largest in this sector), package couriers, High Street retail support and niche retailers. The transport and travel vertical market includes travel advisors (both High Street and web-based), public transport companies, airlines, and car hire firms. Almost 11% of the UK's contact centres are run by these types of organisation. Manufacturing companies account for 8% of UK contact centres, although they are generally relatively small operations, dealing with customer support and sales to other companies rather than the public. The services sector is a broad category taking in those contact centres which do not fit in easily elsewhere. It includes home security, directory services, private housing associations and home improvements companies. The IT sector is made up of both technology sales and external helpdesk operations. This report does not include the large numbers of internal helpdesks which support employees. The outsourcing and telemarketing vertical market consists of telemarketing companies and market research agencies, often focused upon outbound calling, as well as larger, full-service outsourcers. Public services contact centres are very much in the news at the moment, pushed by the many central and local government contact centres being started or formalised owing to the Government's edicts for contactable government. Printing and publishing contact centres include newspaper and magazine subscription and advertisement operations, along with a few book publishers (Suomi and Tahkapaa, 2003).

1.4.2. Customer Contact Centres

The modern contact centre enables the organisation to create a two-way dialogue with their customers (Boyd *et al*. 2002). Each 'contact' with the customer is an opportunity for that organisation to develop a better understanding of its customer base. Customer issues, positive or negative, are now documented and tracked on an individual basis, for future action (Swinyard, 2003). Historically, change within organisations has meant a focus on cost reduction (Koole *et al*. 2003). However, given the shift in the balance of power from organisations to the customer, cost reduction with stable customer satisfaction has become the priority for organisations (Hawkins *et al.* 2001). Understanding your customers' capabilities and needs is a necessity when transitioning to a multi-channel environment. A firms ability to understand its own customers is, however hidden in the data it accumulates about their activities, and their likes and dislikes – not external inputs (Meltzer, 2001). As part of the BT R&D contributions towards achieving the business goal, the research project was initiated. The project aims to develop an intelligent decision support system that categorises the customer and advisors within the contact centres through demographic, experience and behavioural aspects; thus providing customised information system which enables the user to deliver an efficient service to the customer. Some of the tasks necessary to achieve the research objective are stated below.

To develop an intelligent support system with capabilities for customised information screen and categorisation of customer and advisors.

To understand the knowledge of results and techniques (accuracy, applicability, etc) within the categorisation environment of contact centres.

In order to develop the state-of-the-art techniques necessary to satisfy these objectives, BT's R&D collaborated with Cranfield to develop the PhD project.

1.4.3. Industrial Motivation of the Research Project

The PhD project was initiated to identify the information requirement and to design an intelligent decision support framework in contact centres. This section discusses the motivation of the research project in terms of the proposed impact and contributions to BT's R&D. Customer categorisation is widely used in the service sector to understand the customer requirements and provide better customer satisfaction thus maintaining the business within the company. The use of intelligent information and soft computing techniques within customer contact centres is gaining a lot of importance in the service industry. The author have focused here some of the challenges that are faced in the industry and the motivations for the research project.

- **Proper Handling of Customer Requests** – A lack of proper handling of request due to insufficient knowledge available to the advisor. The challenge is to apply soft computing to categorise customer and advisor effectively for better customer handling.
- **Time** – The overall time it takes for any service advisor to deal with the customer query makes the customer feel uneasy about the service been provided to them
- **Lack of Information** – There is insufficient knowledge about the customer in first instance to the service advisor, which in turn makes it difficult to provide better customer service.
- **Proper use of Information** – Once the service advisor identifies the type of customer, the data and knowledge available is hard to find and in some cases examined within contact centres not available to the service advisor to use it completely.
- **Satisfying Customer Requests** – During any customer – service provider interaction it's very hard for the service provider to provide accurate and proper service in the first instance because of the factors mentioned above. Integration of customer requests using soft computing techniques that could enable them to identify the right type of information to be used.
- **Lack of Skilled Staff** – There is always shortage of skilled and experienced staff (advisors) which can help the customer and resolve the customer query in the most efficient possible manner

1.5. Introduction to Soft Computing

As defined by Zadeh (1994), Soft Computing is:

"An evolving collection of methodologies, which aims to exploit tolerance for imprecision, uncertainty, and partial truth to achieve robustness, tractability, and low cost"

SC provides an attractive opportunity to represent the ambiguity in human thinking with real life uncertainty. Fuzzy logic (FL), neural networks (NN), and evolutionary computation (EC) are the core methodologies of soft computing (Zadeh, 1994).

Soft computing differs from hard (conventional) computing in that it is tolerant of imprecision, uncertainty and partial truth (Zadeh, 1996). For all the available research been carried out in fuzzy logic and the development of fuzzy expert system for customer modelling, little has been done to categorise the advisor (CSA) within the contact centre domain. Since the expert knowledge captured in If…Then statements is often not naturally true or false, fuzzy sets afford representation of the knowledge in a smaller number of rules, and smooth mapping can be obtained between input and output data (Ngai and Wat, 2003). Soft computing technologies provide an approximate solution to an ill defined problem and can create user models in an environment such as contact centre to identify: (a) customer willingness to buy (b) companies prediction towards customer purchase intentions (c) advisor reaction towards customer attitude and (d) customer behaviour towards advisors communication (Frias-Martinez *et al.* 2005). The elements that a user model captures (goals, plans, preferences, common characteristics of users) can exploit the ability of soft computing of mixing different behaviour and capturing human decision processes in order to implement a system that is more flexible in relation to user interests.

1.6. Thesis Structure

The structure of the thesis described in this section follows the thesis layout shown in figure 1.3. This section aims to give a 'helicopter view' of the whole thesis. The thesis begins with an introduction to the research in this chapter; followed by the description for the remaining chapters as follows.

In Chapter 2, a structured account of related past and present literature is critically analysed. Customer and CSA behavioural segmentation and modelling for identification of the type of human behaviours are looked within the examples given through the literature. Soft computing techniques, data mining techniques and intelligent decision support systems are some of the topics covered where the current theories are analysed and compared. Finally some of the human behaviour modelling techniques are reviewed and analysed.

In Chapter 3, the reader is introduced to the thesis research methodology and objectives. These are deduced from the critical analysis and structured account of literature. To fulfil the objectives, the author considers different research approaches and strategies. This helps to design and justify a suitable research methodology for tackling the research objectives.

Chapters 4, 5, 6 and 7 describe the main research contributions and how each of the research objectives is met. Chapter 4 describes the current industrial practice (AS-IS model). This is the initial data collection performed using semi-structured interviews and questionnaires. The results and findings were grouped and data was used to develop the next stage of research in the development of customer and advisor categorisation framework.

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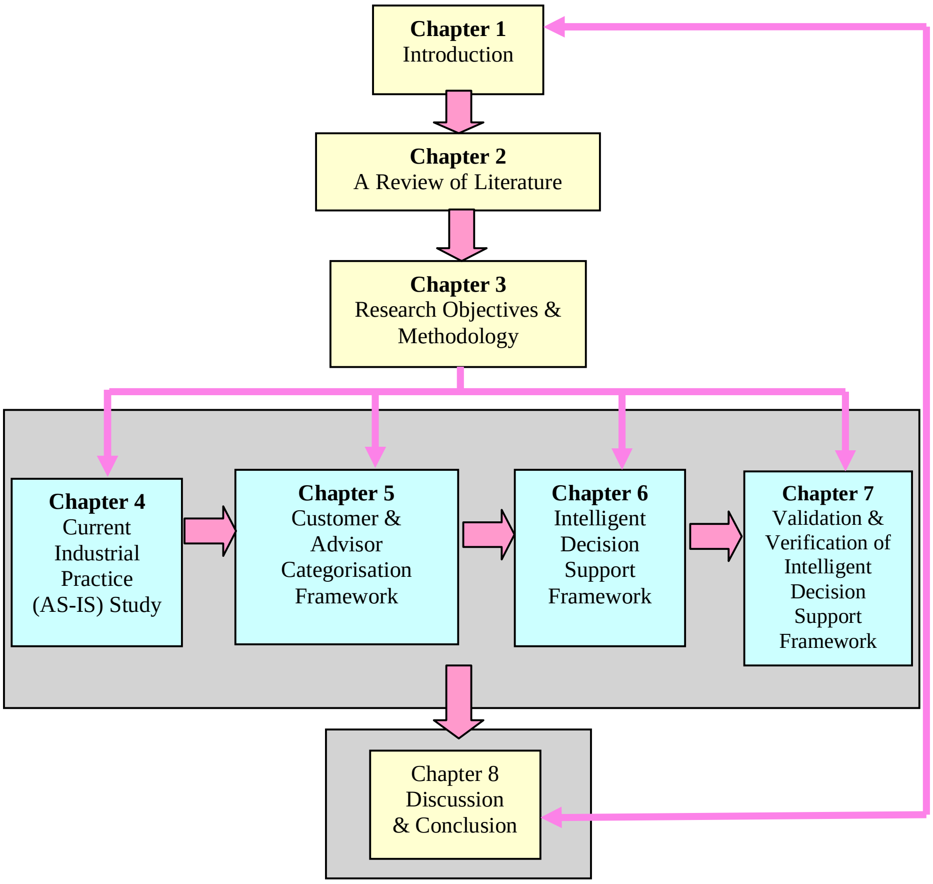


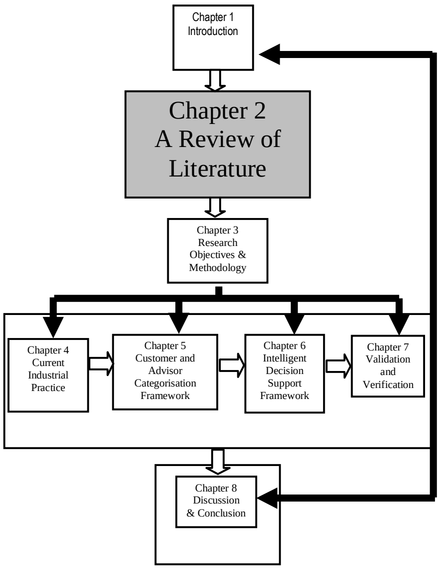
Figure 1-4 Thesis Layout

These conclusions, along with the findings from the literature review lead to Chapter 5, where a customer and advisor categorisation framework was developed. The framework identifies and assigns each customer and advisor to that of a pre-defined category using fuzzy expert system. Methods of clustering analysis and fuzzy expert system development (Matlab Fuzzy Tool) are used to develop the categorisation framework. Through chapter 6 the author presents the development of an Intelligent Decision Support framework. The framework represents a model which identifies the minimum amount of information which is required by an advisor to deal with the customer query at the contact point. The framework is validated through a case study analysis.

In Chapter 7, the author validates and verifies the intelligent decsison support framework with an simulation based and expert judgement approach. He tries to identify any implications that arise if the tool is used in the current contact centre environment. All the major phases of the research framework are validated in chapter 4, chapter 5 and chapter 6.

Chapters 8 synthesises the work of the thesis by discussing the implications of the research findings. The author draws together everything reported from both the work of others and his own work. Areas for future research are discussed before concluding the research. The conclusions respond to the stated aim and objectives of the thesis.

2. A Review of Literature



The introduction outlined the problem area of this research, discussed why the author is interested in the research, and presented the main aim of the thesis. Within this Chapter, the research issues are considered through a structured account from literature. This review provides background information to support the fundamental argument of the thesis on categorising customer and service advisor to provide adequate and customised information with the help of soft computing techniques. Without this review, it would not be possible to adequately defend the arguments nor the need to carry out the research. With this in mind, the main aim of the chapter is: To examine the human behaviour modelling concepts to categorise customer and advisors within contact centres based on demographic, experience and behavioural variables.

The author reviews through the literature techniques applied in other domains, which he could apply in conjunction with the human behaviour modelling methods. To achieve this aim, the Chapter is divided into several Sections. Figure 2-1 presents the different areas covered by the review. In order to perform the research in Contact Centres (CC) the author had to familiarise himself with the terminology and the operations of contact centres. Section 2.1 explains call and contact centres with a brief look on the history of call centres and the birth of next generation of customer contact centres (CCC). The main theme of the thesis is the development of intelligent decision support framework within contact centre through categorising customer and service advisor with respect to demographic, experience and behavioural aspects. For that reason the author investigates and analyses the different techniques used by contact centres to categorise customer and service advisor (Section 2.2). The issues surrounding the human categorisation and human behavioural modelling techniques are addressed and the main focus of the section 2.3. Section 2.4 is devoted to the area of soft computing and their use in telecommunication environment with the major focus on contact centres. The use of soft computing techniques was initiated during the study in section 2.2 on human behaviour modelling techniques and customer and service advisor categorisation which proved that the use of soft computing technique is the most feasible for this research.

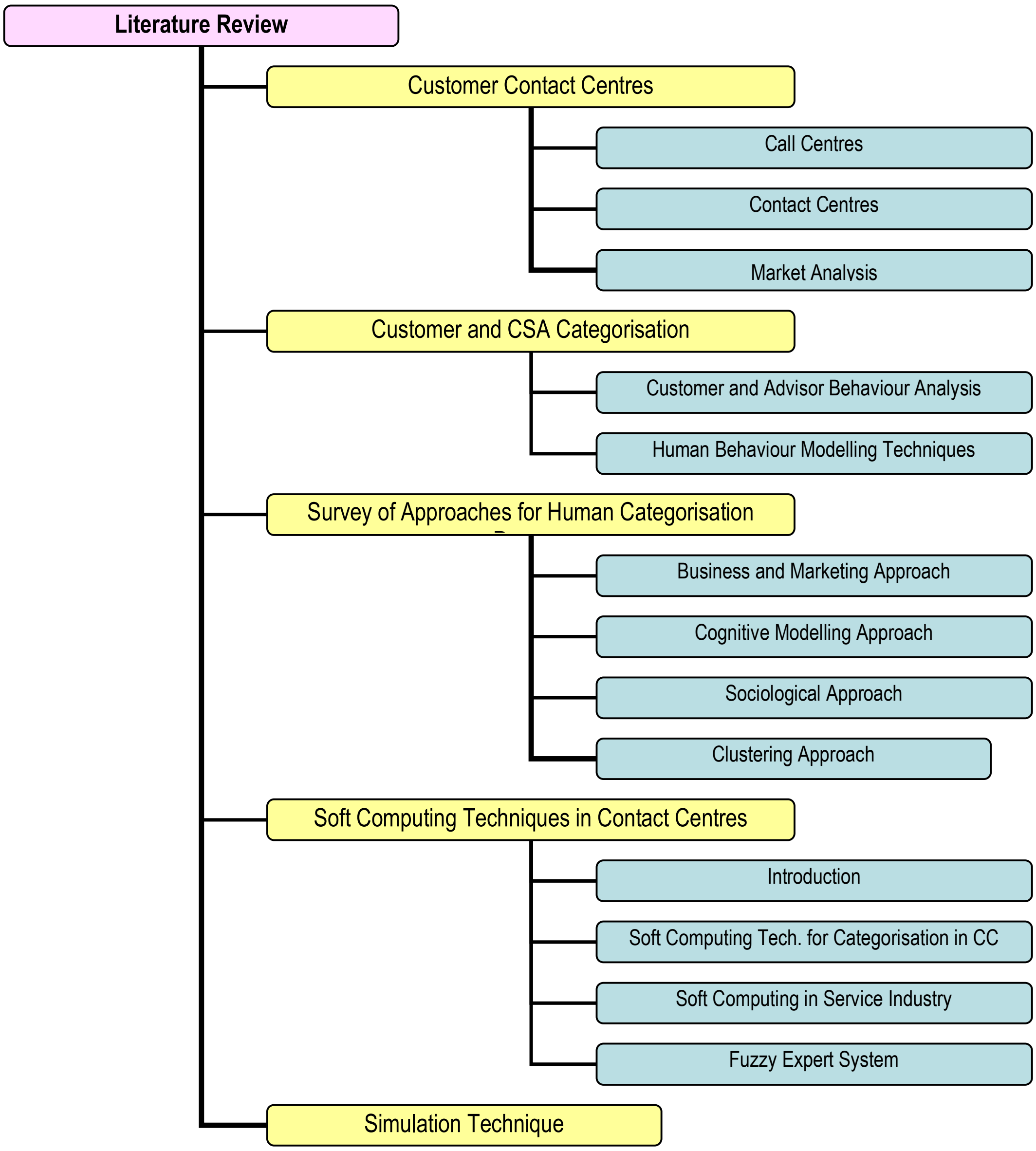


Figure 2-1: Literature Review Map

By reviewing the major soft computing techniques and their use in modelling human (customer and service advisor) behaviour and demographic, experience functionalities the author has highlighted the reasons for the selection of this technique (section 2.3). Finally, in Section 2.5 the author investigated simulation modelling techniques that will help him with the validation of the customer and service advisor categorisation framework which will develop the information requirement model of his research (Chapter 7).

2.1. Contact Centre / Call Centre Environment

Chapter 1 introduced the research aim and context of the thesis with the intoduction to the contact centre environment and the collaborating organisation. This section introduces the literature studies been reviewed on different aspects of contact centres and soft computing techniques along with human behaviour modelling techniques.

2.1.1. Call Centres (CC)

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The term Call Centre can be used with several meanings. In this context, Call Centre is a system which manages the phone calls some human advisors (operators) receive from the users (typically, the customers of a company) or perform toward them. Within service domain, the first types of calls are defined as inbound calls and the second ones as outbound calls. An example of the former are the calls for solving a problem or getting information, while an example of the latter are the promotional calls. Operators play different roles and have differents levels of autonomy, but they are still human with a voice and a heart. Previous studies demonstrated that many people prefer a cool contact on the other side of the line, instead of the cold contextual helps, mailing systems, automatic answerers, SMS, WAP and so on (Calvert, 2001). As a result, the companies have been increasing the implementations of CTI (Computer Telephony Integration) solutions which are able to integrate all these channels and manage all the messages in a single workflow, where the human advisor has a central role (Boyd *et al*. 2002). Figure 2.2 shows typical call centre architecture (Irish, 2000).

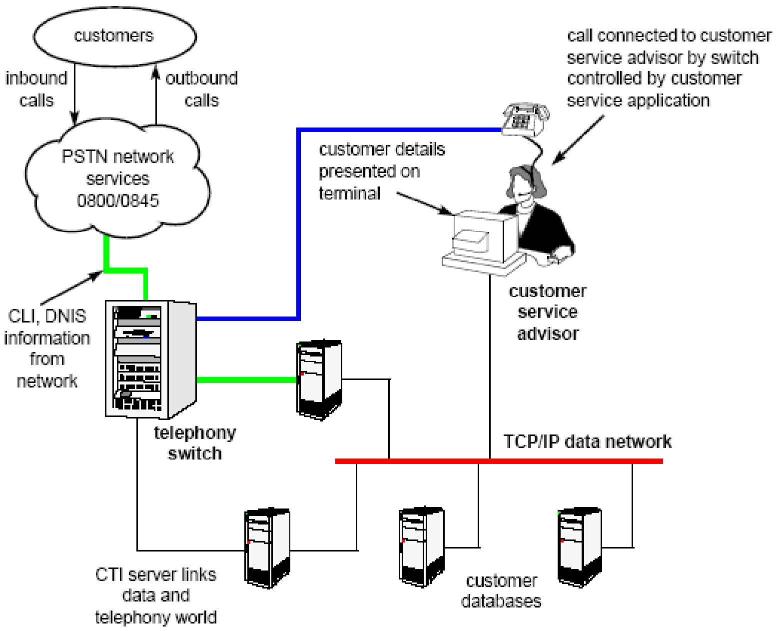


Figure 2-2: Call Centre Architecture (Irish, 2000)

Current call centres are based on the combination of two technologies namely computer-based customer service systems and switched telephony. The customer service system usually consists of a number of sub components from sales ordering system, a problem management or repair handling system. Advisor may be able to perform one, several or all of these functions depending on their complexity and the skill and expertise of the advisor. The telephony system is used to deliver the calls to an appropriate advisor, at its simplest level automatic call distribution consists of a number of queues which are serviced by a range of operators. With the introduction of computer integrated telephony or CTI in the late 1980s, the sophistication of call distribution has improved. The caller's number (calling line identification (CLI)) and the number dialled (dialled number information service (DNIS)) are passed by the network into the switch and on to the CTI middleware. So any customer dialling into a call centre may be identified using CLI and the service they require, as identified by the number dialled. Their records are accessed on the customer database and delivered to an operator (the same operator who last dealt with this customer if available) via a screen pop, a few seconds before the customer is connected to the advisor. Thus the customer service advisor is able to provide a personalised service, appearing to remember customer details even though they have spoken to hundreds of other customers since their last contact (Smith, 2001). If it proves necessary to transfer the call to a colleague with specific expertise, all the customer information may be transferred simultaneously avoiding the customer having to restate their inquiry details (Irish, 2000). But besides the advantages of supporting customers with hearty advisors and higher flexibility, such a solution represents a problem for the companies as it implies high costs of work, costs of training, frequent turnover, no standard answers, no control of the interactions, etc (Torre, 2002).

2.1.2. History of Contact/Call Centre Operations

The development of call and contact centres in the UK market has progressed through four to five distinct phases beginning with the identification of specific business processes focused on contact with either suppliers or customers of the organisation around the 1980s and early 1990s. An increased ability to centralise customer-facing operations resulted from rapid technological change in both information technology and telecommunications systems during the previous decade. Key early drivers for the UK contact centre market included (CM Insight and Contact Babel, 2004).

- Early deregulation of the telecommunications industry compared to the rest of Europe increased 'phone culture', dramatically lowered standard call costs and produced new services such as free phone and low-call rates.
- An increasingly shared business culture with the U.S. which has had a strong customer service and call centre industry since the 1970s.

- Increased competition in certain vertical markets - including banking, insurance, utilities and retail – driven by deregulation, merger and acquisition activity, product homogeneity, diversification and a need to decrease the cost of servicing customers.

Contact centres perform a range of roles: at the lower end, advisors use to do simple, repetitive tasks, such as taking meter readings and reading out bank balances. At the higher end of the contact centre spectrum, advisors are engaged in helping with complex technical queries; cross selling and up-selling based upon sales skills and knowledge of the customer's preferences and learning more about the customer so that future needs be met. The stages of call centres through industries from 1990's is discussed below in table 2.1 (Storey and Cohen, 2002).

Table 2-1: Call/Contact Centre Stages from 1990's to Current

	Call Centre Stages from 1990's
Stages	***Environment***
Proof of Concept **(1990 – 1995)**	During this period larger firms were quick to move operations into dedicated space, either within existing sites or to new call centre spaces, taking the opportunity to realise massive cost savings over other distribution and sales channels.
The drive to Growth **(1995 – 2000)**	The growth of call centre in the UK incremented during the period of 1995 and 2000. this was because of increased perception of the need for and ultimately demand for customer service within all forms of organisation. A drive in some sectors to reduce operating costs through an increased centralisation of functions and remote operations.
Increasing Outsourcing **(1998 – 2001)**	Due to the major employment generators within call centres, professionalisation of the customer service function also occurred. This created a growth of third party suppliers of customer service. By 2000 this trend was well underway and responsible for significant growth and geographic diversification in the sector as a whole.
The Rise of Off shoring **(2001 – 2005)**	In start of 2001 and during 2002-2003 UK now had an over supply of third party outsourced contact centre operation. At the same time technological investments, in particular the true integration of telecoms and information technology resources (customer databases and billing systems), have begun in many of the UK's contact centres. Early success included British Airways and several blue chip billing systems being handled by centres on the Indian sub-continent. At this stage, many businesses that utilise or operate their own contact centres in the UK have simply piloted projects in India and other international locations, although some large banks and insurance companies have developed significant operations in India especially.
Automation and High Value Work **(2005 – Current)**	Automation has the potential to reduce costs but is held back by user inexperience and maintained knowledge bases. Training needs are therefore likely to increase, and part of the savings made at the low value adds part of the business could be reinvested to move the contact centre onto a higher level.

The net result could be improved customer loyalty and satisfaction through good quality multimedia interactions and a consequent rise in resell/up-sell/cross sell rates –the so-called advent of super advisors (Auh and Johnson, 2005) (CM Insight and Contact Babel, 2004). Most significantly, the increasing reliance on remote means of conducting business, such as the communication medium of the telephone, has become a common means of conducting business (Brown and Maxwell, 2002). Prabhaker *et al.* (1997), for example, identify the need for companies to offer a superior service in order to ensure business survival in a service sector economy. Call centres afford companies the potential to manage customer relations more effectively, thus providing some competitive advantage while saving costs (Prabhaker *et al.* 1997). Indeed, the quality of the customer service itself may become a point of competitive distinction and positional advantage (Brown and Maxwell, 2002; Dorman and Zijlstra, 2003).

2.1.3. Disadvantages of Call Centres

Customer satisfaction levels with face-to face services have been found to be significantly higher than with call centre services in the human services arena. However, there are still potential disadvantages in relying on technology, especially if it fails. Services need to be reliable as well as user-friendly. Generally, customers expect the service to work each and every time and may become very angry when there are technological problems. In fact, according to Calk (1998), today's call centre customers want services performed better; they want easier ways of ordering products and services, timely responses to queries and to be treated better (Bennington *et al.* 2000; Calk, 1998). The issues of timeliness and responsiveness are particularly pertinent to call centres. Sarel and Marmorstein (1998) have pointed out that there are real difficulties in consistently providing responsive service yet the majority of customers neither expect nor condone delays. Thus, assessments of service quality will be greatly affected when delays occur. Zeithaml and Bitner (1996) have provided eight explanations of different perceptions of waiting time:

- Unoccupied time feels longer than occupied time;
- Pre-process waits feel longer than in-process waits;
- Anxiety makes waits seem longer;
- Uncertain waits are longer than known finite waits;
- Unexplained waits are longer than explained waits;
- Unfair waits are longer than equitable waits;
- The more valuable the service the longer the customer will wait; and
- Waiting alone feels longer than when waiting with a group.

Given that call centre customers do not have visual or other cues as to what is actually happening at the call centre, and may well be anxious when they call; it is likely that any wait will be perceived to be too long. It has also shown that customers might become frustrated, put off or disenfranchised by having to deal with technology and pre-recorded voices rather than people (Zeithaml and Bitner, 2000). To assist us with this issue, Walker *et al*. (2002) have characterised the services in which technologically assisted transactions may be open to negativity. These include:

- Where there is high importance placed on personal contact
- Where there is a high degree of personal attention required
- Where risk is perceived to be reducing by direct personal contact
- Where customers feel unable to use the technology, and
- Where the technology is not seen to add value

Just like other aspects of service quality, these factors cannot be treated as absolutes; they will vary across customers and time, so detailed and up-to date knowledge of the customer base of any business is required for the planning and monitoring of service design options (Walker *et al.* 2002; Prabhaker *et al.* 1997).

2.1.4. Contact Centres

Customer contact centres (CCCs) represents one of the key emerging trends in the 21st century economy. The integration of customer contact centres into day-to-day organisational operations is expected to affect almost all aspects of society from the private sector to government, to nongovernmental organisations in all parts the world. According to Hawkins *et al. (2001),* a contact is defined as:

"A Contact Centre defined as an internal or outsourced operation largely based on telecommunication and data supports whose primary role is to provide one or many relationship channels for customers, clients, employees or suppliers. This may include inbound and/or outbound, person-to-person and self-service contact capabilities that include service, sales, marketing, fulfilment or data collection".

Customer contact centres are now effectively an industry with their own language, their own technology, and their own culture. While some of the inconsistencies can be attributed to definitional differences, a larger problem at the centre of any analysis of this sector is the general lack of agreement on what constitutes a contact centre. Customer Relationship Management (CRM) is defined as, a business strategy that aims to understand, anticipate, manage and personalize to meet the needs of an organisation's current and potential customers. It is a journey of strategic, process, organisational and technical change whereby a company seeks to better manage its own enterprise around customer behaviour (Hawkins *et al.* 2001). CRM acquires and deploy knowledge about customers and using this information across various touch points to balance revenue and profits with maximum customer satisfaction (Kemper and Lee, 2003). Figure 2.3 describes the architecture for customer contact centre (Hawkins *et al.* 2001).

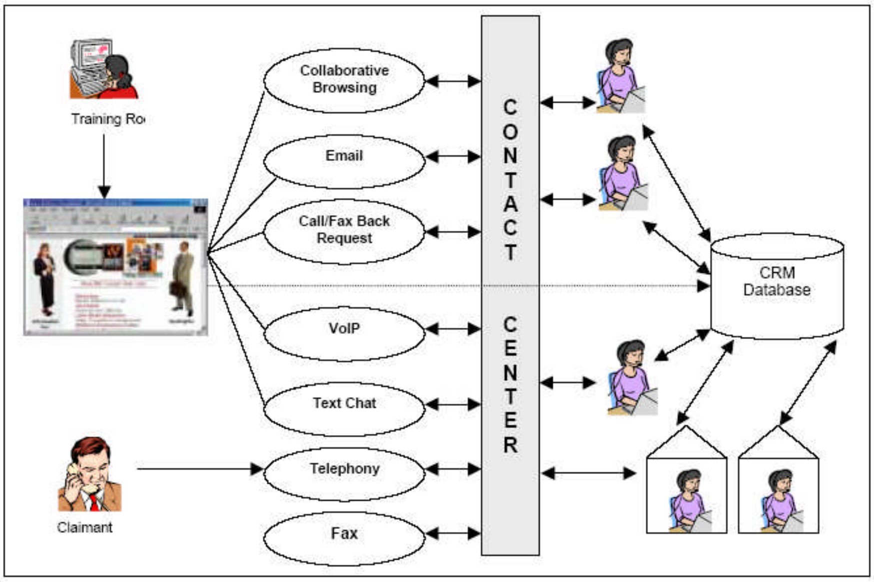


Figure 2-3: Customer Contact Centre Architecture (Hawkins, *et al.* 2001)

The characteristics and role of the modern centre, highlighted in Table 2.2, reflect the shifting nature of today's operations, as well as the increased functionality that are at the centre of the changes taking place in this environment. The level of strategic thought that historically been focused on a corporation's marketing department is now slowly filtering into the contact centre environment - contact centres are becoming strategic assets.

Table 2-2 Characteristics of Call and Contact Centre Environment

		Call Centre Stages from 1990's
Characteristics	***Call Centre***	***Contact Centre***
Primary Objective	Customer support	Relationship management
Main Benefit	Problem resolution	Revenue generation, retention
Channels	Phone, fax	Phone, fax, e-mail, web
View of customer relationship	Fragmented, incomplete	Broad, encompassing
Customer experience	Inconsistent	Personalised, consistent across channels
Value of organisation	Tactical	Strategic
Availability	9 am to 5 pm	24/7

The relationship with the customer has changed dramatically over the past decade. Historically, interactions with customers viewed simply on a transactional basis, as companies continuously sought to acquire additional customers. As companies began to realise the importance of maintaining their customer base, and the potential for increasing the sales of products and services to them, the relationship evolved to one where the customer viewed more strategically. Many organisations are now making attempts to establish on-going dialogues with their customers in the hope of understanding and anticipating their individual needs and to maximize the value of these customers over their lifetime (Koole *et al. 2*003).

2.1.5. Customer Contact Centre Environment

Technology has changed the way organisations manage their relationships with their customers. While some organisations may argue this new reality, the consumer is increasingly in a position of power, as comparison-shopping on a wider-scale becomes the norm. A strong relationship with the customer is of utmost importance to today's organisation, and the modern contact centre can facilitate this. The modern contact centre enables the organisation to create a two-way dialogue with their customers (Boyd *et al.* 2002). Each 'contact' with the customer is an opportunity for that organisation to develop a better understanding of its customer base. Customer issues, positive or negative, are now documented and tracked on an individual basis, for future action. Historically, change within organisations has meant a focus on cost reduction (Koole *et al.* 2003). Figure 2.4 describes the changing shift of services offered through call centres to contact centres (Shah *et al.* 2006).

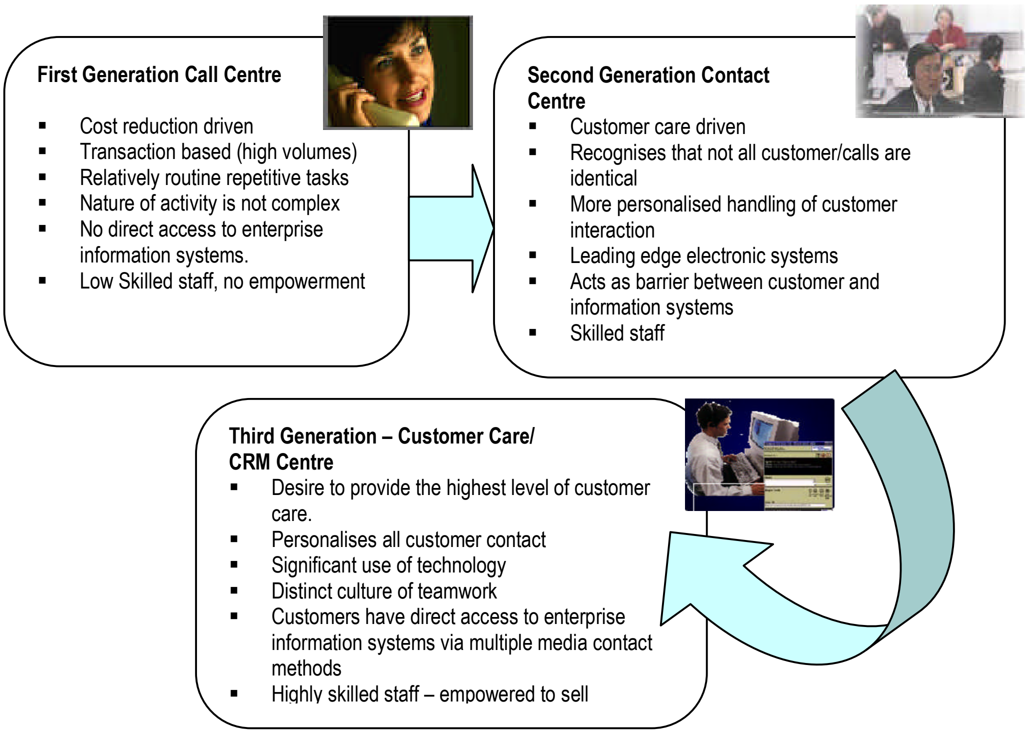


Figure 2-4: Changing shift of call centre to contact centre (Shah *et al.* 2006)

However, given the shift in the balance of power from organisations to the customer, cost reduction with stable customer satisfaction has become the priority for organisations (Hawkins *et al.* 2001). Nonetheless, it is necessary to determine carefully which channels are effective at meeting the needs of the customers. As an example, while the Internet may be an effective self-service technology, certain customer groups, such as the elderly, may be limited in their ability to manoeuvre through such channels.

Understanding the customer's capabilities and needs is a necessity when transitioning to a multi-channel environment. Some people put the cost of acquiring a customer as high as five to ten times more than to retain one. A firms ability to understand its own customers is, however hidden in the data it accumulates about their activities, and their likes and dislikes – not external inputs (Meltzer, 2001). In addition, the proliferation of channels through which customers can interact with organisations has resulted in increased expectations across channels. No longer are customers satisfied with merely having access to multiple channels. Customers are expecting the same level and quality of service across all channels. Because customers are able to access online retailers through the Internet 24 hours a day and 7 days a week (as opposed to the hours of shopping constrained by traditional retailers), customers have come to expect comparable support during this experience. The architecture of a multichannel customer contact centre is as shown below in figure 2.5 (CCCI, 2004)

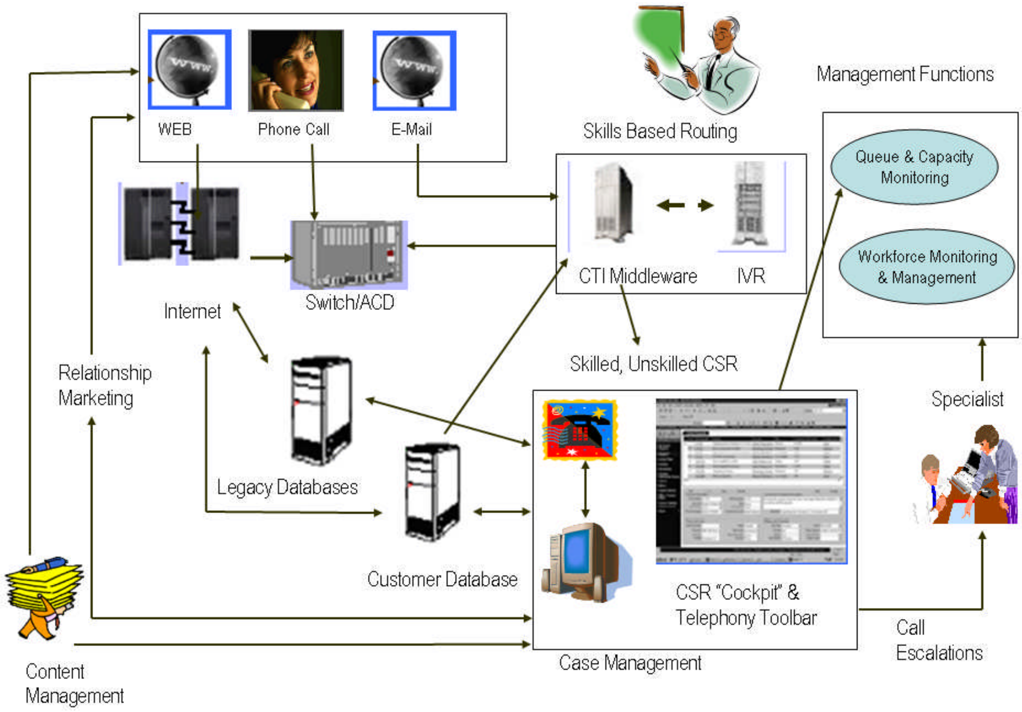


Figure 2-5: Multichannel Customer Contact Centre Architecture (CCCI, 2004)

The failure to offer such support could be the impetus that motivates a customer to move to a competitor that offers a more customer oriented shopping and service experience. Shopping on the Internet also changes the channels through which customers expect to receive support. As an example, some contact centres now allow CSA has to shadow a customer while they are browsing a website. CSA's are able to make recommendations and to push value-added information to the customers instantaneously (Fukunaga *et al*. 2002; Hawkins *et al*. 200).

The role of the CSA is also evolving with the changes taking place around them. Whereas historically, interactions with the CSA have been transaction based, modern day CSA's are dealing with far more complex and varying customer issues. As had been stated earlier, the simpler interactions move to self-service technologies, such as company websites and Interactive Voice Response (IVR). As such, this technological change is not simply transforming the methods by which the organisation operates, but is affecting the level of skill and education required by both CSA's and management within the contact centre environment. The role of the CSA has expanded to provide value across the entire engaging in customer retention programs. CSA's will need to develop skills that are far more complex than the simple information questions that historically been handled within this department. As part of the CRM process, CSA's are increasingly required to identify and act upon cross-selling and up-selling opportunities (Storey and Cohen, 2002). Figure 2.6 describes the drivers of changing customer expectations within service environment (Calvert, 2001)

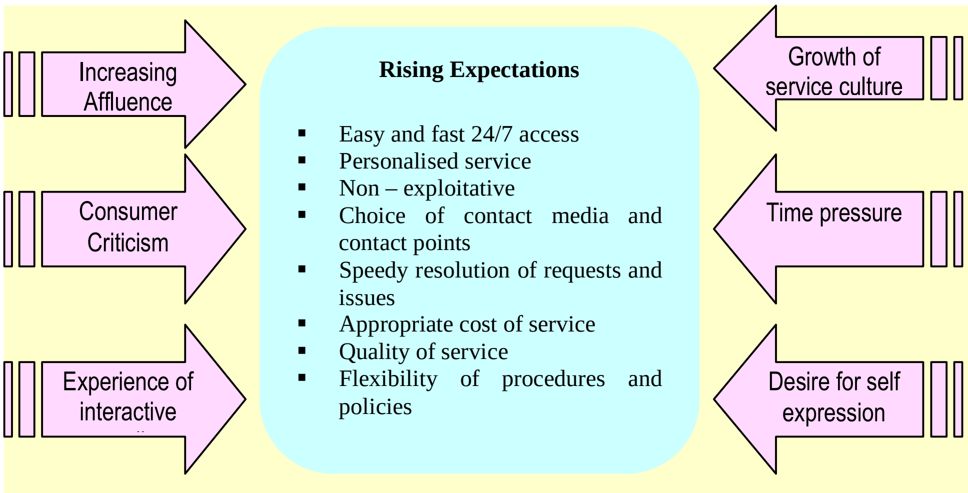


Figure 2-6: The drivers of rising consumer expectations (Calvert, 2001)

There is clearly a need for CSA's with sufficient education to be able to effectively articulate and problem solve. In contact centres, customer contact employees (i.e.

those employees who interact directly with customers over the phone) are call *customer service advisors* (CSA's) (Malhotra and Mukherjee, 2004). They are important for service organisation since they provide a link between the external customer and environment and the internal operations of the organisation (Zeithaml and Bitner, 2000). In addition to the basic training that CSA's may have been provided with regarding the current service and product offerings, the evolved contact centre will provide its CSA's with the necessary technical training to interact within the various channels. The ability of a CSA to provide effective voice service does not guarantee their ability to provide effective email or web-chat service and support. They may have the necessary product and service knowledge – but their ability to communicate with correct spelling and grammar is another skill that must be considered in the recruiting and training processes (Fukunaga *et al.* 2002).

The development and widespread use of the Internet for communication and commerce is creating a skills gap within the modern contact centre. It suggests that as web-chat/collaboration becomes more popular among customers there will be a shortage in the number of qualified or trained CSA's. Further, there is not enough focus and attention given to the training of CSA's in the area of Internet related support (Rose and Wright, 2005). It is not surprising that employee retention within the contact centre is becoming critical to the success of an organisation. Employee turnover results in a substantial expense for a company particularly as it relates skilled CSA's. The efficiency and effectiveness of a department may suffer as new staff progress through the learning curve. Depending on the industry sector and the required level of skill and education, this can be a very lengthy process (Calvert, 2001). The loss of an experienced CSA is a major blow to the organisation, even more so if they are hired away to a competitor. There is another school of thought that believes that modern contact centre technologies will reduce the necessity to hire technologically advanced CSA's (Mohr and Bitner, 1995; CCCI, 2004).

Through the implementation of advanced CTI and case management systems, the skills required by CSA's will evolve from product, service and technological knowledge to skills associated with efficient navigation of a Case Management system. Industry experts suggests that as long as CSA's possess good interpersonal skills and are friendly, then screen pops, etc. – should provide them with automated and pat responses to handle effectively customer inquiries (Harding *et al.* 2001).

2.1.6. CC Technologies and Market Analysis

This section describes the current technologies and market overview of the contact centre environment within UK. The author has described the overall structure of the contact centre, the advisor position and finally a summary of the leading software available from companies / vendors who are providing the call/contact centre solutions and services. Figure 2.7 describes the conceptual stages of enterprise and customer contact centre (Data Monitor, 2002).

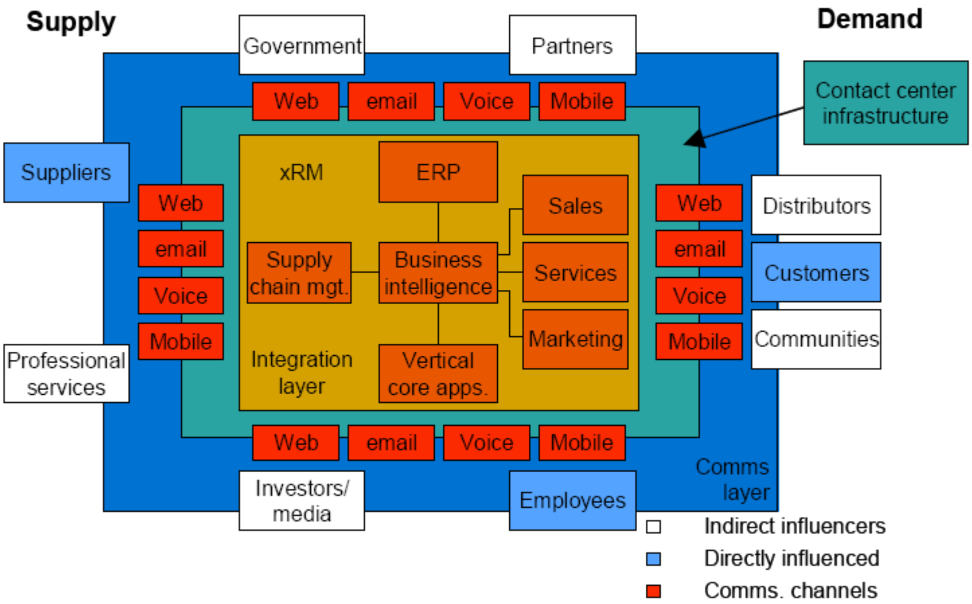


Figure 2-7: Conceptual Diagram of Enterprise and Customer Contact Centre (Data Monitor, 2002)

The key technologies used within the contact centre arena are described with summary of other used technologies. Organisations have started to understand the benefits of certain CC technologies and their use to manage effectively all customer relationships. However, organisations often make technological investments before their organisation is fully ready and/or able to effectively integrate the technology (Data Monitor, 2002; Brown and Maxwell, 2002).

Frequently, companies do not spend the necessary time and money to change the processes and the organisation after new technology has been introduced, nor do they evaluate the success of the investment. Businesses and consumers are not necessarily ready for some of the more sophisticated applications (web-chat, collaboration, videoconferencing, etc.). Though organisations have developed a better understanding of their customers' needs, they must evaluate their customers' capabilities more accurately. Contact centres have often upgraded their technology without paying enough attention to changing their infrastructure (Calvert, 2001; Data Monitor, 2002; CM Insight and Contact Babel, 2004). As shows in figure 2.8, the total number of advisor positions within any CC domain has increased in recent years with increase in number of contact centres shown in figure 2.9. That is, organisations have failed to consider the implications of technology investments on their strategic environment including people and processes. Adopting new technology is not simply a matter of plugging it in and expecting people to use it (Bernett and Gharakhanian, 1999; Harding *et al.* 2001).

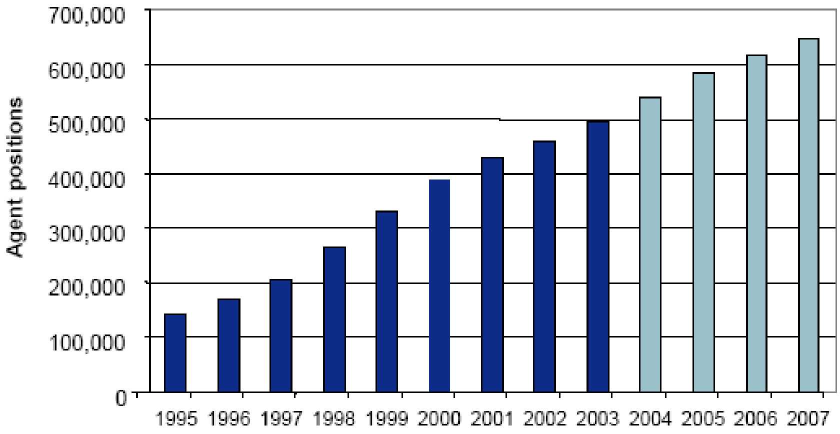


Figure 2-8: Advisor (CSA) Positions in Contact Centres in UK (CM Insight & Contact Babel, 2004)

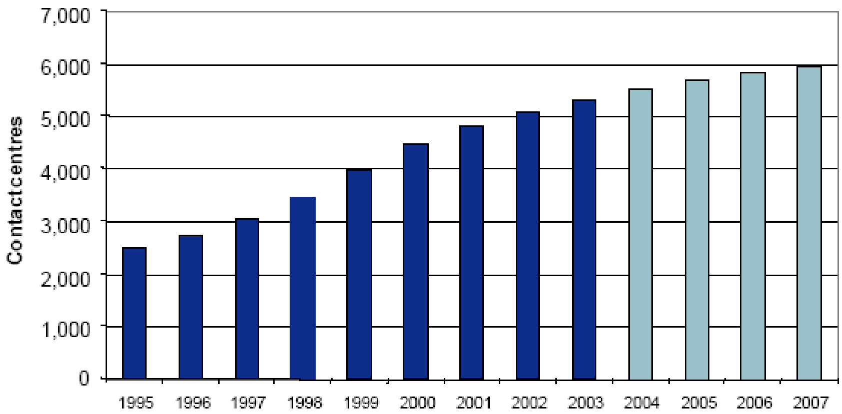


Figure 2-9: The UK Contact Centre Industry - 1995-2007 (CM Insight & Contact Babel, 2004)

More comprehensive change management and skills development initiatives than in the past must increasingly accompany technology investments. The main key technologies used within contact centre environment are as follows:

1. **Multimedia**: Multimedia contact centres are call centres in which at least two channels of communication – including voice –routed to the advisor using the same set of business rules.

2. **IP**: IP-architected call centres are ones in which all forms of communication, including voice, are treated as data within a single enterprise network using Internet Protocol (IP).

3. **Networked call centres**: Networked call centres are call centres that use a routing application or applications to switch calls between call centres, an ACD and, possibly, applications (such as CTI, IVR or customer care automation software) hosted in a public network (multi-tenanted or just off-site).

4. **Speech recognition**: Speech recognition is software that listens to and recognizes spoken words. Used in combination with IVR systems, speech recognition is set to revive a mature technology, allowing more sophisticated self-service solutions and therefore more calls to be directed away from advisors (Bae et al., 2005).

5. **Outbound dialling**: Outbound dialling includes outbound sales, as well as callback and requested outbound calls (e.g., when a customer is stuck on a website, leaves their number and the request are placed in the call queue).

6. **Workforce optimisation**: Workforce optimisation is the collective term for four distinct markets: quality monitoring, workforce management, e-Learning and advisor analytics software.

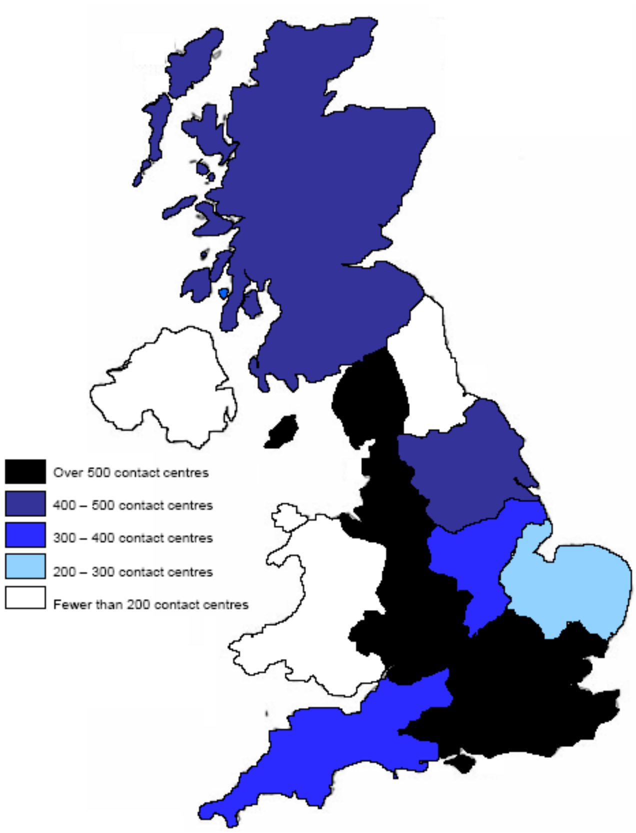


Figure 2-10: UK Contact Centre Locations by Region

Figure 2.10 presents the total number of contact centres across UK (CM Insight & Contact Babel, 2004). The activities of contact centres can be measured by looking at exactly what contact centres do most. Figure 2.11 covers these key areas:

- Call centre – a mixture of activities, inbound/outbound, sales/service
- Customer service – mainly inbound, dealing with existing customers' requirements.
- Telesales – often outbound, calling to existing customers or new.
- Switchboard – transferring calls to individuals or departments.
- Helpdesk – inbound, often technical or IT queries. Mostly the calls are from within the organisation (internal) or from customers (external).
- Reservations – usually inbound sales order taking, often in transport/travel or entertainment/leisure sectors.

Table 2.3 presents the job role of contact centre staff within the current environment

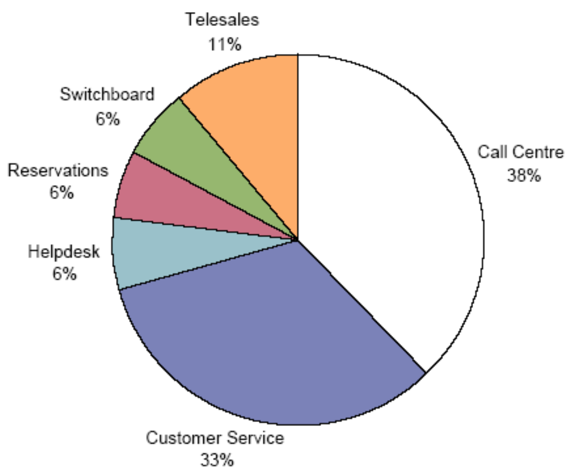


Figure 2-11: Contact Centre Activity (CM Insight & Contact Babel, 2004)

Table 2-3: Employment of Contact Centre staff by job role

	Contact Centre Staff Employment
Job Role	% of Contact Centre Workers
Sales Advisor – inexperienced	10%
Customer service advisor – inexperienced	17%
Sales advisor – experienced	19%
Customer Service advisor –experienced	36%
Sales team leader	3%
Customer service team leader	5%
Product specialist	2%

Coaches	2%
Resources / scheduling manager	1%
Contact Centre manager	2%
New entrant (pre-training)	2%
Source: eSkills UK, “Contact Centre Survey” (2003)	
(CM Insight and Contact Babel, 2004)	

2.1.7. Contact Centre Technology Overview

Based on the initial understanding of the contact centre domain from the literature, the author carried a further technology based study to understand the different trends in technologies used currently in contact centres. A brief overview of some of these technologies studied during the research are as described below and explained in full details in appendix A of the thesis.

- Interactive Voice Response (IVR) – In telephony, interactive voice response, or IVR, is a phone-based technology that allows a computer to detect voice using a normal phone call. This system can respond directly with any pre-recorded audio message to direct the callers to further services offered by the company
- Automatic Call Distributor (ACD) - ACD are mainly devices or a system that distributes incoming calls (to organisations) to a specific group of terminals or points used by the advisors. It is often part of computer telephony integration (CTI) systems.
- Computer Telephony Integration (CTI) – CTI is a technology that allows interactions on a telephone and a computer to integrate together. CTI has expanded to include the integration of all customer contact channels (voice, email, web, fax, etc.) with computer systems.

2.1.8. Summary of Companies/Vendors and Type of Services Offered

Based on the types of technologies identified in the previous section, the author also studied the type of major companies and vendors supplying these technologies/systems to customer facing market within the service sector. The information was gathered within the literature studies and a variety of information searching ways was adapted for this study.

The findings on the type of companies providing solutions for these systems are provided in appendix B of the thesis. Some of the major providers of these systems are mostly based in US and various European countries including UK based solutions providers.

2.2. Customer and CSA Categorisation

Through the understanding of the research and problems encountered as discussed in section 2.1 of the thesis on call and contact centre environment, the author identified to analyse the literature on the customer and service advisor within contact centres. Other sociological and psychological aspects where similar research were carried out to identify the ways to categorise customer and advisor which would enable the author to understand the way the following can be categorised and develop his understanding about the research question more properly. Within this section, the author aims to highlight two main areas of his research into customer and service advisor (CSA) categorisation mainly looking into customer and CSA (human) behaviour analysis and human behaviour modelling techniques respectively.

2.2.1. Customer and CSA (Human) Behaviour Analysis

This section lists the available research and literature on human behaviour and customer/CSA behaviour analysis within the context. Customer satisfaction and retention is an important aspect the author has identified and henceforth the author aims to look on issues related to customer satisfaction with respect to the behavioural segmentation within the contact centre environment.

Customer Satisfaction

Research suggests that customers distinguish between encounter and relationship satisfaction (Swerdlow, 2000). Encounter satisfaction will result from the evaluation of the events and behaviours that occur during a single, discrete interaction. Overall satisfaction, on the other hand, is viewed as a function of satisfaction with multiple experiences or encounters with the firm (Hahm *et al.* 1997). In earlier research, a number of different concepts have been used, related to these two different types of satisfaction; transaction specific/global, transaction specific/brand specific, and episode/relationship (Liljander and Strandvik, 1995). The commonality between them is the distinction between evaluations related to a discrete experience and evaluations related to an overall experience (Moshavi, 2004). Although attitude-like in some respects, the concept of satisfaction is distinguished from attitude towards the product or brand, which represents a more generalised evaluation of a class of purchase objects (Westbrook and Oliver, 1991; Beatty *et al.* 1996; Bennington *et al.* 2000).

Furthermore, the formation of customer satisfaction can be described as a cognitive process, where customers consider whether their product, service, and process needs are addressed. Satisfaction also believed to be created by an affective process, too. This influence of both cognition and affect on the consumption experience is called the two-appraisal model. The cognitive system performs the higher mental processes of understanding, evaluating, planning, deciding, and thinking, whereas affect refers to feeling responses. Although several approaches exist to describe emotions, an emerging body of theory and evidence is available to suggest that the two dimensions, positive and negative affect, are useful in understanding the affective basis for the satisfaction response (Oliver, 1997). However, little has been done to analyze whether positive and negative emotions, evoked during an interaction, influence customer encounter satisfaction as well as relationship satisfaction (Heckman and Guskey, 1998 and Witt *et al.* 2004). The customers' cognitive evaluations of the interaction experience are studied as customer's perceptions of service advisor performance. Whether the focus is on encounter satisfaction or on relationship satisfaction, the performance of the contact employee is critical to satisfaction (Dolen *et al.* 2004). At the encounter level, the behaviour of the contact employee plays a critical role in diagnosing and addressing customer's needs and in shaping the overall evaluation of the way in which the discrete exchange is executed. At the relationship level, research found that customer-oriented employees who show empathy, understanding for the customer, interpersonal care, and trustworthy behaviour, and provide augmented personal service, are critical to long-term relationship building (Beatty *et al.* 1996; Swan *et al.* 1999).

The performance of a contact employee during interactions with customers has been the subject of considerable research, in both sales and service settings (Solomon, 1999). According to this research, a contact employee role should incorporate both relational aspects and core task aspects (Reynolds and Beatty, 1999). Recently, researchers have conducted several studies to improve the indices of service performance (Winsted, 1997, Price *et al*. 1995) propose five dimensions of contact employee behaviour that influence customer's perceptions: mutual understanding, authenticity, extra attention, competence, and meeting minimum standards. While employee performance has been studied extensively, very little research has explored which employee behaviours during an interaction influence customer encounter satisfaction and which behaviours influence relationship satisfaction (Dolen *et al*. 2004; Hahm *et al*. 1997; Kemper and Lee, 2003). The next section tries to elaborate on the role of employee/advisor) performance in interactions with the customer.

Service Advisor – Customer Interaction

The interactive nature of an encounter implies that the display of some behaviours of the service advisor is more dependent on the customer than others, because of their more reciprocal nature (Crosby *et al.* 1990). For example, authenticity, defined as being genuine, is more under control of the service advisor (employee), than mutual understanding; connecting with customers' lives and inviting and sharing personal exchanges seems to us difficult without an active role of the customer. The behaviours produced and performed by the service advisor employee are employee-specific behaviours. Competence has often been noted as an attribute of the service advisor employee (Crosby *et al*. 1990) and as static property of the service advisor employee. It goes to the core of what is expected of the service advisor employee during the interaction and defines the extent to which the individual provider can affect the outcome of the interaction through his or her skills (Price *et al*. 1995; Rose and Wright, 2005). Customers seek to obtain advice and information of the employee that requires an expertise they lack (Liu *et al.* 2005). This implies that the competence of the service advisor employee is a resource of the employee during the interaction irrespective of the input of the customer. Authenticity relates to individuals who present their real selves in interactions. It defines the extent to which the employee is genuine and his/her own person. It has believed that service advisor employees present their true self-alone and that a contribution of the customer is not needed (Ardissono and Goy, 1999). The performance of these behaviours has been influenced, in part, by the contextual demands of the interaction. However, in line with the dyadic decision-making research, it shows that because of their independent nature, employee specific variables are predictive of the occurrence of particular events within the interaction (Kristensen *et al*. 1999). In this way, these behaviours refer to an individual's performance tendency and to relatively stable behaviours that are active in interactions. For example, contact employees who are competent and ordered will structure the encounter, keep materials methodically organized and are thorough in their approach, regardless of the situational inputs. The behaviours that are co produced are presented with the customer interaction-induced behaviours (CCCI, 2004). These behaviours are reactive and reciprocal in nature and exist by the interaction. Examples of these behaviours are a contact employee's response to special requests; meeting customer's needs, and sharing of personal information between customer and contact employee (Malhotra and Mukherjee, 2004; Dolen *et al*. 2004).

With regard to the dimensions of performance of Price *et al.* (1995), it suggests that mutual understanding, extra attention, and meeting minimum standards are interaction induced. Mutual understanding is achieved when both the contact employee and the customer engage in self-disclosure and is only attained by the norm of reciprocity. Extra attention, in this study, relates to the contact employee's responses to customer's explicit or inferred requests for customized treatment (Price *et al.* 1995). Arguably, a response can only happen in reaction to an action of the customer. In addition, meeting minimum standards is reactive and related to the contact employee's responses to needs and requests of customers. However, this relates to responses to meet the basic performance standards for contact employees in the industry, like giving basic information about products (Dolen *et al.* 2004). A more balanced approach to measuring performance based on strategic objectives is valuable, especially if visual representations of service delivery and value creation are used (Bernard and Andrew, 2004).

Analysis:

- According to Hahm overall satisfaction is viewed as a function of satisfaction with multiple experiences or encounters with the firm (Hahm *et al.* 1997). Formation of customer satisfaction can be described as a cognitive process, where customers consider whether their product, service, and process needs are addressed. The use of customer satisfaction values are considered as an important factor while delivering the services by the company.
- Based on the findings of the customer satisfaction, the performance of the contact centre employee (advisors) is critical to satisfaction values as identified by Dolen (2004). The author believes that it is important to look on the aspects of customer satisfaction and sources of the satisfaction to identify the attributes, which were going to be used at the design stage for categorisation.
- Price *et al*. (1995) propose five dimensions of contact employee behaviour that influence customer's perceptions: mutual understanding, authenticity, extra attention, competence, and meeting minimum standards. These dimensions can be considered while determining the variables of customer and advisors within the categorisation frameworks.
- Competence of the service advisor is a resource of the employee during the interaction irrespective of the input of the customer. Authenticity relates to individuals who present their real selves in interactions. It can be believed that service advisor employees present their true self-alone and that a contribution of the customer is not needed. The performance of these behaviours may be influenced, in part, by the contextual demands of the interaction.

In the next sections, the major human modelling methods are evaluated. These techniques have been developed and have evolved over time in response to the changes in customer modelling. The author has looked on various techniques that can be used in his research for modelling human behaviour with respect to customer and service advisor categorisation and at the end of the section a summary of the techniques is represented which highlights the usefulness and limitations of each technique presented in the research.

2.2.2. Human Behaviour Modelling Techniques

As early as 1935, Lewin (1935) identified that human behaviour is a function, which comprises of their personal characteristics and the environment within which they exist (Baines and Kay, 2002). Understanding and adapting to changes of customer behaviour is an important aspect of surviving in a continuously changing environment (Chaochang, 2002). Research in understanding customer preferences, known as 'consumer behaviour study', has been the subject of investigation in psychological marketing area for few decades. It is necessary to understand individual customers from designer side, as well as from the customer's side to provide guidance for customers to find what they want. Customer choice of a product depends on explicit requirements, implicit requirements, available options and latent requirements implied by the product (Zeelenberg and Pieters, 2004). The study of customer helps firms and organisations improve their marketing strategies by understanding issues such as:

- The psychology of how customers think, feels, reason, and select between different alternatives.
- The psychology of how the customer is influenced by his or her environment (e.g. culture, family, signs, media etc.
- The behaviour of customers while shopping or making other marketing decisions.

Although research has suggested that contact employee (CSA's) performance is critical to create customer satisfaction, little has been done to analyse which employee behaviours influence customer encounter satisfaction and which behaviours influence relationship satisfaction (Dolen *et al.* 2004). The performance of a CSA during interactions with customers has been the subject of considerable research, in both sales and service settings. There are five dimensions of CSA's behaviour that influence customer's perceptions: mutual understanding, authenticity, extra attention, competence, and meeting minimum standards (Dolen *et al.* 2004). Customer behaviour and CSA's behaviour can be represented with different attributes such as:

- Geographic
- Economic Conditions
- Knowledge and Awareness
- Customer Mood
- Purchase Behaviour
- Customer need pattern
- Customer/CSA's Performance
- Availability
- Ease of use
- Better customer satisfaction, knowledge
- Customer satisfaction and behaviour
- Buying attitude, tendency to buy
- Requirement Analysis
- Company's overall requirements

<u>Fuzzy Cognitive Maps (FCM)</u>

Fuzzy cognitive maps (FCM's) combine characteristics of both fuzzy logic and neural networks. FCM can model dynamical complex systems that change with time following nonlinear laws. FCM's uses symbolic representation for the description and modelling of the system. A fuzzy cognitive map is consisted of concepts in order to illustrate different aspects in the behaviour of the system, with each concept representing a characteristic of the system, and these concepts interact with each other showing the dynamics of the system (Stylios and Groumpos, 1999). FCM's have been proposed as a generic system for decision analysis and as coordinator of distributed cooperative advisors.

Multiple Classifier Combination Methods

Prediction of customer's purchase behaviour can be classified as a classification problem, and classification is one of the most common tasks in data mining area. There are two families of combining multiple classifiers: serial combination and parallel combination. Serial combination arranges classifiers sequentially and the result from the prior classifier is fed to the next classifier. Parallel combination arranges classifiers in parallel. Some commonly used methods for combining classifiers include majority voting, Bayesian, BKS (behaviour knowledge space), and Borda Count (Kim *et al.* 2002). A method might override the others in classification performance on a specific problem, but in general, it is not possible that one method always outperforms all the other methods for every possible situation. This method based on fact that different classifiers potentially offer complementary information about the patterns required to classified.

Living System Theory

Living system theory recognises the system as collection of elements interrelated together to form a whole. In the living system theory, the elements, relations and wholes later expressed with different notions. The theory of living system explains the living system as cognitive systems, which is an attempt to explain how cognition can be explained by biological phenomena. "Living system theory can be seen as a right approach to describe consumer behaviour, because the phenomena happening in the area of consumer behaviour are actually mediated through consumers" (Kurniawan *et al.* 2003). In modelling the customer behaviour using living system, there are some assumptions taken in order to simplify the model. They are:

- Customers can choose to select components from product family architecture to be assembled into a product or prefer to modify components.
- Customer behaviour is composed of series of activities. These activities are called basic cognitive activities.
- There are no pre-specified relationships between basic cognitive activities.

Customers can be seen as such system, with the basic cognitive activities as the elements of the system. When a customer performed a basic cognitive activity and then followed by another basic cognitive activity, it will describe the relations between them. It will serve as descriptive tool of the model, describing how customer behaves based on what (s) he has done in the past (Kurniawan *et al.* 2003). The limitation of the approach is to understand and model customer behaviour because of its ability to explain the behaviour of human beings as biological system.

Cognitive Process Modelling

Cognitive Engineering – Designing systems and processes to meet user's changing needs, limitations, expectations and abilities (Pasi, 2003). The modelling of collective human behaviour can be done by taking the characteristics on cognitive psychological aspects and human interactions under collective behavioural situations into account (Nakamura, 2001). The cognitive system performs the higher mental processes of understanding, evaluating, planning, deciding, and thinking, whereas affect refers to feeling responses (Dolen *et al.* 2004).

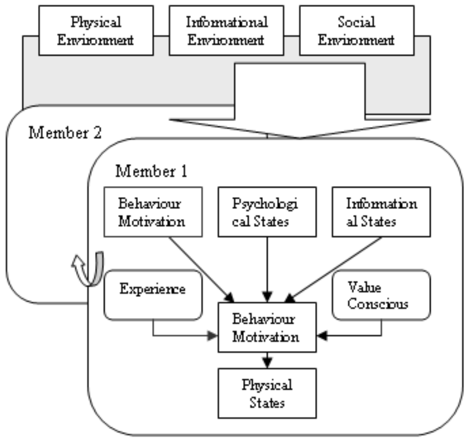


Figure 2-12: Cognitive Process Modelling (Dolen *et al. 2004)*

To develop such models the crucial issues are treatments for:

1. Physical, physiological, psychological and informational interactions among persons.
2. Vagueness, ambiguity, uncertainty of human inner states and knowledge.
3. Flexible information processing in human cognitive processes.

<u>Case – Based Classification Approach</u>

Case based reasoning (CBR) shows significant promise for improving the effectiveness of complex and unstructured decision-making. It is a problem solving technique that is similar to the decision making process used in many real world applications. CBR is both a paradigm for computer based problem solvers and a model of human cognition (Chaochang, 2002).

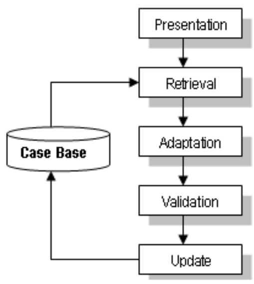


Figure 2-13: The general CBR process (Chaochang, 2002)

CBR's core steps are:

1. Retrieving past cases that resemble the current problem.
2. Adapting past solutions to the current situation.
3. Applying these adapted solutions and evaluating the results
4. Updating the case base.

CuBeS Simulation Approach

The objectives of the CuBeS project (Customer Behaviour Simulator) are to develop software for simulating consumer behaviours in a competitive market including several brands and to build a virtual population of consumers including several thousands of individuals, that reproduce real market properties (segmentation, evolution) independently of a given product. Cubes provide the simulation of:

- Behavioural attitudes (BA) of customers
- Impacts of consumption acts resulting from these attitudes.
- Retroactive effects of these acts on the customer themselves
- Brand reactions to the market evolutions and their retroactive effects on the individual behavioural attitudes.

CuBeS take into account, not only individual cognitive features, but also interactions between customers or specific segments that occur in real customer's population. CuBeS model offers an operational and a conceptual richness that covers a large part of consumer behaviour aspects. The concepts are simultaneously considered at individual and collective levels. The consumer cognitive functions are derived from generic behavioural components intrinsically related to the interaction aspect (Ben Said *et al.* 2002).

ETHOS Modelling and Simulation

Multi advisor system (MAS) approach is used to support the modelling and simulation of advisor based models of human social behaviour and culture change. Ethos extends the traditional features in MAS for advisor based modelling, with new abstractions specially designed to model human behaviour and culture. These include the transmission of information between advisors through observation of performed behaviour and direct generation of social stimulus, management of advisor's social relationships, and support for flexible behaviour selection mechanisms. The Ethos framework provides as basic building blocks the kind of entities a modeller is likely to consider when thinking intuitively about human social behaviour and culture (Simao and Pereira, 2003). The limitation of the research is that it extends from the traditional features of MAS (Multi advisor system). It is currently in prototyping stage. Ethos uses a simple discrete time step scheme to trigger events.

Neural Networks Modelling

Neural networks provide an alternative method of building models of human performance. They can learn behaviour from examples, reducing the need for many identical repetitions and intensive analysis. They can interpolate between, and extrapolate somewhat beyond the training examples, which greatly reduce the manual analysis required. The data upon which the model is based is a statistical representation of a human's performance through many repetitions of a set of tasks. This means the model is actually only correct for the exact tasks in the statistical base, and its applicability to other conditions is only as good as the manual analysis that went into the model (Fix and Amstrong, 1990).

CDM Method

The development of a system that accommodates the diversity of the user population and improves the user's performance is optimal. One method to improve the user's performance is to categorise the system users into groups, describe and model each group's behaviours and the incorporate this information in the design and operational processes. The CDM method (Categorising, Describing, and Modelling method) developed as a technique to generate user models. In the CDM method, the user population is first categorised into a reasonable number of groups. The behaviours for each group described and modelled qualitatively and quantitatively. The purpose of the CDM method is to build a set of precise and accurate models that represent the interaction of diverse user behaviours with the system (Bushey *et al.* 1999). The CDM method been applied only to the sales negotiation. CDM method focuses on modelling different users' behaviours; its best implemented on systems where user behaviour's are measurably different.

Valence Based and Specific Emotions Approach

To model the impact of emotions on satisfaction and subsequent customer behaviours two approaches are used: **Valence Based Approach** – Its used to model the impact of emotions on satisfaction through summation of the positivity and negativity of the different emotions that customers experience to arrive at an overall judgment of (dis)satisfaction. In this approach, negative emotions are expected to lead to more dissatisfaction, whereas positive emotions are expected to lead to more satisfaction (Zeelenberg and Pieters, 2004). **Specific Emotions Approach** – It focuses on the idiosyncratic elements of specific emotions. Different negative emotions may differentially influence (dis)satisfaction. As research in the field of emotion theory has shown, different specific emotions can have different behavioural tendencies and behavioural consequences. The specific emotion approach leans heavily on the appraisal theory of emotions. One of the tenets of appraisal theory is that the cognitive appraisal of the situation is the ruling mechanism in both the elicitation and differentiation of emotion (Zeelenberg and Pieters, 2004).

Decision Trees

Decision tree algorithms tend to automate the entire process of hypothesis generation and then validation much more completely in a much more integrated way than any other data mining techniques. Decision trees have unique advantages. They produce models that are easy to understand and they are unaffected by missing values in data (Berson et al, 2000). Decision trees have been used to predict insolvencies in such a way that this prediction can be operationally useful for the decision support process of the telecommunications business handling customer insolvency (Daskalaki *et al.* 2002).

Classification using decision trees used to extract models describing important data classes or to predict future data trends. The example of a classification model using decision trees is the bank loan model, which characterizes customers as either safe or risky. Classification and prediction have numerous other applications including credit approval, medical diagnosis, performance prediction and selective marketing (Bounsaythip and Runsala, 2001). For example, given a database of customer credit information, classification rules learned to identify customers as having either excellent or fair credit ratings. The rules can be used to categorize future data samples, as well as provide a better understanding of the database contents. A decision tree is a flowchart- like tree structure, where each internal node denotes a test on an attribute, each branch represents an outcome of the test, and leaf nodes represent classes or class distributions. The decision trees can easily be converted to classification rules. When the decision trees are built, many of the branches may reflect noise or outliers in the training data. Tree pruning attempts to identify and remove such branches, with the goal of improving classification accuracy on unseen data. Decision tree algorithms commonly implemented include Chi-squared Automatic Interaction Detection (CHAID), Classification and Regression Trees (CART), C4.5 and C5.0. All are suited for classification; some are also adaptable for regression. The distinguishing features between tree algorithms include:

- Target variables: Most tree algorithms require the target (dependent) variable be categorical. Such algorithms require that continuous variables are binned (grouped) for use with regression
- Splits: Many algorithms support only binary splits, that it; each parent node can be split into at most two child nodes.
- Split measures: Help select which variable to use to split at a particular node.
- Rule generation: Algorithms such as C4.5 and C5.0 include methods to generalise rules associated with a tree; this removes redundancies.

Some of the common algorithms and their characteristics are as discussed below:

- CART – binary split based on GINI (recursive partitioning motivated by statistical prediction), exactly two branches exist from each non terminal node. Handles continuous target variables. Requires data preparation
- C4.5 and C5.0 – produce tree with multiple branches per node. The number of branches is equal to the number of categories of predictor.
- CHAID – multi way splits using chi-square tests. The number of branches varies from two to the number of predictor categories
- SLIQ – fast scalable classifier. Fast tree pruning algorithm

(Black and Hickey, 2003) represents the application of the CD3 decision tree induction algorithm to telecommunications customer call data to obtain the classification rules. (Liu *et al.* 2000) suggests a change mining methodology based on decision trees to find interesting relationships among a large set of data items. However, their research cannot give an answer about how much change has occurred. An example of decision-tree-based methodology to detect changes of customer behaviour automatically from customer profiles and sales data at different time snapshots was presented by (Kim *et al.* 2005). The usefulness of the following technique in business environment regarded as; business managers can follow the change trends using change detection methodology. They need to analyse their customers changing behaviour in order to provide products and services that suit the changing needs of the customers. It is possible for a manager to understand customer needs more deeply and design additional niche-marketing campaigns based on the rule sets of the suggested methodology. Knowing the purchasing history of a certain customer segment can give a better understanding of the behaviour of the segment

Soft Computing Techniques

Soft computing (SC) is a new emerging mathematical approach that shows promise in dealing with the inherent complexity of modelling human behaviour. SC is a discipline situated at the combination of several relatively new and distinct mathematical techniques: fuzzy logic (FL), neural networks (NN) and probabilistic reasoning (PR) which includes genetic algorithms, chaos theory, belief nets and learning theory. The experiment to build and validate the model includes a compensatory task performed by several human subjects to develop training and test set of data in this human behaviour.

Neural networks have the ability to learn from input output functions, and so, they provide simpler solutions to complex control problems. Neuro fuzzy systems have the ability to incorporate human knowledge and to adapt their knowledge base via optimisation techniques (Stylios and Groumpos, 2000).

Analysis:

- Understanding and adapting to changes of customer behaviour is an important aspect of surviving in a continuously changing environment (Chaochang, 2002). With effect to the changes in customer behaviour, the author has highlighted some of the important human behaviour modelling techniques within this section.
- The main aim and the purpose of this study was to identify the behavioural aspects of human in terms of customer and service advisor and how the previous research has been carried out to model these behavioural aspects within different environments.
- The study of customer helps firms and organisations improve their marketing strategies by understanding issues such as: The psychology of how customers think, feels, reason, and select between different alternatives. The psychology of how the customer is influenced by his or her environment (e.g. culture, family, signs, media etc. One of the limitations of behaviour modelling carried out within the research can be to model the behaviour of customers while shopping or making other marketing decisions.
- Some of the modelling techniques discussed within this section are Fuzzy Cognitive Maps (Stylios and Groumpos, 2000), Living Systems Theory (Kurniawan et al, 2003), Cognitive Process Modelling (Dolen *et al.* 2004) (Nakamura, 2001), Case Based Reasoning Approach (Chaochang, 2002), Cubes Simulation (Ben Said et al, 2002), Ethos (Simao and Pereira, 2003) and other Soft Computing Techniques.
- One method to improve the user's performance is to categorise the system users into groups, describe and model each group's behaviours and the incorporate this information in the design and operational processes which is called the CDM method described by Bushey (1999). Although this limits the author on grouping the customers and advisors separately this would identify the type of information required to be displayed.
- Another objective of the research is to model the customer and advisor based on demographic, experience variables together with behavioural attributes, and grouping customer and advisor together can limit the author identifying the information.
- A summary of the human behaviour modelling techniques with respect to customer and advisors within contact centre is described in appendix C.
- Examples of some of the techniques described within this section are also highlighted in appendix C.

2.3. Approaches for Human Categorisation Process

The section aims on answering some of the research question, which the author tried to answer to understand the approaches, which are used in the human categorisation process. The human categorisation process approaches can mainly divided into five kinds such as: (1) business and marketing approach, (2) cognitive modelling approach, (3) sociological approach, (4) psychological approach and (5) clustering approach respectively. All of the following approaches are discussed in detail looking on the aspects of human categorisation with respect to customer and CSA within contact centre environment. Within the human behaviour research, there are several approaches concerning CRM, marketing, organisational behaviour and management; but the author limit his scope within the contact centre environment and has highlighted the key approaches relevant to his research.

2.3.1. Business and Marketing Approach

This section focuses on the understanding of consumer behaviour based on the overview of the existing body of business literature on the subject. Focus is given to the formation of consumer needs and attitudes, information processing and the decision- making process within the purchasing decision. The goal of this decision-making process is satisfaction of consumer needs (Swerdlow, 2000). This section helps to understand different stages in the consumer decision process and distinguish between the notions of customer acceptance and customer satisfaction (Langerak, 2001).

Business management and marketing are concerned with ways of satisfying and retaining customers for the purpose of generating profits, improving companies competitiveness and securing market share (Taylor and Baker, 1994). Some of the major themes in the business management domain include studies of customer relationship marketing, which analyses how customer satisfaction relates to competitiveness and profits, methods for measuring customer satisfaction (Thomson, 1995), and approaches that can help transfer customer satisfaction data into strategies for improvement of customer relations and their retention (Johnson and Gustafsson, 2000; Schellhase and Hardock, 2000).

The ultimate goal of the marketing domain is to understand the consumer and to influence their buying behaviour. The main perspectives of the consumer behaviour research analyses buying behaviour from the information processing perspective. One of the models for understanding the consumer buying behaviour, is the model suggested by (Engel *et al.* 2001), as it combines the consumer decision process with the influencing factors.

2.3.2. Cognitive Modelling Methods

Emotions are now considered as associated with adaptive, organizing and energizing processes (Witt *et al.* 2004). Few already identified phenomena of interaction between affect and cognition, which the author expect will be further studied and manipulated by building intelligent interfaces which acknowledge such an interaction. The author also identifies the relevance of these findings about emotions for the field of consumer and human behaviour modelling (Ryder *et al.* 1996).Table 2.4 discusses the human cognitive emotions identified within the cognitive modelling methods.

Table 2-4: List of Human Cognitive Emotions (Ryder *et al. 1996)*

	Human Cognitive Emotions
Organisation of memory and learning	We recall an event better when we are in the same mood as when the learning occurred (Swinyard, 2003). Hence eliciting the same affective state in a learning environment can reduce the cognitive overload considerably.
Focus and attention	Emotions restrict the range of cue utilization such that fewer cues are attended to (Westbrook and Oliver, 1991)
Perception	When we are happy, our perception is biased at selecting happy events, likewise for negative emotions (Bower, 1981). Customers evaluate quality by comparing their expectations with their perceptions (Dean, 2004)
Categorization and preference	User models which aim at discovering the user's preferences also need to acknowledge and make use of the knowledge that people prefer objects that they have been exposed to, even when they were shown these objects subliminally.
Motivation and performance	An increase in emotional intensity causes an increase in performance, up to an optimal point.
Intention	not only are there positive consequences to positive emotions, but there are also positive consequences to negative emotions.
Communication	Important information in a conversational exchange comes from body language, voice prosody, facial expressions revealing emotional content, and facial displays connected with various aspects of discourse.
Learning	People are more or less receptive to the information to be learned depending on their liking (Winsted, 1997).

2.3.3. Sociological Approach

The transition to a service economy has important implications for organisations and how they operate (Bowen & Schneider, 1988). To begin with, goods and services differ on several dimensions that impact the way they are delivered. Schneider and Bowen (1985) describe three defining features of services. First, services are intangible in nature. In contrast to products, or goods, that can be touched and possessed, services tend to be experiential in nature. A second distinguishing feature of services is that production and consumption occur simultaneously. The chain of events involved in the creation and consumption of goods differs from the order of events that occurs in the creation and consumption of services (Kristensen *et al.* 1999).

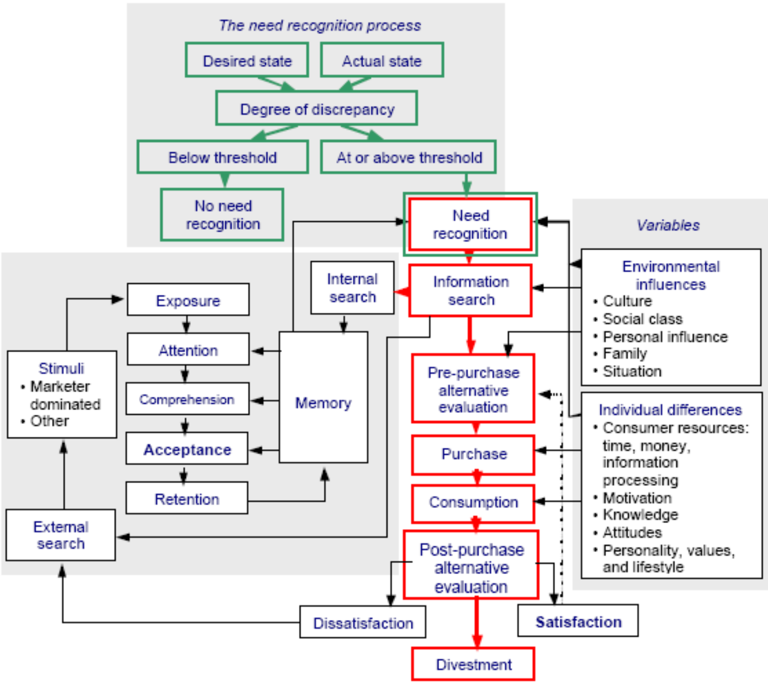


Figure 2-14: Customer Satisfaction Process (Engel *et al.* 2001)

These three characteristics of services (i.e., intangibility, simultaneous production and delivery, and customer participation in production and delivery) mean that the customer service employee, who directly interacts with the customer, is critical to the delivery of quality service. Schneider and Bowen (1985) suggest that these boundary-spanning employees perform two important functions.

- ✓ First, customer service employees, because of their direct contact with customers, are a crucial source of information about customer expectations and attitudes as well as a source of suggestions for improving the quality of the service and its delivery.
- ✓ Second, and perhaps even more importantly, they represent the organisation to the customer. As Schneider and Bowen (1985) point out, for most customers, the service employee is the embodiment of the organisation.

Consequently, the behaviour of the service employee, and the experience that behaviour creates for the customer during the service interaction, are critical factors in defining customer perceptions of service quality (Malhotra and Mukherjee, 2004). Given the important roles filled by customer service employees, organisations wishing to deliver quality service must find ways to support and effectively coordinate the behaviour of these individuals (Soteriou and Chase, 1998).

The manner in which customer service employees behave toward an organisation, customers will have a significant impact on the development of these long-term relationships. That is, when employees reported that their organisations expected, supported, and rewarded quality service, customers reported that they received superior service (Froehle and Roth, 2004). It seems to follow then, that organisations wishing to form long-term relationships with their customers should first develop quality relationships with their employees in as many ways as possible (Sarel and Marmorstein, 1998). Given that the way organisations treat their employees is evident in the way that employees treat their customers, the nature of these organisation-employee and manager - employee relationships will likely play a key role in the way employees treat their customers. The higher levels of employee motivation associated with higher levels of commitment and higher quality exchanges are suggested to result in a higher level of customer service quality on the part of the employee (Cronin *et al.* 2000).

Social institutions, collective behaviour, and constraints of consumption environments enable and affect consumer behaviour. Social studies focus on identifying and studying parameters of external environments that influence consumption patterns. The major themes that are studied by sociologists with regard to consumption behaviour are culture, social class, personal influence, ethnic influence, family and household, and situational influences. Engel (2001) shows the scope of individual and environmental influences and this distinction is used in this study for the narrowing down and distinguishing between the two research areas: sociology and psychology (Engel *et al.* 2001).

Sociology studies why people buy products and find various answers to that simple question: products provide function; products should comply with people preferences about the form in which product function could be delivered; products become symbols of meaning in society. The importance of values is described by a theory of consumption values (Sheth and Newman, 1991). The authors propose that consumer choice is influenced by functional value, conditional value, social value, emotional value, and epistemic value. Changes of values are usually explained from a life-cycle perspective (people grow older and their values change) or from a generational perspective, suggesting that values of all generations are being replaced by values of the “leading” generation. Another line of sociological research on consumption analyses institutional influences on consumption patterns. The main institutions in focus are family, religion, and the education system. Social class also affects consumption patterns to a large degree, because people who belong to the same class share similar values, lifestyles, and interests. Sociologists study the role different goods play in distinguishing between different classes and reinforcing identity within a certain class. Marketing segmentation is also often based on marketing products to a specific social class by using special language, symbols, and appeal, which triggers associations of a particular social class (Williams, 2002).

At the heart of the sociological view is the role played by goods in marking the distinction between different social groups and classes and strengthening identity within the group. Several sociologists investigated how people belonging to the same class use the construct of taste to choose particular goods. Personal influences on the consumption patterns are studied by investigating the meanings that consumers attach to the process of consumption, as parts of the dimension of identify construction. Consumers create themselves and are created by products, services, and experiences. Four different types of meanings can be distinguished: utilitarian meaning (perceived usefulness of a product in its ability to perform functional tasks), hedonic meaning (specific feelings the products evoke or facilitate), sacred products that are very important to people, and social meanings (Engel *et al.* 2001).

2.3.4. Psychological Modelling

The major part of psychological research, besides social psychology, studies individual processes. The domain of psychology research on consumer behaviour focuses on identifying and studying personal human qualities that influence consumer behaviour. Another line of research focuses on studying how various stimuli from the surrounding world affect consumer behaviour. Psychology is interested in learning how the urge of need created, how different stimulators influence the personal decision-making process, and how the satisfaction sensation is created and confirmed. It seems that the focus given to four major topics: consumer resources (time, money), motivation, knowledge, attitudes, personality, values, and lifestyle. Alongside these, three major processes are being studied by psychologists: information processing, influencing attitudes and behaviour, and learning processes (Engel *et al.*, 2001). Behaviourists that support a classical conditioning view study how consumers respond to brand names, scents, colour, and other stimuli when making purchasing decisions based on knowledge they have gained over time.

Psychological studies analyse the influence of the emotional state of consumers on purchasing decision. Psychological processes such as attention, comprehension, memory, and cognitive and behavioural theories of learning, persuasion, and behaviour modification constitute an integral part of marketing studies on consumer behaviour and have been outlined in section 2.3.1. The lifestyle concept comprises a formal process of integration of social practices, through which actors express their individual identity (Witt *et al.* 2004). At the individual level, the psychology has to offer two theories that aim at explaining cognitive processes behind individual decision-making, connecting such constructs as intentions, attitudes, subjective norms, and perceived behavioural control. These theories provide some input to the discussion held above about social relevant actors and the importance of belonging to a group. The Theory of Reasoned Action (TRA) suggests that behaviour depends on the intention to perform the behaviour – the most important determinant of a person's behaviour is behavioural intent. The *Theory of Planned Behaviour* includes the concept of perceived behavioural control, which is the person's belief about feasibility of using the provided opportunity.

Analysis:

- Section 2.2 develops a thorough understanding about different human behaviour modelling techniques that the author plans to consider within this research.
- Section 2.3 focuses on the approaches/areas where human categorisation process can be developed. Through this section, the author tries to answer two important research questions, discussed in chapter 3 which are: (1) What are the current issues concerned with the categorisation of customer and advisor behaviour in CC and (2) Can we identify and categorise generic groups of customer and advisor within the population.
- There is a lack of categorisation considering advisor and customer together within contact centre environment.
- Within approaches identified within this section, it has understood that social institutions, collective behaviour, and constraints of consumption environments enable and affect consumer behaviour. These studies focus on identifying and studying parameters of external environments that influence consumption patterns. Due to the extent of work carried out within this research, the study of sociological aspects of human behaviour cannot be identified within the research.
- From the psychology aspects on consumer, behaviour studies focuses on identifying and studying personal human qualities that influence consumer behaviour.
- Due to the complexity of the data and the collection through case study based analysis it is observed that the author might be limited to areas of attention, comprehension, memory, and cognitive and behavioural theories of learning.

2.4. Clustering Approach

Clustering is considered useful for discovering groups and identifying interesting distributions and patterns in the underlying data. (Guha *et al.* 1998) identifies clustering as a partitioning algorithm of a any data set into groups so that data points in a cluster which are similar to each other than different clusters. Within any customer-facing environment, customers can be grouped together based on their purchase history, buying patterns, choice history into the same cluster. So clustering analysis groups different patterns that can allow any user or organisation to identify differences, similarities and address any business perspective into the clusters. Presently clustering techniques are used in many areas such as customer modelling, marketing, engineering, etc. In the clustering process, predefined classes and examples are not present which enables the user to see the relations among the data and hence it is identified as unsupervised learning process (Aloha and Runsula (2001). Alternatively, classification is identified by (Fayyad *et al.* 1996) as a procedure of data assignment to pre-defined set of categories. Clustering produces initial categories in which values of a data set are classified during the classification process. (Fayyad *et al.* 1996) derives the clustering process as different partitioning data set that depends on the specific criterion within it. Hence, pre processing of the data set is not required within the clustering process as shown below in figure 2.15 presented by (Halkidi, *et al.* 2001).

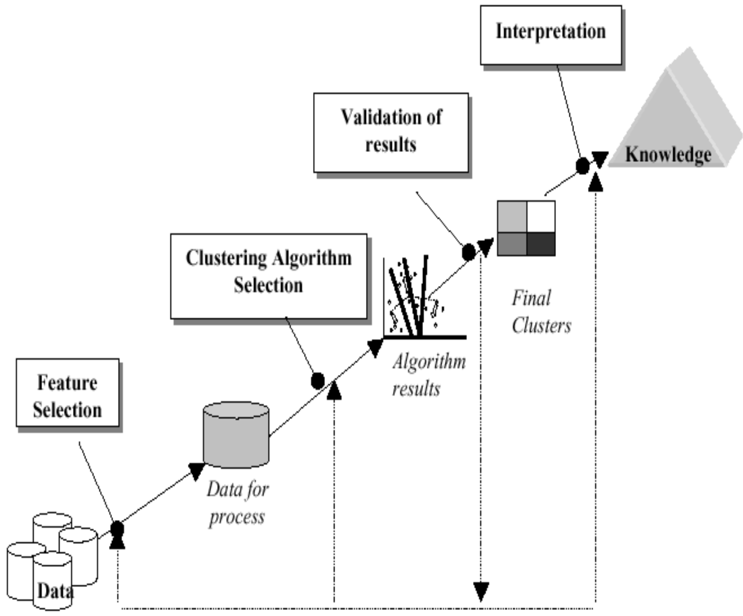


Figure 2-15: Clustering Process (Halkidi, *et al.* 2001)

The basic steps involved in clustering process are (1) Feature Selection – which selects the features properly where clustering is required to encode much information about the task. (2) Clustering Algorithm – is the choice of algorithm where results are considered to be of clustering scheme of a data set. Criterion and proximity measure characterises the clustering algorithm and its efficiency to define a clustering scheme, which fits the data set. Proximity measure quantifies how similar two data points are. Clustering criterion defines the clustering criterion, which can be expressed via a cost function or some other type of rules. (3) Validation of the results - correctness of algorithm results is verified using appropriate criteria and techniques. Since clustering algorithms define clusters that are not known a priori, irrespective of the clustering methods, the final partition of data requires some kind of evaluation in most applications (Rezaee *et al.* 1998). (4) **I**nterpretation of the results **-** the experts in the application area has to integrate the clustering results with other experimental tests and analysis in order to identify the right conclusion.

Cluster analysis is a tool widely used in applications within the fields of business and science. The uses of clustering analysis identified by Theodoridis and Koutroubas (1999) identify them mainly in data reduction, prediction on groups, hypothesis generation and testing. Cluster analysis contributes in compression of the information included within the data sets used for analysis. In the following case, the amount of available data is very large and its processing becomes very demanding. Cluster analysis used within hypothesis generation to infer some hypotheses concerning the data. It can be used for the verification of the validity of a specific hypothesis. It is also applied to the data set and the features of the patterns that belong to these clusters to categorise the resulting clusters within prediction based on groups. Some of the applications identified by Han and Kamber (2001) are in business where it can help marketing experts identify groups of their customers from large sets of database based on order and purchasing history. Within web mining, mainly used to discover different groups of documents (web pages) with semi structured documents and files. In science, clustering mainly used to define taxonomies and categorise gene factors with similar and different variance to identify the correlation within any given population. In any larger datasets, clustering can automate the process of analysing and understanding the spatial data. It can also be applied to identify and extract characteristics patterns that may exist in large amounts of data.

Clustering algorithms mainly classified according to the type of data input to the algorithm. In addition, the clustering criterion, which defines the similarity between any given data points used within the classification of clustering algorithm. Theoretical and fundamental concepts such as fuzzy theory can be used to classify the clustering algorithms. Clustering algorithms are classified into the following types (Jain *et al.* 1999):

- Partitioned clustering which attempts directly to decompose the data set into a set of disjoint clusters.
- Hierarchical clustering proceeds successively by merging smaller clusters either into larger ones, or by splitting larger clusters. This forms the tree of clusters from the algorithm.
- Density-based clustering group neighbouring objects of a data set into clusters based on density conditions.
- Grid-based clustering is mainly used for spatial data mining. The main characteristic is that they quantise the space into a finite number of cells and then they do all operations on the quantised space.

For each of above categories there are also different subtypes and different algorithms for finding the clusters. Based on the type of variables in the data set it can be categorised into (Guha *et al.* 1999; Huang *et al.* 1997; Rezaee *et al.* 1998). Statistical that are based on statistical analysis concepts which uses similarity measures to partition objects and are limited to numeric data. Conceptual types used to cluster categorical data and cluster objects according to the concepts. This leads to clustering schemes that are compatible with everyday life experience as they handle the uncertainty of real data (Bezdeck *et al.* 1984). Crisp clustering considers that a data point either belongs to a class or not. Most of the clustering algorithms result in crisp clusters, and thus can be categorised in crisp clustering. Compared to Crisp set clustering, Kohonen net clustering are based on the concepts of neural networks and has input and output nodes. The input layer (input nodes) has a node for each attribute of the record, each one connected to every output node (output layer). Finally, the clustering algorithms are based on a criterion for assessing the quality of a any given partitions of data set used for analysis. More or less, they take some parameters are inputs such as the number of clusters to be used and attempt to define the best partition of a data set for that parameters. Hence, they define a partition of a data set based on assumptions and not necessarily the best one that fits the data set.

Analysis:

- From the above section, it is identified that clustering is one of the most useful tasks in data mining process for discovering groups and identifying interesting distributions and patterns in the underlying data.
- With the use of clustering analysis, the author intends to identify and categorise the generic groups of customer and advisor within the population. Clustering analysis would identify the categories that are further used in the development of the fuzzy expert system, which assigns these categories to any customer and advisor.
- There is a vast amount of literature available on clustering techniques and use of clustering in different applications of business and science. The author intends to highlight the basic understanding behind the clustering process.

2.5. Soft Computing Techniques in Telecoms

The author concentrates his efforts on understanding the concepts of soft computing techniques that be applied within the categorisation of customer and advisor within contact centre environment. It is therefore important to investigate the relationship between different soft computing techniques and contact centre within telecommunications section. Service industries have recently witnessed several innovations, one of which is the widespread use of contact centres in the front of customer service management. Service encounters based on call centres have raised new issues about the management of services. In service industries such as hotels, insurance, banking, retail, etc companies are increasingly paying more attention to CSA to achieve the desired profit and market share goals. Companies are now adopting a people oriented approach as compared to a profit-oriented approach. In customer contact businesses, the quality of service delivered cannot be separated from the quality of the service provider. Because service delivery occurs through human interaction, customer service advisor during the service encounter largely determine the level of service quality delivered (Walker *et al.* 2002). All kinds of behaviour and actions on behalf of advisor during the service interaction cannot be controlled by management (Malhotra and Mukherjee, 2004).

2.5.1. Soft Computing

Soft computing (SC) is an evolving collection of methodologies, which aims to exploit tolerance for imprecision, uncertainty, and partial truth to achieve robustness, tractability, and low cost. SC provides an attractive opportunity to represent the ambiguity in human thinking with real life uncertainty. Fuzzy logic (FL), neural networks (NN), and evolutionary computation (EC) are the core methodologies of soft computing. Figure 2.16 shows the difference in hard and soft computing techniques.

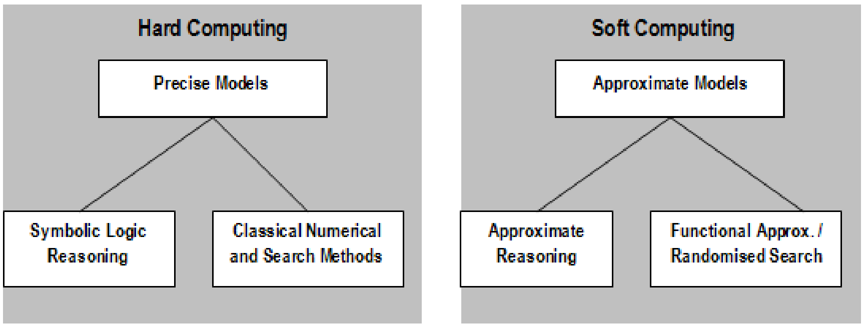


Figure 2.16: Hard and Soft Computing Techniques (Bonissone, 1997)

However, FL, NN, and EC should not be viewed as competing with each other, but synergistic and complementary instead. SC has been theoretically developed for the past decade, since L. A. Zadeh proposed the concept in the early 1990s. Zadeh emphasises that precise measurement and control approaches are not always effective in coping with such difficult problems, but *perception* can often help (Zadeh, 1988). Soft computing is causing a breakthrough in engineering and science fields since it can solve problems that have not been able to be solved by traditional analytic methods (Bonissone, 1997; Ovaskav *et al.* 2002; Dote and Ovaska, 2001). In addition, SC yields rich knowledge representation (symbol and pattern), flexible knowledge acquisition (by machine learning from data and by interviewing experts), and flexible knowledge processing (inference by interfacing between symbolic and pattern knowledge), which enable intelligent systems to be constructed at low cost (Dote and Ovaska, 2001; Zadeh, 1994). Figure 2.17 describes an overview of different soft computing techniques (Bonissone, 1997).

Specifically, in the modern control system design and analysis, there is a promising trend going on to employ some heuristic methods that can benefit from human experts, because the currently existing complex plants cannot be accurately described by rigorous mathematical models, and are, therefore, difficult to control using conventional *model-based* methods (Fazlollahi and Vahidov, 1997). Soft computing is an appropriate candidate for creating these knowledge-based intelligent systems (Djian *et al.* 2000; Tsui *et al.* 1998). It has attracted the growing interest of researchers from various scientific and engineering communities during recent years (Baldwin *et al.* 1998) .

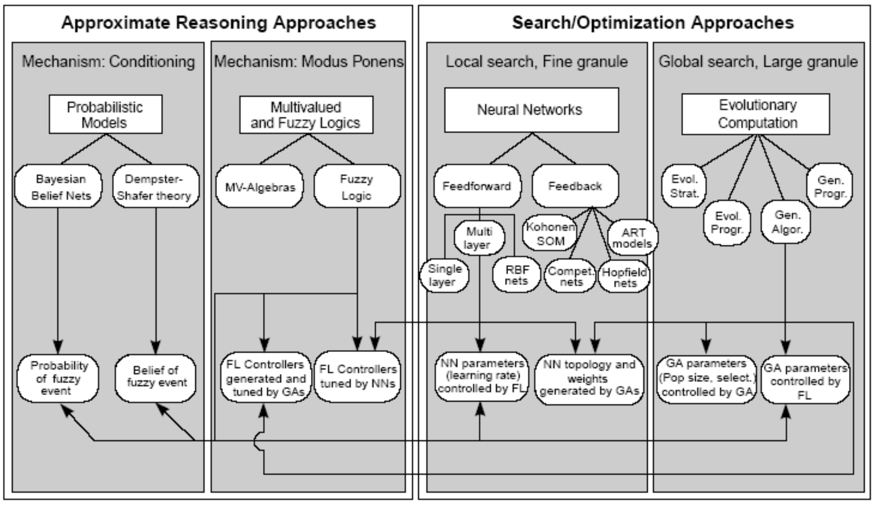


Figure 2.17: Soft Computing Techniques Overview (Bonissone, 1997)

In contrast with hard computing methods, which only deal with precision, certainty, and rigor, soft computing is effective in acquiring imprecise or sub-optimal but economical and competitive solutions (Ovaska *et al.* 2002). In short, because of its unique feature in coping with real-world problems, e.g., intelligent control, decision making support, nonlinear programming and optimisation; soft computing has drawn increasing research attention from people of different backgrounds (Zeleznikow and Nolan, 2001; Azvine and Wobcke, 1998). The common denominator of SC technologies is their departure from classical reasoning and modelling approaches that are usually based on bollean logic, analytical models, crisp classifications, and deterministic search. Figure 2.17 shows the overview of the soft computing techniques. In ideal problem formulations, the systems to be modelled or controlled are described by complete and precise information. Soft computing technologies provide us with a set of flexible tools to perform the approximate reasoning and search tasks (Bonissone, 1997; Sterritt and Bustard, 2002). Since communication systems involve human beings, soft computing can be effectively applied to such systems. Soft computing enables solutions to be obtained for problems that have not been able to be solved satisfactorily by hard computing methods (Dote and Ovaska, 2001; Zha, 2003).

Among the attempts to mimic the human brain intelligence, soft computing is not the first trial. In fact, soft computing has some similarities with the conventional expert systems in Artificial Intelligence (AI) (Dubois and Prade, 1998). Their common goal is to explore and realize machine intelligence. Expert systems target to imitate intelligence in the form of language expressions or symbolic rules. On the other hand, there are no symbolic manipulations in soft computing. This feature makes it free from the handicap inherent in the expert systems-oriented classical symbolises, which can result in the '*dimension curse*'. Instead, the knowledge acquisition procedure in soft computing is based on learning from practical data samples as well as operator experience. Neural networks are often trained by the application data from measurement or provided by the supervisor (Tran *et al.* 2003). The antecedent and consequent of the mostly used IF-THEN rules in the fuzzy inference are interpreted by the linguistic variables arising from the knowledge of the operation experts (Mitra *et al.* 2002). Therefore, soft computing can also be viewed as a kind of data driven intelligent technique (Mitra *et al.* 2002; Peizfiuang and Shaohua, 1997).

Analysis:

- The author concentrates his efforts on understanding the concepts of soft computing techniques that can be used within the categorisation of customer and advisor within contact centre environment.
- Service encounters based on call centres have raised new issues about the management of services. Companies are now adopting a people oriented approach as compared to a profit oriented approach (Malhotra and Mukherjee, 2004).
- Soft computing (SC) is an evolving collection of methodologies, which aims to exploit tolerance for imprecision, uncertainty, and partial truth to achieve robustness, tractability, and low cost (Zadeh, 1996).
- According to research been carried out it suggests that Soft computing is causing a paradigm shift (breakthrough) in engineering and science fields since it can solve problems that have not been able to be solved by traditional analytic methods (Bonissone, 1997) (Ovaska *et al*. 2002). Section 2.4.2 discusses about the use of soft computing for categorisation in contact centres.

2.5.2. SC Techniques for Categorisation in CC

This section describes the important soft computing techniques, which are reviewed for categorisation in customer contact centre.

<u>Fuzzy Logic</u>

Fuzzy Logic (FL) defines a framework in which the inherent ambiguity of real information can be captured, modelled and used to reason with uncertainty. An introduction to FL can be found in (Ross, 2004 and Dote, 1995). FL is not a machine learning technique; nevertheless, due to its ability to handle uncertainty it is used in combination with other machine learning techniques in order to produce behaviour models that are able to capture and to manage the uncertainty of human behaviour. A traditional fuzzy logic inference system divided into three steps: (1) Fuzzification; (2) Fuzzy Inference; and (3) De-fuzzification. Typically, FL has been used to implement applications that are based on a recommendation task. In these applications, FL provides the ability of mixing different user preferences and profiles that are satisfied to a certain degree. FL has been used to implement recommendation tasks (Nasraoui and Petenes, 2003), where fuzzy inference is used for recommendation purposes using user profiles obtained with hierarchical unsupervised clustering. Better communication can be attained through fuzzy logic because of its ability to utilise natural languages in the form of linguistic variables (Kuanchin and Gorla, 1998). Various studies and applications of FL for user type modelling are presented in (Frias-Martinez *et al.* 2005 and Torre, 2002).

Fuzzy technology, for example, despite having a sound mathematical basis, uses simple expressions taken from everyday language to describe relationships between variables. Fuzzy systems reduce the complexity of a problem by refraining from unnecessarily discriminating very similar values (data compression). Because they are rule-based, fuzzy systems can easily make use of prior knowledge. Sophisticated learning algorithms, taken from neural network theory, are able to automatically refine a fuzzy system or can even create it completely from scratch. Fuzzy systems endowed with such learning capabilities are called Neuro-fuzzy systems (Goldberg, 1994; Frias-Martinez *et al.* 2005). Fuzzy technology can also be conveniently used for combining different models that provide partial solutions. In (Ardissono and Goy, 1999) fuzzy logic was used to model user behaviour and give recommendation using this fuzzy behaviour model. Although there is not strictly a fuzzy inference process, the stereotypes that characterize users are modelled using membership functions, and the recommendation process is done using a fuzzy AND operator. Schmitt *et al.* (2003) presents a system designed to recommend products in an e-commerce site, according to how well this product satisfies user preferences. The score of an item (according to how much that item matches user interests) is done using an OWA (Ordered Weighted Averaging) operator. This family of operators allows the representation of fuzzy logic connectives and the aggregation of different user preferences. In this case FL provides a soft filtering process based on the degree of concordance between user preferences and the elements being filtered (Vrettos and Stafylopatis, 2001).

Neural Networks

Neural Network (NN) is an information-processing paradigm that is inspired by the way biological nervous systems, such as the brain, process information. Neural networks, with their remarkable ability to derive meaning from complicated or imprecise data, can be used to extract complex patterns (Hu and Tsoukalas, 2003) . A trained neural network is described as an expert in the category of information it has been given to analyse. Traditionally, NNs have been used for classification and recommendation in order to group together users with the same characteristics and create profiles (Yasdi, 2000; Fix and Amstrong, 1990). NNs have also been used for recommendation, which predicts the next step for a given user trajectory in a virtual environment (Sas *et al.* 2003), and in (Beck *et al.* 2003) which models student behaviours for an intelligent tutoring system. For credit scoring or behavioural scoring analysis, many studies have presented that neural networks perform significantly better that statistical techniques such as linear discriminate analysis (LDA), multiple discriminate analysis (MDA) , logistic regression analysis (LRA) and so on (Hsieh, 2004).

Genetic Algorithms

Genetic Algorithms (GAs) are search algorithms based on the mechanics of natural selection. A GA begins with a set of solutions (chromosomes) called the population. Solutions from one population are taken and used to form a new population, which are closer to the optimum solution to the problem at hand. GAs are search strategy that is tailored for vast, complex, multimodal search spaces. In general GAs have been used for Recommendation in the form of rules, which can capture user goals and preferences, because they perform a global search and cope better with attribute interaction than algorithms used in data mining, where the search is more local (Ishibuchi *et al.* 1995; Rees and Koehler, 2002).

Fuzzy Clustering

In non-fuzzy or hard clustering, data is divided into crisp clusters, where each data point belongs to exactly one cluster. In Fuzzy Clustering (FC), the data points can belong to more than one cluster and associated with each data point are membership grades which indicate the degree to which it belongs to the different clusters (Crespo and Weber, 2005). One of the key elements of any FC system is the definition of the concept of distance used for the creation of the clusters. The most widely used fuzzy clustering algorithm is the Fuzzy C-Means (FCM) Algorithm. Typically, FC applied to UM has to use techniques that can handle relational data because the information used to create stereotypes (pages visited, characteristics of the user, etc.) cannot be represented by numerical vectors. In these systems, the definition of distance is done using vectorial representations of user interactions with the adaptive hypermedia system. Fuzzy clustering can be regarded as an improved clustering technique, which has been used successfully in diverse fields for both data compression but and data categorization (Lazzerini *et al.* 2003). Recent years have seen remarkable advances in developing diverse fuzzy clustering techniques. For example, the fuzzy c-means algorithm, the fuzzy c-varieties algorithm, the adaptive fuzzy clustering algorithm, the fuzzy c-ellipsoidal shells algorithm, and the fuzzy hybrid hierarchical algorithm; for dealing with different complex levels of pattern recognition, the advantages offered by fuzzy clustering techniques for diverse real-world applications remain noteworthy (Tung-Lai and Jiuh-Biing, 2003). In contrast with classical hard (crisp) clustering tools, fuzzy clustering techniques exhibit two distinctive features, which make their real-world applications relatively flexible.

- ✓ First, unlike the hard clustering techniques, which assign each data sample to one and only one cluster, fuzzy clustering utilizes fuzzy partitioning to group data such that any given data sample is allowed to belong to several groups with different degrees of similarity bounded within the range of 0 and 1. Such a feature permits the use off fuzzy clustering in cases where patterns of data attributes are relatively unclear.

- ✓ Second, fuzzy clustering techniques overall outperform conventional hard clustering techniques in multi-dimensional data analysis, particularly with data that consists of linguistic attributes.

Fuzzy clustering processes can be appropriate for grouping users in classes by navigational behaviour. Information in user profiles can be used to customise and identify a user with a social group, done by assigning a general profile related to preferences shown by the user (Martin-Bautista *et al.* 2002).

Neuro-Fuzzy Systems

Neuro-Fuzzy systems (NFS) use NNs to extract rules and/or membership functions from input-output data to be used in a Fuzzy Inference System. With this approach, the drawbacks of NNs and FL, the black box behaviour of NNs and the problems of finding suitable membership values for FL, are avoided. NFS automate the process of transferring expert or domain knowledge into fuzzy rules. NFS are especially suited for applications where user interaction in model design or interpretation is desired (Mitra and Hayashi, 2000). NFS are FL systems with an automatic learning process provided by NN. The combination of NN and fuzzy sets offers a powerful method to model human behavior, which allows NFS to be used for a variety of tasks. (George and Cardullo, 1999) represents a Neuro-fuzzy system for modelling human operator behaviour in computer-generated forces. Neuro-fuzzy technology can be used to learn these rules. Neuro-fuzzy systems have the potential to revolutionise IDA and form the basis of the approach to platform and solution development (Azvine *et al.* 2003)

Analysis:

- The author is surprised that although literature does exist in the area of soft computing techniques and human categorisation, a lot of it is based on designers. It is evident from the methodologies followed by the authors reviewed that very few of them have actually captured and analysed data from behavioural aspects of customer and service advisors.
- There is a distinct lack of literature between the interaction of soft computing techniques with behavioural modelling and how these techniques can be implemented in contact centre environment.
- Based on the literature reviewed, the author has focused more on Fuzzy Logic and fuzzy systems. (Ardissono and Goy, 1999) used fuzzy logic to model user behaviour and give recommendation using this fuzzy behaviour model.
- According to (Martin-Bautista *et al.* 2002) information in user profiles can be used to customise and identify a user with a social group, done by assigning a general profile related to preferences shown by the user.
- It is the author's belief that if a framework can be constructed that links customer and service advisor with respect to demographic, experience and behavioural attributes, a better understanding on the type of customer and advisor can be developed at the design state.

2.5.3. Fuzzy Expert System Development in CC

Zadeh (1965) initially conceived the concept of fuzzy logic or fuzzy sets. He described the theory of fuzzy sets as a theory in which everything is a matter of degree. A fuzzy set defined as a class of objects with a continuum of degrees of membership characterized by a membership function that assigns to each object a grade of certainty ranging between zero and one, and thus permitting partial membership. Fuzzy systems are applicable to most real life scenarios which tend not to be dichotomous and descriptions of their nature are quite often imprecise (Zadeh, 1988). In many real-world applications, fuzzy systems that make use of linguistic rules are aptly suited to describe the behaviour of the computer systems' problem, which is difficult to model mathematically (Zadeh, 1988; Zadeh, 1994).

Fuzzy sets (FS) provides a framework to work easily with qualitative data, it can be used as a qualitative modelling approach to describe system behaviour using a natural language (fuzzy quantities) (Dudois and Prade, 1998). Fuzzy modelling offers a more practical approach in information engineering for bridging the gap between human-originated and formalised knowledge. A FS assigns membership values between 0 and 1 to reflect the degree to which the element belongs to the set. The mapping between elements of the fuzzy set and values in the interval [0,1] defines a membership function for the fuzzy set. Such a membership function definition is required in order to represent a fuzzy set for a problem. The membership function definition of a fuzzy set represents the human subjective knowledge of a given problem. It can map a finite term set to a linguistic scale, for example temperature (fuzzy variable) on a real interval [0,100] to a fuzzy term set {low, high}. FS can translate expert information about the problems to be solved and to incorporate the expert knowledge in the process models. FS can be used either to represent different forms of system knowledge or to model interaction and relationships among the system variables.

Expert systems (ESs) solve problems that human expert cannot solve. An ES is a problem-solving package that mimics a human expert in a specialised area. It also be defined as a computer program that exhibits, within specific domain, a degree of expertise in problem solving that is comparable with that of a human expert. Expert systems plays a key role as a tool to enhance productivity, improve quality and increase profits while minimizing costs and capturing expertise in many business and industrial environments (Zimmermann, 1996; Turban and Aronson, 1998). The expert system consists of three main components, which include knowledge base, the inference engine and the user interface. Figure 2.16 shows the general architecture of an expert system.

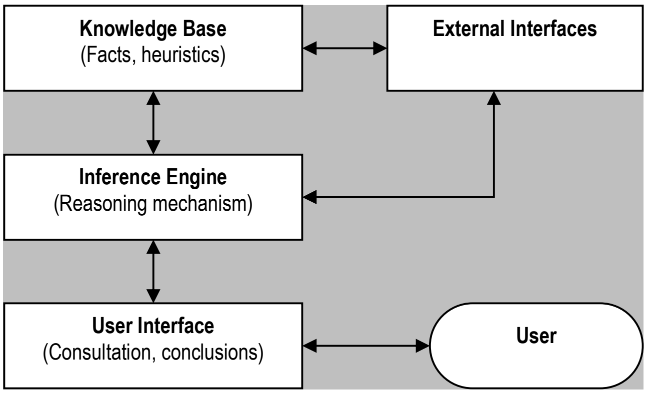


Figure 2-16: Expert System Architecture (Turban and Aronson, 1998)

The knowledge base is the heart of the system and contains the knowledge needed for solving a specific problem. The inference engine examines the status of the knowledge base, handles the content of the knowledge base and determines the order in which inferences are made (Chen *et al.* 2002). The user part enables interaction of the system with the user. Expert system also provides interfaces for communication with external programs including databases and spreadsheets (Metaxiotis and Psarras, 2003). A fuzzy expert system is defined if and only if the rule sets and membership functions associated with their fuzzy sets are defined (Matthews, 2003; Huang and Fan, 1993). All the fuzzy rules in a fuzzy system are fired in parallel mode. The working of a fuzzy expert system can be described as follows.

1. Evaluate the values of fuzzy membership by energizing the inputs.
2. Obtain the fuzzy rules, which are fired in the rule set.
3. Adopting AND operator, club the values of membership for each energized rule.
4. Search rule activation membership values supported by the min-max compositional rule to obtain the appropriate output fuzzy membership value.
5. Determine the value of each output variable by defuzzification.
6. Take decisions according to the output values.

The process of fuzzifying a crisp quantity is termed as fuzzification. Certain quantities that we consider crisp and deterministic are actually non-deterministic. They carry considerable uncertainty (Ross, 2004). Thus, the form of uncertainty if happens to arise because of imprecision, ambiguity or vagueness, the variable is fuzzy and can be represented by a membership function. Thereby, each input variable activates one or more fuzzy sets according to the definitions of the fuzzy membership functions. After the fuzzification of the variables, the rules with at least one activated antecedent set possibly fired by the inputs. Then the AND (^) operator is employed to combine the membership values for each fired rule to generate the membership values for the fuzzy sets of the output variables in the consequent part of the rule. Owing to the partial overlapping of the fuzzy sets corresponding to the input variables, several rules are fired in a parallel mode. Thus, for some fuzzy sets of the output variables, there may be different membership values obtained from different fired rules. The most common procedure adopted to combine these values is by employing the OR (^{v}) operator, that takes the maximum value as the membership value of that fuzzy set.

The output of a fuzzy process needs to be a single scalar quantity as opposed to the input quantity in a fuzzy set. Defuzzification is the conversion of a fuzzy data to a precise data as opposed to the process of fuzzification, i.e. conversion of a precise data to a fuzzy data. Popular defuzzification approaches include the Max-membership principle, the centroid method, the weighted average method, the mean-max membership, the centre of sums, the centre of largest area, and the First (or last) of maxima (Ross, 2004; Tiwari and Roy, 2002).

Fuzzy sets offer a strict mathematical framework in which vague conceptual phenomena can be precisely and rigorously dealt with. In other words, there is nothing fuzzy about fuzzy logic. Since its inception, the concept has advanced in various directions and has found applications in many disciplines (Perrone *et al.* 2001). Particularly in the last decade or so, fuzzy set theory experienced tremendous growth, showing remarkable results in a wide range of applications (Harding *et al.* 2001). Full discussions of fuzzy set theory can be found in (Zadeh, 1994; Zadeh, 1996; Zadeh, 1988; Zimmermann and Sebastian, 1995) and (Cox, 1994). Baldwin *et al.* (1998) presents a survey concentrating on the need for, and the application of soft computing techniques in intelligent knowledge-based systems. It makes a strong case for the necessity to handle uncertainty in knowledge-based systems at the input/output and the processing stages. Logic programming concentrates on a number of tools that can be used to build intelligent knowledge-based systems (Baldwin *et al.* 1998). Some of the examples of expert systems and fuzzy expert systems are discussed below through which the author aims to understand the design and development of these systems within the categorisation of customer and service advisor environment.

- *Unemployment System* - This system is used for unemployed and enterprises profile data. The process of matching an unemployed with an offered job is performed through a Sugeno type Neuro – Fuzzy inference systems (Drigas, 2004).
- *Analyser Tool* – It was designed for solving management problems concerning the employee's classification into several projects. It combines neural networks and rule based analysis to match the employees of a company with certain jobs of new projects (Labate and Medsker, 1993).
- *ESCFE* – An expert system for customer facing environment designed for Telecoms Company, which supports service centre staff in the three-way dialog between staff, the customer and computer system. It was designed to be user friendly and to provide quality customer service by promoting a professional image and efficient customer handling (Houghton *et al.* 1991).

- *Hotel Advisory System* - describes the development of fuzzy expert system for hotel selection called HAS (hotel advisory system) to assist tourists in conducting hotel selection using fuzzy logic (Ngai and Wat, 2003).
- *DecTOP* – Is a decision table evaluation and optimisation tool. It represents a decision model in the form of a table. The software enables the user to identify individual decision of poor performance and to optimise them manually or automatically (Azvine *et al.* 2003).
- *SC Tool* – A soft computing tool that can be used to learn fuzzy classification rules from examples is described in this example. It describes the tool in terms of its model, platform, capabilities, learning algorithm and the interface (Nauck and Kruse, 1998).
- *CASPER* – Collaboration filtering techniques were used to enforce with intelligence the search engine of job finder website (Rafter *et al*. 2000).
- *ITEMS* – This system predicts, manages, visualises and explains travel patterns of a mobile workforce. It provides colour – coded geographical visualisation of travel patterns; so that managers can easily identify areas where travel is slow and can access the performance on weakly, daily and individual basis (Azvine *et al*. 2003).
- *Codified Language Sharing* – This system encourages and enables the sharing of explicit codified knowledge and tacit knowledge among groups of users. The knowledge shared between the users originates from a variety of sources, including the World Wide Web, an organisation's intranet, or even from other users (Davies *et al.* 1998)
- *Learning User Interests* – They present a system that automatically learns a user's interests and preferences in order to provide personalised services to the user. They describe a series of experiments aimed at discovering whether a user's interests automatically classified through use of several heuristics (Soltysiak and Cabtree, 1998).
- *Workforce Management System* – Description of a distributed software platform of an intelligent multi-modal interface used to obtain information from a large workforce management system. The architecture supports the integration of speech, text, simulated gestures and gaze input, allowing for a more natural and flexible user/system interaction (Tsui *et al.* 1998).
- *DE- Roeck Intelligent Directory Enquiry Assistant – An* intelligent directory enquiry assistant that combines the latest natural language processing techniques and information retrieval. Prototype system for accessing classified directory information that goes beyond the capabilities of systems that rely on simple pattern matching or database look-up (DeRoeck *et al*. 1998).

Analysis:

- Although the author has highlighted the importance of using soft computing techniques such as neural networks, genetic algorithms, etc, fuzzy logic has proved to be the most appropriate technique for categorising customer and advisor within contact centre domain.

- Within this section, the author aims on reviewing some of the systems and types of frameworks already been developed with the help of fuzzy logic which can model the user (human being) in some aspect and thus improve the overall process automation.

- Through literature identified within this section, the author has shown some of the examples where fuzzy expert system been used to categorise user based on the profile.
- Also, from the literature it has identified that in many real-world applications, fuzzy systems that make use of linguistic rules are suited to describe the behaviour of the computer systems' problem, which is difficult to model mathematically (Zadeh, 1988).

- Use of real time business intelligence can be used in any business environment and applied to areas such as business automated analytics, semantics based information and process automation (Azvine *et al.* 2005).

- Through the understanding of the literature for the fuzzy expert system, the author uses to develop the categorisation framework of the research described in chapter 5.
- The next section (2.6) looks on simulation techniques that the author intends to use as one of the methods for validating the frameworks developed within the research.

2.6. Simulation in Contact Centres

This section describes the importance of simulation techniques within contact centres and focuses on using an information flow type simulation that might be use within the research. The main reason to consider the use of simulation technique was to validate the research frameworks with the experts giving them a visual and graphical representation of research model.

2.6.1. Simulation Technique – An Introduction

Simulation is the imitation of the operation of a real-world process or system over time. Simulation involves the generation of an artificial history of the system, and the observation of that artificial history to draw inferences concerning the operating characteristics of the real system that it represented. Simulation is an indispensable problem-solving methodology for the solution of many real-world problems. Simulation used to describe and analyze the behaviour of a system, ask "what if" questions about the real system, and aid in the design of real systems. Both existing and conceptual systems can be modelled with simulation (Bapat and Pruitte, 1998). Simulation has been recognised as a way to solve problems arising from design and operational processes (Chaharbaghi, 1990). Modelling of systems, such as manufacturing systems, achieved using a number of tools and techniques one of which is simulation (Smith, 2003; Shan *et al.* 2001). The Oxford English Dictionary describes simulation as:

"The technique of imitating the behaviour of some situation or system (economic, mechanical, etc.) by means of an analogous model, situation, or apparatus, either to gain information more conveniently or to train personnel."

In another point of view, simulation is the technique of a building a model of a real or proposed system so that the behaviour of the system under specific conditions may be studied (Ball, 1996). Based on some definitions mentioned above, simulation considered as a tool that commonly used to assist with systems analysis. It can be widely used in combination with other techniques linear programming, expert systems, and neural networks. Moreover, simulation thought to be the imitation of the operation of a real-world process or system over time. As (Banks, 2000) defined, simulation involves the generation of an artificial history of the system, and the observation of that artificial history to draw inferences concerning the operating characteristics of the real system that is represented. There are a number of reasons for using simulation to that of analytical models that deal with the deficiencies of the models:

- Analytical models are not available
- Existing analytical models are too complex
- Static results of analytical models are insufficient
- Analytical models only provide averages, not variability and extremes
- Analytical models cannot identify process bottlenecks nor recommend design changes
- Analytical models cannot provide sufficient detail nor identify interactions
- Animation is a better method of demonstrating results to management

Generally, using simulation modelling, the data be collected and the assumptions about a process or system can be created. The simulation model can simulate a real event or a projection of future events, over a period in terms of hour, day, week, and year. In addition, one of the key powers of simulation is the ability to model the behaviour of a system as time progresses.

2.6.2. Simulation in Call / Contact Centre Environment

With the importance of call centres on the rise and as reengineering activities within them growing rampant, simulation technology is emerging as the best analysis tool to manage change within an increasingly complex environment. Advances in simulation technology have made it possible to transfer credible historical and forecasted data, such as call volumes and patterns, advisor schedules, and so forth, from these repositories into a simulation model with little or no messaging (Klungle, 1999 and

1998). With simulation, the call centre is finally emerging as a manageable, responsive, and customizable strategic weapon (Bapat and Pruitte, 1998). Modern contact centres use *skill-based* routing for processing different types of requests when each advisor is trained for handling only a subset of these types. Each contact is assigned a type (or skill). Before reaching an advisor, a customer must indicate his needs: callers interact with an *interactive voice response* (IVR) unit while Internet users enter data in a Web form. Outbound contacts can also have a type, since all customers are not contacted for the same reason (Buist and L'Ecuyer, 2005). Figure 2.17 shows typical example of call centre simulation.

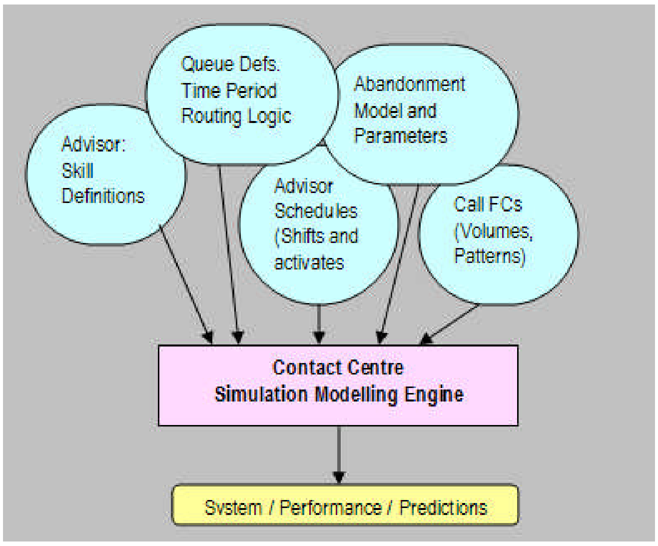


Figure 2-17: Call Centre Simulation Modelling Framework (Buist & L'Ecuyer, 2005)

Call centres typically handle more than one type of call, with each distinct call type referred to as a queue. Inbound calls within each queue arrive at random over the course of time. In many centres, advisors make outbound calls to customers, either proactively or as a follow up to previous inbound calls (Chokshi, 1999). Each call is of a random duration, as is the work (data entry, documentation, research, etc.) that advisors must do after completing the phone call. Through Automatic Call Distribution (ACD) and Computer Telephony Interaction (CTI) devices, inbound calls can be routed to advisors, groups, and/or locations, with advancements in these routing technologies supporting more and more sophisticated logic over time. Individual advisors can be skilled to handle one type of call, several types of calls, or all types of calls, with different priorities and preferences specified in the routing logic (Mehrotra and Fama, 2003; Saltzman and Mehrotra, 2001)

There are three major ways simulation is utilized within the contact centre industry:

1. Traditional Simulation Analysis: A simulation model is built to analyse a specific operation, with inputs obtained from a variety of data sources.

2. Embedded Application – ACD/CTI Routing: Many of the leading ACD and CTI applications include a routing simulation to provide insights to routing design engineers about the impact of different decisions.
3. Embedded Application – Advisor Scheduling: Already a complex scheduling problem, optimal call centre advisor scheduling is even more complex when both calls and advisors are non-homogeneous. Many commercial scheduling software applications, including the one developed by the authors' company, make use of simulation as part of their overall optimization engine (Bulbeck *et al.* 1997).

In each of these cases, the key output statistics typically include the some or all of the following metrics:

- **Queue Statistics -** The two dominant queue statistics for inbound queues and call centres are Average Speed of Answer (ASA) and Percent of Calls Answered with a queue time of less than some defined value (PCA or, more commonly, Service Level). Note that for each queue this statistic is interesting at the interval level (typically 15 minutes, 30 minutes, or one hour) and also at the aggregate daily and weekly levels; additionally, management is interested in the overall performance across a collection of queues that draw upon a common pool of advisor resources (Laughery, 1999; Miller and Pegden, 2000)
- **Abandonment Statistics -** For most inbound call centres, particularly those focused on customer service and/or sales, a great deal of attention is paid to the overall number of customers who abandon (that is, hang up and thus leave the queue before being served). This is known to be a significant indicator of customer satisfaction (Feinberg *et al*. 2000). Many centres will look at the more restrictive metric of number of customers abandoning beyond the target Service Level parameter, based on the rationale that a certain waiting time in queue (as defined by the Service Level parameter, which ranges from 5 seconds to several minutes across companies and industries) is inevitable (Gulati and Malcolm, 2001).
- **Volume Statistics -** For outbound queues and call centres, the real statistic of interest is Right Party Connects (RPC). That is, for all of the attempted calls that were made, what percentage of these calls reached the targeted individual (as opposed to no answer, answering machine, or some other human being)? Outbound contact centre managers are typically interested in RPC on both an absolute and a percentage basis. For inbound queues, the Calls Handled statistic is of interest, and is easily derived by subtracting Abandoned Calls from the total number of incoming calls (referred to as Offered Calls) (Mehrotra and Fama, 2003; Dennis *et al.* 2000).

A contact centre is a set of resources (communication equipment, employees, computers, etc.) providing an interface between customers and a business (Mehrotra and Fama, 2003; Koole *et al.* 2003). A contact represents a customer's request for some service such as information, subscription, order, etc. Customers may use various media for contacting a business: telephone, fax, mail, or Internet. Customers trying to communicate with the business initiate inbound contacts. A customer can be blocked, i.e., receive a busy signal, if all phone lines are used at the time he calls. He can also be queued if service cannot be started immediately. A queued customer may become impatient and abandon without receiving service. Outbound contacts are initiated by advisors contacting customers, or by a predictive dialler making phone calls by trying to anticipate the number of free advisors at the time contacted customers are reached. A right party connect occurs when an outbound contact is successful. A mismatch represents a successful contact that cannot be served immediately (Buist and L'Ecuyer, 2005) .

The advisors are partitioned in advisor groups or skill sets. All advisors in a group share the same skills, i.e., they can serve the same types of contacts (although some members may be more efficient than others may). Queuing theory can be used to derivate approximations for estimating the performance measures of contact centres, but only for models that oversimplify the complexities of real-life systems for which only simulation can provide accurate results (Koole and Mandelbaum, 2002; Koole *et al.* 2003). A contact centre can of course be modelled using generic simulation tools, but that could be a very large programming task for complex models. Supporting multi-skill contact centres with complex routing policies, these point-and-click tools provide convenient graphical user interfaces (GUIs). Many common performance measures can be estimated, and animations can help debugging models. However, the great number of software layers reduces performance, and modelling some aspects not supported by the tool is often difficult, complicated, and can lead to inefficient code.

Analysis:

- Simulation studies were reviewed to identify the areas where the author can validate his framework and prototype of the system within a simulated environment.
- Simulation is used to describe and analyze the behaviour of a system, ask "what if" questions about the real system, and aid in the design of real systems (Bapat and Pruitte, 1998).
- The main purpose of this study was to identify the simulation techniques and the use of discrete event simulation in call and contact centre environment.
- The customer and service advisor categorisation and information requirement frameworks would be validated with the use of simulation within this research.

2.7. Summary and Key Observations

In the first Section (2.1), the author explains the call and contact centre environment briefly. Understanding of the contact centre environment is discussed with the help of the history of call / contact centres and the technologies behind the CC. In Section 2.2 the author explains the need and use of customer and service advisor (CSA) categorisation within contact centre environment. The list of human behaviour modelling methods is also represented within the section which looks on some of the techniques which are available.

The key observations are:

- The importance of customer categorisation together with human behaviour modelling techniques is developed.
- The importance of customer and service advisor categorisation within the customer contact centre environment is highlighted.
- A distinct lack of literature to model human behaviour with respect to behavioural aspect is identified.
- The importance of customer satisfaction and customer – service advisor interaction within the service industry is the main focus of the study within this section

Finally the human behaviour modelling methods are reviewed. A summary is provided below:

Fuzzy Cognitive Maps

- ✓ Fuzzy cognitive maps combine the use of fuzzy logic and neural networks. A fuzzy cognitive map is consisted of concepts in order to illustrate different aspects in the behaviour of the system, with each concept representing a characteristic of the system, and these concepts interact with each other showing the dynamics of the system

Multiple Classifier Method

- ✓ Prediction of customer purchase behaviour can be classified as a classification problem.
- ✓ There are two families of combining multiple classifiers – serial combination and parallel combination.
- ✓ This method is because different classifiers potentially offer complementary information about the patterns to be classified.

Cognitive Process Modelling Method

- ✓ The modelling of collective human behaviour can be done by taking the characteristics on cognitive psychological aspects and human interactions under collective behavioural situations into account.
- ✓ Physical, physiological and informational interactions among persons.
- ✓ Flexible information processing in human cognitive processes.

Case Based Classification (CBR) Process

- ✓ CBR shows significant promise for improving the effectiveness of complex decision-making.

- ✓ Paradigm for computer based problem solvers and human cognition models

Living Systems Methods

- ✓ Recognises the system as collection of elements interrelated together.
- ✓ Elements, relations and wholes are expressed with different notions.
- ✓ Seen as right approach to model consumer behaviour

CuBES Simulation Approach

- ✓ Develop software for simulating consumer behaviours in a market
- ✓ Provides the simulation of behavioural attributes, consumption impacts, effects on consumer, brand reactions.
- ✓ Takes into account not only cognitive features, but interactions between customers

CDM Method

- ✓ User population is first categorised into number of groups.
- ✓ Purpose of CMD is to build a set of precise and accurate models that represent the interaction of diverse user behaviours with the systems.
- ✓ CDM method can only be applied to sales negotiations.
- ✓ Focuses on modelling different user behaviour

Soft Computing Modelling Techniques

- ✓ Some of the soft computing modelling techniques include fuzzy logic (FL), neural networks (NN) and probabilistic reasoning (PR)
- ✓ NN have the ability to learn from input output functions
- ✓ Neuro fuzzy systems have the ability to incorporate human knowledge.
- ✓ Further analysis of soft computing techniques are discussed in section 2.4

In Section 2.3 the author discusses the approaches for human categorisation process that can be used to categorise customer and service advisor (CSA) within contact centre environment. Major approaches such as business and marketing approach, cognitive modelling approach, sociological and clustering approaches are discussed which were identified through the literature studies available. In Section 2.4 the author describes some of the soft computing techniques used in telecommunications industry. The key observations are:

- ✓ Service encounters based on contact centres have raised new issues about the management of services.
- ✓ Soft computing provides an attractive opportunity to represent the ambiguity in human thinking with real life uncertainty.
- ✓ SC provides set of flexible tools to perform the approximate reasoning and search tasks.
- ✓ Fuzzy technology can be used for combining different models that provide partial solutions.
- ✓ Use of GA for recommendation in the form of rules, which can capture user goals and preferences.

- ✓ Expert systems solve problems that are normally solved by human experts. Fuzzy expert system are true if and only if the rule sets and membership functions associated with their fuzzy sets.
- ✓ Different examples of design and development of expert systems with the help of soft computing are described within the section.

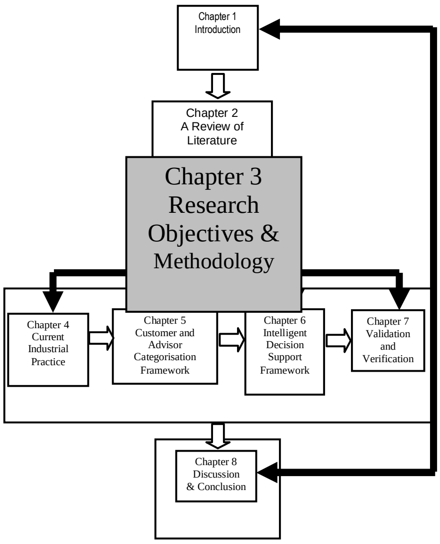
In Section 2.5 the author discusses about the design and development of Intelligent Decision Support Systems and the use of simulation in contact centre environment. In Section 2.6 the author describes the simulation methods to simulate the framework and model in order to identify suitable tools for his study.

- ✓ The key observation within this section understands the simulation techniques in general.
- ✓ The use of simulation technique used within CC environments that the author intends to adopt discussed in this section.
- ✓ Simulation fits well to simulate the contact centre environment with respect to examples such as workforce scheduling, performance management, time analysis and call duration values and so on.

In summary, the author has presented a structured account of the human behaviour modelling techniques. The importance of customer and service advisor categorisation within the contact centre industry is observed. The author identified lack of research as to the segmentation of customers and advisors with respect to behavioural attributes been seen within their interaction and communication during the service encounter.

Another gap identified in the research literature is the interaction of customer and service advisor categorisation with the use of soft computing techniques. It is the author's intention to conduct an AS IS study (Chapter 4) that will address these issues and provide some insights to their relationship.

3. Research Objectives and Methodology



In the previous chapter, the techniques and methodologies within contact centres and human behaviour modelling were presented. With that, the issues related to the use of soft computing techniques within CC were discussed. The key observations from this study were firstly, the distinct lack of research in the categorisation of customer and advisor with respect to demographic, experience and behavioural aspect and a lack of formalised approaches for identifying behavioural attributes of customer and advisors in CC. Through these key observations, the main research aim and associated objectives were identified. To fulfil the research aim and objectives, an appropriate research methodology is required. Therefore, the aim of this Chapter is:

- To present the research methodology used to accomplish the research aim and objectives.

To achieve this aim, the chapter is divided into several sections. In section 3.1, the research aim and objectives are defined. Section 3.2 describes the research plan the author intends to develop for the framework development. In section 3.3, available research approaches are examined. Due to the exploratory nature of this research, a qualitative research approach is chosen. In section 3.4, various research strategies are considered. A survey study was deemed most appropriate for the initial research and a case study research approach was used to develop further the ideas defined. In section 3.5 the research methodology is defined. The research plan is illustrated, which shows how risks to research validity are countered. In section 3.6, chapter summary and key observations are provided before moving onto chapter 4, which discusses how the initial results were collected.

3.1. Research Aim and Objectives

The aim of this thesis, stated earlier within the introduction, is:

To develop an Intelligent Decision Support Framework for effective engagement between any customer and advisor within Contact Centre environment.

The development and relevance of the research is more clearly visible now that the structured account of literature in chapter 2 is complete. Here summary of research ‘gaps’ are presented. There is a lack of research within the area of use of categorising customer and advisor behaviour within the contact centre industry. There is also a lack of research to categorise the customer service advisor (CSA) to help them with customised information for serving any customer. To address the research gaps the questions raised are as follows:

- What are the current issues concerned with the categorisation of customer and adviser behaviour in CC?
- Can we identify and categorise the generic groups of customers and advisors within the population through clustering techniques?
- Can we develop a Soft Computing based methodology to classify customer and human advisor behaviour within Contact Centre environment?
- What is the minimum amount of information required by the advisor for a given situation, which can satisfy the three business objectives of (1) Customer satisfaction (2) Resolving the enquiry and (3) Cross/Up Sell opportunities?
- Can we simulate the environment and validate the minimum amount of information required for display to advisor in a simulated environment?

By answering these questions, the author seeks to address the lack of research related to the data requirements for categorisation in the contact centre industry. In addition, to assess whether a model can be developed to capture the user requirements and information mapping and apply the expert judgement and thereby create a more structured, formalised information and service process to facilitate the reuse. To guide the research process the following objectives were set:

- To identify the current practice in handling customer enquiries within contact centre environment.
- To identify and categorise generic groups of customers and service advisor (CSA) within the contact centre environment.
- To identify how soft computing techniques could be used for categorising customer and CSA behaviour within the centre.
- To identify the minimum amount of information that is required by the advisor to serve the customer query; and to develop an intelligent decision support framework for the contact centre environment.
- To implement and verify the research frameworks with simulation and expert judgement based validation.

3.2. Research Plan

The research plan that is adapted for the research is divided into four different phases throughout the reserch process as shown below in figure 3.1. The research scope in terms of the extent of the involvement of the PhD programme with the sponsor company and the scope of the research problem addressed in the sponsor company are also addressed within the phases.

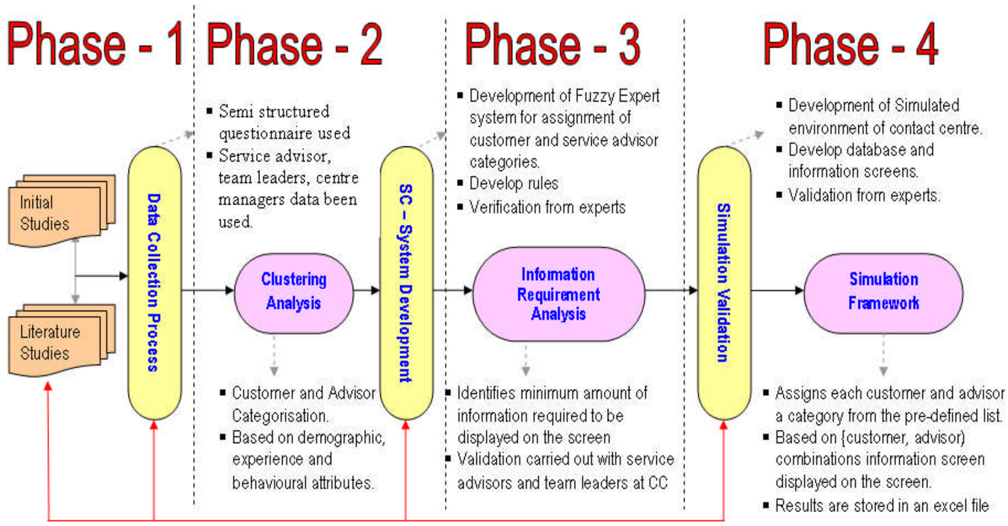


Figure 3-1: Research Plan Phases

3.3. Research Design and Real World Enquiry (RWE)

Enquiry in its broad sense is a way of solving problems, which range from purely theoretical to totally practical (Robson, 2002). This section outlines the nature of RWE and explores the features of the research project that characterises it as a RWE. The section also explores available research designs and identifies how these challenges can be addressed for a selected approach.

3.3.1. Nature of Real World Enquiry

Real world enquiry carries out application-based research involving people in real-life situations. In contrast to the laboratory experiments, which permits a large degree of control to a ‘closed’ system, the RWE seeks to find objective solutions to complex or poorly defined problems (‘open’ systems) (Robson, 2002). While the researcher benefits from the appropriate access provided by client organisation needed to help improve theory, the client organisation on the other hand benefits from the service offered by the researcher. Other related features of the RWE as compared to purely theoretically based research are outlined in Table 3-1.

Table 3-1: Related Features of RWE

Related Features of RWE and Pure Research	
RWE	***Pure Research***
Solving problems Multiple methods Outside organisation Concern for actionable factors	Just gaining knowledge Single methods Research institution Accessing statistical significance

3.3.2. Characterising the Research Project as a RWE

Chapter 2 outlines features of the contact centre and the process involved in categorising customer and advsior in contact centre environment. Adopting the same features, this section identifies the features of the research project that characterises it as a RWE and explores how these features can influence the research design. These are outlined below.

Real-world engineering problems normally involve many design variables, which increases their complexity and reduces the ability of engineers to easily reason about them. This often results in poorly defined problems, often requiring a number of iterations and close interaction between the concerned parties to improve the problem definition. Service design projects are multi-disciplinary in nature, often involving more than one discipline. Since each discipline has its own local problem and possible methods, this can pose challenges for the research design adopted. It is important to ensure that the research design involves the participation of decision-makers across the disciplines concerned in order to ensure that the underlying problems identified have significant impact on the client's business.

Table 3-2: Advantages and Disadvantages of Insider and Outsiders

Advantages and Disadvantages of Insider and Outsider		
Option	**Advantages**	**Disadvantages**
Insider	Understands the real issues, and brings experience to deal with underlying problem	Can introduce bias based on experience knowledge to the solution strategy, which can question the objectiveness of the study. It can also influence the credibility of the research outcome.
Outsider	Brings in a fresh outlook to the problem solving process. This can have a significant impact in acquiring 'out-of-the box' solutions	Requires extensive resource (time and cost) for training to acquire working knowledge in the subject area

Since this research is done in collaboration with the industry, there are two categories of researchers for research work carried out in the client organisation; the outsider and the insider (Robson, 2002). The author in this thesis is an outsider to the client organisation. An outsider with no engineering background is likely to be at a disadvantage compared to those who do. Conducting real-world research in such a specialised subject requires a set of particular skills, which can take significant time and resources to acquire. An insider on the other hand, would have acquired theories, principles, and experience over many years of work useful to the research. Both situations have a significant influence on the adopted research design. Table 3-2 outlines the advantages and disadvantages of these options. The features and considerations outlined above confirm the research project represents a RWE. In order to deal with such enquiries it is necessary to adopt a suitable research strategy. Therefore, the following section briefly outlines the available research designs.

3.3.3. Available Research Designs

Since the research strategy adopted influences the method of data collection, which in turn can affect the outcome of the research, it is imperative to ensure that the strategy adopted is suitable for the nature of the RWE conducted. There are two main types of approaches used in real world enquiries; quantitative (fixed) and qualitative (flexible) (Robson, 2002).

Quantitative (Fixed) Research

Quantitative research is a scientific research approach characterised by numerical approaches to data analysis. They require a detailed amount of pre-specification about what is involved and how it is to be accomplished. The advantage of fixed designs is their ability to transcend individual differences and identify patterns in a group, which can aggregate the general tendencies of group behaviours. This can be a very useful feature for real world enquiry for generating an overall behaviour from samples of the population. Most of these features are similar to strategies for solving most engineering design problems, where the variables to be studied are specified in advance followed by exact numerical analysis based on known theories. Exploring problem features such as problem context, scope, and areas of operability from multiple participants necessary at the initial problem solving stage. This presents difficulties if adopted in this research since human reasoning are often used to formulate and reason about the problem. In such cases, alternative approaches like qualitative (flexible) approaches could be adopted.

Qualitative (Flexible) Research

Qualitative (flexible) research is an investigative approach. When viewed in the context of the framework it does not require detailed pre-specification of the problem before starting data collection. This research makes use of a substantial amount of qualitative data (words, observation, and survey) and is framed within the characteristics of the flexible approach to research in the sense that design evolves, develops, and unfolds as the research proceeds. The flexibility of such approaches also combines two or more methods, which results in numeric (numbers) as well as linguistic (words) data.

Table 3-3: Comparison of Qualitative and Quantitative Research Strategies (Burns, 2000)

Qualitative and Quantitative Research Strategies	
Qualitative	***Quantitative***
Assumptions	
Reality socially constructed	Facts and data have an objective reality
Variables complex and interwoven; difficult to measure	Variables can be measured and identified
Events viewed from informant's perspective	Events viewed from outsiders' perspective
Purpose	
Interpretation	Prediction
Contextualisation	Generalisation
Understanding the perspectives of others	Causal explanation
Method	
Data collection using participant observation, semi-structured interviews	Testing and measuring
Concludes with hypothesis and grounded theory	Commences with hypothesis and theory
Inductive and naturalistic	Deductive and experimental
Data analysis by themes from informants' descriptions	Statistical analysis
Data reported in language of informant	Statistical reporting
Descriptive write-up	Abstract impersonal write-up
Role of researcher	
Researcher as instrument	Researcher applies formal instruments
Personal involvement	Detachment
Emphatic understanding	Objective

(Burns, 2000) provides a useful comparison of quantitative and qualitative research strategies, which distinguishes the two succinctly as described in Table 3-3: . It should be noted that flexible or qualitative research strategies can and do include the collection of quantitative data. Whereas fixed strategies rarely include qualitative data although they could do (Robson, 2002). Moreover, researchers often use a combination of both quantitative and qualitative research strategies.

3.4. Selecting a Research Strategy

A useful comparison of the three mentioned research strategies is shown in table 3.4 Two key factors related to this research suggest a case-study strategy is the most appropriate. Firstly, the research is industrially sponsored, providing an available case-study environment, focus, and access to 'reality'. As such, much of the theories and ideas explored within this thesis 'emerge' from findings within the case study environment and the literature review. Secondly, case studies, within a business related context, tend to be limited to exploratory research (Gummesson, 1999).

Table 3.4: Research Strategies in Flexible-Fixed Designs (Robson, 2002)

	Research Strategies in Flexible Fixed
Strategy	***Description***
Experiments	Measuring the effect of manipulating one variable on another variable. Its typical features are: ▪ The selection of samples of individuals from known populations ▪ Allocation of samples to different experimental conditions ▪ Introduction of planned change on one or more variables ▪ Measurement of small number of variables ▪ Control of other variables Usually involves hypothesis testing
Surveys	Collection of information in standardised form from groups of people. Its typical features are: ▪ Selection of samples of individuals from known populations ▪ Collection of relatively small amount of data in standardised form from each individual Usually employs questionnaire or structured interview
Case Studies	Development of detailed, intensive knowledge about a single ‘case’ or of a small number of related ‘cases’. Its typical features are: ▪ Selection of a single case or a small number of related cases of a situation, individual or group of interest or concern ▪ Study of the case in the context Collection of information via a range of data collection techniques including observation, interview and documentary analysis.

In line with the research project, the collaborating organisation is treated as a case study. Therefore, the case study based strategy is used within the research. The knowledge elicitation exercise conducted at the initial stage of the project indicated the need to acquire more specialist contact centre domain knowledge through participation in the categorisation process. This consideration coupled with the increasing adoption of case studies in management led to the selection of the case-based research strategy. Table 3.4 illustrate the main strategies involved in the research design. Here it is likely that these strategies are suitable for solving the problem stated in chapter one. Since the case study strategy combines the use of several data collection techniques (such as observation, interviews and documents) (Gummesson, 1999) it raises a number of issues such as validity and generalisation regarding the rigour of its use in aspect of the research project (MacNealy, 1997). The issues are addressed as follows.

3.4.1. Data Collection Techniques

The following data collection methods: interviews, questionnaires, observations, and experimental designs have been utilised in the case studies adopted in this thesis.

Structured and unstructured interviews were used to identify the categorisation knowledge at the contact centres. The author also adopted participant observation to examine the nature and extent of contact centre process. This knowledge has been useful in developing categorisation and information requirement frameworks for the research project. The next section outlines the main threats to validity and describes measures adopted to overcome them.

3.4.2. Validity

Validity is concerned with the degree a theory, model, or concept describes reality. The main threats to the validity of the research are reactivity, respondent, and researcher bias. Reactivity refers to how the research's presence may interface with the case settings. Respondent bias refers to the respondent withholding information or giving superficial response. Researcher bias relates to the preconceived ideas brought to the problem. The strategies outlined below are adopted to reduce these biases.

Prolong involvement: The author stayed at the client organisation for a period of four months and was involved with the service and system engineers.

Triangulation: Multiple methods of data collection such as documents, interviews, participation observation, and literature reviews. This reduced the threats to validity.

Audit trial: The author reduced self-bias by keeping full records of analysis work carried out, meetings, publications, and interviews.

Peer debriefing and support: The author worked extensively with industrial and academic supervisors to debrief and collate ideas after meetings, and workshops within research settings. This also reduced researcher bias.

Generalisation

Generalisation concerns the characteristics of research findings that allow them to be applied to other situations and other populations. In quantitative research, it is common to use probability sampling. That is, to take a representative sample from a population, test hypotheses, and make generalisations from the results. In case-study research, probability sampling is rarely applied. More often, a case study is chosen because it is available, typical, or unique (Burns, 2000). It is common that a single or limited number of cases are used on which to develop the research findings. As a result, the main criticisms of case study research are summarised as (Gummesson, 1999) (1) Case studies lack statistical validity, (2) Case studies can generate hypotheses but not test them, and; (3) Generalisations cannot be made based on case studies. Of these three criticisms, generalising is the most volatile issue ((Yin, 2003) and (Robson, 2002)). To counter this issue, the author uses the research findings from the case study environment, and develops them using an action research approach with experts from other CC environments.

3.5. Designing the Research Methodology

Based on the research choices made, and developing an understanding of the issues related to undertaking a qualitative case-study research strategy, a research methodology is proposed in Figure 3-2. The research methodology is divided into three sections covering all the phases described in section 3.2 earlier into: (1) research strategy development (2) data collection and idea formation (3) data analysis and validation.

In the first section, *'research strategy development'*, the purpose was to decide on an appropriate research strategy. Quantitative and qualitative research approaches were considered and a qualitative strategy chosen. After which time, available research strategies considered (see table 3-2). The methods and issues related to the chosen research strategy i.e. case study were analysed to understand how best to use this strategy.

In the second section, '*data collection and idea formation'* the data collection techniques and risks to validate the research were considered and planned. The qualitative approach to research requires a level of interpretation in the events that the author is participating or observing. To reduce the bias within the research the author arranged to spend time, varying from a couple of days to weeks within the AS IS study environment. Subsequently, more time was spent within the sponsoring companies identifying the issues. This 'prolonged involvement' helped overcome many of the issues related to case study research mentioned earlier in section 3.3. Spending such a long time within the environment has the disadvantage of introducing researcher bias. To counter such a threat, multiple sources of data collection techniques are used. For example, participant observation, interviews, and document analysis. Using a combination of data collection techniques helped provide validity and reliability to the results. The specific techniques and results discussed fully in Chapter 4. In addition to collecting data from within the case study environment, available contact centre and human categorisations techniques in telecommunication and service industry literature constantly reviewed.

The closing stage of the research methodology was the *'data analysis and validation'* section. In this section, the categorisation framework (Chapter 5) was developed and validated with experts. This ensured that the research would be applicable to wider industry than just that of the research sponsor.. Through the results and categories derived from the categorisation framework, development of intelligent decision support framework was conducted and validated for effectiveness and usability by the research sponsors described in chapter 6. To test the complete research frameworks, validation was carried out within simulated environment and with expert based judgement and described in chapter 7. The results of the continous validation with expert judgement are presented in Chapter 6 and 7. The research contributions, conclusions, and recommendations are discussed in Chapters 8.

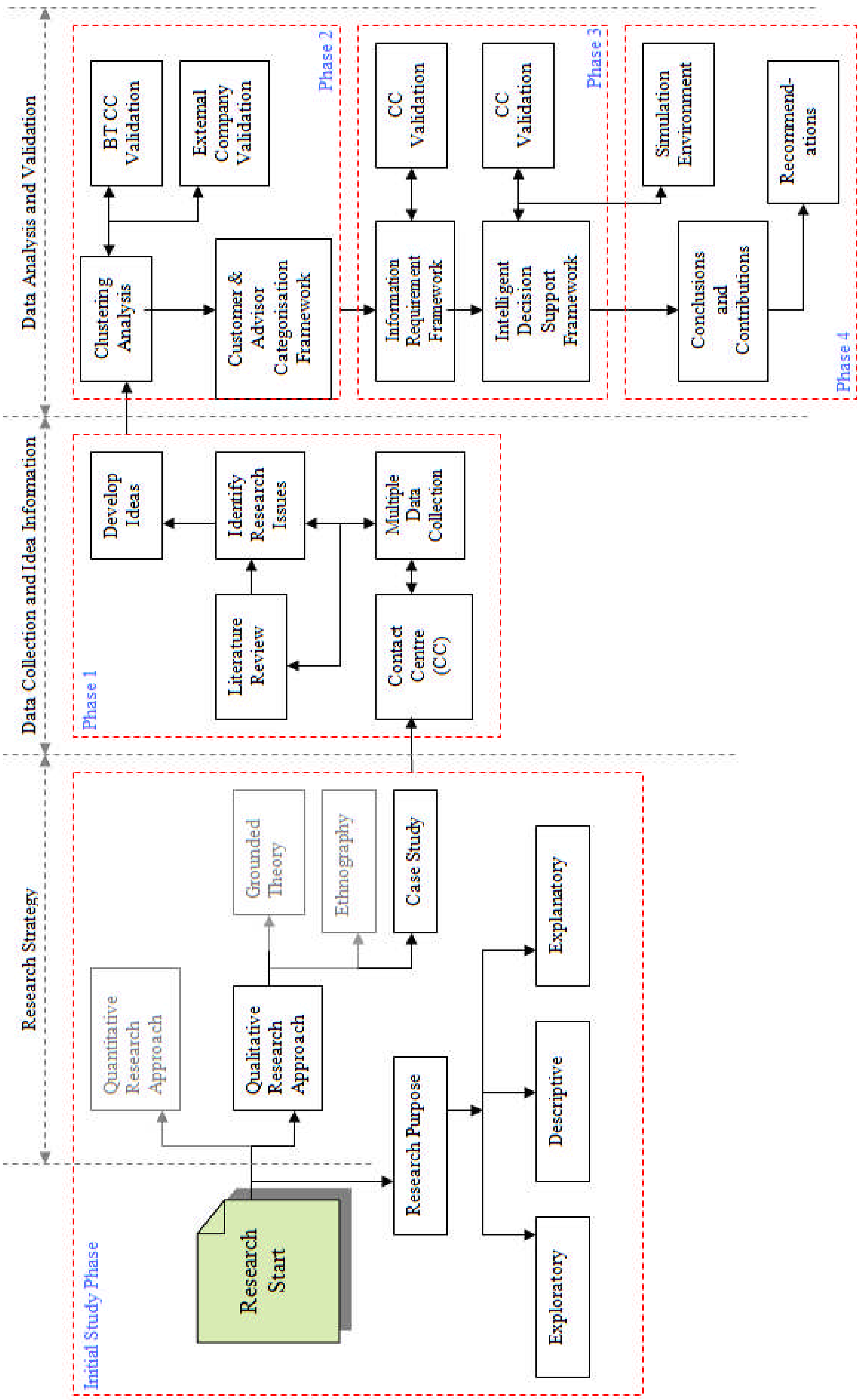


Figure 3-2: Research Methodology

3.6. Summary

In section 3.1, the research objectives were set. To fulfil the research objectives an appropriate research strategy was designed and followed. In section 3.2, available research approaches were examined. A qualitative research approach was chosen due to the exploratory nature of the research. The most appropriate qualitative research strategy for the initial stage was the survey approach due to the numerous organisations the researcher needed to cover, then a case study approach was chosen, mainly because the research was industrially sponsored. Therefore, in section 3.3, the issues of case study research were analysed. In section 3.4, the final research methodology was illustrated. In addition, the methods to deal with risks to research validity were presented This provided a research plan, which highlighted how risks to research validity could be countered e.g. through spending time within the research environment, using multiple sources of data collection, and involving experts from other contact centre domains during the development and testing of the research findings and model.

In the following chapter, the findings of the survey in interactions between contact centre and customer/advisor categorisation are presented. Data, information, and other relevant issues collected from the case study environment are presented. The structured approaches to data collection, such as process modelling and participant observation, lead to the identification of the problem under investigation more importantly, helped to establish how customer/advisor categorisation to identify the right amount of information within contact centres do not communicate with clarity due to their restricted access to the information.

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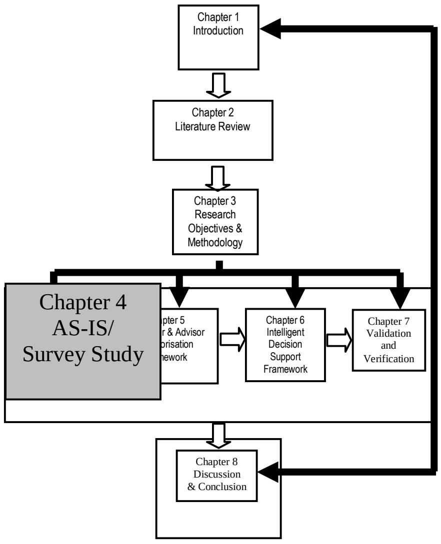
4. Current Industrial Practice (AS-IS)



Chapter one established that advisor retention and customer satsifaction were crucial for the quality and service provided to the customer within contact centres. Within service sector environment, the problems highlighted in chapter one are increasingly important component for the customer satisfaction levels in the company. Therefore, this chapter aims to explore the current design and environment of contact centres, focussing on the customer and advisor environment, information systems and design and implementation of systems within the domain. The chapter attempts to achieve this aim with the sections outlined as follows. For the purpose of the research and AS-IS study, the author organised visits to different customer contact centres (CCC) in order to understand the current and overall operations of the contact centre environment. The objectives for the AS – IS study are:

- Identify the operation and working of Customer Contact Centres
- Identify the current practices within the customer contact centres regarding customer and advisor categorisation.
- Identify the behavioural variables for customer and advisors through observations at the contact centres.

Section 4.1 gives a brief outline of the design of the AS – IS study conducted for the research. Section 4. 2 introduces the behavioural analysis and the methodology followed. Section 4.3 presents an evaluation of the software and systems identified through the contact centres. Finally, the chapter concludes in section 4.4 with a summary and key observations achieved through this chapter.

4.1. Design of AS-IS

An AS-IS model, as the name suggests, is a representation of a practice or situation as it currently stands: A thorough investigation into the subject being outlined is required in order to present it accurately, with insight and to highlight useful detail. In the next sections the author describes the steps he took in order to complete the AS-IS study. The approach followed during the data collection is as shown below in figure 4.1.

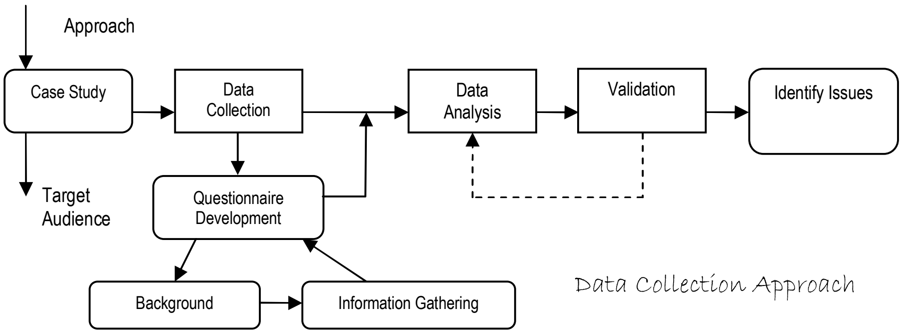


Figure 4-1: Data Collection Approach for AS – IS Study

4.1.1. Target Audience

Prior to the visit, some information regarding the research project was sent to the centre manager in the company. Further, the interviews were preceded by a presentation, which introduced the project and explained the purpose of the visit. The objectives of the questionnaire and of each of its modules were also provided in the questionnaire. After guaranteeing the confidentiality, the CSA's/advisors and manager's were individually interviewed by the researcher..

Table 4-1: AS IS Study Interview Details

	AS – IS Study Interview Details		
	CC – Role	**Age Group**	**Experience**
Contact Centre (A)	Team Leader (TL) (1) Manager (M) (1) Advisor (A) (4)	36 yrs 45 yrs 18-25 (2), 25-40 (2)	TL – 4/6 yrs M = 7 yrs <1 yrs (1), 1-5 (2), 5-10 (1)
Contace Centre (B)	Team Leader (2) Manager (1) Advisor (8)	24 – 40 yrs 30 - 50 yrs 18-25 (3), 25-40 (2), 40+ (3)	1 TL- 2-6 yrs, 1 TL – 7-9 yrs M = 11 yrs <1 yrs (1), 1-5 (2), 5-10 (2), 10+ (3)
Contact Centre (C)	Team Leader (1) Manager (1) Advisor (11)	29 yrs 38 yrs 18-25 (4), 25-40 (4), 40+ (3)	TL – 5-7 yrs M = 10 yrs <1 yrs (3), 1-5 (5), 5-10 (1), 10+ (2)
TL – Team Leader, Manager – M			

The questions were set to fit the time frame available in the contact centre environment. The questionnaire was divided in two separate groups as (1) managers/team leaders and (2) service advisors.

4.1.2. Questionnaire Development

A semi structured open and closed type of questionnaire was used within the research AS – IS study at contact centres (appendix D). The questionnaires designed and analysed by the author used in order to test the hypothesis of this thesis that identifies the customer and advisor categorisation and the design requirements for a customised information system. The survey's objective is threefold:

1. Identifying issues, if any, that exists between information systems and customer/advisor categorisation across the broad field of 'categorisation'. Thus to an extent the questionnaire was generic, designed to be relevant for specialists across areas involved within commercial and technical contact centres;
2. Help to identify the process and data requirements in order to construct a categorisation framework (more information on Chapter 5) and;
3. Used as the basis for a semi-structured interview (section 4.1.3) as the experts often-raised issues that didn't concern the author's research and were not covered by the questionnaire; but were also of significant importance for the author to have an overall picture of Contact Centres.

The questionnaire consists of two major parts: Categorisation Issues and the Information Systems.

Categorisation Issues information is important in order to know about the customer and the advisors within the centre interviewed so that the researcher is able to place their comments into perspective.

Information Systems questions asked how the current systems providing the services to the customer and the information provided to the advisors were adequate.

The questions used within the questionnaire are shown in appendix D for advisor and manager/team leaders within contact centre. The questions used within the questionnaire are as shown below in table 4.2 for mangers and team leaders.

Table 4.1 provided a consistent process to the data collection. The format of the semi-structured interview was to use the questionnaire as a guide, and if necessary ask other questions. All the interviews recorded and transcribed later for analysis. This provided an audit trail, reducing the threat of researcher bias. The questionnaires divided into seven sections as follows.

Section 1 designed to gather information related to the profile of the contact centre visited. Section 2 designed to assess the workforce (advisors, support staff) within the centres. The questions in both Sections 1 and 2 were asked without sharing the researcher knowledge acquired through literature studies in order not to influence their answers. Section 3 assessed the workforce recruitment and retention issues the centre followed for their advisors and support staff. Section 4 and 5 respectively collected information related to the skills and educational requirement for the advisor within the centre. Section 6, highlighted on issues of training been provided within the centre, and any specific ways they felt in improving it. Finally, section 7 provided the details of the systems and technology used within the centre. The questions used within the questionnaire for advisors are as shown in table 4.3.

Table 4-2: Questions used in AS – IS for Managers/Team Leaders

Section 1: Profile of CCC	
1.	Could you give me a brief overview of the experience in CCC environment?
2.	What kind of calls do you handle?
3.	What type of services does the company offer? Moreover, what are the hours of operation?
4.	What are the communication channels used (IVR, live voice, fax, internet, email, others)?
5.	Are there any specific languages offered the service in to the customers.
6.	**Section 2: The Workforce**
7.	What is the employment lifecycle of the workforce (advisors) in CC?
8.	What is the staff structure within your CC, and what is the percentage of advisors within this?
9.	Of the employees you have hired in last 2 years, what is the level of education they typically posses. (Options given with the type/nature of work?
10.	For each of the given set of skills, please state the current workforce meets the business requirements (Customer service, using technology, product awareness, etc).
11.	Do you categorise your advisors? If yes, please provide details.
12.	Is there any particular method used to manage the working nature or behaviour of advisors while dealing with the customer?
13.	How is the performance of the advisor measured?
14.	Do you categorise your customers within the centres?
Section 3: Recruitment and Retention	
15.	What programs and processes are in place to attract applications?
16.	What factors influence your ability to recruit (unqualified, competitive salary, location)?
17.	Does your organisation (CC) able to attract the quality of candidates required to maintain and improve the service efficiency provided to the customers?
18.	What strategies you have in place to retain the advisors?
19.	On average, how long does your full time advisor remain employed with your CC?
Section 4: Skills	
20.	What skills are most important for your advisor to possess?
21.	What major shifts have been there in the skills requirement of the centre over the last three to five years? What is driving this change and is this pressure likely to continue over time?
22.	Are there any skills gaps faced within your centre?
Section 5: Education Levels	
23.	What are the current expectations/requirements for educational attainment of your advisors?
24.	What sort of product knowledge or industry expertise do your advisors require?
25.	Has there been a significant change in the educational attainment or skills levels of the advisors?
26.	Do they require attaining any contact centre certifications?
27.	What is the relationship between the wages and educational level requirement within your centre?
Section 6: Training	
28.	What kind of training provided to the advisors?
29.	How do you insure that your advisor possess the following (product knowledge, customer relationship skills, knowledge of using systems and technology and communication skills)?
30.	What type of training provided to the advisors and its period (in house, external providers)?
31.	Which of the following have you experienced because of implementing new channels?
Section 7: Systems and Technology	
32.	What is the type of system used within this centre?
33.	What technologies do you think that the company would be implementing in the centre in short term/long term?
34.	What do you see as the most important technology trend or development within the contact centres?
35.	Do changes you foresee have any implications for your future workforce? [the skills, qualifications or characteristics of the current or future workforce (advisors, support staff)]
36.	What do you see in changes to the current system used that would be useful to the advisors?

Table 4-3: Questions used in AS – IS for Service Advisors

Section 1: Employee Profile	
1.	Advisor details (gender, age, experience)
2.	What first attracted you to work for contact centres?
3.	What is your job profile and level of work carried out at this centre?
Section 2: Contact Centre Perception	
4.	What do you think about the customer and public views of the level of service that contact centres should provide?
5.	Did this image influence your decision to join this sector?
Section 3: Job Satisfaction	
6.	What are the most positive aspects of working in contact centres?
7.	What are the negative aspects of working in contact centres?
8.	What makes your work challenging?
Section 4: Customer Categorisation	
9.	Is there any sort of categorisation used for your customers?
10.	Are these categorising of customers divided based on experience, behaviour/trend of customer?
11.	Do you look on any historical data of the customer to serve their query while having conversation?
12.	Do you do any modifications in the customer data after the conversation? Do you have any levels, which can record the customer behaviour or mood patterns?
Section 5: Career (Training and skills development)	
13.	What levels of educational background do you posses?
14.	What skills do you possess or plan to acquire that can improve your service level within the centre?
15.	In you opinion, what are the strengths and weaknesses of the following in your organisation?
Section 6: Systems and Technology	
16.	What systems and technologies do you use within your working environment?
17.	What are the capabilities of these systems been used?
18.	Do you think that there is any specific changes required within the current system been used?
19.	Does the current environment provide any levels of categorisation of the caller details?
20.	Do the current systems provide any mapping (similarities) across group of customers?
21.	Does the current system identifies the type of caller and the type of information required for the advisor dealing with particular customer in the instance?

The questionnaire was divided into six sections. Section 1 was designed to gather information related to the profile of the advisor. Section 2 was designed to assess the perception of the centre from advisor point. Section 3 assessed the job satisfaction levels of the advisor working at the centre. Section 4 was designed to gather information related to the customer categorisation (if any) was used within the centre. Section 5 respectively collected information related to the training and skills development issues of the advisor within the centre. Finally, section 6 provided the details of the systems and technology used within the centre. The questions were asked without sharing the researcher knowledge acquired through literature studies in order not to influence their answers. The focus on customer and advisor categorisation, identify the system requirements and the information presented are at the conceptual design stage of the system. Before the questionnaires were reviewed and data was collected, it was reviewed initially by the sponsoring companies and some experts within the contact centre community. Sections of the introduction and the layout of the questionnaire were modified accordingly, as and where necessary, until a satisfactory version was produced.

4.1.3. Conducting the Interviews

The questionnaires were derived by the understanding of the author's knowledge and discussions with the colleagues at BT and supervisors at Cranfield University. The questionnaire was both closed or pre-coded answer and open or free response type of questions. A closed question is one in which the respondents are offered a choice of alternative replies. Although these type of questions allow less freedom of expression, but they are easy to answer and analyse. On the other hand, open or free response type questions not allowed by any kind of choice, and the answers have to written in full.

The data and information collected from these centres were captured, understood and were combined with the current information obtained from the literature review and, they were used to identify the different advisor & customer behaviour categorisation. The questionnaires were derived with the aim on collecting information related to contact centres and other important factors such as profile of contact centres, workforce management, advisor recruitment and selection, skills, training and systems used within current environment.

4.1.4. Contact Centres Visited

The researcher visited three customer contact centres within United Kingdom for the understanding of the overall operations and technologies involved within the contact centre environment. There is a variety of application CC within UK and the author has presented three centres used within this study. They are:

- Contact Centre A – Telecoms Business Centre
- Contact Centre B – Fault Reporting, Technical Problems Solutions Centre
- Contact Centre C – Sales, Payments Collection and Credit Management Centres.

CC – Company A

Contact Centre A was a telecoms business team with a total of 90 advisors with three teams having two supervisors and two managers handling the overall operations of the business customers of the company. The common services that the centre handled were the moving of business customer, their premises, their services, billing enquires, cancellation of services, addition of extra services and other order related enquires. The systems used within this centre were the Liberty and the Smart systems.

CC – Company B

Contact Centre B was a fault reporting and fault finding centre of a telecommunications company operating for the company. The centre had a team of 80 advisors within 6-8 teams; working in shift patters providing 24/7 services to the customers. There were six managers and four supervisors within the centre. The services handled by this centre were fault reporting for the telephone or the fax line, resolution of the fault, dispatching the technical engineer to the site location where the fault being detected and providing the services again to the customers. The system used within this centre was the Elixir – fault-reporting systems.

CC – Company C

Contact Centre C had multiple services providing to the customers of the company. This centre employed 90 full and part time advisors. With a set of six managers for each group, and one centre manager the team of CSA carried out functions such as Sales, payments collection and credit management for the company. The systems which were used at the centre were Power Dialler (automatic dialling to customers and links to CSS) and Card system (payment services).

4.1.5. Results from the Questionnaire

The following table 4.4 (A and B) describes the summary of the results for each major question used within the data collection at the contact centres discussed in table 4.2. Three contact centres visited where the interviews conducted with team leaders and advisors.

Table 4-4: Summary of Results from the Managers/Team Leaders (continued)

	Questionnaire: Summary of Key Questions (Managers/Team Leaders)		
Questions	Respondent A (Business Movers)	Respondent B (Fault)	Respondent C (Sales)
2. What kind of calls do you handle?	Inbound – customer calling to move/shift their services provided by the company to a different location or premises	Inbound/Outbound – Customer calls to report problems/fault with their service and product. Company then reports the problems to the service department and notifies the customer about the progress/resolution of the fault	Inbound/Outbound – customer are called by the centre to inform them about new product and offers provided by the company. Customer call in to acquire information about the new products and any changes within their current services been used. Also payments and collection from the customer are acquired within the centre.
7. What is the employement liftcycle of the workforce (advisors) in CC?	Advisor – application, interview, experience overview and test to identify their IT skills knowledge which are required by the centre.	Advisor – application and experience overview. No test is conducted as such but knowledge about IT systems and applications such as windows based operations is required.	Advisors - application and their experience of selling (telephone sales, and any other previous sales experience). Customer handling abilities is also required. Their abilitiy to deal with customer over telephone is also monitored in an example scenario.

Table 4-5 : Summary of Results from the Managers/Team Leaders (continued from 4.4)

	Questionnaire: Summary of Key Questions (Managers/Team Leaders)		
Questions	Respondent A (Business Movers)	Respondent B (Fault)	Respondent C (Sales)
18. What strategies do you have in place to retain the advisors?	More staff benefits and increments provided with number of satisfied customers dealt with during the communication.	Staff packages and benefits of increments at different stages of advisors is provided. Discounts on company products and services.	Commissions given to the advisor with successful completion of the sale of the product/service to the customer. Discounts and offers to the advisos on companies products.
20. What skills are the most important for you advisor to posses?	Efficient communication and abilitiy to deal with the customer query. Faster IT skills to process the customer call in the most efficient manner.	Telephone skills and database management skills. IT efficiency required for faster service provided to the customers query.	Customer service skills, sales and negoitation skills, telephone skills for better communication with the customers and IT skills (generic windows based). Awareness of the products and services offered by the company.
23. What are the current expectations requirements for educational attainment of the advisors?	Mostly educated to graduate levels, with combination of college education and IT related certification courses achieved.	Some level of college or graduate level. School leavers need to provide sufficient evidence of any IT or specific skills certification courses carried out.	Mostly college level education required by the advisor. Further training of the IT related aspects can be achieved through the training development offered to the advisors at the centre.
28. What kind of training is provided to the advisors?	IT training, efficient customer communication skills, systems training and product knowledge provided to the advisors. Experienced advisors can advance on higher levels of training provided by the centre.	Mostly system use based training provided to the advisors. Assistance provided to the advisor if they require any outside training.	Systems training, sales and customer service training, IT skills and windows based training also provided.
32. What is the type of system used?	CSS (Customer Service System) – customer records and service system.	Elixir – front end system of CSS.	Minerva – Internal stand alone system for order processing and sales
36. What do you in see changes to current system be useful to advisors?	Efficient use of windows based system which can reduce the time.	A collection of information in one system that is requred in any customer query	More background information provided to the advisor on sales techniques.

The key objectives from the results of the advisor questionnaire from the study are shown in table 4.6.

Table 4-6: Summary of Results from Advisors at CC

	Questionnaire: Summary of Key Questions (Advisor)		
Questions	Respondent A (Business Movers)	Respondent B (Fault)	Respondent C (Sales)
3. What is your job profile and level of work carried out at this centre?	Service Advisor – dealing with business customer calls required to move their services to new premises. Installation of new services	Service Advisor – dealing with customer calls regarding faults in their telecommunication services (telephone/fax). Assignment of service engineer to the fault location	Service Advisor – dealing with customer queries regarding information of new products/offers offered by the company. Work includes sales, account transactions and collection
6. What is the most positive aspect of working in CC?	Dealing with customer query in most efficient manner	Identifying the customer problem/fault within the service and resolving the fault	Satisfying the customer needs of the product requirements based on the choices available.
9. Is there any sort of categorisation used for customers?	Mostly business customers depending on the type of services/products used	Mainly residential and business customers	None. Customer queries on product information depends on randomly selection of customers.
11. Do yo look on any historical data of the customer?	Yes. Customer type, services currently used, and status of the customer	Yes. The information about any previous faults/problems encountered by the customer is present in the customer records	Only if the customer has registered the details for further product information
13. What levels of educational background do you posses?	Graduate and College.	College	College and some graduate
16. What systems and technologies do you use within the working environment?	CSS	Elixir	Minerva
18. Do you think that there is any specific changes required within the current system been used?	Less forms to fill out regarding any change of services for the customer. Reduced amount of codes which can reduce the time to serve each individual customer	Information related to fault recording on customer record and ordering of service engineer for fault repairs should be in one windows based platform rather than separate systems	More customised information might be helpful related to the product information.
20. Do the current systems provide any mapping across group of customers?	None.	Only if there has been significant problems reported within the same area/location of customers	None. The customers are only grouped if they have bought similar products from us in the past.

4.1.6. Analysis of AS-IS Study Results (from questionnaire)

The analysis from case studies carried out within the research is presented in the above section. The main observations through the different contact centres used during the study were compared for similar, different and unique differences across them (table 4.7).

Table 4-7: AS-IS Study Analysis of Managers/Advisors in Contact Centres

	Analysis of AS – IS Study Results (from questionnaire)		
	Similar	Different	Uniqueness
Centre Managers/Team Leaders			
Profile of Contact Centres	Inbound and Outbound contact centres.	Handles the credit management within the customer records	-
Technology Trends	Services include IVR, telephone, mail, fax and email. Technologies implemented are CTI, security, email response systems	Wireless communication and chat features Quality monitoring	Chat features and sms text features enabling the customer notified about the resolvement of the query. CRM software
Workforce management	Mostly advisors are male with telephone and IT skills	-	Previous experience working in CC with similar work environment
Future Challenges	Need to be a user friendly and less consuming time in dealing with complex customer queries	Sales and customer satisfaction values are important criterias. Call monitoring systems used more often to monitor customer satisfaction levels	User friendly system with less forms to fill.
Advisors			
Personal Profile	Age of the advisor mostly in the range of 18 to 40	There are part time shift pattern advisors working compared with full time advisors	Within sales contact centre, there is a 70% female population versus 30 % male advisors
Customer Contact	Many times calls are mis-transferred to wrong departments.	Lack of information (selecting options) leads to the transfer of calls to other departments of the centre	Lack of customer knowledge provided to the advisor which makes it difficult to process the call in one attempt
Learning and Skills Training	Systems training provided before they start taking calls	Regular system update and other telephone and communication skills are also provided	There is a lack of approach for contact centre certification courses provided to the advisors
System Implementation	Most of the system are easy to use but with complex features	Windows based systems are easy to use than stand alone systems	System are complex and requires a lot of training for the implementation
Future Challenges	Would change the job environment in next 18-24 months	There is less effort towards appreciation to the advisors from the managers and team leaders	-

The results highlighted the main areas within the contact centres, and are grouped between centre managers/team leaders and advisors accordingly. The conclusions from the results are discussed later in 4.1.6 and section 4.4. The data presented within table 4.7 presents the information analysed through all the centres visited. The analysis of the data is provided in detail within appendix B within the data analysis (AS-IS) section. Based on the analysis carried out by the author the summary of the results presented in table 4.7. The modules discussed earlier used for the collection were personal profile of the advisors (demographic and experience levels), their job specifications, training and development and their future challenges (problems and concerns) within their respective centres. The information collected through semi-structured interviews was analysed for service advisor (CSA) within CC.

4.2. Behaviour Analysis Methodology

The behvaioural analysis was derived for identifying the behavioural attributes for customer and advisors within contact centre environment. The study was carried out to identify the behaviours that were latter going to be used as one of the variables for the design and development of the categorisation framework discussed in chapter 5 of the thesis. The behavioural categorisation of customer and advisor is also considered as an important element for the research identified earlier in chapter 3.

4.2.1. Target Audience and Questionnaire Development

Initial studies within the behavioural analysis of customer and advisors identified a set of behaviours, which were compared and reviewed with the literature studies and with expert judgement from the centre managers within the contact centres. During the observations at the contact centre, new sets of behaviours were noticed and recorded by the author.

Table 4-8: Questions for Behaviour Categorisation used with Managers/TL

Section 8: Advisor Categorisation
37. Do you categorise your advisor within the centre?
38. Do you use experience and education level for categorisation?
Section 9: Advisor Behaviours
39. Do you record any changes of advisor behaviour during and after the conversation with the customer?
40. What are the specific behaviours noticed within the advisors in the centre?
Section 10: Customer Categorisation
41. Do you categorise your customers within the centre?
42. On what basis the customer are categorised?
Section 11: Customer Behaviours
43. Do you record any changes of customer behaviour during the call conversation with the advisors?
44. What are the different types of behaviours noticed within the customer calling the contact centre?

The complete list of behaviours for customers and advisors is as shown below. The detailed explanation of each behaviour type refers to appendix E of the thesis. The number of people interviewed for the study is same as described in section 4.1.1.

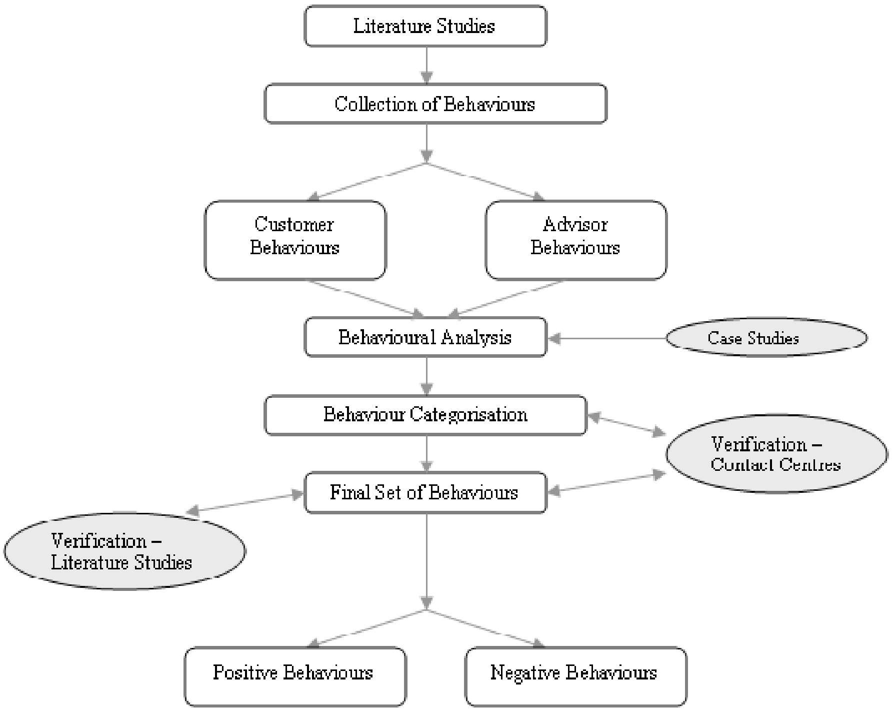


Figure 4-2: Behaviour Analysis Flowchart

The selection of the questions from the questionnaire used to identify the key behaviours of customer and advisors is as shown below in table 4.9. The process followed for the collection of behaviours for customer and advisor within contact centres is as shown in figure 4.2.

Table 4-9: Questions for Behaviour Categorisation used with Advisors

Section 7: Customer Categorisation
22. Do you use any categorisation for your customers within the centre?
23. On what basis the customer are categorised?
Section 8: Customer Behaviours
24. Do you record any changes of customer behaviour during the call conversation?
25. What are the different types of behaviours noticed within the customer calling the contact centre?
Section 9: Advisor Behaviours
26. What are the specific behaviours experienced by you during any customer conversation?

The process followed for carrying out the behaviour analysis methodology for the research is as shown in figure 4.2.

4.2.2. Conducting the Interviews

The results observed during the data collection of the advisor and customer behaviours were collected through monitoring of calls during the interaction within the CC. The author collected these behaviours while listening to the calls and the responses of customers towards the advisors and vice-versa. Although a set of behaviours were initially identified by the the author through literature studies, more sets of behaviours were applied to the analysis through the call monitoring process carried out during the case studies. The set of behaviours identified from the data collection with advisors and team leaders is shown in figure 4.3.

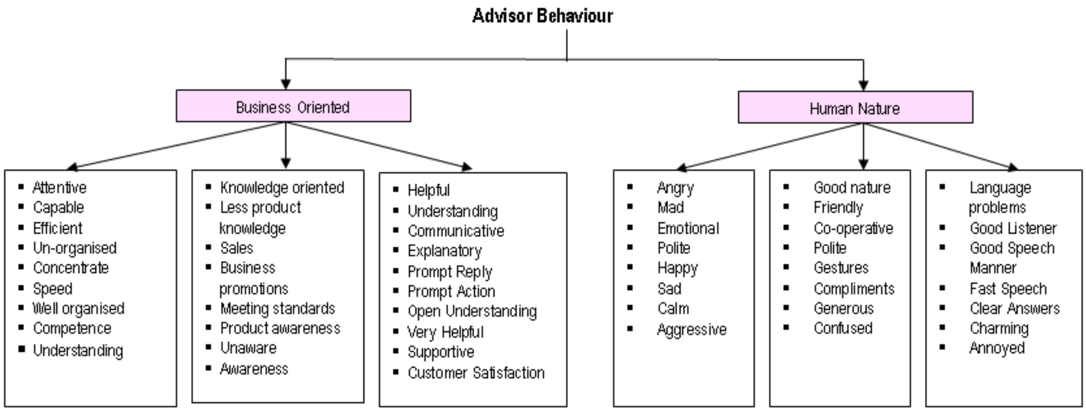


Figure 4-3: Initial Advisor Behaviour Categorisation

The initial set of behaviours identified through the questionnaires for customers are shown in figure 4.4 and explained in detail within appendix E.

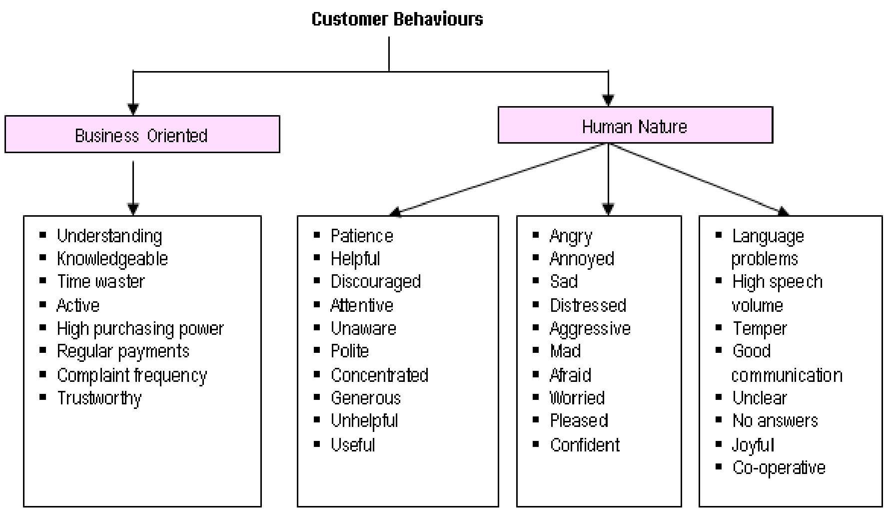


Figure 4-4: Initial Customer Behaviour Categorisation

4.2.3. Reducing the Behaviour Categorisation – Intermediate Stage

The reduced set of advisor behaviours observed from the contact centre monitoring process are as discussed in table 4.10 and 4.11.

Table 4-10: Advisor Behaviour – Intermediate List

Advisor Behaviour – Intermediate List					
Attentive	Capable	Angry	Confused	Language Problems	Emotional
Friendly	Compliments	Calm	Unaware	Annoyed	Aggressive
Speed with service	Customer Focused	Helpful	Co-operative	Understanding	Knowledge Oriented

Similar to the list of advisor behaviours, the author also noticed the same pattern of customer behaviours from hearing to the calls, and also the way the advisors used to derive their customer once the call was finished. The lists of customer behaviours were as follows:

Table 4-11: Customer Behaviour – Intermediate List

Customer Behaviour Intermediate List					
Understanding	Trustworthy	Angry	Patience	Distressed	Language problems
Aggressive	Helpful	Unclear	Joyful	Unhelpful	Co-operative
Polite	Annoyed	Concentrated	Useful	Attentive	

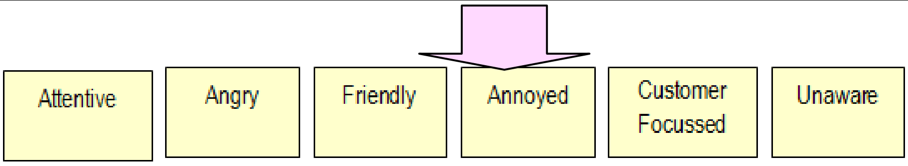
Based on the classification of this behaviours observed by the author at the contact centre for advisors, it was not possible to consider all of those behaviours for further analysis and study of the research. For this reason, the author then identified which of the behaviours were the most repetitive ones which were observed through out the monitoring of advisors. The final set of behaviours used for categorisation framework were verfied with team leaders and advisors within contact centres. The results from the verification with team leaders and advisors is as shown in table 4.12.

4.2.4. Identification of Final Set of Behaviours

During a particular call situation, the researcher highlighted the key observations in terms of advisor behaviour changes or the way the customer dealt with. From the customer's point of view, it was purely hearing the calls during the conversation, and the researchers own understanding and judgement that derived from the literature studies and earlier knowledge of the contact centre. Once the situation observed and analysed, further checks and validation carried out with the advisor, to verify the results from the observations. It also checked with the team leaders, and after the validation from both sides completed, it structured as shown in the below in table 4.13.

Table 4-12: Identification of Final set of Advisor Behaviours

	Identification of Final Set of Advisor Behaviours				
Advisor Behaviour	**Team Leader 1**	**Team Leader 2**	**Team Leader 3**	**Team Leader 4**	**Team Leader 5**
Attentive	Agree	Agree	Slightly agree	Agree	Agree
Capable	Slightly Agree	Slightly Agree	Disagree	-	Disagree
Angry	Agree	Slightly Agree	Agree	Agree	Slightly Agree
Confused	Disagree	Disagree	Slightly Agree	Disagree	Disagree
Language Prob.	Disagree	Disagree	Disagree	Disagree	Disagree
Emotional	Slightly Agree	Disagree	Disagree	Disagree	-
Friendly	Agree	Agree	Agree	Slightly Agree	Agree
Compliments	Disagree	Slightly Agree	Disagree	Slightly Agree	-
Calm	Slightly Agree	Disagree	Disagree	-	Disagree
Unaware	Slightly Agree	Agree	Agree	Agree	Agree
Annoyed	Agree	Agree	Agree	Slightly Agree	Agree
Aggressive	Agree	Slightly Agree	Agree	Disagree	Slightly Agree
Speed with service	Slightly Agree	Slightly Agree	Disagree	Slightly Agree	Disagree
Customer Focused	Agree	Agree	Slightly Agree	Agree	Agree



Annoyed

The set of behaviours identified through validation from team leaders for advisors are as described below:

Attentive – attentive, capable. Attentiveness - Giving care or attention. Expressing affectionate interest through close observation and gallant gestures. Whether the advisor was attentive to the customer query during the communication. Whether or not the advisor understood properly what was the customer query and looked on ways to solve the problem. Example – "Yes,…..that is correct, the fax line and telephon e line are different at your premises madam"

Friendly – a person whom one likes and trusts. Did the advisor show a friendly approach to the customer with commands like thank you, sorry and so on? Example – "Well sir, it was nice talking to you and good look with your business"

Customer Focussed – the fulfilment or gratification a desire, need or appetite. Was the advisor looking on the satisfaction point of the customer, did he happened to ask the customer, whether he/she was satisfied and the query/problem been resolved. Example – " was your query been dealt with properly and are you completely satisfied with the service which has been offered to you today"

Angry – Feeling or showing anger; incensed or enraged, indicative of a resulting from anger. Anger is defined a strong feeling of displeasure or hostility. During the communication with the customer, did the advisor showed any means of behaviour which depicted that he was angry with the way the customer was taking to her/him. Example – to himself " I don't know why is this customer wasting my time"

Annoyed – to cause slight irritation to (another) by troublesome, often repeated acts. Was the advisor annoyed with the type of service, type of caller, the customer query and so on? Example – " this lady doesn't understands a single thing, doesn't have patience, and then shouting on me, forget it"

Unaware – not aware or cognizant. Did the advisor had enough resources to know about that particular customer, the product, services been offered, or was he just unaware of the situation and the customer query. Example – "well sir, I don't know. I have to find it and call you back sometime later (no specification on the way query is going to be resolved and the time).

Based on the initial set of behaviours for advisors, the author had a selection of behaviours and asked the team leaders to verify the list on their experience within the real environment. From the list, the author was then able to identify a set of key behaviour attributes and divided them into positive and negative behaviours. Once this identification was done, the author then validated with the team members, to check whether the derived list was correct and simplified. Based on the observations from the customer call monitoring process, the author listed the key customer behaviours from the overall understanding of the environment, and then validated it with the advisors in form of table with slightly agree, completely agree or disagree. Further suggestions were also asked by the author to verify that the behaviours captured from the observations were valid in the real environment.

Table 4-13: Identification of Final Set of Customer Behaviours

	Identification of Final Set of Customer Behaviours				
Customer Behaviour	**Advisor 1**	**Advisor 2**	**Advisor 3**	**Advisor 4**	**Advisor 5**
Understanding	Agree	Agree	Slightly Agree	Agree	Agree
Trustworthy	Disagree	Slightly Agree	Disagree	-	Disagree
Angry	Agree	Agree	Slightly Agree	Disagree	Agree
Patience	Slightly Agree	Agree	Disagree	Slightly Agree	-
Distressed	Disagree	Slightly Agree	Agree	-	Disagree
Language Prob.	-	Disagree	Slightly Agree	Disagree	Disagree
Aggressive	Agree	Agree	Disagree	Slightly Agree	Agree
Helpful	Disagree	-	Slightly Agree	Agree	Agree
Unclear	Slightly Agree	Disagree	Agree	-	Slightly Agree
Joyful	Agree	Slightly Agree	Agree	Slightly Agree	Agree
Unhelpful	-	Disagree	Slightly Agree	Disagree	-
Co-operative	Agree	Slightly Agree	Agree	Agree	Slightly Agree
Polite	Slightly Agree	Agree	Disagree	Slightly Agree	Disagree
Annoyed	Agree	Slightly Agree	Agree	Agree	Agree

Understanding | Angry | Joyful | Annoyed | Co-operative | Aggressive

Understanding – The quality or condition of one who understands. Did the customer understand clearly what the problem was, and was the customer able to make the advisor tell his/her problem. Example - " yes Andy, I understand what you trying to say and I am doing just the things which you are suggesting me at the moment"

Joyful – Feeling, causing, or indicating joy (intense and especially ecstatic happiness. Customer reaction of happiness were derived from the voice, the comments the customer made. Example "well its lovely weather isn't it love.

Co-operative – To work or act together toward a common end or purpose was the customer been able to provide all the information which the advisor required to process the customer's query? Example – "Well, I would try my best to see what I can do in response to the payment option".

Angry – Anger is defined a strong feeling of displeasure or hostility. Was the customer angry with the way the services were been offered or the problem been solved. Example – " What do u mean you don't know, I need my phone line working because I am loosing business due to it

Annoyed – because of the waiting time to speak to the available advisor, was the customer annoyed with the service. Example – " what kind of service do you provide, I have to wait 40 minutes on phone to speak with you".

Aggressive – Inclined to behave in an actively hostile fashion, assertive, bold and energetic. Did the customer shown any means of aggressive nature while the advisor communication? Example – "I don't know why have you people stopped my payment"

Similar method of verification and validation carried out by the author to identify the key behaviours used within the categorisation framework. As mentioned earlier with the advisor behaviour categorisation, the author found the customer categorisation to be difficult task, and based on the expert judgement from the advisors, and the author's own understanding from the literature studies, the author was able to identify the key behaviours for customers, which were going to use further within the research. The behaviours for the customers and advisors observed and classified mainly in positive and negative behaviours and discussed above.

4.2.5. Verification of Data

This behaviour were derived by the author's observation during the call monitoring process in which the author was observing the reactions from the customers side as well as advisors side. During a particular call situation, the researcher highlighted the key observations of advisor behaviour changes or the way the customer was dealt with. From the customer's point of view, it was purely hearing the calls during the conversation, and the researchers own understanding and judgement which was derived from the literature studies and earlier knowledge of the contact centre. Once the situation was observed and analysed, it was then checked and validated with the advisor, where the observation was correct or not. It was also checked with the team leaders, and after the validation from both sides was done, it was then structured as shown in the data structuring charts. From the list the author was then able to identify a set of six key behaviour attributes and divided them into positive and negative behaviours. Once this identification was done, the author then validated with the team members, to check whether the derived list was correct and simplified.

4.3. Software Evaluation and Comparative Study

This section presents the software and systems currently used within the contact centre environment. The studies from the AS – IS with questionnaire identified the key software and systems used within the study and are highlighted in appendix F. The system identified with the study are as shown below in table 4.14.

Table 4-14: Summary of Software Evaluation used within CC

	Software Evaluation and Comparative Studies			
Systems Analysed	Type	Functional Specifications	Customer Details	Customer Mapping
CSS	Customer records systems	Offers customer detailed records about current account and services been used. Billing information, add on services and other business services.	Account details, address details, previous services used, time with company, billing transaction details	No
Minerva	Internal stand alone system, drag and drop option available only on few features	It enables offline order processing. Allows the advisor to capture all of customer information about the call.	Customer historical data, types of services used and account details	No
Elexir	Front end system with CSS on the back end. Desktop application system which enables the reporting and detection of fault in services	Line testing for customer fault in the line, identification of the fault, notification of the fault to the service engineer. Keeping customer informed about eh update of the services carried out.	Customer account details, type of products and services used, address details	No

- CSS – Customer record details, backend system and requires a lot of codes to use. It offers customers detailed records about current account details, services been used, billing information and add on services
- Minerva – An internal stand alone system upgraded version from pervious system used within the environment. It enables offline order processing, allows the advisor to capture all of customer information on the calls history and reduced time delay
- Elixir – An front end system within CSS on the back end. It can develop desktop application, enables reporting of the fault and keeps customer informed.

The complete study on the systems used within the CC environment are discussed in more details in appendix F.

4.4. Summary and Key Observations

The chapter has identified the operation and working of the current contact centres within the service industry with the use of semi-structured questionnaires at three contact centres. The primary targets for the centres studied during the data collection through semi-structured questionnaire are as mentioned below:

1. RAP – The time spent other than on voice calls, for making up the project and the order query. The advisor at least takes 4-5 minutes after each call, to attend the next call.
2. Talk Time – The time spent while attending the queries of the customer. Call times sometime take about minimum of 2 minutes and maximum of 10-12 minutes.
3. Call Handling Time – The effective time, the advisor spends on calls with the customers.
4. Sometimes the calls are miss-transferred to the intended lines and they have to be transferred to the appropriate department.

However, as reported in chapter 2, there is still very little application reported for advisor categorisation and modelling. Section 4.1.6 and 4.1.7 describes the analysis of data gathered through case study analysis at CC. Customer and advisor behaviours were derived from the studies carried out at contact centres. The behvaiours were also validated with the knowledge from the literature studies and from expert judgement. This confirms the proposed approach can be used to study a wide variety of the categorisation problem. This chapter has thus achieved the following:

Identified challenges posed by customer and advisor categorisation within contact centres.

Presented the concepts of contact centre environment and explored the behavioural attributes of customer and advisors.

Provides description of the behavioural analysis of customer and advisors; later used for the framework development.

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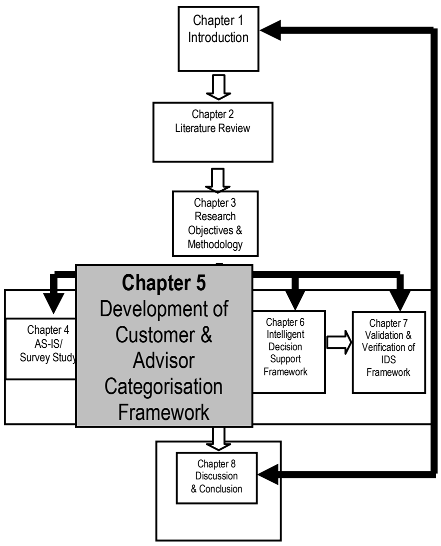
5. Development of Customer and Advisor Categorisation Framework



The features of customer and advisor categorisation problems were introduced in chapter 1. The aim of this chapter is to propose a fuzzy expert system methodology for categorising customer and advisor based on demographic, experience and behavioural attributes derived from the case study analysis. The objectives of this chapter (Customer and Advisor Categorisation Framework) are:

- A case study based analysis for identifying the key attributes to be used in the development of categorisation framework with the help of semi-structured questionnaires for team leaders and advisors. A method to monitor the call process of each customer was also followed although the data for individual customer was identified through a collective effort with expert knowledge and call monitoring process (Section 5.1)
- Clustering analysis is used to identify groups of customer and advisor from the data collected. Results from the clustering analysis determined set of categories for customer and advisors (Section 5.2)
- The categories identified from previous section (5.2) are now used as a basis to develop a fuzzy expert system capable of assigning any customer and advisor against the pre-defined categories (Section 5.3 and 5.4)

The chapter is organised as follows. Section 5.1 describes the case study analysis approach for collection of the data and analysis carried out to identify the variables & attributes which are further be used within the methodology. Section 5.2 details the clustering analysis methodology to identify groups of customers and advisors. Section 5.3 describes the use of categories from clustering analysis as basis to develop fuzzy expert system which is capable of assigning any customer and advisor against the pre defined categories. Section 5.4 summarises the experimental tests conducted for verification of the results derived from the fuzzy expert systems methodology. Finally, section 5.5 concludes the chapter with a summary of the main points.

5.1. Case Study Analysis for Data Collection & Data Analysis

This part of the research identifies the steps followed for the data collection and the ways, which the data validated by expert judgement. The flowchart for the data collection used within the categorisation framework development is as described in figure 5.1. A semi structured type questionnaire was designed for team leaders and advisors at the centres. Data collected from the questionnaires was further analysed and used within the development of the frameworks.

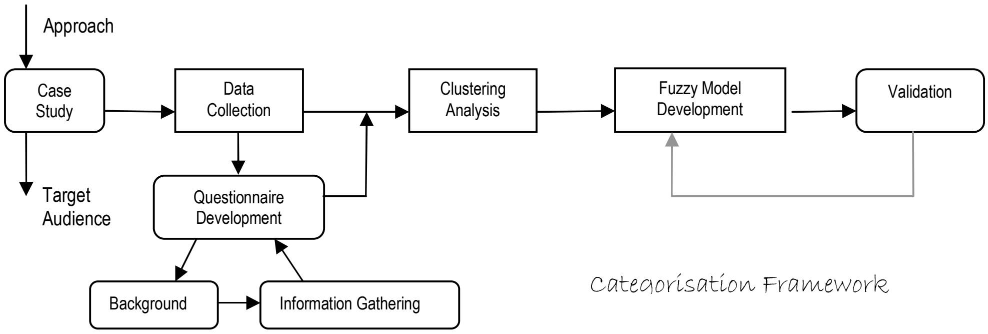


Figure 5-1: Categorisation Framework Flowchart

5.1.1. Target Audience and Questionnaire Development

The data collected from the case studies was conducted through questionnaire style method. Two sets of questionnaires were designed which were for advisors and team managers as shown in table 5.1 and 5.2 respectively. The style of questionnaire was designed after looking at the current understanding of the contact centre operations through the AS-IS model which was designed during the nine month review. There were five different case studies carried out for the data collection. The questionnaires grouped into (1) team leaders, (2) advisors and (3) observations/call monitoring for customer information (Appendix E).

The call monitoring process conducted by the author gathered information regarding the customer and the nature of advisor dealing with the customer query. Once the data was gathered, it was verified with the advisors and the team leaders for their expert judgement on the information received and interpreted by the author. Due to the nature and type of call, no personal information or call information recorded aiming in mind the security issues from the contact centres.

Table 5-1: List of Questions from Team Leaders Questionnaire

Section 1:Manager/Team Leader Details	
1.	What is your job role within your centre?
2.	Personal Details (Demographic, experience and educational background)
Section 2: Advisor Information	
3.	How many advisors do you have within your centre?
4.	What are the demographic details about these advisors?
Section 3: Experience and Knowledge Levels	
5.	What is the experience background of the advisors within the centre?
6.	Do you look on any IT specific skills within the advisors? (IT efficiency, speed with service, other)
Section 4: Advisor Categorisation	
7.	What is the educational background of the advisors at the centre?
8.	What skills are most important for your advisor to possess?
9.	Do you group or categorise your advisors based on their work, demographic and experience variables?
10.	Do you record any advisor behaviour during the call conversation with the customer at the centre?
Section 5: Customer Information	
11.	What types of customers are calling the contact centres? (Business, residential and others)
12.	Do you categorise your customer according to the type of services offered by the centre?
13.	What data do you record for each individual customer?
14.	Do you categorise your customer based on their financial details, type of products/services currently taken by the customer and others?
15.	Do you record any behavioural attributes of customer anytime during conversation with the advisors?
Section 6: Information Requirement	
16.	What type of information displayed on the screen of the advisor to serve the customer query?
17.	Do you record any customer behavioural changes on the customer accounts?
18.	Is there any record of historical data of the customer?
19.	Does the information presented on the screen of the advisor an customised information screen?
20.	Does the advisor have to look on other systems (information screens) to find the relevant information?

Table 5-2: List of Questions from Advisor Questionnaire

Section 1: Advisor Profile	
1.	Advisor details (gender, age, experience)
2.	What is your job profile and level of work carried out at this centre?
Section 2:Experience and Knowledge Levels	
3.	What experience background do you have for working at the centre?
4.	Does the environment require any specific knowledge/skills appropriate for working? (IT skills, others)
Section 3: Customer Categorisation	
5.	What are the different types of customer calling at your centre?
6.	What type of customer data is available to you to serve the customer query?
7.	Are the customer call conversations with you recorded by the centre for monitoring purposes?
8.	Do you notify any change of customer behaviours within the customer data?
9.	Do you look on any historical data available to you for customer during the call conversation?
Section 4: Information Screens	
10.	Is there any sort of categorisation used for your customers?
11.	Are these categorising of customers divided based on experience, behaviour/trend of customer?
12.	What is the generic information screen presented to you at any time to serve the customer query?
13.	Is this information screen a “customised information” screen?
14.	What type of system would be more useful in your current environment?
15.	Can you provide me a with a list of information displayed on your screen?

5.1.2. Conducting the Interviews

The researchers opted for a semi-structured interview approach. This enabled the researcher to define the depth of answers provided for different questions and the amount of time and attention given to different topics. The analysis of the interviews was performed separately. The primary function of the questionnaire was to support the principle method of knowledge elicitation, which was through personal interviews with the industrial specialists. The details of the interviews for data collection is shown in table 5.3.

Table 5-3: Details of Interview for Data Collection

	Data Collection – Interview Details		
	CC – Role	Age Group	Experience
Contact Centre (A) (Fault)	Team Leader (TL) (3) Manager (M) (1) Advisor (A) (25) Customer Calls (C) (20)	25 – 50 yrs 48 yrs 18-25 (14), 25-40 (9), 40+ (2)	2 TL – 4/6 yrs, 1 TL – 8-10 yrs M = 9 yrs <1 yrs (2), 1-5 (11), 5-10 (8) 10+ (4)
Contact Centre (B) (Sales)	Team Leader (4) Manager (2) Advisor (14) Customer Calls (14)	24 – 48 yrs 38 – 60 yrs 18-25 (8), 25-40 (4), 40+ (2)	2 TL- 0-4 yrs, 1 TL -4-8, 1 TL – 10 M = 9 yrs and 13 yrs <1 yrs (3), 1-5 (7), 5-10 (2), 10+ (2)
Contact Centre (C) (Telecoms Business)	Team Leader (3) Manager (2) Advisor (22) Customer Calls (13)	20 – 55 yrs 35 – 55 yrs 18-25 (7), 25-40 (8), 40+ (6)	2 TL – 5-7 yrs, 1 TL – 8-12 yrs M = 8 yrs and 12 yrs <1 yrs (5), 1-5 (5), 5-10 (8), 10+ (4)
Contact Centre (D) (Helpdesks)	Team Leader (2) Manager (1) Advisor (14) Customer Calls (9)	20 – 45 yrs 52 yrs 18-25 (8), 25-40 (4), 40+ (2)	1 TL – 4-6 yrs, 1 TL – 8-10 yrs M = 10 yrs <1 yrs (4), 1-5 (7), 5-10 (2), 10+ (1)
Contact Centre (E) (Council)	Team Leader (2) Manager (1) Advisor (9) Customer Calls (13)	26 – 42 yrs 48 yrs 18-25 (5), 25-40 (2), 40+ (2)	1 TL – 3-5 yrs, 1 TL – 7-9 yrs M = 12 yrs <1 yrs (1), 1-5 (2), 5-10 (3), 10+ (3)
TL – Team Leader, Manager – M , Advisor - A			

The interviews were conducted on site, at each company location, by the author; they were taped, where possible, to ensure maximum accuracy; and to utilise the information to the best detail. The interviews conducted in order to obtain the tacit knowledge of the experts; as well as to procure the processes employed customer interaction within the company, processes that would be documented both formally and informally.

5.1.3. Results from the Questionnaire

The results from the information collected through questionnaire are as described below in table 5.4 for managers/team leaders and table 5.5 for advisors.

Table 5-4: Categorisation Questionnaire Results - Managers

	Categorisation Questionnaire Summary for Managers/Team Leaders			
Questions	Respondent A (Fault)	Respondent B (Sales)	Respondent C (Telecoms Busines)	Respondent D (Helpdesk)
3. How many advisors do you have within your centre	80 customer advisors in 4 groups. There is another 40 advisors in 3 groups for the night (24/7) centre services	120 customer advisors in different groups and teams.	90 customer advisors	60 customer service advisors in 8 different groups/teams.
4. What are the demographic details of the advisors?	Age – 18 – 40	Age – 18-50 group. Mostly female advisors	Age – 22-55. Mostly senior level of advisors from experience	Age 17-45
5. What is the expereience background of the advisors	Some sort of prior experience working in contact centres	Telephone sales experience within other similar environment	Senior level experience of advisors in business environment	Some experienced advisors. Mostly new advisors working part time.
12. Do you categorise you customers by the type of services offered by the centre (call rounting)?	Yes. The calls are diverted according to the type of service required	No. Inbound calls are from customers requiring product/service information	Yes. Mostly business customers are grouped accoding to the type of service installed at their premises. Some transaction details are also used to categorise	Sometimes the calls are diverted to a specific query of the customer.
13. What data you record for the customer?	Account details, address details, services/products used	Demographic data, sales enquiry data, financial details	Demographic data, services used, address details	Demographic data, products used, address details
15. Do you record any behavioural attributes of customers?	No	No	No	No
16. What type of information is displayed on the screen of the advisors?	Service related information, account details, allocation of service engineer	Product information, company offers, past record of purchases	Business services, product information, account details, customer financial details	Product information, customer details, record of past communication
18. Is there any record of historical data?	Yes. All the faults reported by the customer are recorded on the account data	Yes. All the previous enquiries about the product by the customer are recorded	Yes. All the previous three years details are recorded on the customer accounts	No. Customer calls are for enquiries on new and old products
20. Does the advisor have to look into any other systems?	Yes. For allocation of service engineer the advisor uses other stand alone system	No. Only if the customer requests for more product information to be sent to them.	Yes. There are three back end systems to the main system that the advisor uses.	Yes. The advisor uses the product information system with the main helpdesk system.

Table 5-5: Categorisation Questionnaire Results - Advisors

	Categorisation Questionnaire Summary for Advisors			
Questions	Respondent A (Faults)	Respondent B (Sales)	Respondent C (Telecoms Business)	Respondent D (Helpdesk)
1. Advisor Details	Mostly in the age group of 18 – 40	Age group of 18 – 50. High proption of female advisors versus male advisors	Age group of 22 – 55. Some proportion of senior level advisor with vast experience background	Age group of 17 – 45. Part time and shift hours working advisor in majority
3. What background experience do you have for working at the centre?	Some level of previous contact centre experience in other company	Mostly tele-sales experience, but not at contact centre levels	Mostly experienced within the same company in another department and centres across region	Mostly fresh college leavers joining the centre with very little amount of contact centre experience
4. Does the environment require any specific skills?	Telephone & IT Skills are much required. Some level of company knowledge is also useful	Sales and negotiation skills required. Customer contact and commnication skills	Speech and communication skills at business level customers. IT skills and speed in service is very important	IT and Telephone skills
6. What sort of customer data is available to you to serve their query?	Customer background, account details, address details, payment details, services details	Some. Product information, sales teachniques, company offers, customer records	Business customer details, account details, payment details, address details, services/products details, new product details	Gerneral product/service details, customer details, payment details, help pages
7. Are the call conversations recorded by the centre for monitoring purposes?	Yes. Some of the calls are randomly monitored for quality and training purposes	Yes. All calls are recorded for monitoring purposes	Some calls are recorded	Only some proportion of calls are recorded
9. Do you look on any historical data about the customer?	Yes. All the details of previous faults reported by the customer are available	Only if the customer has registered their details with the company.	Yes. Past customer data about the products and services are used to offer new services	Yes
10. Is there any sort of categorisation used for the customer?	No. All customer calls are diverted on first served basis	No.	Different types of customer are selected on the basis of their services selected. Gold, Diamond and so on	No
12. What is the generic information screen presnted to you at any time?	All the details about the customer and the products used. Additional details of the service can be looked on different system	Gerneal sales and product details information.	Customer details and the type of services offered. Based on the type of query, the information can be looked on other different system platforms	Information related to the products, faults and problems, other forms required to complete customer query
14. What type of system would be more useful in your current environment?	All the information related to the customer query in one screen would be more useful, rather than going back to different information screens	More product information and information which can highlight other similar products bought by other customers	More highlight on the type and value of the customer which enables the advisor to deal with the customer in better ways	Some level of help and customer background information where the system can control everything from one rather than 3-4 other systems.

5.1.4. Key Observations

The researcher first had a thorough conversation with the team leaders understanding the current environment, the work done within the centre, the strength of advisors within the centre, and portfolio of advisors that were working at the centre. Based on the information provided from the team leader, the researcher then identified the types of advisors that used for monitoring and observation. Once the identification carried out, the researcher then asked the team leaders, to arrange a sitting with the advisors and hearing the call conversation of the customer. The key observations that the researcher noticed for the data collection were (1) Advisors Characteristics and (2) Customer (voice) Observations respectively.

Advisor Criteria Selection

The set of information used to derive the criteria for the advisors were as follows:

[1] Demographic Value – Age and Sex
[2] Knowledge Level – details about the advisor knowledge and education
[3] Experience Level – type of experience of the advisor
[4] IT Skills – level of the IT skills acquired by the advisor
[5] Characteristics – behaviour with the customer
[6] Speed – speed of the advisor on the computer and telephone
[7] Relationship – type of relationship with the customer
[8] Positive & Negative – type of behaviour the advisor is having during the conversation
[9] Understanding – mutual understanding levels of the customer situation
[10] Competence – advisors competence level with the service
[11] Performance – advisor performance within the work

Table 5-6: Set of Criteria for CSA

	CSA Criteria's and Attributes	
Situation/Condition	**Criteria**	**Attributes**
▪ CSA Demographic Value	Age & Sex	18-30, 30-50, Above 50 and Male & Female
▪ CSA Knowledge of Service	Knowledge level	Knowledge – School, College, Graduate
▪ Level of Experience	Service Experience	Novice (<1yr), Experienced (>1 yr)
▪ IT Experience	IT Skills	Little, moderate, extensive
▪ Characteristics Behaviour with the customer	Characteristics	Competence, attitude, communication
▪ Speed with the service	Speed	Slow, medium, fast
▪ Relationship with the customer	Relationship	Helpful, very helpful
▪ CSA positive and negative emotions	Positive & Negative	Positive – Attentive, Concentrated, Joyful, Happy Negative – Sad, Discouraged, Angry, Mad
▪ Mutual understanding of customer's situation	Understanding	Open, close
▪ CSA's Competence	Competence	Capable, efficient, organised, thorough
▪ Performance	Performance	Understanding, attentive, meeting standards

The data collected was observational understanding of the researcher and verifying it with the advisors while at the centre. The variables used for the questionnaire were from the literature study of the researcher, and verified with expert judgement (supervisor, industry representative, and team leaders at the contact centre). Based on the information provided through the experts, it was obvious that advisors would share the following attributes, and thus the data collected in that manner only.

Customer Criteria Selection

The data collected for the customers provided by the advisors through the on screen information about the particular customer giving the details such as:

[1] Demographic – age and gender of the customer
[2] Customer Type – any given type of customer as prospectus or active
[3] Education level – the education level of the customer
[4] Income – the customer financial details
[5] Relationship – customers time with the company (duration)
[6] Lifecycle – details about the customer period of purchases
[7] Purchasing Power – details about the customers purchasing power in family
[8] Payment Problems – any previous/past payment difficulties of customer
[9] Complaint Frequency – details of customer complaints frequency
[10] Positive & Negative – customers behaviour during call conversation

Table 5-7: Set of Criteria for Customer

	Customer Criteria's and Attributes	
Situation/Condition	**Criteria**	**Attributes**
▪ Customer Demographic Values	Age & Sex	18-30, 30-50, Above 50 and Male/Female
▪ Types of Customers	Customer Type	Prospectus, Responders, Active, Former
▪ Customer's Education	Education Level	School, College, Graduate, Professional
▪ Financial Levels	Income	Poor, Average, Good
▪ Customer Time with the company	Relationship	Old, Less than 2 yrs, More than 2 yrs, New
▪ How often does the customer buy	Lifecycle	Frequently, Intermediate, Rarely
▪ Customer's purchasing power in family	Purchasing Power	Low, Medium, High
▪ Customer's previous payment difficulties	Payment Problems	Regular, Irregular
▪ Customer's method & frequency of complaints	Complaint Frequency	Rarely, Regular, Often
▪ Customer's Emotions	Positive & Negative	Attentive, Concentrated, Joyful, Happy Sad, Discouraged, Angry, Mad

Through the call monitoring process (hearing to each customer call), the researcher identified the type of customer and in which group of categories the customer would fall in. Through extensive literature studies and understanding of the current operations of contact centre through AS-IS model, the researcher had derived the questionnaire to be used for the data collection and identified few categories to be used for categorising the customers and advisors based on few attributes.

5.1.5. Final Set of Attributes

The final set of attributes for advisor and customer derived from the data collected from the questionnaires at the contact centres is shown in table 5.8. Based on the values, which were available to the researcher, the final set was limited to six numbers of attributes for customer and advisor respectively. Variables such as gender, both for customer and advisor were not feasible for using within the clustering analysis. For advisor selection, criteria's such as understanding, competence and relationships all fell under the behaviour part of the selection. For customer selection, criteria's such as lifecycle of the customer for buying the products and purchasing power details were not available within the company and hence were not used within the research.

Table 5-8: Final Set of Attributes for Advisors and Customer

	Final Set of Attributes for Advisors and Customer
Advisor Variables	**Advisor Attributes**
Age	18-25, 25-40, 40-50, 50+
Education	School, College, Graduate, Profess
Experience	1-5yrs, 5-10yrs, 10-15yrs, 15+yrs
IT Speed	Low, medium, high
Previous Experience	Low, moderate, extensive
Behaviour	None, Positive, Negative, Both
Positive Behaviour	None, Attentive, Friendly, Customer Focussed
Negative Behaviour	None, Angry, Annoyed, Unaware
Customer Variables	**Customer Attributes**
Age	18-25, 2=25-40, 3=40-50
Education	School, College, Graduate, Profess
Financial Status	Poor, Average, Good
Time with Company	>1 yrs, 1-5yrs, 5-10yrs, 10+yrs
Business Value	Low, Medium, High
Behaviour	None, Positive, Negative, Both
Positive Behaviour	None, Understanding, Joyful, Co-operative
Negative Behaviour	None, Angry, Annoyed, Aggressive

5.2. Clustering Analysis

An overview of clustering analysis and the techinques in chapter 2 derived that clustering techniques are the most appropriate when dealing with qualitative data focussed primarily on customer centric environments. The decision to use clustering techniques for the research is also based on the observations that contact centre companies collect high volumes of data which are of different aspects of interactions between the company and its customers. The clustering analysis was done with the help of Two – Step cluster analysis in SPSS. The SPSS two step cluster method is a scalable cluster analysis algorithm designed to handle very large data sets. It can handle both continuous and categorical variables and attributes. It require only one data pass. It has two steps:

1. Pre cluster the cases (or records) into many small sub clusters
2. Cluster the sub clusters resulting from pre cluster step into the desired number of clusters

5.2.1. Two Step Cluster Approach

Two-step cluster analysis does what all clustering procedures do – group's data so that records within a group are similar. However, it goes further than other clustering techniques, ensuring accurately work with mixed data and very large datasets. Nearly all clustering methods need a distance measure. Distance measures may lead to different cluster results and accept continuous variables only or categorical variables only. Various distance measures exists based on the weighted sum of continuous variable distances and categorical variable distance. Traditional clustering methods are effective and accurate on small datasets, but usually do not scale up to very large datasets. With two – step cluster analysis, you group observations into clusters based on a nearness criterion. In this process, individual cases combined to form clusters whose centers are far apart. Two-step clusters requires only one data pass in the procedure – it passes the data once to find cluster centres (pre cluster stage) and to assign cluster memberships. It clusters observations by building a data structure called a modified Cluster Feature (CF) tree, which contains the cluster centres. A two-step cluster grows the CF tree during the first stage of clustering and adds values to its leaves it they are close to the cluster centre or a particular leaf. With two-step cluster analysis, the user has the flexibility to specify the cluster numbers, specify the maximum number of clusters or let the technique automatically choose the number of clusters. Two-step cluster analysis uses one of two available algorithms, Bayesian Information Criterion (BIC) or Akaike Information Criterion (AIC) to determine the number of clusters.

5.2.2. Clustering Analysis Steps

Based on the data structuring from the case studies, development of data set with 60 samples of customer records and 84 samples (cases) of advisors (CSA's) within the SPSS database carried out. From the samples, clustering analysis identified the groups of categories from the clustering results. The steps followed for the clustering of the customer and advisor data was based on two-step cluster analysis within SPSS are:

1. Define the variables,
2. Enter the data,
3. Selection of Clustering method and
4. Analysis

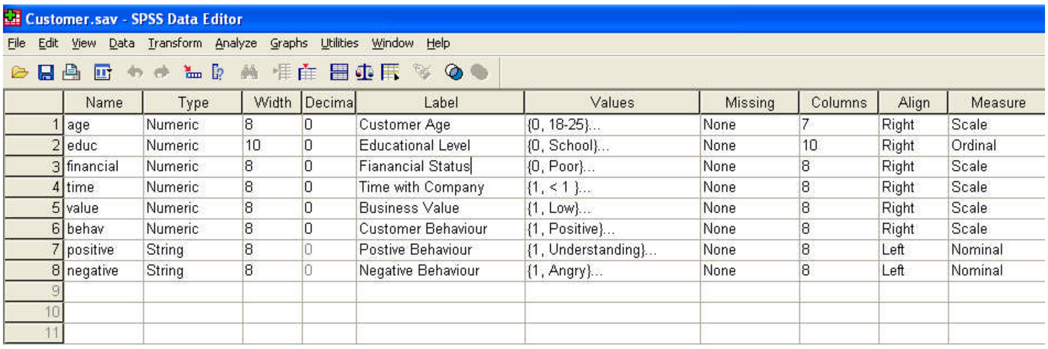
Step 1: To define the variables and values used with the SPSS tool for the customer and advisor data (Variable View)

With the structured data obtained from the questionnaire, the variables for customer and advisor were derived and the values were set. The variables and its values for the customer and advisor are as described in table 5.8

Table 5-9: Advisor and Customer Variables

	Advisor and Customer Variables for Clustering Analysis
Advisor Variables	**Values**
Age	1=18-25, 2=25-40, 3=40-50, 4=50+
Education	0=School, 1=College, 2=Graduate, 3=Profess
Experience	0=1-5yrs, 1=5-10yrs, 2=10-15yrs, 3=15+yrs
IT Speed	0=Low, 1=medium, 2=high
Previous Experience	0 =Low, 1=moderate, 3=extensive
Behaviour	0=Both, 1=Positive, 2=Negative
Positive Behaviour	0=None, 1=Attentive, 2=Friendly, 3=Customer Focus
Negative Behaviour	0=None, 1=Angry, 2=Annoyed, 3=Unaware
Customer Variables	**Values**
Age	1=18-25, 2=25-40, 3=40-50
Education	0=School, 1=College, 2=Graduate, 3=Profess
Financial Status	0=Poor, 1=Average, 2=Good
Time with Company	0=>1 yrs, 1=1-5yrs, 2=5-10yrs, 3=10+yrs
Business Value	0=Low, 1=Medium, 2=High
Behaviour	0=Both, 1=Positive, 2=Negative
Positive Behaviour	0=None, 1=Understanding, 2=Joyful, 3=Co-operative
Negative Behaviour	0=None, 1=Angry, 2=Annoyed, 3=Aggressive

Once the variables and values were derived for customer and advisors, the data was then formalised based on the information collected from the questionnaire.


Customer.sav - SPSS Data Editor

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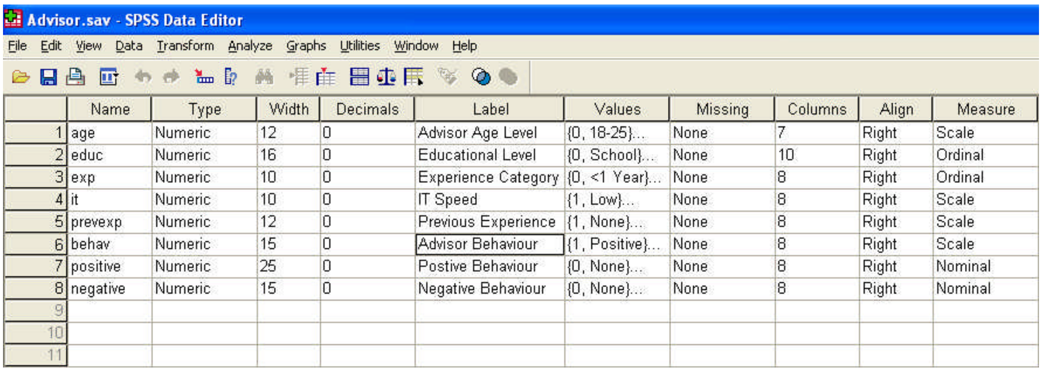
	Name	Type	Width	Decima	Label	Values	Missing	Columns	Align	Measure
1	age	Numeric	8	0	Customer Age	{0, 18-25}...	None	7	Right	Scale
2	educ	Numeric	10	0	Educational Level	{0, School}...	None	10	Right	Ordinal
3	financial	Numeric	8	0	Fianancial Status	{0, Poor}...	None	8	Right	Scale
4	time	Numeric	8	0	Time with Company	{1, < 1 }...	None	8	Right	Scale
5	value	Numeric	8	0	Business Value	{1, Low}...	None	8	Right	Scale
6	behav	Numeric	8	0	Customer Behaviour	{1, Positive}...	None	8	Right	Scale
7	positive	String	8	0	Postive Behaviour	{1, Understanding}...	None	8	Left	Nominal
8	negative	String	8	0	Negative Behaviour	{1, Angry}...	None	8	Left	Nominal
9										
10										
11										

Figure 5-2: Variable and Data View within SPSS for Customer



Advisor.sav - SPSS Data Editor

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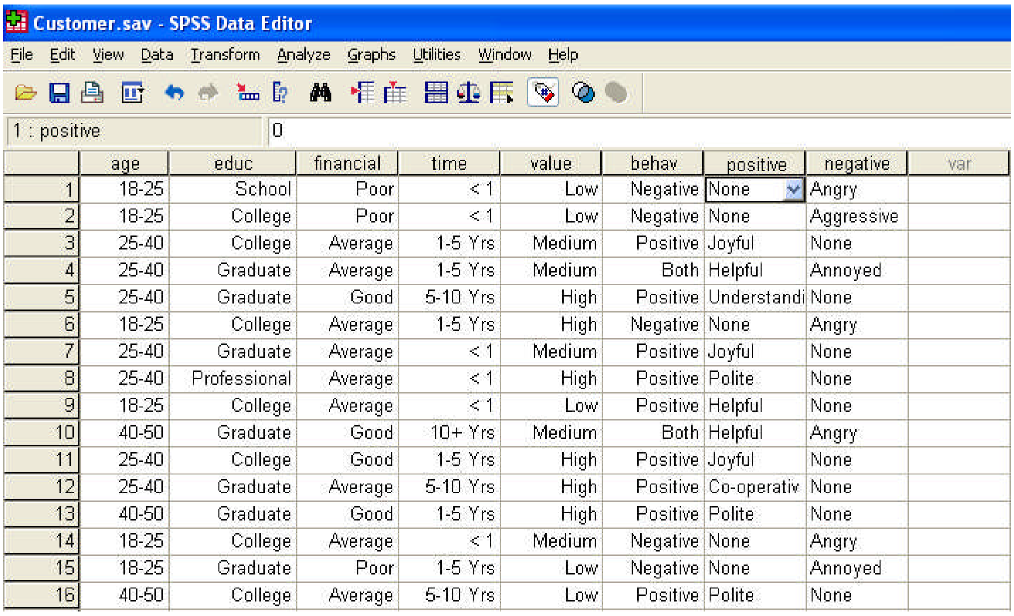
	Name	Type	Width	Decimals	Label	Values	Missing	Columns	Align	Measure
1	age	Numeric	12	0	Advisor Age Level	{0, 18-25}...	None	7	Right	Scale
2	educ	Numeric	16	0	Educational Level	{0, School}...	None	10	Right	Ordinal
3	exp	Numeric	10	0	Experience Category	{0, <1 Year}...	None	8	Right	Ordinal
4	it	Numeric	10	0	IT Speed	{1, Low}...	None	8	Right	Scale
5	prevexp	Numeric	12	0	Previous Experience	{1, None}...	None	8	Right	Scale
6	behav	Numeric	15	0	Advisor Behaviour	{1, Positive}...	None	8	Right	Scale
7	positive	Numeric	25	0	Postive Behaviour	{0, None}...	None	8	Right	Nominal
8	negative	Numeric	15	0	Negative Behaviour	{0, None}...	None	8	Right	Nominal
9										
10										
11										

Figure 5-3: Variable and Data View within SPSS for Advisor

Step 2: Enter the data for customers and advisors within the SPSS Tool (Data View)

Once the data variables and values are derived, the data are entered into the SPSS data analysis tool as shown below in figure 5.3 and 5.4 for customer and advisor respectively.



Customer.sav - SPSS Data Editor

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1 : positive 0

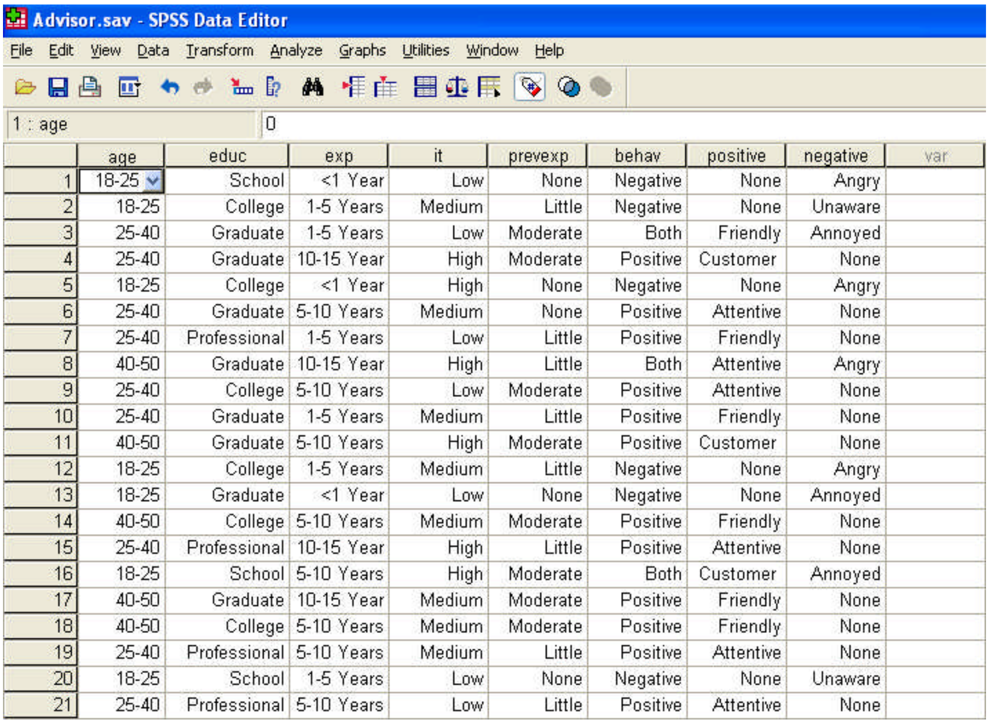
	age	educ	financial	time	value	behav	positive	negative	var
1	18-25	School	Poor	< 1	Low	Negative	None	Angry	
2	18-25	College	Poor	< 1	Low	Negative	None	Aggressive	
3	25-40	College	Average	1-5 Yrs	Medium	Positive	Joyful	None	
4	25-40	Graduate	Average	1-5 Yrs	Medium	Both	Helpful	Annoyed	
5	25-40	Graduate	Good	5-10 Yrs	High	Positive	Understandi	None	
6	18-25	College	Average	1-5 Yrs	High	Negative	None	Angry	
7	25-40	Graduate	Average	< 1	Medium	Positive	Joyful	None	
8	25-40	Professional	Average	< 1	High	Positive	Polite	None	
9	18-25	College	Average	< 1	Low	Positive	Helpful	None	
10	40-50	Graduate	Good	10+ Yrs	Medium	Both	Helpful	Angry	
11	25-40	College	Good	1-5 Yrs	High	Positive	Joyful	None	
12	25-40	Graduate	Average	5-10 Yrs	High	Positive	Co-operativ	None	
13	40-50	Graduate	Good	1-5 Yrs	High	Positive	Polite	None	
14	18-25	College	Average	< 1	Medium	Negative	None	Angry	
15	18-25	Graduate	Poor	1-5 Yrs	Low	Negative	None	Annoyed	
16	40-50	College	Average	5-10 Yrs	Low	Positive	Polite	None	

Figure 5-4: Customer Data View in Clustering

Based on the structured chart from the questionnaire, the author analysed 60 samples of customer data and 84 samples of advisor data for the database. Once this data was entered, the clustering analysis can be done based on these samples for customer and advisors.

Step 3: Selection of Clustering Analysis Method –

There are four different types of clustering methods within SPSS that could be applied within the current research environment. They are: (a) Two Step clustering, (b) K-Means clustering, (c) Hierarchical clustering and (d) Discriminant clustering method.



	age	educ	exp	it	prevexp	behav	positive	negative	var
1	18-25	School	<1 Year	Low	None	Negative	None	Angry	
2	18-25	College	1-5 Years	Medium	Little	Negative	None	Unaware	
3	25-40	Graduate	1-5 Years	Low	Moderate	Both	Friendly	Annoyed	
4	25-40	Graduate	10-15 Year	High	Moderate	Positive	Customer	None	
5	18-25	College	<1 Year	High	None	Negative	None	Angry	
6	25-40	Graduate	5-10 Years	Medium	None	Positive	Attentive	None	
7	25-40	Professional	1-5 Years	Low	Little	Positive	Friendly	None	
8	40-50	Graduate	10-15 Year	High	Little	Both	Attentive	Angry	
9	25-40	College	5-10 Years	Low	Moderate	Positive	Attentive	None	
10	25-40	Graduate	1-5 Years	Medium	Little	Positive	Friendly	None	
11	40-50	Graduate	5-10 Years	High	Moderate	Positive	Customer	None	
12	18-25	College	1-5 Years	Medium	Little	Negative	None	Angry	
13	18-25	Graduate	<1 Year	Low	None	Negative	None	Annoyed	
14	40-50	College	5-10 Years	Medium	Moderate	Positive	Friendly	None	
15	25-40	Professional	10-15 Year	High	Little	Positive	Attentive	None	
16	18-25	School	5-10 Years	High	Moderate	Both	Customer	Annoyed	
17	40-50	Graduate	10-15 Year	Medium	Moderate	Positive	Friendly	None	
18	40-50	College	5-10 Years	Medium	Moderate	Positive	Friendly	None	
19	25-40	Professional	5-10 Years	Medium	Little	Positive	Attentive	None	
20	18-25	School	1-5 Years	Low	None	Negative	None	Unaware	
21	25-40	Professional	5-10 Years	Low	Little	Positive	Attentive	None	

Figure 5-5: Advisor Data Input within Clustering Analysis

From previous studies and the advantages highlighted within the literature it was observed that two step clustering method is more appropriate within the research as it can handle very large datasets, your can define the number of clusters which are going to be use, and it can handle both categorical and continuous variables.

Step 4 - Clustering Analysis Results

Because of the size of the customer and advisor data, the author realised that it was necessary to identify the number of clusters to be used for the clustering analysis. With two-step clustering method, the author first derived the number of clusters using the automatic clustering selection, which gave only two sets of clusters for customers and three sets of clusters for the advisors. Based on these results, the author had to identify what would be the right number of cluster to be used for the analysis. For this reason, the author then did the clustering analysis ranging from automatic to a maximum of ten clusters within the clustering tool. Examples of automatic, four clusters, five clusters, six clusters, and tenth clusters are shown in the appendix H.

<u>Automated Clustering</u>

For automated clustering within two-step clustering analysis, it generated two sets of clusters for advisors, and customers. For advisors it was noticed that there was equal distribution of people for age cluster 1 had high number of proportion of 18-25, and cluster 2 were having high number of people between 40-50 and 50+. From education point, cluster 1 had a mixture of people having school and college level education, and cluster 2 having variety levels of education, from 36.4% having school, 46.2% having graduate and 84.6 having professional education. From behaviour point, cluster 1 was having very high percentage of negative behaviour, cluster 2 having high value of positive behaviour

For customers the automated clustering created only two sets of clusters, with all the variables having equal number of people. For example, cluster 1 was having high percentage of people 18-25 age group and with school education level. From the financial background cluster 1 had high number of people with poor level, and cluster 2 having mixture of average (66.7%) and good (69.2%). From behaviour point it was divided equally with cluster 1 and cluster 2, with cluster 1 having negative behaviour and cluster 2 having positive behaviour. Based on the results it was noted that with automated selection of cluster numbers within two-step, it created three clusters for advisors and two clusters for customers. The distribution level of each cluster was identical, and therefore the author decided to do the selection of clusters manually, ranging from three clusters to a maximum of 10 clusters.

Selection of Cluster Number 3 – 5

With the cluster number selected to three or four, there was a good difference in the results from the previous automated clustering analysis. From the clustering results for the advisors, it noticed that rest of values for other variables totally opposite with age from 18-25 and 50+, education level from school to professional, experience level from 1-5 yrs to 15+ yrs, IT experience level from low to high, and behaviours from negative behaviour in cluster 1 to positive behaviour in cluster 2. Cluster 3 and cluster 4 having percentage of variables ranging from high to low such as, age group from 25-40 to 18-25, education level from graduate to college level, experience from 10-15 yrs to 1-5 yrs and behavioural level from both behaviours to positive behaviours.

Selection of Cluster Number 6

With the cluster number selected to six, the distribution of the percentage of cases within each cluster was satisfied. The distribution for each cluster for advisor clustering were cluster 1 having 10 cases, cluster 2 having 21 cases, cluster 3 having 20 cases, cluster 4 having 15 and cluster 5 having 18 cases respectively. The result for each cluster for advisor is as follows. Cluster 1 was having high number with age group in between 18-25 and school level of education, 1-5 yrs of experience and low IT skills, were having negative behaviour. Cluster 2 on the other side was having 50+ age group and professional level of education, 5-10 yrs of experience and medium IT skills were having high percentage of positive behaviour and no negative behaviour. Cluster 3 and cluster 4 compromised with varying percentage for variables. This category was having a mixture of both positive and negative behaviours compared to other clusters. Cluster 5 was having 40-50 age group, professional education, 10-15 yrs of experience and high IT skills were having high positive behaviour and no negative behaviour. Therefore, for this cluster analysis, 50+ age and 40-50 age with a similarity of professional education, but experience level of 5-10 yrs and 10-15 yrs were having only positive behaviour and no negative behaviour compared to other clusters.

For customer clustering analysis, compared to other selection of number of clusters, it noticed that with six numbers of clusters, the cases for each cluster were considered properly and significantly. The distribution were cluster 1 having 15 cases, cluster 2 for 9, cluster 3, 4 and 5 having 12 numbers of cases for each cluster respectively. Compared with other clusters, the 5 cluster number method was more suitable has it created the categories, which were more meaningful, and the categories derived from the clusters were having no repetitive rules while compared to other clustering analysis. The results for each cluster for customer are as follows:

Cluster 1 were having 18-15 age group, school level of education and poor financial history, less time of 1-5 yrs with company, were having high percentage of negative behaviour. Cluster 2 25-40 group of customers, graduate and good financial background, 5-10 yrs of experience, but having both positive and negative behaviour. Again cluster 3 and 4 was a mixture of customers, with cluster 3 having 18-25 and college education, with poor financial history and less time of >1 yrs with company but still having only positive behaviour and no negative behaviour. Cluster 4 was of age group of 40-50 and professional education, average financial and 10+ yrs with the company were having high business value and only positive behaviour. Cluster 5 was of customers, with professional education, good financial history, 5-10 yrs with company and having both behaviours.

Selection of cluster number greater than 6

It was noticed that significant results were shown when the number of clusters were set to six. Once the cluster number was increased, there was a rapid change in the distribution of cases, and the number of rules that were derived from the clusters were repeated which made some clusters less significant and important than others. With number of cluster selected to six, for both advisor and customer, there were an equal proportion of people with selected variables from the list. The distribution of cases for each cluster was lower compared to other cluster analysis. For example, for customer clustering, cluster 2, 5 and 6 were having only nine, eight and four cases each with their clusters. With cluster number selected to seven, the distribution for number of cased started to reduce, with somewhat same similarity of results compared to five cluster selection, only with now more number of clusters which would have repetitive rules from each clusters. It was also noticed advisors were only having age group of either 18-15 or 40-50+, with either low (school) or high (professional) level of education. With other set, the classification was different, as they were considered for each age group ranging from 18-15 to 50+, and college level of education to professional level. Experience level was also either 5-10 yrs or 15+ yrs.

As the total number of cluster selection was increased, more and more difference was observed. With cluster number selected to eight, high portion of advisors were with 25-40 age and 10-15 yrs of experience were having both positive and negative behaviour and this was repeated within cluster 3 and cluster 6 (Appendix H). For customers, again the distribution was too low for each cluster only having few numbers of cases within them. This made them less significant compared to other clusters within other selection group. With cluster selection finally set to nine and ten number of clusters, the author was confident that the total number of cluster selected for clustering analysis should be no more than a maximum of five numbers of clusters. With cluster selection 9 for advisors, distribution of the lowest cases that was only five cases for a cluster, and the rest were minimal such as six and eight number of cases. With 10 numbers of clusters, the distribution reduced constantly within each cluster, and the categories derived from each cluster were somewhat similar to each other. Because of number of cases within the advisor and customer databases is limited, for each cluster to have appropriate and equal number of cases considered, it was better to select the number of clusters to five only.

5.2.3. Results and Observations

Cluster Analysis – To identify different clusters of customers and CSA's based on the variables and attributes used. The cluster distribution for advisor is as shown in table 5.10

Table 5-10: Cluster Distribution table for CSA's

		N	% of Combined	% of Total
Cluster	1	18	21.4%	21.4%
	2	11	13.1%	13.1%
	3	16	19.0%	19.0%
	4	10	11.9%	11.9%
	5	21	25.0%	25.0%
	6	8	9.5%	9.5%
	Combined	84	100.0%	100.0%
Total		84		100.0%

The following two charts shows the representations of the clusters in terms of CSA's age and experience level in graphical pie charts. Based on the clustering analysis described above the selection of cluster should be set to six number of cluster only. With cluster number selected to six, there were an equal proportion of cases distributed to each number of clusters. The complete set of results and analysis of the clustering analysis is described in detail in appendix H of the thesis. The author has represented the steps for clustering within section 5.2.2 and sample of results from automated to selection of six cluster number is also shown within the section.

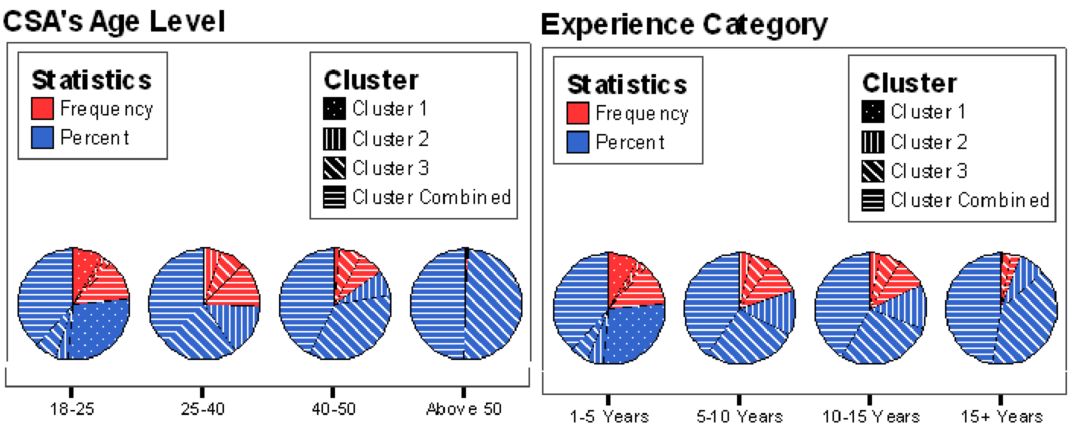


Figure 5-6: Clustering (Data Analysis) Results for Advisors

Clustering Analysis Results

The results from selection of cluster number from automatic to six number of cluster are as shown below in figure 5.7 and 5.8. The complete list of clustering analysis results are shown in appendix H.

Advisor – Automatic Clustering (derived only two clusters)

Cluster	Age				Education				Experience				IT Speed			Prev Experience				Behaviour						
																				Postive			Negative			Both
	18-25	25-40	40-50	50+	School	College	Grad	Prof	1 to 5	5 to 10	10 to 15	15+	Low	Medium	High	None	Little	Moder	Ext	Attentive	Friendly	Cust. Sat	Angry	Annoyed	Unaware	
1	94.4	0.0	0.0	0.0	76.9	61.1	32.5	0.0	72.0	5.0	10.0	0.0	66.7	45.7	14.3	83.3	55.2	9.7	0	25.0	27.3	41.2	69.2	43.8	60.0	34.6
2	5.6	100.0	100.0	100.0	23.1	38.9	67.5	100.0	28.0	95.0	90.0	100.0	33.3	54.3	85.7	16.7	44.8	90.3	100	75.0	72.7	58.8	30.8	56.3	40.0	65.4

Customer – Automatic Clustering

Cluster	Age			Education				Financial Status			Time With Company				Behaviour							Business Value		
															Postive			Negative			Both			
	18-25	25-40	40-50	School	College	Graduate	Profess.	Poor	Average	Good	>1	1-5 Yrs	5-10 Yrs	10+ Yrs	Understand	Joyful	Co-operat	Angry	Annoyed	Aggressive		Low	Medium	High
1	60.0	0.0	0.0	70.0	33.3	8.0	0.0	71.4	15.2	0.0	28.6	36.4	10.0	0.0	0.0	0.0	57.1	60.0	30.0	85.7	33.3	55.6	14.8	6.7
2	12.0	30.0	6.7	0.0	0.0	36.0	14.3	0.0	15.2	38.5	14.3	18.2	20.0	14.3	30.0	9.1	0.0	40.0	50.0	14.3	53.3	0.0	29.6	13.3

Figure 5-7: Clustering Analysis – Automatic Clustering

Ten different types of experiments carried out within the cluster analysis method ranging from automatic clustering to a maximum of 10 clusters within SPSS. Based on the clustering few results were noted which were:

1. Because of the number of clusters increased from 6-10, the total number of cases each cluster is taking is not properly distributed.
2. The number of people (customers and advisors) in each cluster is too low for making it a significant cluster.
3. The rules derived from the cluster results are repeated and are too close to each other.

Advisor – 6 Cluster Analysis

Cluster	Age				Education				Experience				IT Speed			Prev Experience				Behaviour						
																				Postive			Negative			Both
	18-25	25-40	40-50	50+	School	College	Grad	Prof	1 to 5	5 to 10	10 to 15	15+	Low	Medium	High	None	Little	Moder	Ext	Attentive	Friendly	Cust. Sat	Angry	Annoyed	Unaware	
1	47.2	3.3	0.0	0.0	46.2	33.3	15.0	0.0	36.0	0.0	0.0	0.0	52.4	17.1	3.6	44.4	27.6	6.5	0.0	9.4	13.6	0.0	69.2	18.8	60.0	23.1
2	25.0	3.3	5.9	0.0	15.4	0.0	22.5	0.0	8.0	15.0	10.0	0.0	14.3	17.1	7.1	27.8	13.8	6.5	0.0	6.3	0.0	47.1	0.0	31.3	0.0	15.4
3	0.0	43.3	17.6	0.0	0.0	11.1	30.0	15.4	12.0	30.0	30.0	16.7	4.8	22.9	25.0	0.0	20.7	25.8	33.3	34.4	13.6	11.8	30.8	50.0	40.0	61.5
4	0.0	10.0	41.2	0.0	15.4	5.6	7.5	30.8	0.0	10.0	40.0	0.0	0.0	0.0	35.7	0.0	0.0	19.4	66.7	15.6	0.0	29.4	0.0	0.0	0.0	0.0
5	5.6	40.0	35.3	100.0	15.4	22.2	20.0	53.8	16.0	45.0	15.0	83.3	19.0	28.6	25.0	5.6	24.1	41.9	0.0	18.8	59.1	11.8	0.0	0.0	0.0	0.0
6	22.2	0.0	0.0	0.0	7.7	27.8	5.0	0.0	28.0	0.0	5.0	0.0	9.5	14.3	3.6	22.2	13.8	0.0	0.0	15.6	13.6	0.0	0.0	0.0	0.0	0.0

Customer - 6 Cluster Analysis

Cluster	Age			Education				Financial Status			Time With Company				Behaviour							Business Value		
															Postive			Negative			Both			
	18-25	25-40	40-50	School	College	Graduate	Profess.	Poor	Average	Good	>1	1-5 Yrs	5-10 Yrs	10+ Yrs	Understand	Joyful	Co-operat	Angry	Annoyed	Aggressive		Low	Medium	High
1	60.0	0.0	0.0	70.0	33.3	8.0	0.0	71.4	15.2	0.0	28.6	36.4	10.0	0.0	0.0	0.0	57.1	60.0	30.0	85.7	33.3	55.6	14.8	6.7
2	12.0	25.0	6.7	0.0	0.0	36.0	0.0	0.0	15.2	30.8	14.3	13.6	20.0	14.3	20.0	9.1	0.0	40.0	40.0	14.3	46.7	0.0	25.9	13.3
3	28.0	15.0	13.3	10.0	33.3	20.0	0.0	28.6	24.2	0.0	28.6	22.7	0.0	14.3	0.0	36.4	14.3	0.0	0.0	0.0	0.0	16.7	22.2	20.0
4	0.0	25.0	46.7	20.0	5.6	24.0	42.9	0.0	27.3	23.1	28.6	0.0	10.0	71.4	10.0	45.5	14.3	0.0	0.0	0.0	0.0	11.1	22.2	26.7
5	0.0	30.0	13.3	0.0	5.6	12.0	57.1	0.0	6.1	46.2	0.0	27.3	20.0	0.0	50.0	9.1	14.3	0.0	10.0	0.0	6.7	0.0	11.1	33.3
6	0.0	5.0	20.0	0.0	22.2	0.0	0.0	0.0	12.1	0.0	0.0	0.0	40.0	0.0	20.0	0.0	0.0	0.0	20.0	0.0	13.3	16.7	3.7	0.0

Figure 5-8: Clustering Analysis – Six Cluster Results

5.2.4. Customer and Advisor Categories (based on clustering)

Based on the clustering analysis carried out in SPSS on two-step clustering process the following set of categories for customers and advisors were derived as shown in table 5.11 for customer and 5.12 for advisors.

Table 5-11: Customer Categorisation

Customer Categorisation

Categories / Attributes	C1 (Angry Customer)	C2 (Understanding)	C3 (Joyful)	C4 (Good)	C5 (Aggressive)	C6 (Old)
AGE	18-25	25-40	18-25	40-50	25-40	40-50
EDUCATION	SCHOOL	GRADUATE	COLLEGE	PROF.	PROF.	COLLEGE
FINANCIAL STATUS	POOR	GOOD	POOR	AVERAGE	GOOD	AVERAGE
TIME WITH COMPANY	1-5 YRS	5-10 YRS	<1 YRS	10+ YRS	5-10 YRS	5-10 YRS
BEHAVIOUR	NEGATIVE	BOTH	BOTH	POSITIVE	BOTH	BOTH
POSITIVE	-	UNDERSTANDING	JOYFUL	CO-OPERATIVE	UNDERSTANDING	CO-OPERATIVE
NEGATIVE	ANGRY & AGGRESSIVE	ANGRY	ANNOYED	-	AGGRESSIVE	ANNOYED
BUSINESS VALUE	LOW	MEDIUM	MEDIUM	HIGH	HIGH	LOW
TOTAL CASES (OUT OF 60	12	9	13	6	11	9

Customer Category C1 (Angry Customer) – 18-25, School (education), Poor (financial status), 1-5 yrs (time with company), Low (business value), Angry and Aggressive (behaviour)

Table 5-12: Advisor Categorisation

Attributes \ Categories	A1	A2	A3	A4	A5	A6
						Advisor Categorisation
AGE	18-25	18-25	25-40	40-50	50+	18-25
EDUCATION	SCHOOL	GRADUATE	GRADUATE	PROF.	COLLEGE	COLLEGE
EXPERIENCE	<1 YRS	1-5 YRS	5-10 YRS	10-15 YRS	15+ YRS	1-5 YRS
IT SPEED	LOW	MEDIUM	HIGH	HIGH	MEDIUM	MEDIUM
PREVIOUS EXP.	NONE	LOW	EXTENSIVE	MODERATE	MODERATE	LITTLE
BEHAVIOUR	NEGATIVE	BOTH	BOTH	POSITIVE	POSITIVE	BOTH
POSITIVE BEHAVIOUR	-	CUSTOMER FOCUSED	ATTENTIVE	CUSTOMER FOCUSED	FRIENDLY	ATTENTIVE
NEGATIVE BEHAVIOUR	ANGRY & UNAWARE	ANNOYED	ANNOYED	-	-	UNAWARE
TOTAL CASES (OUT OF 84)	16	18	20	4	7	19

Advisor Category A1 (Novice Advisor) – 18-25 (age), School (education), >1yrs (experience), Low (IT speed), none (previous exp.), Angry and Unaware (behaviour)

5.2.5. Summary

- From the results analysis explained above and as shown in the appendix H, it was observed that for each cluster to have right number of cases and to avoid the repetition of categories from each cluster for advisors and customer, the selection of cluster should be set to six numbers of clusters only.
- With cluster selection set to automatic number of cluster, it was creating only two clusters for customers who were having cases divided equally within clusters, and there was only two categories derived from clusters.
- With cluster selection set to three or four, there was a repetition of male and female values for each cluster, and the categories were either too low or too high and also opposite to each other.
- For cluster selection set to more than six number of clusters, it was thoroughly noticed that as it was increased, the distribution of number of cases was reduced, there was a repetitions of categories from each clusters, and they were not significant for both customer and advisors.
- So it was more feasible to select the total number of clusters to six, as the distribution was of somewhat equal proportion, and the categories derived from each cluster was having equal number of all the cases.

These categories are now used as a basis to develop a fuzzy expert system capable of categorising customer and advisor against the pre-defined categories explained in the next section.

5.3. Fuzzy Model Development Methodology

This section presents the methodology for developing the fuzzy models. The basic framework is shown in Figure 5-9. The basic idea is to construct fuzzy membership function and rules that respond to a set of inherited structured data points. This is achieved by changing the underlying fuzzy sets and the rules. Fuzzy Modelling (FM) is an approach to develop system models using natural language based on fuzzy logic and fuzzy predicates. In a broader sense, FM can be viewed as a qualitative modelling scheme that describes system behaviour using natural language. FM is a collection membership functions and fuzzy rules that are used to reason about data. A general fuzzy modelling approach consists of four modules: a fuzzy rule base, a fuzzy inference engine, fuzzification and defuzzification modules. A detailed description of these modules and fuzzy representation is presented in Appendix G.

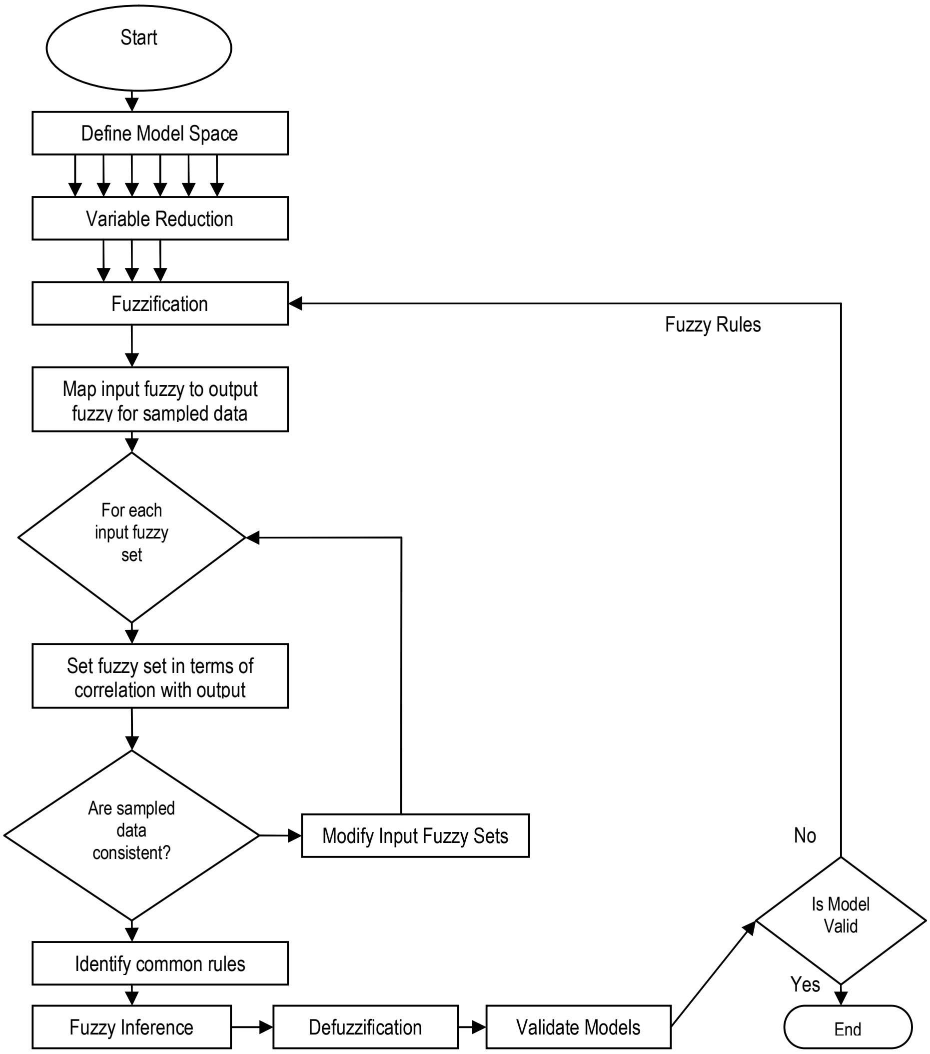


Figure 5-9: Fuzzy Modelling Methodology

The key points of the fuzzy modelling methodology followed for the framework development is detailed as follows:

- Identify the critical factors (5.3.1)
- Identification of membership functions (5.3.2).
- Perform fuzzification (5.3.3).
- Construct fuzzy rules (5.3.4).
- Implementation in Matlab (Fuzzy Expert System) (5.3.5)
- Experimental Tests (5.4)
- Validation of fuzzy expert system (with expert judgement) (5.5)

The development of fuzzy expert system was carried out in fuzzy logic toolbox within matlab environment. The toolbox extends the technical computing environment with tools for designing systems based on fuzzy logic. Graphical user interface (GUIs) guide through the steps of fuzzy inference system design. Functions are provided for many fuzzy logic methods, including fuzzy clustering and adaptive neurofuzzy learning. The toolbox also provides a fuzzy controller block that can be used to in Simulink to model and simulate a fuzzy logic control system. The key features of using fuzzy logic toolbox in Matlab for this framework development are:

- Specialised GUIs for building fuzzy inference systems and viewing and analysing results
- Membership functions for creating fuzzy inference systems
- Standard Mamdani and Sugeno-type fuzzy inference systems described earlier in literature studies.
- Automated membership function shaping through fuzzy clustering learning techniques
- Its ability to embed a fuzzy inference system in a Simulink model

5.3.1. Identify Critical Factors

The first step of the process involved the combination of a list of critical factors based on the literature review and in-depth interviews with the advisor, team leaders, centre managers and systems expert within the environment. The critical factors were the input variables of the fuzzy ES, which were as age, education, financial background, time with the company, business value and behavioural from the customer side, which would identify the type of category, they belong to. The initial consideration is to establish the design and response variables of the fuzzy model. The basic vocabulary fuzzy sets, hedges and variable definitions can also be established. The conventional system flow of input-process-output relationship can be used to explore the nature of model behaviour. This can give results such as model decomposition strategy, nature of relationship between the solution variables and the control variables and an overview of how the fuzzy model can be structured. In addition, the following features: variable domains, granularity and performance metrics are determined. The variable domain describes the extent to which the particular variables apply. While the design variable limits are determined from design rules, operational limits or expert knowledge, the response variable domain are determined from the variable reduction module.

5.3.2. Identification of Membership functions

The following screenshots are presented from the fuzzy expert system within matlab environment for customer and advisor. The membership functions for customer with seven inputs and one output as category is as shown below in figure 5.10 – 5.13. For the purpose of the fuzzy expert system development the author has called customer and agent (i.e. advisor).

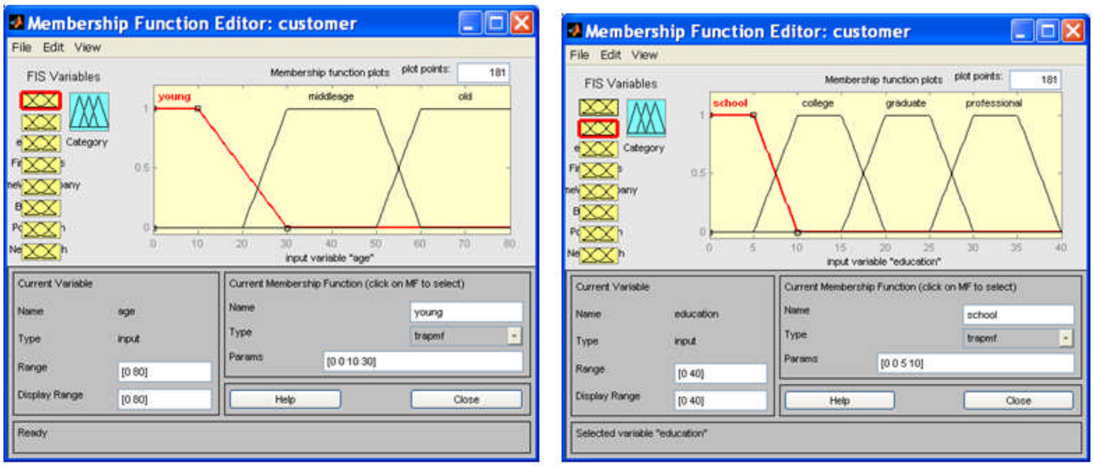


Figure 5-10: Customer Membership Functions – Age and Education

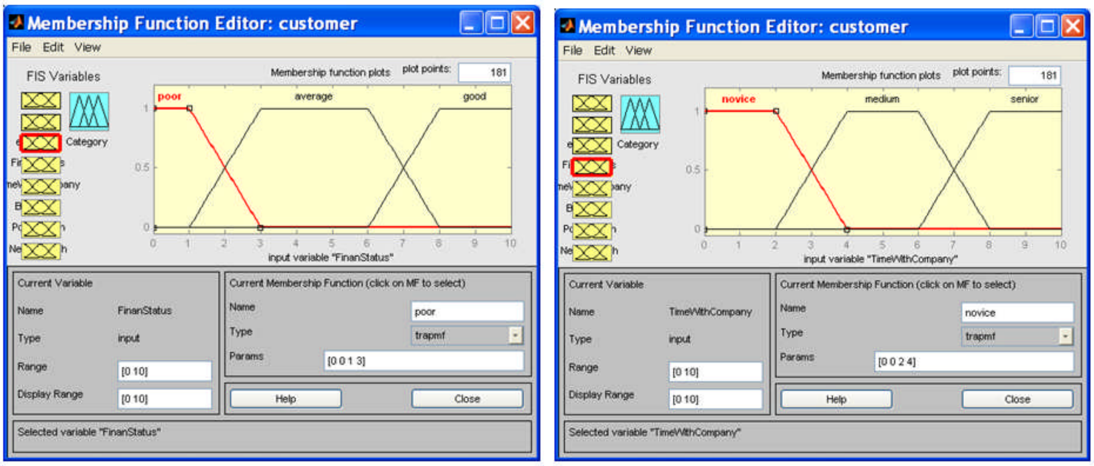


Figure 5-11: Customer Membership Functions – Financial Status and Time

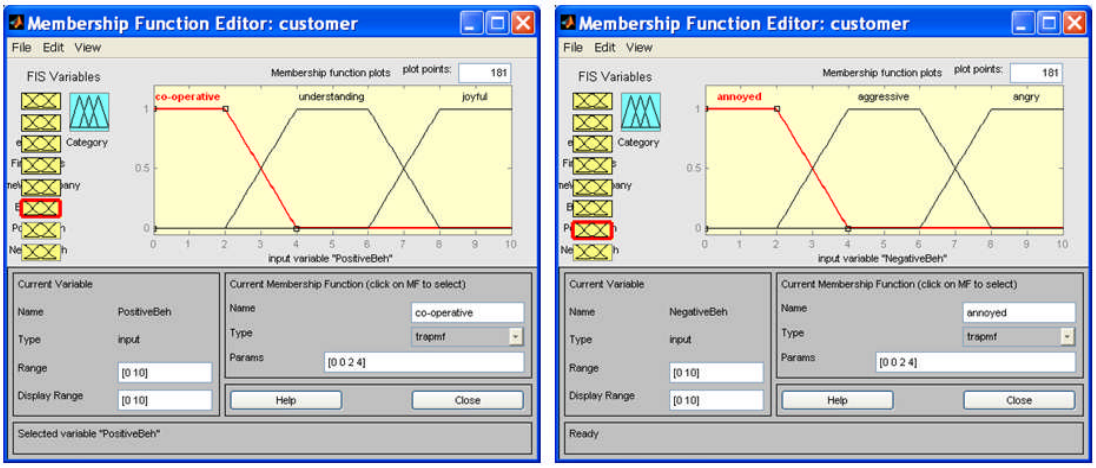


Figure 5-12: Customer Membership Functions – Positive/Negative Behaviour

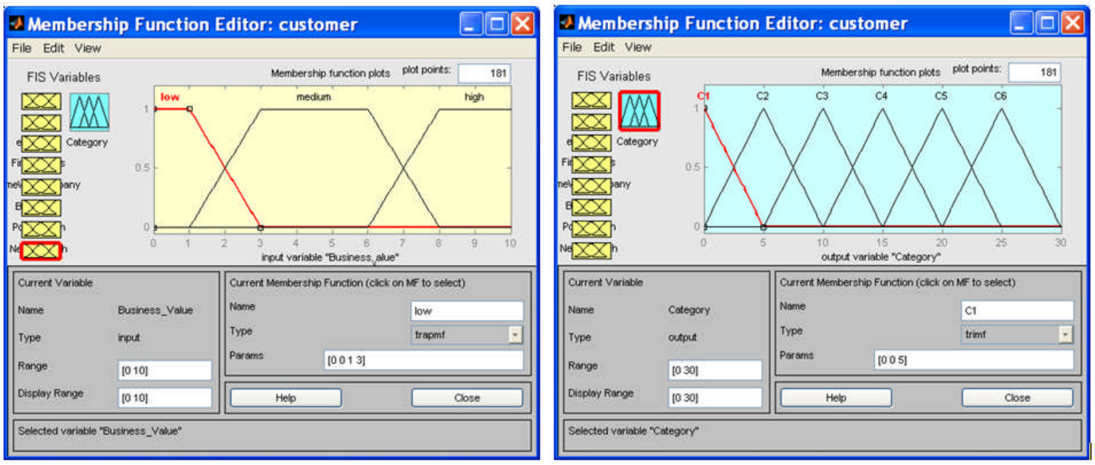


Figure 5-13: Customer Membership Functions – Business Value and Category

The membership functions derived for advisors are as shown in figure 5.14 – 5.17.

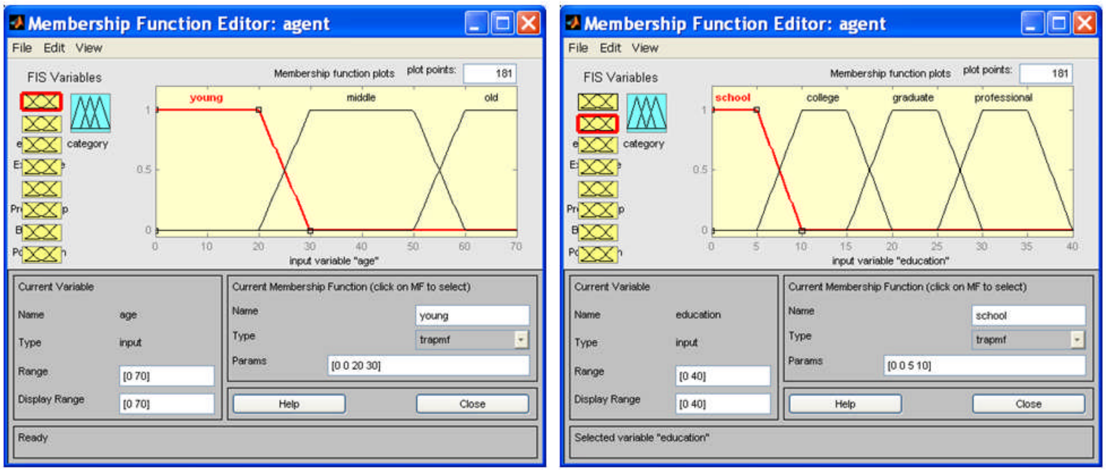


Figure 5-14: Advisor Membership Functions – Age and Education

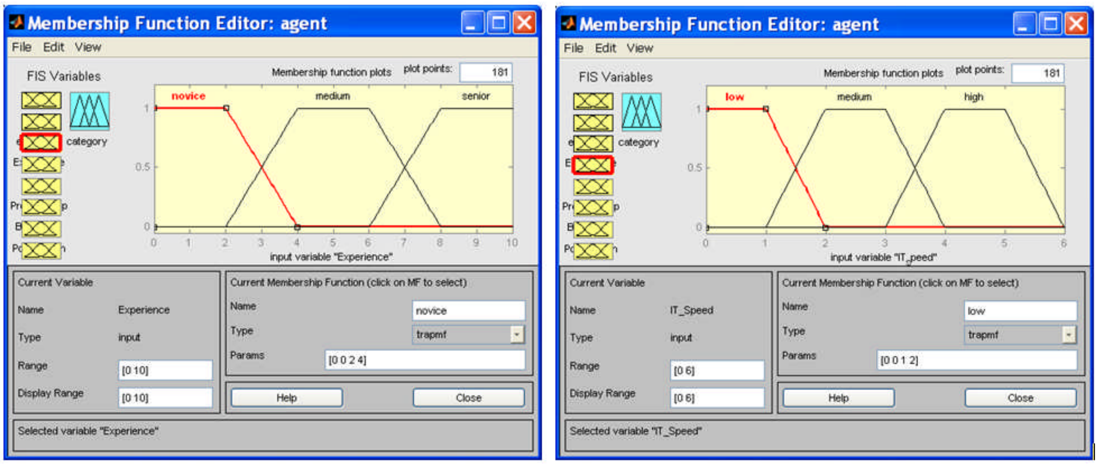


Figure 5-15: Advisor Membership Functions – Experience and IT Speed

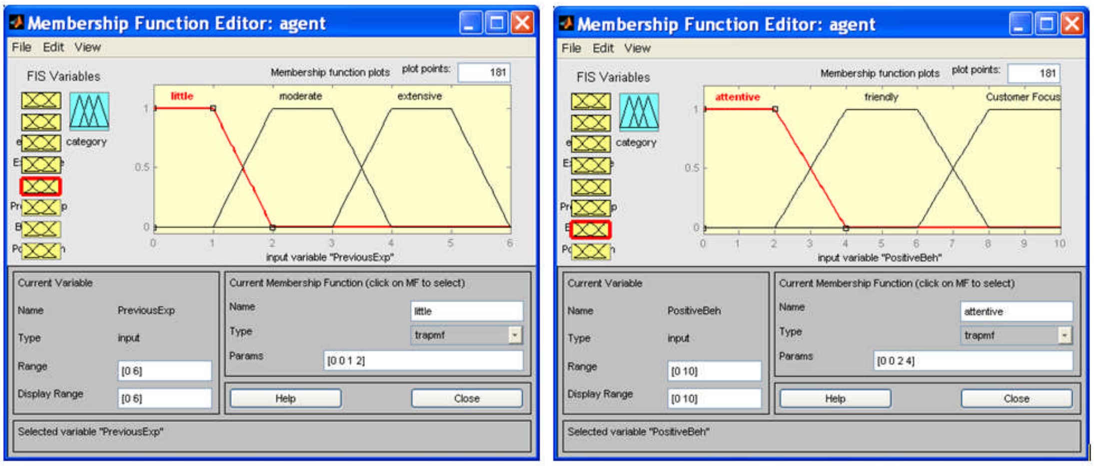


Figure 5-16: Advisor Membership Functions – Previous Exp and Positive Behaviour

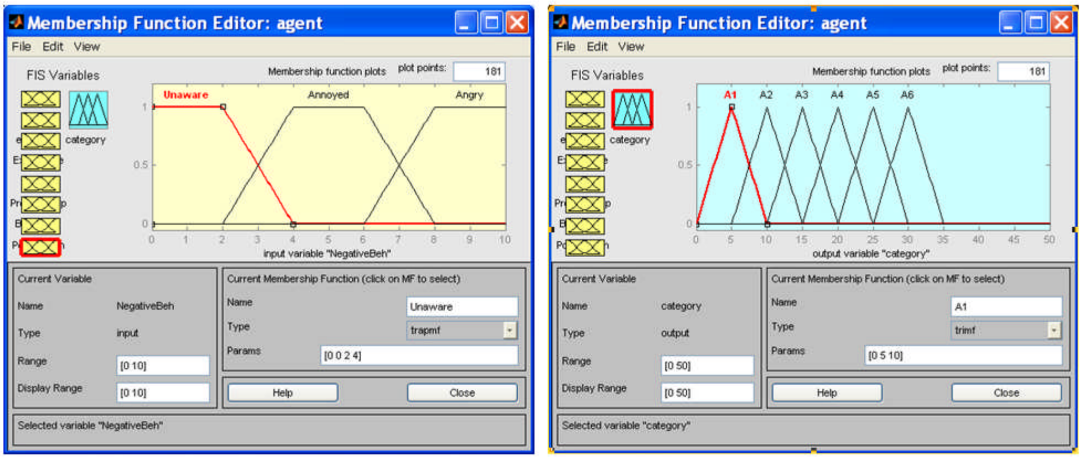


Figure 5-17: Advisor Membership Functions – Negative Beh and Category

This determines the range of the statistical response variable that is used in the fuzzification module. An important consideration is to ensure the cohesion of calibration between the design and response variables. Granularity of the fuzzy model information processing is related to the level of precision with which a given system can be represented by a fuzzy model. This is influenced by such factors as the number of linguistic terms and the particular shape and the overlap of the membership function.

5.3.3. Fuzzification

This step involves the actual definition and construction of the fuzzy sets. Several development issues need to be considered when constructing the fuzzy sets. Due to the discreteness present in qualitative information, it is necessary to divide a variable into multiple fuzzy sets, where the collection of the fuzzy sets correlates with the domain of the variable. Each fuzzy set describes some sub-section of the variable and attaches a linguistic meaning to that sub-section. When naming the fuzzy sets, it should be ensured that the fuzzy set reflects the natural language meaning of the term rather than what it does. This has important implications for understanding the model and model validation. Since the fuzzy model is required to explain the entire domain variable, it is necessary to convert the series of fuzzy regions into a continuous surface. This requires each of the fuzzy set to overlap its neighbouring set. An overlap is defined as the natural consequence of the fuzziness and ambiguity associated with the segmentation and classification of a continuous space (Cox, 1999). Several membership function shapes exists as shown in Figure F.2. However, the triangular, trapezoidal and the bell- shaped membership functions are adopted in the thesis since they seem to be most appropriate in capturing the expert’s approximate reasoning about the domain problem.

5.3.4. Generate Fuzzy Rule Base

Within the fuzzy expert system model once the membership functions of the input and output variables for customers and advisors were derived, fuzzy if…then rule were written which identified the type of input for customers and advisors. Rules are written to explain the behaviour of an underlying phenomenon. They establish the relationship between a collection of fuzzy space and the variables (both design and response). The rules are written in the form: *if x is A then y is B*, where *x* and *y* are scalar expressions and *A* and *B* are linguistic variables.

The rule base specifies qualitatively how the output of the system “Category” for the advisor and the customer is determined for various instances of the input variables of Age, Education, Financial Status, and Time with Company, Business Value, Experience, and Behavioral attributes. A total of forty-five rules were derived within the expert system. A sample of the rules derived for the fuzzy logic expert system are shown below and explained as below. The rules for advisors were selected from the understanding of the advisor input attributes and the results from the clustering analysis are explained: **IF** age is young, education is school, experience is novice, previous exp is low, IT speed is slow, positive behaviour as friendly and negative behaviour as unaware **THEN** the selected category is A1. A sample of advisor rules is shown here in the table 5.13 and detailed description of the rules for advisor is described in appendix I.

Table 5-13: Sample of advisor fuzzy if. Then rules

	Advisor If Then Rules for Fuzzy Expert System							
No	Age	Education	Experience	Previous Experience	IT Speed	Positive Behaviour	Negative Behaviour	Output Category
1	Young	School	Novice	low	Slow	Friendly	Unaware	A1
2	Middle age	Graduate	Medium	Moderate	Medium	Attentive	Annoyed	A3
3	Old	Professional	Senior	Extensive	Medium	Customer Focus	None	A5
4	Young	College	Novice	Moderate	Fast	Customer Focus	None	A6
5	Young	Graduate	Novice	Low	Fast	Attentive	Annoyed	A2
6	Middle age	Graduate	Medium	Extensive	Fast	Attentive	Angry	A3
7	Old	College	Medium	Moderate	Fast	Friendly	Annoyed	A5
8	Old	Graduate	Senior	Extensive	Fast	Friendly	None	A4
9	Middle age	School	Medium	Moderate	Medium	Friendly	Unaware	A3
10	Young	Graduate	Medium	Moderate	Fast	Attentive	None	A2

If…Then rules for customer were derived similarly to that of the advisors within the fuzzy expert system model. Some of the rules derived for the system are as explained: low, business value is low, positive behaviour is none and negative behaviour is aggressive **THEN** the category selected is C1 as shown in table 5.14.

Table 5-14: Sample of customer fuzzy if…then rules

	Customer If Then Rules for Fuzzy Expert System							
No	Age	Education	Financial Status	Time with Company	Business Value	Positive Behaviour	Negative Behaviour	Output Category
1	Young	School	Poor	Low	Low	None	Aggressive	C1
2	Middle Age	Graduate	Good	Moderate	Low	None	Annoyed	C2
3	Old	Graduate	Average	Moderate	Medium	Understanding	Angry	C6
4	Young	College	Poor	Low	Medium	Co-operative	None	C3
5	Middle Age	Professional	Good	Moderate	High	Joyful	None	C5
6	Young	Graduate	Average	Moderate	Medium	None	Angry	C2
7	Middle Age	Graduate	Good	Low	High	Co-operative	Aggressive	C6
8	Old	Professional	Average	High	High	Joyful	Annoyed	C4
9	Middle Age	School	Poor	High	Medium	None	Aggressive	C1
10	Middle Age	Graduate	Good	Moderate	High	Understanding	Angry	C2

Since it is important to establish relationship between a collection of fuzzy space and the response variables, the approach adopted for generating the fuzzy rules from numeric data and human expert shown in this section. The fuzzy inputs are discovered from the sample data set while the fuzzy outputs are defined by the expert knowledge. The resulting fuzzy rules are learnt from these two sources.

5.3.5. Implementation in MATLAB

For the implementation of the fuzzy expert system, Matlab fuzzy logic toolbox was used. The system can be build graphically within the Graphical User Interface (GUI) tools provided by the toolbox. There are five primary GUI tools for building, editing and observing fuzzy inference system in the fuzzy logic toolbox: the fuzzy inference system (FIS Editor), the membership function editor, the rule editor, the rule viewer, and the surface viewer as shown in figure 5.18.

These GUIs are dynamically linked, in that changes you make to the FIS using one of them, can affect what you see on any of the other open GUIs. The FIS editor handles the high-level issues of the system such as the number of input/output variables and their names. The membership function editor is used to define the shapes of all the membership functions associated with each variable. The rule editor is for editing the list of rules that defines the behaviour of the system. The rule viewer and the surface viewer are use for looking at, as opposed to editing, the FIS. The rule viewer is a Matlab based display of the fuzzy inference diagram shown at the end. The surface viewer is used to display the dependency of one of the output on any one or two of the inputs; it generates and plots an output surface map of the system. The five GUIs can all interact and exchange information. Any of them can read and write both to the workspace and to the disk (Mathworks, 2005).

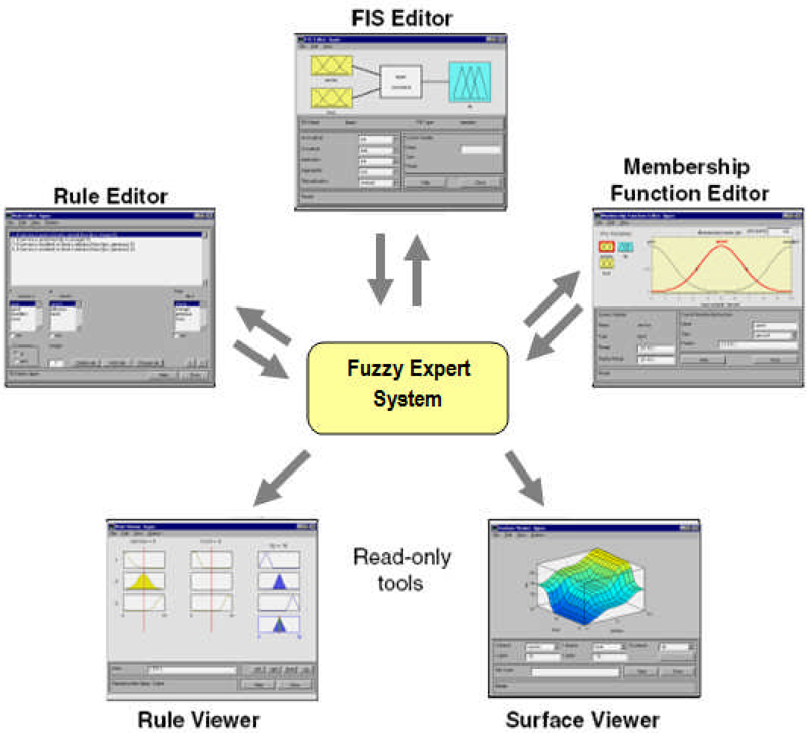


Figure 5-18: Fuzzy Expert System Implementation in Matlab (Mathworks, 2005)

For any fuzzy inference system, any or all of these five GUIs may be open. If more than one of these editors is open for a single system, the various GUI windows are aware of the others, and will, if necessary, update related windows. The FIS editor, the membership function editor, and the rule editor can all read and modify the FIS data, but the rule viewer and the surface viewer do not modify the FIS data in any way.

The FIS Editor

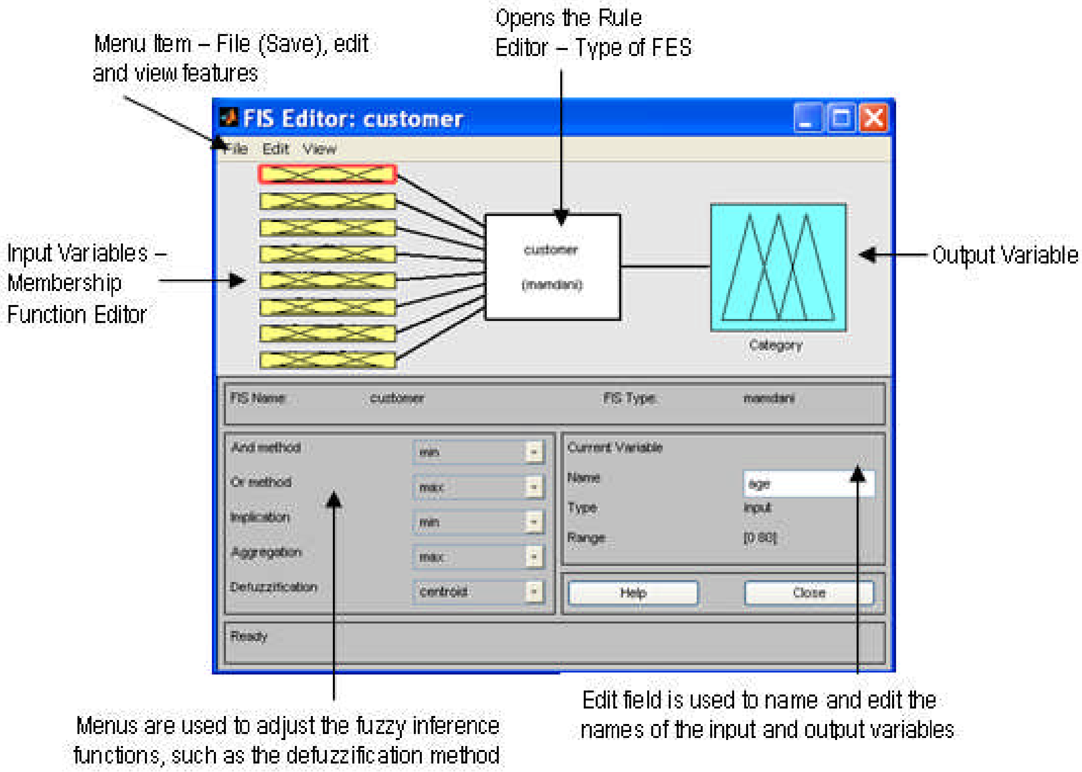


Figure 5-19: FIS Editor View of Fuzzy Expert System

The FIS Editor displays general information about a fuzzy inference system shown for customer example in figure 5.19. The names of each input variable are shown on the left, and that of the output variable (category) is shown on the right. The membership functions shown in the boxes are just icons and do no depict the actual shapes of the membership functions. The centre blocks are the name of the system (customer) and the type of inference that are used.

The Membership Function Editor

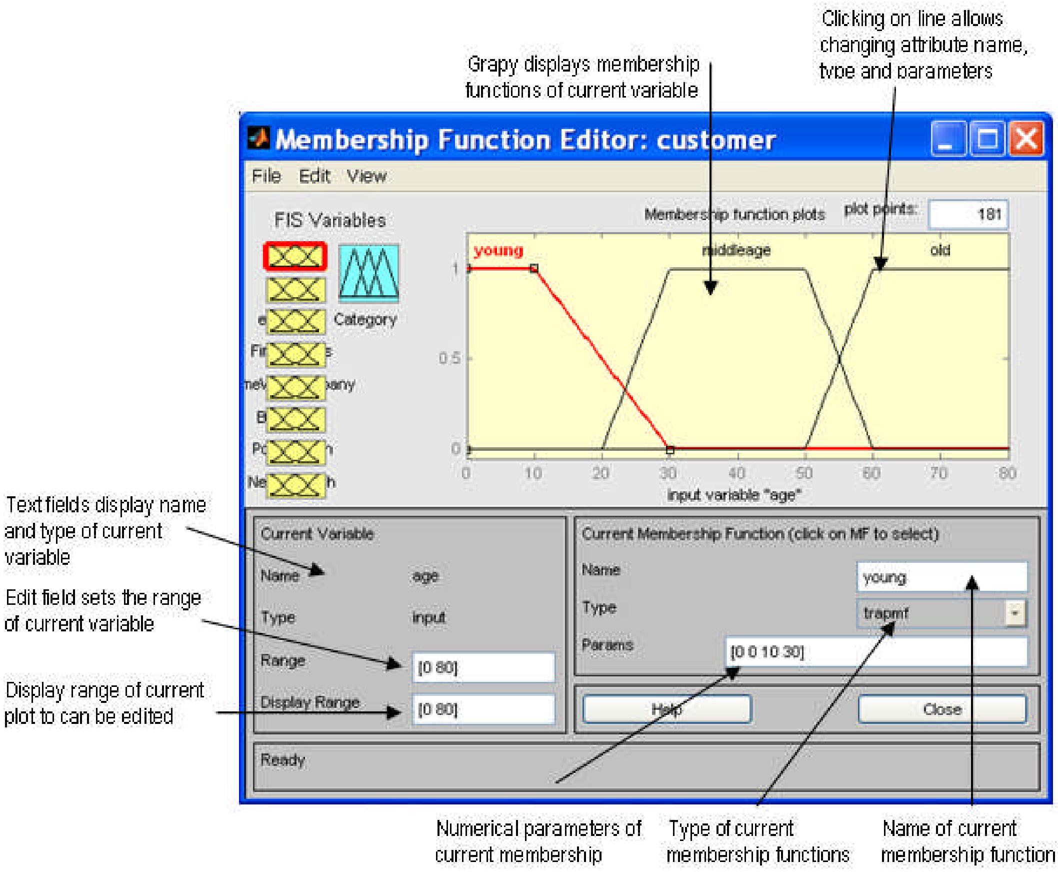


Figure 5-20: Membership Function Editor View in Matlab

The membership function editor shown above in figure 5.20 is the tool that allows displaying and editing all the membership functions associated with all of the input and output variables of the entire fuzzy inference system.

The Rule Editor

The rules are constructed using the graphical rule editor interface. Based on the description of the input and output variables defined with the FIS editor, the rule editor allows to construct the rule statements automatically, by clicking on and selecting one item in each input variable box, one item in each output box and one connection item. Choosing none as one of the variable qualities will exclude that variable from a given rule. Choosing no under any variable name will negate the associated quality. Rules may be changed, deleted, or added, by clicking on the appropriate button as shown in figure 5.21.

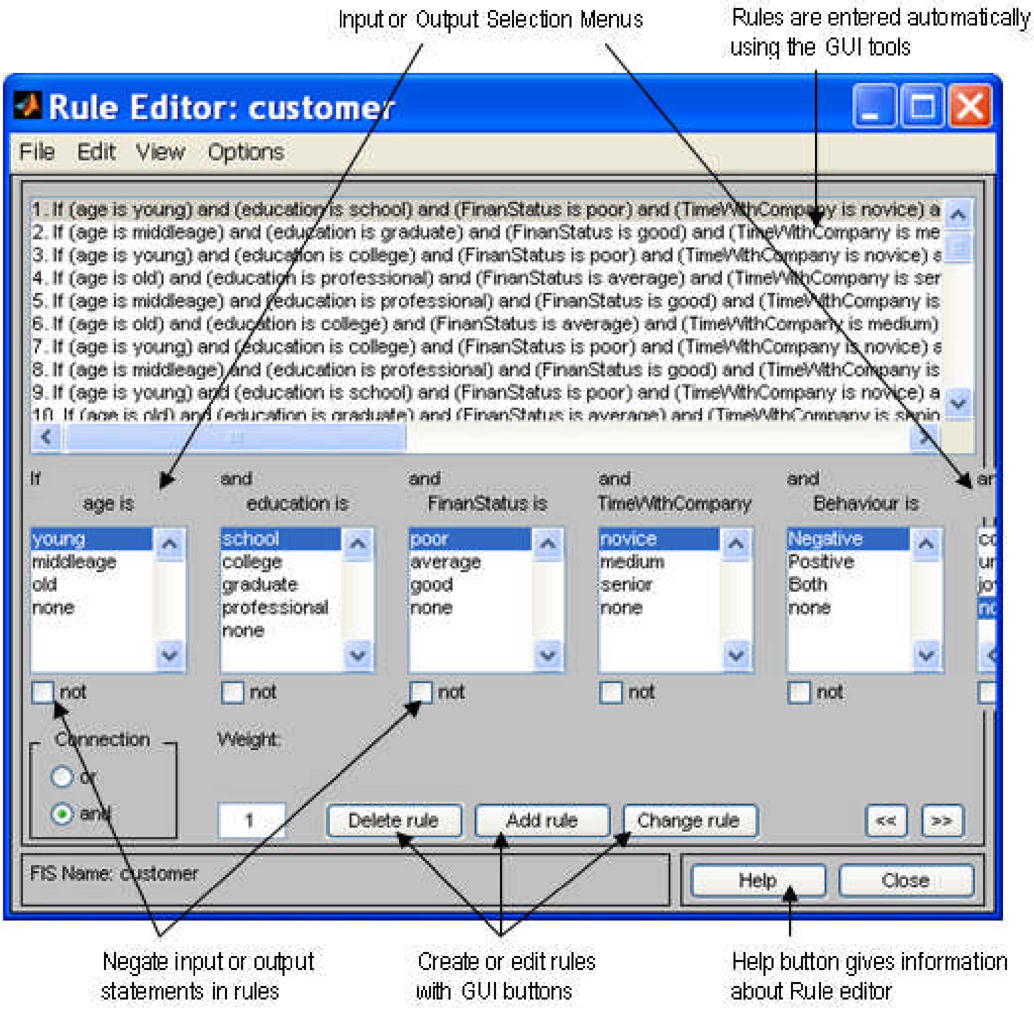


Figure 5-21: Rule Editor View in Matlab

The Rule Viewer

The rule viewer displays a view of the completely fuzzy inference process. It is based on the fuzzy inference diagram described earlier. The rule viewer allows to interpret the entire fuzzy inference process at once. This also shows how the shape of certain membership functions influences the overall results. Since it plots every part of every rule, it can become unwieldy for large systems, but a relatively small number of inputs and outputs, which in our case is 7 inputs and 1 output, it performs well. It also presents a sort of micro view of the fuzzy inference system. To see the entire output surface of the system, surface viewer is used which is explained next. This shows the entire span of the output set based on the entire span of the input set as shown in figure 5.22.

The Surface View

Surface view within the GUI presents a two-dimensional curve that represents the mapping from age and education (inputs) to category (output). Once the inputs are changed, the plotting can also be viewed in different ways shown in figure 5.23.

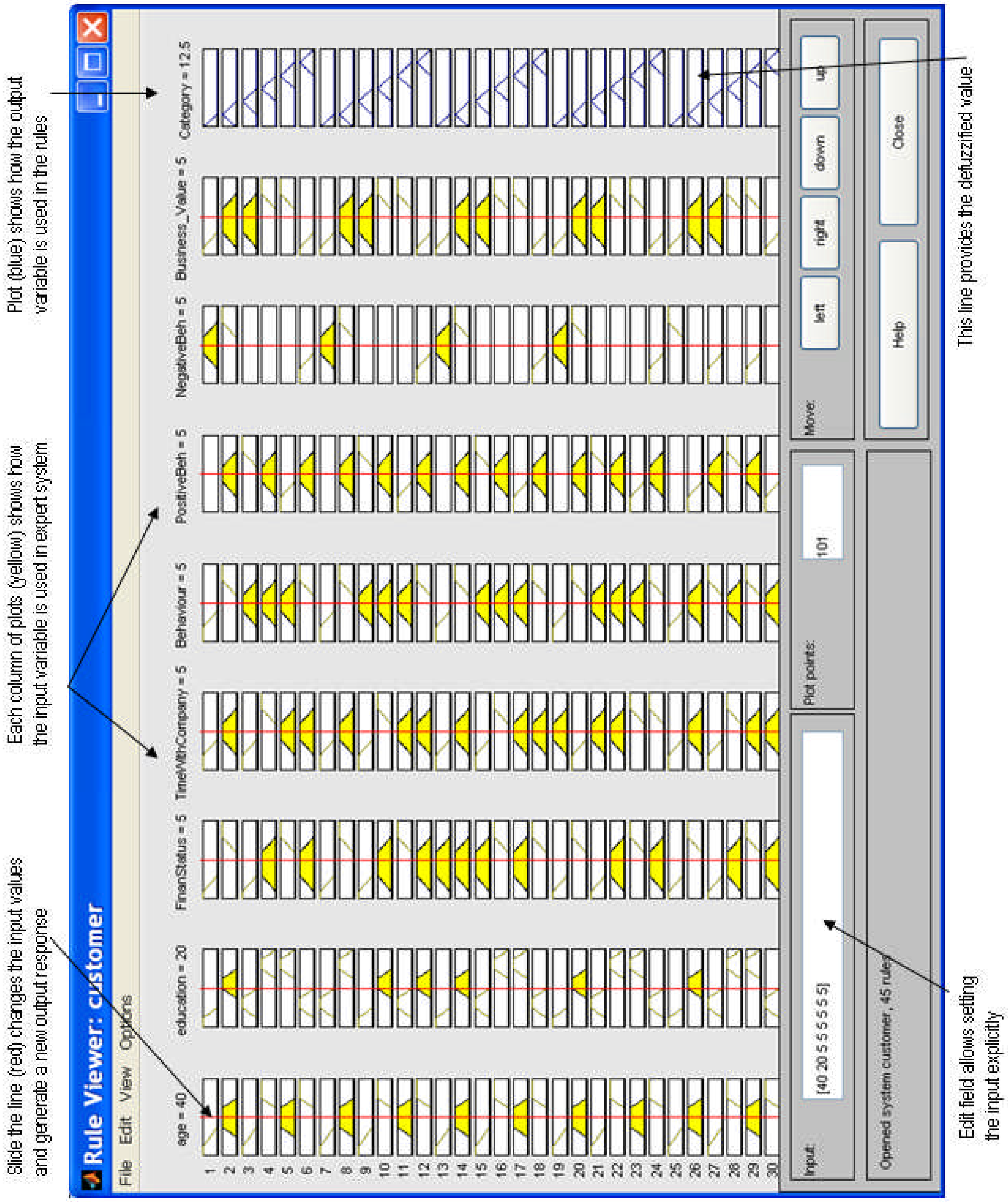


Figure 5-22: Rule Viewer in Matlab

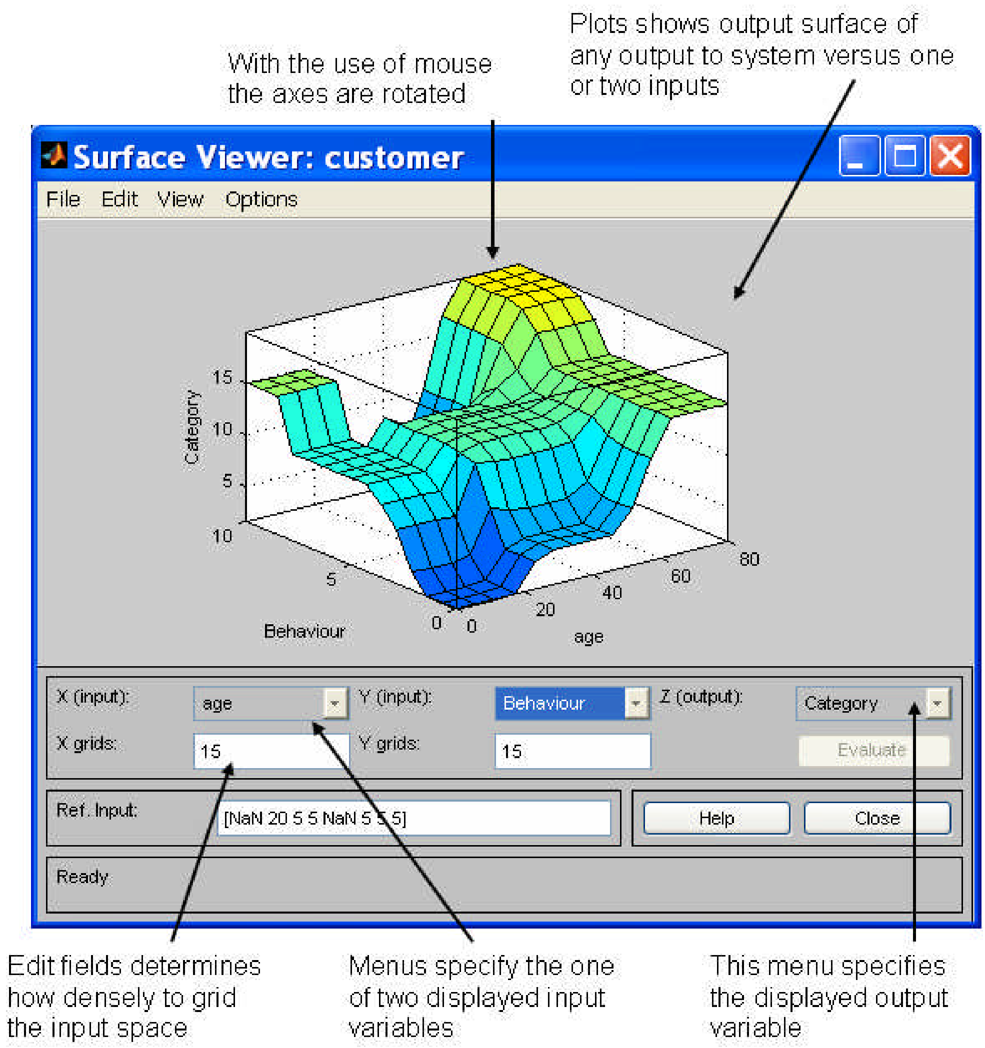


Figure 5-23: Surface View in Matlab

5.4. Experimental Tests and Validation

This section presents an analysis of the experimental tests carried out on the fuzzy expert system which assigns each customer and advisor from the database a set of pre-defined category. The analysis from this tests also aims to demonstrate any weeknesses that might occur during the framework development and implement phases. This aim is achieved by presenting a brief overview of existing modelling techniques for the chosen problems and assessing the suitability of a fuzzy based approach.

5.4.1. Experimental Tests for Customer and Service Advisor

With respect to the model, the authors carried out experiments with the fuzzy expert system model by changing the input variable values and monitoring the change in the output, which showed the change in the category for customer and advisors. The results, which were analysed, are the set of new data points from sampling for customer and advisors as shown in table 5.15 and 5.16 respectively. The results derived from the experiments carried out within the expert system model validated within the contact centre environment with the team leaders and managers. The complete list of the experiments conducted for customer and service advisor described in appendix F of the thesis.

Advisors Experimental Examples

This section highlights the experimental examples, which carried out within the fuzzy expert system model to assign the customer and advisor to that of the pre-defined category from the clustering analysis. For example, the input values in the first experiment is for age=21.5, and from our membership functions it justifies that the input variable for age is young; education=12 (college), experience=5 (5-10 yrs), previous exp=1.8 (low), IT Speed=1.5 (slow), positive behaviour=5.5 (friendly).

Table 5-15: Experimental Results for Advisor Expert System Model

Experimental Results for Fuzzy Expert System - Advisors									
No	Age	Education	Experience	Previous Experience	IT Speed	Positive Behaviour	Negative Behaviour	Output	Category
1	21.5	12	5	1.8	1.5	8.5	2.1	30	A6
2	30	21	4.2	5	4	1.8	5	10	A3
3	33.8	17.2	5.5	4.2	3	3.5	4	10	A3
4	20	5	1	0.5	1.3	1.2	1.8	5	A1
5	24	11	3	0.2	2	2	0	25	A6
6	28	24.6	0	1.5	3	8	4	5	A2
7	32.4	19.8	4.8	4	5	2	6.2	10	A3
8	51.2	27	8.6	5	2.8	5	1.2	20	A5
9	39.2	16.5	7	3.8	4.2	10	2	15	A4
10	22.8	18	2	2.1	2.5	3.2	1	26.1	A6
11	15	2	1	1	0.8	7	0	2.33	A1
12	50	31.2	7.8	4.2	4	8	6	15.8	A4
13	48.7	27	10	5	3.2	10	8	21	A5
14	34.3	21	6	4	4	3	5	15	A3
15	19.9	4	4	0.8	1.5	2	4	25	A6

Ex. 8 - If Age = 51.2, Education = 27, Experience = 8.6, IT Speed = 2.8, Previous Exp = 5, Positive Behaviour = 5, Negative Behaviour = 1.2. Then Advisor Category output is 25 which determines that the category for advisor is A5

Ex. 10 - If Age = 22.8, Education = 18, Experience = 2, IT Speed = 2.5, Previous Exp = 2.1, Positive Behaviour = 3.2, Negative Behaviour = 1. Then Advisor Category output is 26.1 which determine that the category for advisor is A6.

Customer Experimental Examples

Table 5-16: Experimental Results for Customer Expert System Model

	Experimental Results for Fuzzy Expert System - Customer								
No	Age	Education	Financial Status	Time with Company	Business Value	Positive Behaviour	Negative Behaviour	Output Value	Category
1	20	10.2	2	0.8	4	10	1	15	C3
2	25	5	3	5	2.5	1.2	5	5	C1
3	30	7	8.9	9	6.8	5	0	25	C5
4	36	16.5	6.5	4.5	5	6.2	10	10	C2
5	28	10.7	0	0	5	10	2.1	15	C3
6	32.1	27.6	10	7	9	5.6	1.5	25	C5
7	40	25	5	10	8.5	9	0.4	20	C4
8	50	10	4.3	6.5	0	5	3	30	C6
9	18	1.2	1.5	3	1.2	1.2	8	5	C1
10	23	7.5	2	0.5	5.2	9	1.5	15	C3
11	31.6	35	8	4.8	8	6	1.5	25	C5
12	45.2	15	4	4.5	4	4.8	4	20	C6
13	52.8	5	6	7	6	5.2	7	10	C2
14	28	18	9.1	2	3	4.1	2	25	C5
15	16	6	1.8	0	5	3	10	5	C1

Ex. 7 - If Age = 40, Education = 25, Financial Status = 5, Time with company = 10, Business Value = 8.5, Positive Behaviour = 9, Negative Behaviour = 0.4. Then Customer Category output is 20 and category is C4

Ex.8 – If Age = 50, Education = 10, Financial Status = 4.3, Time with company = 6.5, Business Value = 0, Positive Behaviour = 7, Negative Behaviour = 3. Then Customer Category output is 30 and category is C6. These results were validated with the team leaders at the contact centre to verify that the given selection of the pre-determined categories for customer and advisor was properly justified.

5.4.2. Validation of Experimental Tests from Contact Centres

The information and the results from the model were verified through team leaders and managers at three of the contact centre where the case studies were carried out. Five team leaders were interviewed with the help of an open set questionnaire, showing the categories derived and the assignment of a particular customer or advisor to these categories through the help of the fuzzy expert system tool developed. From the validation, it was noticed that the expert judgment did correspond to that of the results from the expert system model framework for 80% of the overall experiments that were carried out. The experimental results in table 5.17 and 5.18 shows the assignment of a particular customer and advisor to the categories, which were derived from clustering. Based on experiment 8, the expert system assigned category A5 to the advisor. However, from validation with team leaders it revealed that the category should be A4. Based on the validation the changes were made with respect to behavioural attributes from friendly behaviour to customer focus behaviour.

Table 5-17: Fuzzy ES Validation Results – Advisor

Fuzzy Expert System Validation - Advisors

No	Age	Edu	Exp	Pre Exp	IT	+ve Beh	-ve Beh	Out	Cat	TL1	TL2	TL3	TL4	TL5
1	21.5	12	5	1.8	1.5	8.5	2.1	30	A6	A6	A6	A6	A1	A6
2	30	21	4.2	5	4	1.8	5	10	A3	A2	A3	A3	A3	A3
3	33.8	17.2	5.5	4.2	3	3.5	4	10	A3	A3	A4	A3	A3	A3
4	20	5	1	0.5	1.3	1.2	1.8	5	A1	A1	A1	A2	A1	A1
5	24	11	3	0.2	2	2	0	25	A6	A6	A3	A6	A5	A6
6	28	24.6	0	1.5	3	8	4	5	A2	A2	A2	A2	A2	A3
7	32.4	19.8	4.8	4	5	2	6.2	10	A3	A2	A3	A3	A4	A3
8	51.2	27	8.6	5	2.8	5	1.2	20	A5	A4	A4	A4	A5	A4
9	39.2	16.5	7	3.8	4.2	10	2	15	A4	A4	A1	A4	A4	A2
10	22.8	18	2	2.1	2.5	3.2	1	26.1	A6	A2	A3	A2	A6	A2
11	15	2	1	1	0.8	7	0	2.33	A1	A1	A1	A1	A1	A1
12	50	31.2	7.8	4.2	4	8	6	15.8	A4	A4	A4	A2	A4	A4
13	48.7	27	10	5	3.2	10	8	21	A5	A5	A5	A5	A5	A5
14	34.3	21	6	4	4	3	5	15	A3	A3	A3	A3	A3	A3
15	19.9	4	4	0.8	1.5	2	4	25	A6	A6	A6	A6	A4	A6

Edu = Education, Exp = Experience, Pre = Previous Experience, +ve Beh = Positive Behaviour, -ve Beh = Negative Behaviour, Out = Output value of ES, Cat = Category, TL = Team Leader at CC

Experiment number 10 revels that the expert system assigned category A6, which on further validation with team leaders at the contact centres fall into A2 category. The reasons for this significant change in selection of category were for the following reasons, (a) Education level to be high, (b) Positive behaviour to be attentive and (c) Less amount of negative behaviour. The rules were fine-tuned to predict A2 category and share characteristics of that category.

Table 5-18: Fuzzy ES Validation Results – Customer

Fuzzy Expert System Validation - Customer

No	Age	Edu	Fin	Time	Val	+ve Beh	-ve Beh	Out	Cat	TL1	TL2	TL3	TL4	TL5
1	20	10.2	2	0.8	4	10	1	15	C3	C3	C3	C2	C3	C3
2	25	5	3	5	2.5	1.2	5	5	C1	C1	C1	C1	C5	C1
3	30	7	8.9	9	6.8	5	0	25	C5	C5	C5	C5	C5	C5
4	36	16.5	6.5	4.5	5	6.2	10	10	C2	C2	C2	C2	C2	C2
5	28	10.7	0	0	5	10	2.1	15	C3	C3	C4	C3	C3	C3
6	32.1	27.6	10	7	9	5.6	1.5	25	C5	C5	C5	C5	C5	C5
7	40	25	5	10	8.5	9	0.4	20	C4	C6	C6	C4	C6	C6
8	50	10	4.3	6.5	0	5	3	30	C6	C4	C4	C4	C6	C4
9	18	1.2	1.5	3	1.2	1.2	8	5	C1	C1	C3	C1	C1	C1
10	23	7.5	2	0.5	5.2	9	1.5	15	C3	C3	C3	C3	C3	C3
11	31.6	35	8	4.8	8	6	1.5	25	C5	C4	C5	C5	C5	C5
12	45.2	15	4	4.5	4	4.8	4	20	C6	C6	C6	C6	C6	C6
13	52.8	5	6	7	6	5.2	7	10	C2	C2	C1	C2	C2	C2
14	28	18	9.1	2	3	4.1	2	25	C5	C5	C5	C5	C5	C5
15	16	6	1.8	0	5	3	10	5	C1	C1	C1	C3	C1	C1

Edu = Education, Fin= Financial Status, Time = Time with Company, Val = Business Value, +ve Beh = Positive Behaviour, -ve Beh = Negative Behaviour, Out = Output Value, Cat = Category, TL = Team Leader at CC

For customer categorisation, the results from the expert system for experiment 7 and 8 did not match that to the validation from the team leaders at CC (table 5.18). Appropriate modifications carried out within the expert system to assign a category to customer to match with the validation results from the team leaders. As seen in experiment 7, the changes made were education level changed from graduate to college level to assign customer with C6 category. Experiment 7 revealed that expert system assigned C6 category which on further validation fall into C4 category. The changes made within the expert system were, (a) Customer time within company, (b) Positive attitude towards the advisor and (c) Less amount of negative attitude shown from the customer.

5.5. Summary

The chapter presented a fuzzy expert system methodology for assignment of pre-defined categories to customer and advisor. Data was collected through semi-structured questionnaire for team leaders/managers and advisors within contact centre environment. From initial observations through the collection and analysis of data, a set of attributes for customer and advisors were derived which were:

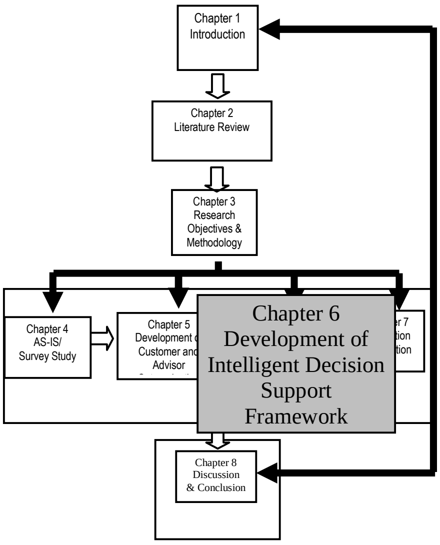
- Advisor Attribtues – Age, Education, Experience, IT Speed, Previous Experience, Postive Behaviour and Negative Behaviour
- Customer Attributes – Age, Education, Financial Status, Time with Company, Business Value, Positive Behaviour and Negative Behaviour

Some of the observations from the categorisation framework are summarised as:

- Clustering analysis was derived to identify groups of customer and advisors for categorisation. The analysis was carried out within SPSS Data Analysis Tool with two step clustering method applied to the analysis.
- From the results and expert validation a total of six number of clusters were selected as the distribution was carried out in equal proportions and clusters derived were having equal number of cases
- These categories were used as a basis to develop fuzzy expert system which categorises customer and advisor against the pre-defined categories.
- Experimental tests were carried out on the system which assigned an category for each customer and advisor data entry. The results from the categorisation were validated with expert judgement from the contact centres.

The next chapter now presents an information requirement framework, which identifies the minimum amount of information that is required to display on the screen of the advisor serving the customer with their query. Based on the categorisation and the assignment of categories to each customer and advisor from the database, the information required framework would identify the information screen based on this categorisation.

6. Development of Intelligent Decision Support Framework



As discussed in chapter 2, the contact centre environment is actively involved in identifying new ways to improve customer experience within the company. This needs better service and right amount of information at the right time required by the advisors serving the customer enquiry thus reducing the overall time taken by the advisors and increasing the customer satisfaction levels within the company. Information requirement framework addresses the problems within the current contact centres information screens and how the use of behavioural modelling derived in chapter 2 and identified through chapter 5 can be implemented through this research. This aim is achieved by satisfying several objectives. These objectives are explained below and organised into sections within this chapter.

- Identifying the current information screens used within contact centre through case study approach.
- Identify the challenges of creating information requirement framework which is later used to develop intelligent decision support frameowork.
- To understand the minimum amount of information required to display in any given custome and advisor combination.
- To propose the development of intelligent decision support framework

This chapter begins with Section 6.1 which presents the methodology followed and details of the interviews carried out with experts and advisors in contact centres. Section 6.2 presents an overview of the current information screen within the company reviewed through the case study analysis. Section 6.3 describes the challenges of creating information requirement framework within customer contact centre environment. Section 6.4 presents the devlopment of the information requirement framework to be used within the research. Section 6.5 describes the test scenarious used to validate the information screen with expert judgement. Section 6.6 discusses the general observations derived from this chapter. Section 6.7 presents the proposed intelligent decision support framework to be used for the simulation and expert judgement validation in chapter 7. Section 6.8 concludes the chapter with a summary of the main points.

6.1. Methodology

The methodology followed for the development of intelligent decision support framework is as shown below in figure 6.1. During the initial data collection at contact centres described in chapter 5, the author collected relevant information for information requirement. Based on customer and advisor categorisation, the author developed the initial understanding on the type of information required to be displayed on the screen in any given customer and advisor combination.

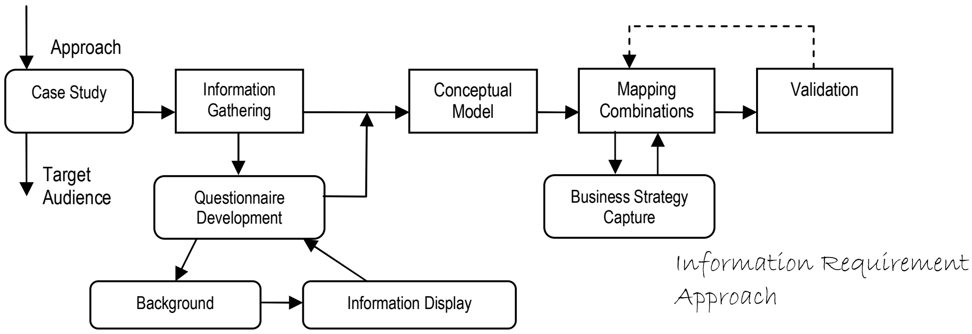


Figure 6-1: Methodology for Information Requirement Framework

The details about the total number of people interviewed for the information requirement framework is shown earlier in section 5.1.2 in table 5.3. The set of questions used for information collection were highlighted earlier in chapter 5 which consist of a set of questions used with team leaders and advisors. The collection of the information requirement questions are as discussed in table 6.1 and 6.2 within next section 6.2.

6.2. Current Information Screen within CC

This section presents an overview of some of the current information screen layouts of the systems used by contact centres studied by the author through case study analysis. The case studies presented in this section were conducted in contact centres with advisors and experts and explained earlier in chapter 4 of the thesis. The data collected for information requirement was collected through semi-structured questionnaire described earlier in chapter 4 and 5. The section also identifies the type of information required by the advisor in any customer facing environment to serve the customer query more efficently and thus providing satisfaction to the company's customers. The list of questions used to derive the information requirement data is as described in table 5.1 and 5.2 in chapter 5 and the analysis of results from the respondents is described in table 6.2 below. The responses from the team leaders on the information requirement questions used during the data collection are discussed as below in table 6.1.

Table 6-1: Information Requirement Questions – Responses from Team Leaders

	Information Requirement Questions – Responses from Team Leaders			
Questions	Respondent A (Fault)	Respondent B (Sales)	Respondent C (Telecoms Busines)	Respondent D (Helpdesk)
13. What data do you record for each individual customer?	Account details, address details, services/products used	Demographic data, sales enquiry data, financial details	Demographic data, services used, address details	Demographic data, products used, address details
15. Do you record any behavioural responses of customer during conversation with advisors?	No	No	No	No
16. What type of information is displayed on the screen of the advisor to serve the customer query?	Service related information, account details, allocation of service engineer	Product information, company offers, past record of purchases	Business services, product information, account details, customer financial details	Product information, customer details, record of past communication
17. Do you record any customer behavioural change in recrods?	No. Only the details are are recorded on the records (historical data), if the advisor finds it useful to enter	No. All the changess are recorded on customer records	No	No. This is not requried as the call is for help information and other prodct related inforamtion
18. Is there any record of historical data of the customer?	Yes. All the faults reported by the customer are recorded on the account data	Yes. All the previous enquiries about the product by the customer are recorded	Yes. All the previous three years details are recorded on the customer accounts	No. Customer calls are for enquiries on new and old products
19. Is the information presented on the screen a "customised information"?	Yes. The screen is somewhat customised and depends on the type of customer query. There are features which are accessible if required	There are many help windows which can be used by the advisor to serve the customer query in better ways	Mostly, the system is not designed as a windows based system, and customised information is not relevant in our case	The system displays the information which is only requred by the advisor in any given situation. All the information is not supplied at any time.
20. Does the advisor have to look on other systems (information) to find relevant information?	Yes. For allocation of service engineer the advisor uses other stand alone system	No. Only if the customer requests for more product information to be sent to them.	Yes. There are three back end systems to the main system that the advisor uses.	Yes. The advisor uses the product information system with the main helpdesk system.

The responses from the advisors on the information requirement questions used during the data collection are discussed as below in table 6.2.

Table 6-2: Information Requirement Questions – Responses from Advisors

	Information Requirement Questions – Responses from Advisors			
Questions	Respondent A (Fault)	Respondent B (Sales)	Respondent C (Telecoms Busines)	Respondent D (Helpdesk)
6. What type of customer data is available?	Customer background, account details, address details, payment details, services details	Some. Product information, sales teachniques, company offers, customer records	customer details, account details, payment details, address details, services/products details, new product details	Gerneral product/service details, customer details, payment details, help pages
8. Do your record and notify any change of customer behaviours?	There is no such option to record or change/notify the customer behaviour. Any such details are recorded on customer recrods	No. Any behaviours are notified on the records for future use	No. It doesn't happen that often due to business customers. Although there might be an option where the details can be recorded.	No. There is no option to record any change of customer behaviour
12. What is the generic information screen presented to you?	All the details about the customer and the products used. Additional details of the service can be looked on different system	Gerneal sales and product details information.	Customer details and the type of services offered. Based on the type of query, the information can be looked on other different system platforms	Information related to the products, faults and problems, other forms required to complete customer query
13. Is the information screen a customised information screen?	No. The information is divided into sections, which are only accessible if required during the customer query	It is user friendly information screen, with pop-ups but not as such customised information screen	No. There are lot of codes to remember to operate the system.	No. The information is very limited and only presented in certain situations
14. What type of information screen would be more useful in your current environment?	All the information related to the customer query in one screen would be more useful, rather than going back to different information screens	More product information and information which can highlight other similar products bought by other customers	More highlight on the type and value of the customer which enables the advisor to deal with the customer in better ways	Some level of help and customer background information where the system can control everything from one rather than 3-4 other systems.
15. Can you provide me with a litst of information displayed on your screen?	Customer contact details, type of customer, customer notes, service descriptions, advisor notes, order details	Customer demographic details (name, address, telephone numbers), company product details, advisor sell information, help sheets provided for advisors	Customer details, order details, contact details, customer summary (charges), account details, advisor help options	Customer data (telephone, address and id number), product information, fault and problems detail, termination of services, return of goods/products

6.2.1. Case Study 1 – Fault CC Environment

The first case study started with looking onto a telecommunications faults contact centre. The centre details are as follows. The data was collected within the ongoing data collection described in chapter 5 through semi-structured questionnaire.

- Contact Centre: Telecoms Fault Contact Centre
- Advisors: 80 Customer Service Advisor
- Managers: 6 Managers
- Environment: Fault calls, complaints, and service disruptions.

Within the telecommunication faults centre, the customer calls in to report a fault in either the telephone (voice or data) or broadband communication of the products and services used by the company. The customer itself might be calling from the line of which he/she wants to report the fault or from another line to report a particular fault for the line. The process flowchart for the centre is as shown below in figure 6.2.

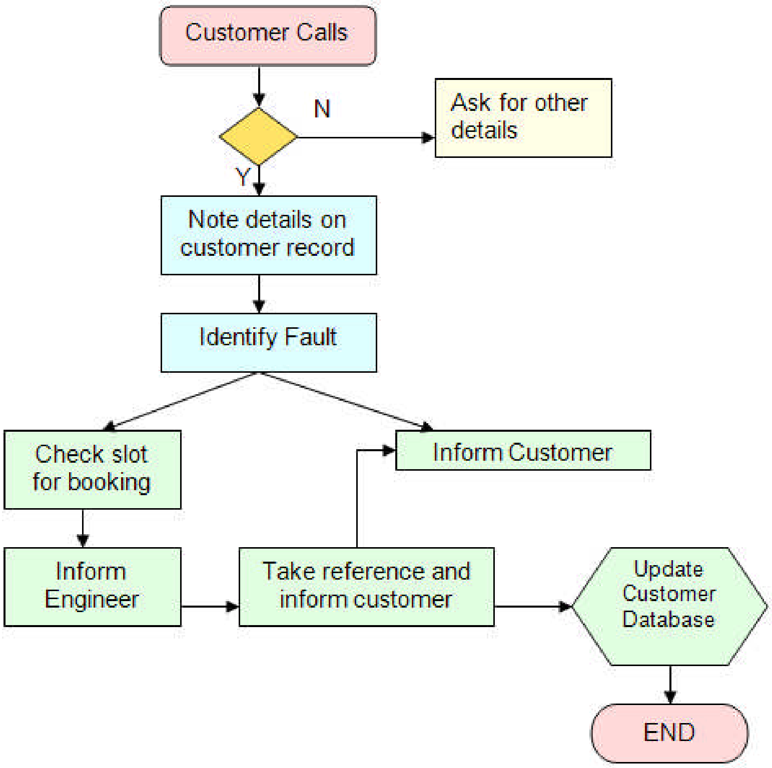


Figure 6-2: Case Study 1 – Process Flowchart

In either situation, the customer service advisor (CSA) has to do some of the following to process with the fault complaint:

- Identify the customer type by taking in the details of the customer.
- Verify the details given by the customer with that available on the customer databases (like account number, address, name etc.)

- Based on the type of fault complaint, take the necessary steps to check the fault itself, once the fault is identified, inform the customer about the fault.
- Check for the available time slot for the engineer to check and repair the fault, and inform the customer about the situation.

The system used in business fault management contact centres and consumer repair is shown in figure 6.3. The system allows the company to manage proactively the customer experience from beginning to end. Starting with fault reception and ending with a welcome back to service call

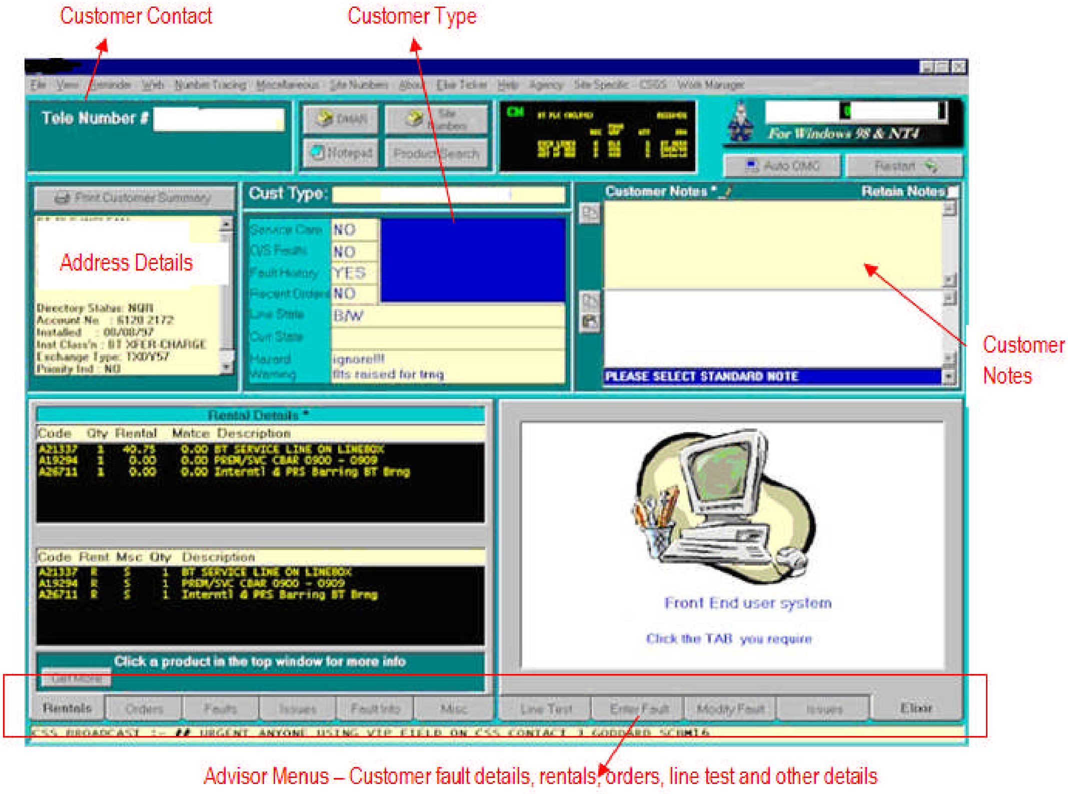


Figure 6-3: Information Screen Layout for Fault CC

The system is a desktop application that combines the various legacy systems in use at the company to enable the reporting of a fault, correct diagnosis and dispatch, keeping customers informed (KCI) and welcome back to service (WBTS). Being a PC programme, it is possible to add pop up reminders and compulsory field entries to ensure process are followed. It has full flexibility to enable swift implementation of initiatives within the repair world. In this technologically advanced world, it has a state of the art interface with the web-based tools that enhance the diagnostic processes. It has screen pop capability using the Genesys platform. One of the advantages of the system screen was that it provided some level of required information to serve the customer. Although there were no means of accessing the customer order details on the same screen layout, and the advisor had to access this information from another set of system within the network. There is a lack of cross up sell opportunities within the current system. There was also the disadvantage of not customising the information screen by providing the advisor about any other products or services that the company might offer to their customer to upgrade. As the system was looking on the information about the fault management service provided by the company, it would have also been feasible if there was an opportunity provided to the advisor to cross/up sell to their customer which serving their enquiry.

6.2.2. Case Study 2 – Sales CC Environment

The second case study conducted at a general sales contact centre, providing and selling telecoms services to the customers. The centre details are as follows:

- Contact Centre: Telecoms Sales Contact Centre
- Advisors: 120 Customer Service Advisor
- Managers: 8 Managers
- Environment: Customer Sales enquiries, new orders, product upgrade

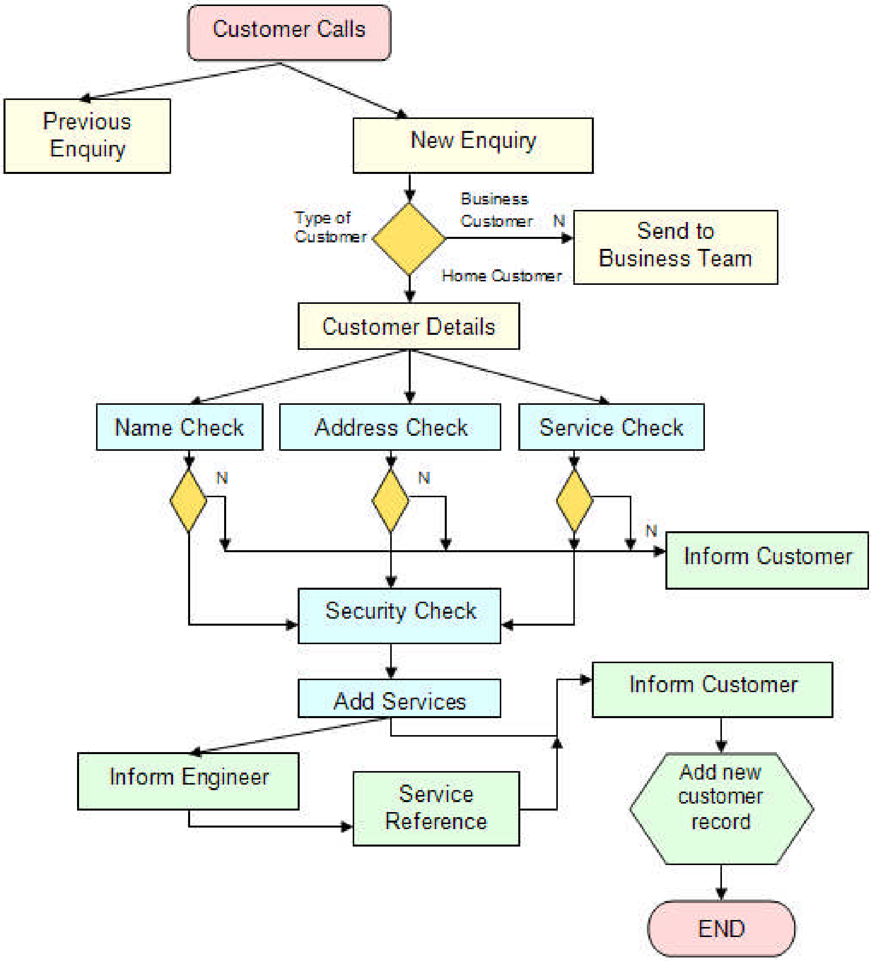


Figure 6-4: Case Study 2 – Process Flowchart

The sales advisors are divided according to the type of service required by the customer and their experience level. Another alternative of advisor teams looks into calls related to new business set-up and services. The process flowchart of the sales CC as shown above in figure 6.4.

- Once the advisor receives the customer calls, the advisor first checks whether it is an old query or a new customer query.
- For home use, the advisor takes the details about the new customer, and does a name, address and service (whether the company can provide the service to the mentioned address) checks.

Once that has done, the advisor then looks for security check about the customer (any prior credit history), and then informs the customer about the possible services and charges that may be occurred, processes the order to the service engineer, and informs the customer. The information screen layout used within the centre was not allowed to be used for data security reasons. The researcher had gathered the information within the questionnaire on the type of information provided to the advisors when dealing with customer query. The important set of information about the customer presented on the screen is as follows:

- Customer Demographic Data (Name, Address, Telephone Number)
- Company Product Details (products, services, offers)
- Advisor Sell Information (notices and warning about offers and benefits of the products sold to the customers)
- Help Sheets (for advisors who require information on specific product or service)

6.2.3. Case Study 3 – Telecoms Business CC Environment

This case study looks on a telecommunications company providing business solutions to new start up business companies or previous customers intending to upgrade their services or add on new services. The centre details are as follows:

▪ Contact Centre:	Business Solutions Contact Centre
▪ Advisors :	90 Customer Service Advisor (22 interviewed)
▪ Managers:	6 Managers
▪ Environment:	Business sales, start up companies, business solutions

The detailed flow chart of the operation of the customer calls is as shown in figure 6.5. Within the telecoms business solutions contact centre, CSA's look only to existing business customers or customers who are start up business or new business customers. These teams are having special sort of calls from the business customers, has it generates revenue and profile for the company. The following system shown in figure 6.6 is the replacement for another older version of the system used within the centre. The system enables offline order processing. It allows the advisor to capture all of the customer information on the call with the customer.

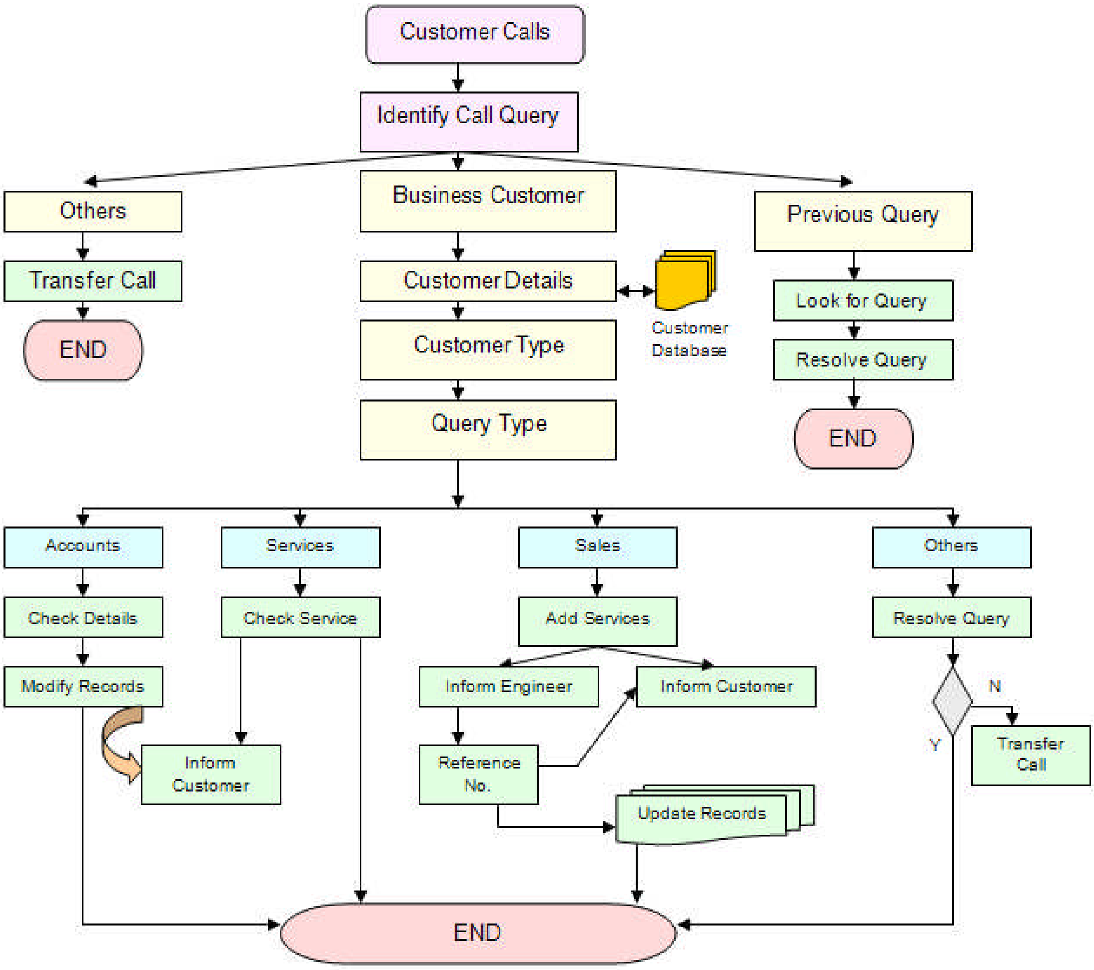


Figure 6-5: Case Study 3 – Process Flowchart

There is no time delay whilst the advisor has to wait for confirmation of the order number. The advisor is free to move to the next call whilst the order is passed offline either to a robot for complete order automation or to the back office for manual order issuing. In turn, this allows more efficient call handling at the front end. Its also improves order quality.

This system addresses the various ways in which it fulfils an order. It also address the following scenarios –

- Orders that are fully automated at the front office which (a) do not require an appointment and (b) requires an appointment.
- Non Automated orders
- Partially automated orders
- Non Sales Queries (NSQ's)

- Failed orders
- Failed orders where the robot has failed to allocate a provisional order to an order
- Finding a front end users id.

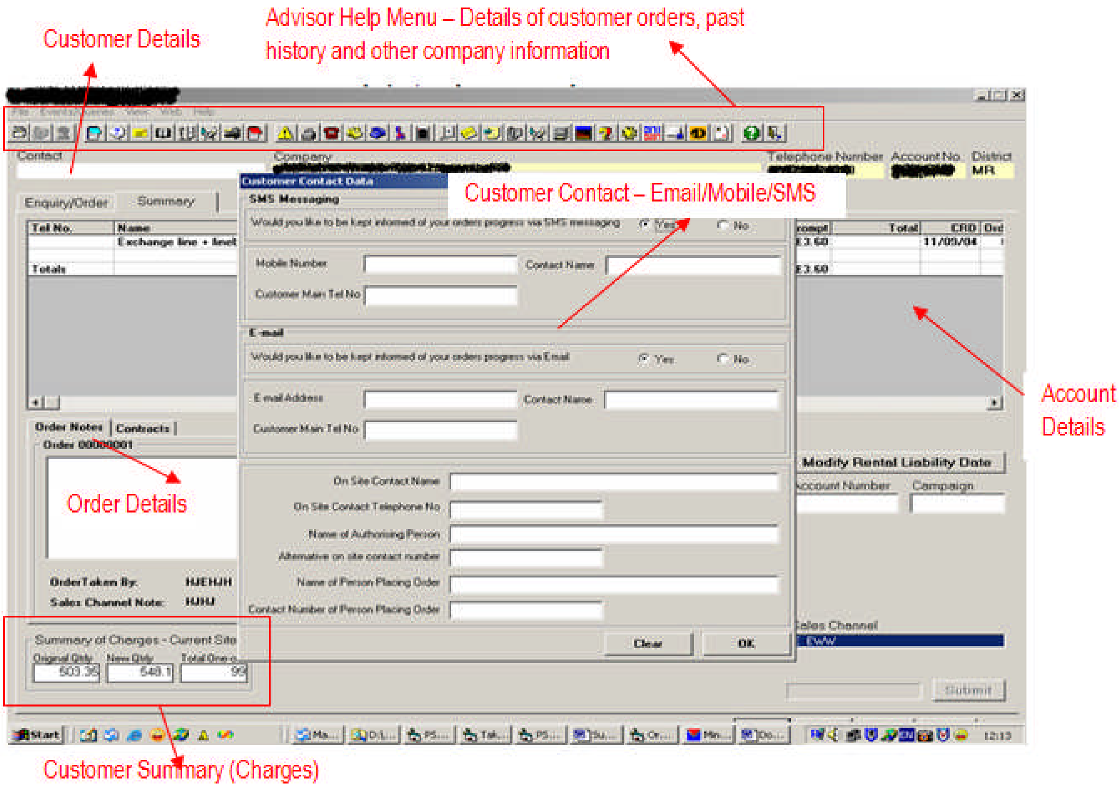


Figure 6-6: Information Screen Layout for Telecoms Business CC

It will not address the current queue structure and the routing of orders from the front office into the back office queues. However, the comments in blue regarding queue structure, desired state and actual state have been included to assist in the understanding of the current system order flow process. The information presented within the screen to the advisor depends on the type of customer and its query the advisor is resolving. The important set of information about the customer presented on the screen is as follows:

- Customer Demographic Data (Name, Address, Telephone Number)
- Business Solutions (details of products and services suitable to business customers)
- Advisor Information (details of all past history of communication with the customer to understand the query of customer)
- Help Sheets (additional information on available products and company offers)

6.2.4. Case Study 4 – General Enquires CC (Helpdesk) Environment

The following case study carried at a help desk contact centre, providing information, help and support on general enquiries to the customers about the services, products and company. Figure 6.7 shows the process flowchart of the help desk contact centre.

- Contact Centre: Help Desk Support Centre
- Advisors: 60 Customer Service Advisor (14 interviewed)
- Managers: 4 Managers
- Environment: General enquiries, account information, services and products, background info

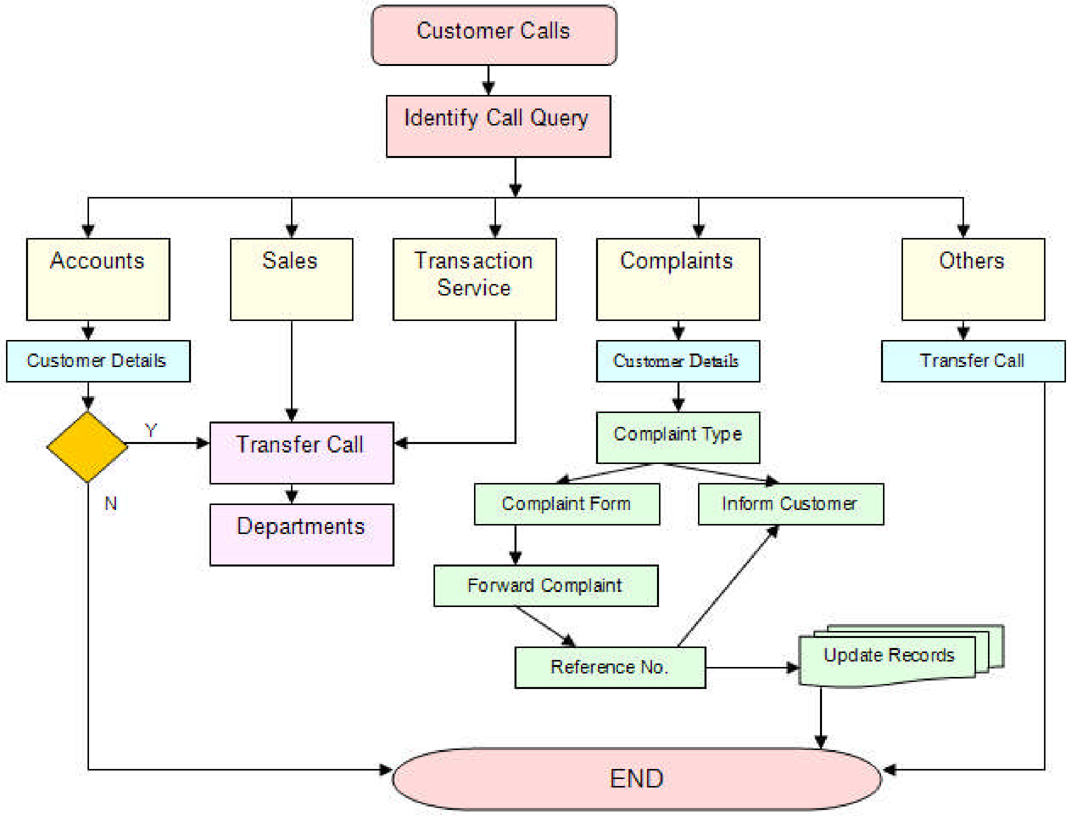


Figure 6-7: Case Study 4 – Process Flowchart

The help desk centre deals with customer calls with general enquires related to their account problems, service problems, product enquires. This help desk gets the calls from every corner of the country with any type of query, with sometimes getting the diverted calls from the customers who have been in the queue system for another service depending on the traffic of calls in the system. The information screen layout used within the centre not allowed to be used for data security reasons. The researcher had gathered the information within the questionnaire on the type of information provided to the advisors when dealing with customer query. The information presented within the screen to the advisor depends on the type of customer and its query the advisor is resolving. The important set of information about the customer presented on the screen is as follows:

- Customer Demographic Data (Name, Address, Telephone Number)
- Product Information (general product and service information)
- Fault & Problems (details registered about any problems with any products acquired from the company)
- Termination of Services (if customer wants to terminate any services)

6.2.5. Case Study 5 – Council Environment

The last of the case study was carried out at a local city council contact centre, which looks on dealing with calls of many groups and varieties from general council services, claims and benefits services, environmental and waste disposal, anti social behaviour, housing rents and benefits, council tax payments and council fraud services. Because of lack of time and the nature of work, not many advisors were available to review; but a thorough understanding of the type of work was followed and documented. The centre details are as follows.

- Contact Centre: Council Tax and Services Environment
- Advisors: 45 Customer Service Advisor (9 interviewed)
- Managers: 3 Managers
- Environment: Council tax enquiries, general council services, benefits and payments, other services.

The council services environment looks on a variety of services provided to customers (residents/business) within the area. Because of the nature of work and data involved within the centre, the researcher was limited to only certain areas of the centre overlooking on the services provided within the centre. The process flow chart of council contact centre is as shown below in figure 6.8. The process for any given customer call is diverted to seven different types from council services to tax payments and housing. Each call is then dealt with a specialist advisor who helps the customer query. There is also an identification setup, which can identify if the caller is a business customer or a residential customer. The following system was used within general enquiries of the council environment CC. The screen highlights the details of the customer and the advisor is given with other added benefits to serve the customer query as shown in figure 6.9.

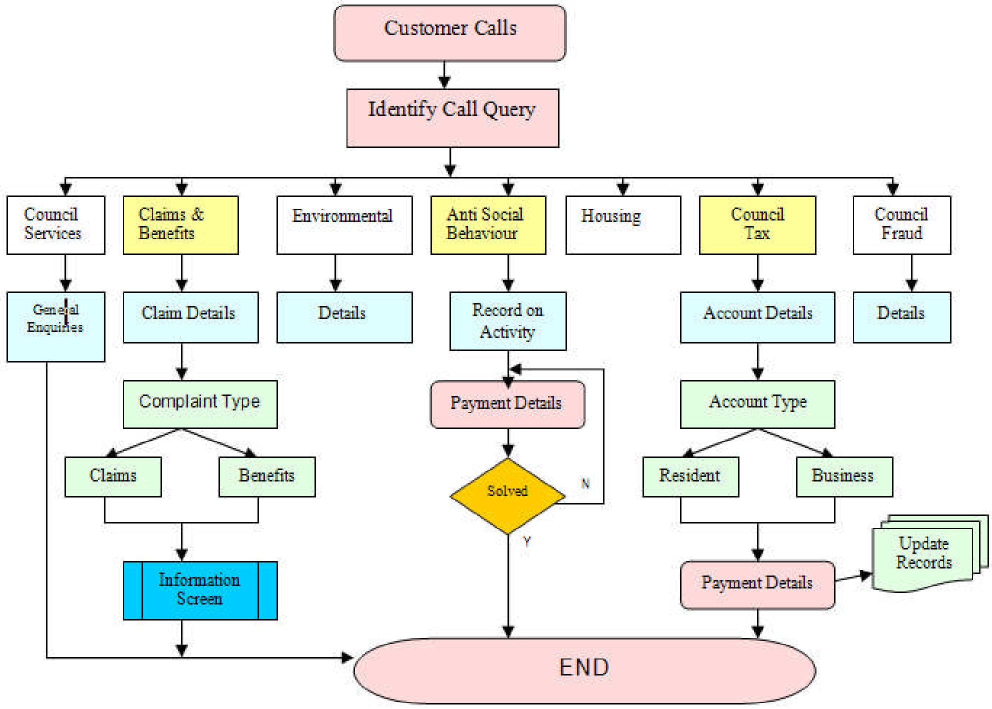


Figure 6-8: Case Study 5 – Council Process Flowchart

The screen presents the system used in dealing with city council customer contact database, which are primarily the citizens and businesses within the city.

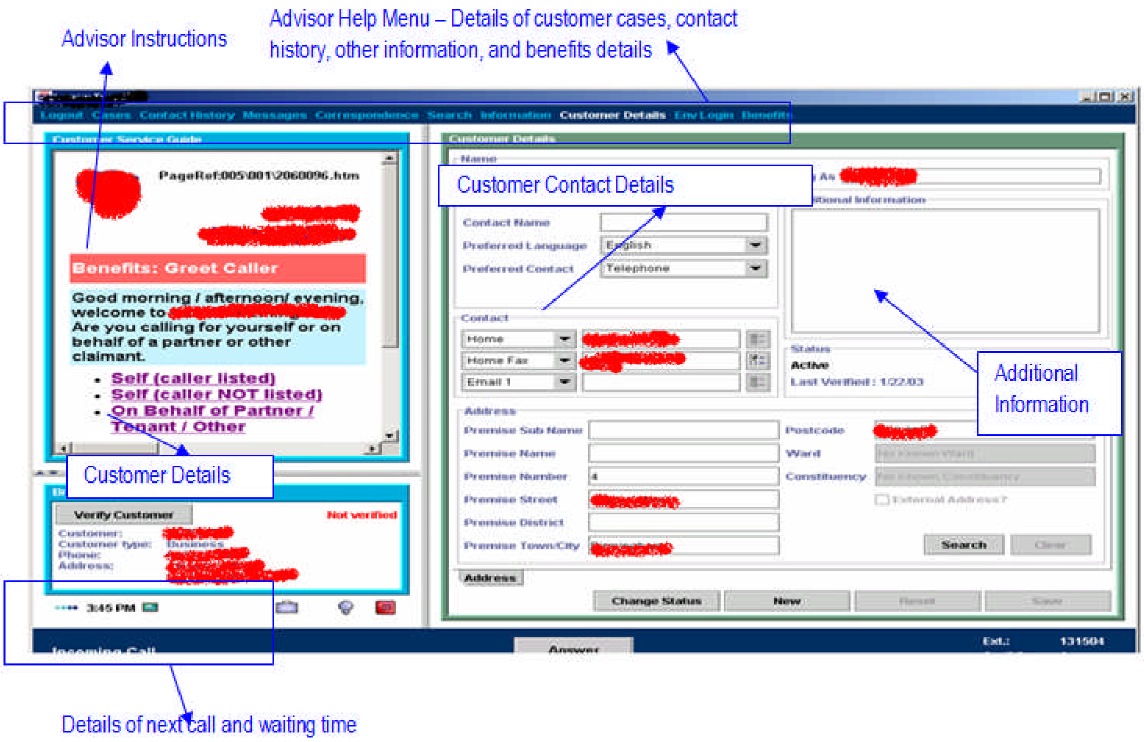


Figure 6-9: Information Screen Layout for Council Environment CC

The system mainly used for:

- Record customer’s details name, address and contact details
- Record details of customer enquiry to create a contact history
- Provide supporting scripts to assist CSA’s answering enquiries
- Provide supporting information from City Council to answer the enquiry

Provide management information on call volumes and enquiry types

The information presented within the screen to the advisor depends on the type of customer and its query the advisor is resolving. The important set of information about the customer presented on the screen is as follows:

- Customer ID Details
- Type of Service Required will then display the relevant information on screen
- Customer past query records
- Records of the outcomes and work carried out

6.3. Challenges of creating Information Requirement

There are several challenges posed by the creation of information requirement within current contact centre domain. These challenges often inhibit the wider application of these procedures for customer/advisor categorisation. This section identifies the challenges from CC application viewpoint and also from advisor requirements use within the contact centres. Based on data collection results (chapter 4) and from literature studies (chapter 2), the author identified the challenges of information requirement in contact centres.

6.3.1. Challenges of Information Requirement in CC

Although the industries are aware of the information overload problem identified in chapter 2 which is of the problem in any customer facing environment, industries are trying to find solutions to resolve this problem which can improve satisfaction levels of both the customer and advisor. This section presents the challenges poised by the information requirement framework from an contact centre prespective based on the author’s observations on the contact centres reviewed through case studies and the development activities. The observations have been acquired throughout the period of research and during the data collection and validation studies conducted in the industry environment. The cross-disciplinary data collection approach adopted in this research has enriched the knowledge used for generating the observations outlined below.

Due to the high volumes of data been used in contact centres, there is a problem of information overload identified earlier in chapter 2 and later within the chapter.

To overcome the issue of *information overload;* which acquires all the information present within the system and identifies the necessary information to use in any given scenario.

During the initial studies by the author on the layout and description of the information screen, the author identified that the screen were not customised or user friendly. Although many systems are not just stand alone systems and they are linked to other networked systems, but the use of *customised information* which allows the advisor (user) to use the information screen in efficient manner. From the design point of view on the information screens provided to the advisors, the general layout of the screen was also the reason the advisor was finding it difficult to access and acquire the necessary information. Based on this observation, the author concluded that if the general layout of the information screen is modified; it would enable the advisor to find all the necessary information required in any particular combination.

6.3.2. Challenges of Information Requirement on Advisors

This section identifies some challenges of information requirement posed on the service advisors (CSA) within contact centres. Through the challenges identified from the information requirement on the contact centres designers and experts within, this section describes the requirements of the information requirement from the advisors view. The information presented within this section was collected as part of data collection presented in chapter 4. An information screen that can satisfy all the areas of information required by the advisor in order to serve the customer is crucial within any organisation.

Advisors have a ***lack of knowledge*** on the working operations of the systems they are using, other than the use based on a 10-15 day training period. The training is focussed more on basic features on the use of the system, and the advanced features are left for the advisors to understand and operate once they are familiar with the system functionalities. One of the team experts identified the problem during a semi-structured interview including the author. The team expert was asked about the viewpoint regarding the training provided to these advisors. An important criterion of information requirement framework is the use of ***customised screen*** that enables the advisor to use this information more efficiently. The advisors mentioned to the author during the initial interviews that the use of customised information would be more useful rather than a normal "information dump" screen.

Most of the organisations are keen on the ***talk times*** (i.e. the time it takes by the advisor to serve a customer query) identified in chapter 4. The advisors adhere to these times in order to serve the customer and for that, they need to find the necessary information within the period. Some of the systems viewed during the analysis were also not stand-alone systems, and therefore the advisors find it difficult to ***access all required areas of information*** on one screen. On some occasions, the author noticed that at one given time, the advisors were looking on three different information screens in order to find the required information to serve the customer enquiry. Based on all of the above observation the author identified the use of information requirement based on providing the relevant information to the advisor at the required time and the use of customised information screens would be useful in order to satisfy all of the above challenges. Section 6.1 describes examples of the type of information screen used by the companies during the case studies conducted by the researcher.

6.4. Development of Information Requirement Framework

In any customer facing environment the information requirement is crucial to any business success in providing better customer service and satisfaction levels. The design and layout of the information screen, information provided and the time it takes to access the information all play important factors in the development of the framework. The proposed information requirement framework developed from the research for identifying the minimum amount of information required at any given customer advisor situation is as fhown in figure 6.10. This section explains the complete list of information that requires displaying to the advisor to help them to understand and resolve the query of the customer. Information requirement development was done on the basis of the set of categories for customer and advisor derived from the clustering and assigned through fuzzy expert system model.

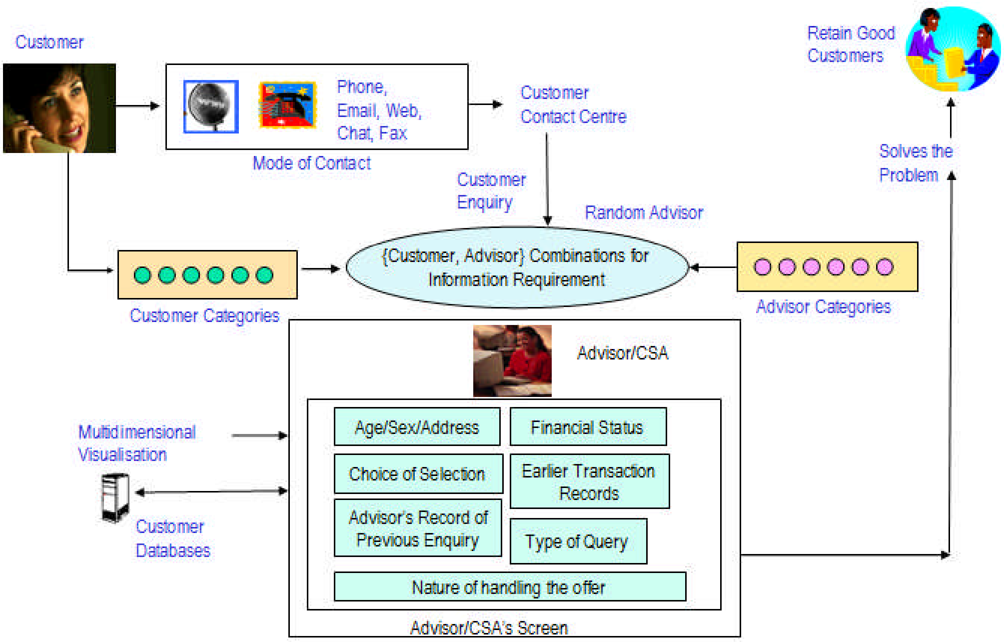


Figure 6-10: Proposed Information Requirement Framework

The main objective of this section was to identify the minimum amount of information which is required to be displayed on the screen to the advisor which would enable the advisor to help the customer. This information should always satisfy the three important business aspects of customer contact which were (1) Customer Satisfaction, (2) Resolving the conflict and (3) Cross Sell – Up Sell opportunities.

Information Requirement framework was developed to overcome the *information overload* with the current contact centre environment

Also from the point of customer satisfaction *speed of response* was crucial and the *right amount of information* which is required to be displayed to the advisor under particular customer – advisor situation was important (Shah, *et al.* 2007). Once the information to be displayed to the advisor is known from the possible combinations of {customer, advisor}; the information is then grouped into master list of information screen (Shah, *et al.* 2006). The main objectives behind the design and development of the information requirement framework were identified through literature studies identified within chapter 2 and from the expert judgements derived during the case study analysis and the use of minimum amount of information screen. Some of the key objectives are as below:

- To identify the minimum amount of information required by the advisor to serve the customer in any situation or possible combination
- To provide the right amount of information at the right time, at the right place and in the right quantity.
- To provide the information in the format any advisor from experienced to novice can use it and serve the customer to the best possible manner.
- To reduce the problem of information overload identified earlier in chapter 2.

6.4.1. Identification of Minimum Amount of Information Requirement

The following section outlines the minimum amount of information which is required by the advisor in any situation. The information was derived by the author based on the judgement from the experts at contact centres and through literature discussed in chapter 2 and in appendix F (system analysis). The steps followed for identification of the information required for any given situation is as follows:

1. Customer Info – details about the customer and account status
2. Company & Product Info – details about the services and products, their status details, transaction and financial details and any complaints information
3. Advisor Info – details about the last communication from the customer, any product updates and add on, and any change of services notification.

The details were captured during the data collection using semi-structured questionnaires, and advisor and teamleader/managers were asked on the type of information required in any of the combinations discussed in chapter 5 of categorisation. The list of information required to be displayed on the advisor screen is divided into three main categories namely:

1. Customer Information

- Customer ID info - Customer information (name, telephone number, etc)
- Type of customer - Customer type – business, residential, single, etc.
- Address details. – customer address details
- Demographic data – other demographic data (marital status)

This information is the basic information about the customer based on the data provided by the customer to the company during the initial registration. This information is always needed in all the cases as the advisor can verify whether they are dealing with the customer only, or someone on behalf of the customer. Depending on the nature of the query; the advisor can only deal with the customer directly and not with someone else on their behalf. Because of the data protection and privacy act the advisor is also not allowed to disclose any of the personal information to any third party.

2. Business (Service) Details

- Type of services and products ordered – customer records of products
- Time with the company – the length of time customer is with the company
- Previous transaction details – last customer communication with the company
- Behavioral changes – any change in the behaviour of the customer
- Financial Status – financial status, job status etc.
- Buying Power – the buying power, regularity of buying
- Complaint Details – customer complaints in the past history.

This information relates to the customers service details with the company. It also shows the type of services and products the customer is currently subscribed to (in case of a telecoms or internet service provider) or the products the customer has bought in the past years (Past History in case of retail and financial sector). In many cases of the {customer, advisor} combinations, it would also show the financial status and buying power of the customer, which would enable the advisor to have any cross / up sell opportunities. The advisor in the customer database records any change in the behaviour.

3. Advisor Details

- Business value to the company – the value the customer is bringing to the company (business customer – high value)
- New products and services (cross / up sell) – according to the customer likes and dislikes; list of new products/services which be offered to the customer.
- Last advisor details – the last advisor notes and communication message
- Account update – any change in account status, cancellation etc.

- Change of services – any change in services
- Product update – awareness to the product to the customer.

This category of information based on the business value of the customer towards the company. This information section would help the advisor to identify the customer potential of buying new products / services. It would show the advisor the possibility of the cross sell and up sell opportunities. It would also show the advisor, all the information of the previous transaction of the advisors who dealt the particular customer, which would enable them to deal with the customer in the most efficient manner. Once the total information to be displayed was known, it was validated with the industry experts as described later in section 6.5.

6.4.2. Master Information Screen

From the initial understanding of the contact centre and from the literature the author designed a template with the complete list of information, used during a particular customer-advisor conversation. This list divided into three sections with customer information, business service details and advisor details.

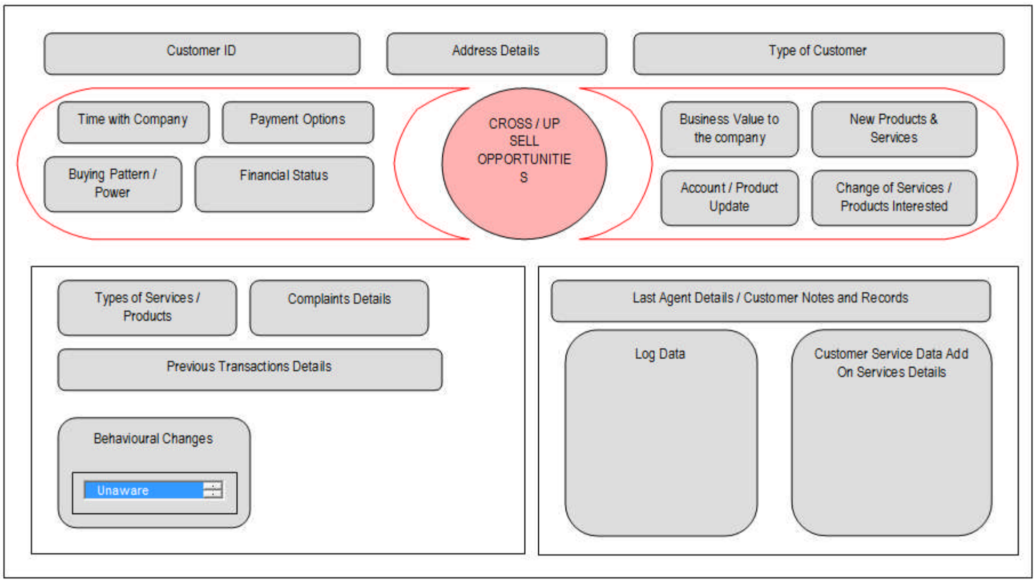


Figure 6-11: Master Information Screen Layout

Based on the list of the information screen to be displayed to the advisor, a master screen was derived and as shown in figure 6.11 (Shah *et al.* 2006). The following section provides the design of an information requirement framework for identifying the minimum amount of information required by the advisor. The information should also satisfy the business requirements discussed in section 6.4 to provide better service to the customers. Once identification of the total information to display was carried out, validation with the industry experts of team leaders and advisors within the centre was conducted.

6.4.3. Customer – Advisor Mapping Combinations

Based on the information provided through case studies, the author identified the information to be used within the framework and as discussed in section 6.2. Once the identification of the information was derived the customer and advisor mapping combinations were derived through the categories described in chapter 5. The combination of customer and advisor can identify which of the information screen is required to be displayed to the advisor during any particualr combination. The information required for each set of customer-advisor combination was derived on the basis of categorisation and from questionnaire used during validation of the frameworks. The examples of customer – advisor combination is described in section 6.5. The mapping table used for customer and advisor combination highlighted the use of different combination that are possible based on the categorisation framework. The information required for each of the combination shown in the mapping table (figure 6. 12) was derived through expert knowledge from team leaders and advisor at contact centres.

A1C1	A1C2	A1C3	A1C4	A1C5	A1C6
A2C1	A2C2	A2C3	A2C4	A2C5	A2C6
A3C1	A3C2	A3C3	A3C4	A3C5	A3C6
A4C1	A4C2	A4C3	A4C4	A4C5	A4C6
A5C1	A5C2	A5C3	A5C4	A5C5	A5C6
A6C1	A6C2	A6C3	A6C4	A6C5	A6C6

Figure 6-12: Customer-Advisor Mapping Table

A business strategy capture table was created by the author to capture the information requirement for each of the combination. The experts were asked for each of the combination by showing them the categories for customer and advisors. The requirements were captured in an iterative manner and final set of information requirement are presented in table 6.3. Through the scope of the research, the author has identified more ways of representing the information and which are discussed later in the chapter 8 within the discussion and conclusions section. The next section describes the valdiation approach used to validate the information requirement framework at the contact centres, through expert judement.

Table 6-3: Set of Information required in Customer – Advisor Combinations

CUSTOMER

ADVISOR	C1	C2	C3	C4	C5	C6
A1	Customer ID, Address details, Type of customer, Time with company, payment options, financial status, account update, type of services, complaints details, previous transactions, behavioural changes, last advisor details, log data, customer service data	Customer ID, Address details, Type of Customer, Time with company, buying pattern, financial status, cross/up sell opportunities, business value to the company, new products and services, change of services, type of services, previous transaction details, behavioural changes, last advisor details, log data, customer service data	Customer ID, Address details, Type of Customer, time with company, financial status, cross/up sell opportunities, account update, new products and services, type of services, previous transaction details, behavioural changes, last advisor details, log data, customer service data	Customer ID, Address details, Type of Customer, buying pattern, financial status, cross/up sell opportunities, business value to company, new products and services, change of services, previous transaction , behavioural changes, last advisor details, log data, customer service data	Customer ID, Address details, Type of Customer, time with company, buying pattern, cross/up sell opportunities, business value to company, new products and services, account update, previous transaction details, behavioural changes, last advisor details, log data, customer service data	Customer ID, Address details, Type of Customer, payment options, financial status, account update, type of services, complaints data, previous transaction details, behavioural changes, last advisor details, log data, customer service data
A2	Customer ID, Address details, Type of Customer, time with company, payment option, account update, type of services, complaints data, previous transaction details, behavioural changes, last advisor details, log data	Customer ID, Address details, Type of Customer, financial status, cross/up sell opportunities, business value to company, new products, change of services, type of services, previous transaction details, behavioural changes, last advisor details, log data	Customer ID, Address details, Type of Customer, payment options, account update, type of services, previous transaction details, behavioural changes, last advisor details, log data, customer service data	Customer ID, Address details, Type of Customer, time with company, buying pattern, cross/up sell opportunities, business value to company, new products, change of services, previous transaction details, behavioural changes, last advisor details, log data, customer services data	Customer ID, Address details, Type of Customer, time with company, buying pattern, cross/up sell opportunities, business value to company, new product and services, account update, type of services, previous transaction details, behavioural changes, log data, customer services data	Customer ID, Address details, Type of Customer, payment options, account update, type of services, complaints data, previous transaction details, behavioural changes, last advisor details, log data, customer services data
A3	Customer ID, Address details, Type of Customer, payment options, financial status, account update, complaints data, previous transaction details, behavioural changes, last advisor details, log data, customer services data	Customer ID, Address details, Type of Customer, time with company, buying pattern, cross/up sell opportunities, business value to company, new products, account update, type of services, previous transaction details, behavioural changes, last advisor details, log data, customer services data	Customer ID, Address details, Type of Customer, payment options, account update, type of services, previous transaction details, behavioural changes, last advisor details, log data, customer services data	Customer ID, Address details, Type of Customer, buying pattern, cross/up sell opportunities, business value to company, new products, change of services, type of services, previous transaction details, behavioural changes, last advisor details, log data, customer service data	Customer ID, Address details, Type of Customer, payment options, buying pattern, cross/up sell opportunities, business value to company, new product, type of services, previous transaction details, behavioural changes, last advisor details, log data, customer services data	Customer ID, Address details, Type of Customer, time with company, financial status, account update, type of services, complaints details, previous transaction details, behavioural changes, last advisor details, log data, customer services
A4	Customer ID, Address details, Type of Customer, time with company, financial status, change of services, type of services, complaints details, previous transactions details, behavioural changes, last advisor details, log data, customer services data	Customer ID, Address details, Type of Customer, time with company, payment options, business value to company, account update, type of services complaints details, previous transaction details, behavioural changes, last advisor details, log data, customer services data	Customer ID, Address details, Type of Customer, payment options, account update, type of services previous transaction details, behavioural changes, last advisor details, log data, customer services data	Customer ID, Address details, Type of Customer, payment options, cross/up sell opportunities, change of services, account update, type of services previous transaction details, behavioural changes, last advisor details, log data, customer services data	Customer ID, Address details, Type of Customer, time with company, buying pattern, cross/up sell opportunities, account update, business value to company, type of services previous transaction details, behavioural changes, last advisor details, log data, customer services data	Customer ID, Address details, Type of Customer, time with company, financial status, account update, type of services, complaints details, previous transaction details, behavioural changes, last advisor details, log data, customer services data
A5	Customer ID, Address details, Type of Customer, time with company, payment options, account update, type of services, complaints details, previous transaction details, behavioural changes, last advisor details, log data, customer services data	Customer ID, Address details, Type of Customer, financial status, time with company, buying pattern, cross/up sell opportunities, business value to company, change of services, type of services previous transaction details, behavioural changes, last advisor details, log data, customer services data	Customer ID, Address details, Type of Customer, payment options, time with company, account update, type of services previous transaction details, behavioural changes, last advisor details, log data, customer services data	Customer ID, Address details, Type of Customer, payment options, , buying pattern, cross/up sell opportunities, business value to company, new product, change of services, type of services previous transaction details, behavioural changes, last advisor details, log data, customer services data	Customer ID, Address details, Type of Customer, payment options, financial status, business value to company, new product, account update, type of services previous transaction details, behavioural changes, last advisor details, log data, customer services data	Customer ID, Address details, Type of Customer, payment options, time with company, account update, type of services previous transaction details, behavioural changes, last advisor details, log data, customer services data
A6	Customer ID, Address details, Type of Customer, time with company, payment options, financial status, account update, type of services, complaints details, previous transaction details, behavioural changes, last advisor details, log data, customer services data	Customer ID, Address details, Type of Customer, time with company, payment options, cross/up sell opportunities, account update, type of services, complaints details, previous transaction details, behavioural changes, last advisor details, log data, customer services data	Customer ID, Address details, Type of Customer, time with company, payment options, account update, type of services, complaints details, previous transaction details, behavioural changes, last advisor details, log data, customer services data	Customer ID, Address details, Type of Customer, time with company, buying pattern, financial status, cross/up sell opportunities, business value to company, new product, change of services, type of services previous transaction details, behavioural changes, last advisor details, log data, customer services data	Customer ID, Address details, Type of Customer, time with company, buying pattern, financial status, cross/up sell opportunities, business value to company, new product, type of services previous transaction details, behavioural changes, last advisor details, log data, customer services data	Customer ID, Address details, Type of Customer, time with company financial status, account update, change of services, type of services previous transaction details, behavioural changes, last advisor details, log data, customer services data

6.5. Validation of Information Requirement Framework

The information and the results from the model verified through team leaders and managers at three of the contact centres where the case studies conducted. A total of five team leaders and managers were interviewed with the help of an open set questionnaire (appendix K) showing the categories derived and the assignment of a particular customer or advisor to these categories through the help of the fuzzy expert system tool developed. The team leaders at the contact centre were shown the possible combinations of the customer and advisor categories, and on what basis these categories were derived.

6.5.1. Validation Questionnaire Details

The questionnaire used for validation of the information requirement is as described below in table 6.5. The questionnaire were divided into three sections mainly as (1) Complete Information Screens, (2) Examples of Information Combinations and (3) Any modifications on the information screen layouts. The experts from the contact centres used for validation are as shown in table 6.4.

Table 6-4: Validation Interview Details

	Validation Interview Details – Team Leaders and Advisors		
	CC – Role	Age Group	Experience
Contact Centre (A)	Team Leader (TL) (2) Advisor (A) (3)	28 and 35 yrs 18-25 (1), 25-40 (1), 40+ (1)	1 TL – 4/6 yrs, 1 TL – 8-10 yrs 1-5 (1), 5-10 (1) 10+ (1)
Contace Centre (B)	Team Leader (1) Advisor (2)	32 yrs 18-25 (1), 25-40 (1)	TL -4-8 yrs 1-5 (1), 5-10 (1)
Contact Centre (C)	Team Leader (1) Advisor (2)	28 yrs 18-25 (1), 40+ (1)	1 TL – 5-7 yrs, <1 yrs (1), 1-5 (1)
TL – Team Leader, Manager – M			

They were initially asked the questions related to the information requirement, followed by the examples for the given customer and advisor combinations. The author had used six different combinations from the possible thirty-six combinations of customer and advisor as an example.

Table 6-5: Validation Questionnaire for Information Requirement Framework

Section 1: Complete Information Screens
1. Is the minimum information displayed on the screen appropriate for the given customer-advisor combination?
2. Is there any specific information that is not specified?
3. What do you think about the list of complete information shown here?
4. What are your views regarding the information “master screen” shown here?
Section 2:Examples of Information Screens
5. Do you agree to the type of information been shown for the examples given? If No - Explain
Section 3: Modifications/Suggestions to the Framework
6. Are there any modifications required to the information requirement framework provided here?
7. Any suggestions.

The validation was carried out within the validation questionnaire explained in table 6.5 and summarised below in table 6.6. This section explores the concept customer and advisor combination information screens used for the validation of the information requirement framework of the research. The author has highlighted two examples of the combination based on the mapping table, and how the information would be presented to the advisor on these combinations. Full list of combinations of customer and advisors and the respective screens can be found in appendix M. The examples of customer and advisor mapping combinations for the type of information required to be displayed is as shown in table 6.6. Six examples were conducts with expert judgement and results for the examples are discussed later in the section.

Table 6-6: Customer and Advisor Mapping Examples used in Validation

				Customer – Advisor Mapping Examples
No	Advisor	Customer	Mapping Combination	Information Requirement
1.	A1	C1	A1 – C1	Customer ID, Address Details, Type of customer, Time with Company, Payment options, Financial status, Cross/Up sell, Types of products services, Previous transaction details, Log data, behavioural changes, Last advisor details
2.	A1	C4	A1 – C4	Customer ID, Address details, Type of customer, Cross sell, Time with company, Buying pattern, Financial status, Type of services, Business value to company, New products and services, Change of services, Last advisor details
3.	A4	C4	A4 – C4	Customer ID, Address details, Type of customer, Buying pattern, Financial status, Business value, New products, account update, change of services, Type of services, Customer service data, Last advisor details
4.	A3	C6	A3 – C6	Customer ID, Address details, Type of customer, Payment options, Buying pattern, Account update, change of services, Type of services, Previous Transfaction details, Behavioural changes, Last Advisor details, Log data.
5.	A4	C2	A4 – C2	Customer ID, Address details, Type of customer, time with company, Financial status, Account update, New products, Change of services, Complaints data, Behavioural changes, Last Advisor Details
6.	A5	C1	A5 – C1	Customer ID, Address details, Type of customer, Account update, Type of services, Complaints data, Previous transactions data, Log data, Behavioural changes, Last advisor details

An example of one of the customer advisor combination is as shown in figure 6.13 for Advisor (A1) and Customer (C1) category. For the information required to be displayed on the screen for other combination refer to table 6.3.

Example 1: Advisor (A1) and Customer (C1) – Worst Case Scenario

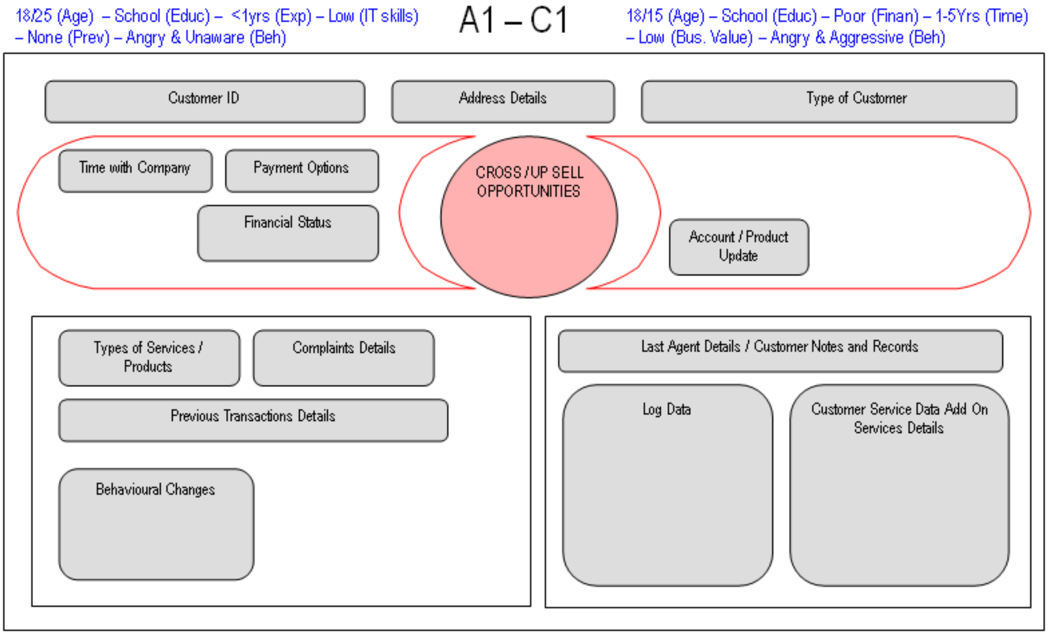


Figure 6-13: Information Screen Layout for A1 – C1

6.6. Results from Validation

Validation of the information requirement framework was carried out with set of questions and examples of six combinations, which were shown to the experts from the industry. Results from this validation showed the following:

- Three team leaders at three different contact centres agreed to the type of information displayed on the screen for the given customer advisor combination was appropriate to that case.
- One team leader was more concerned with the level of details provided within the screen would vary according to the type of customer and nature of query.
- Out of seven advisors, six advisors find the information useful compared with their existing system. The results also showed that these advisors were comfortable by using one information screen rather than separate screens to find the relevant information. One advisor preferred to have more detailed options on the “cross/up sell opportunities” section to allow him to help the customer better.
- For our test example case (A1-C1), one team leader preferred not to have the option of “cross/up sell opportunities”, as it was not required in the given case.

The summary of the information requirement framework validation is as shown in table 6.7. From the results of the validation, the following modifications/alterations were carried out in the framework, which were:

- Because of the nature of work carried out at each individual contact centre, it was not feasible from research project within the framework to design information screens specific to individual design requirements.
- More details on cross/up sell opportunities can be provided within the framework during the implementation of the framework in real environment, which enables the advisor to have more information that is specific.
- For the combination of A1-C1, cross/up sell feature was removed due to the requirement of the specific combination of customer and advisor. Although financial details feature was left on the screen to provide better update on the type of customer as shown below in figure

Based on the analysis of the results from the validation, the author then interpreted for the remaining combinations of information screen for customer and advisor. As the author had worked on the extreme examples as described in table 6.6, it was assumed that other remaining sets could be derived based on the six cases. The information screens used for the six cases are explained in section 6.5 and full details of the test examples are explained in appendix M.

Table 6-7: Summary of Information Requirement Validation

	Information Requirement Validation – Contact Centres				
Criteria	**CC – A**	**CC – B**	**CC - C**	**Summary**	**Critical Analysis**
1. Is the minimum information displayed on the screen appropriate for the given customer advisor combinations?	Yes. The information does satisfy the requirements for the advisor to serve the customer in the situation. Although the type of customer is only known to the advisor once the customer provides with the details	Yes. The given customer and advisor combinations are satisfactory in the framework shown here. Within real environment it might require to make changes accordingly	Yes. For the given set of combinations within your framework, it does satisfy all the information provided for the combinations	The minimum information displayed on the screen was satisfactory within the given situation and no changes were as such required	No modifications were done to the framework on the basis of the expert judgement provided by the managers at the centre
2. Is there any specific information that is not specified?	Details about the allocation of the service update would have been useful within our environment (faults). Also details about communication via the means of chat and text feature	More details about the cross sell of products, as it might be required to update the information regularly to make the advisor aware of all the current offers	Details about other similar products (business products) that other customers might have used in similar situations of the present customer.	Allocation of the service update More details about the cross/up sell features Details of similar products on offer	It is not feasible within the framework to design specific to the requirements of centre. More details of cross sell are addressed. Details of other similar products can only be added when the framework has that information.
3. What do you think about the list of complete information shown here?	This is an exhaustive list which may not be necessary for the advisor during each customer interaction, but yes it does covers most of the aspects of customer – advisor communication	The division of the type of information is a good way to identify the complete set of info. The cross sell option shown can tell the advisor (new) about the possible chances for advising the customer with new products and services.	This may not be required in all of the cases. The advisors are experts in their working environment, and if they are there to sell the products, they do not need to be shown about the "cross – up sell opportunities" option.	Cross and Up sell opportunities may not be required in every case, and to that of the experienced advisors.	Cross & Up sell opportunities were selected carefully for new advisors and advisors with less knowledge about the customer type.
4. What are your views for the information "master screen" shown here?	Some of the information shown in the master screen may not be required for the current working environment (ex. Financial details of the customer)	This is something we always have thought about, but the problem of the amount of information which is relevant for the particular case should be the main focus.	The master screen shows all sorts of various CC environments. Faults team may no require the payment options and so on. Looks descriptive and quite helpful.	Master screen shows all sorts of information which might be required in some of the cases	Changes were made within the master screen on the basis of the feedback provided through earlier question (a) of the section with regards to cross – up sell opportunities.
5. Do you agree to the type of information been shown for the examples given?	Scenario 1 – (A1 – C1) – The financial status of the customer is not required by the advisor to solve the customer query. Payment options list is sufficient.	Scenario 1 – (A1 – C1) – Looks okay with the option of previous transaction details for this type of customer	Scenario 1 – (A1 – C1) – Cross sell option not required in this case.	Financial status and cross sell options are not required.	Cross sell feature is removed and financial details are left on the screen for better update on the type of customer to the advisor

6.7. General Observations

This chapter proposed solutions to the two problems that the information requirement framework is required to satisfy. The solution relates to the information requirement within contact centre environment where the advisors access this information to serve the customer enquiry.

The proposeed approach exploits the use of minimum amount of information which is required at any particular time to the advisor to create a customised information screen required to serve the customer. However, this approach is limited to when the information provided on the screen is required by the advisor for the particular task required within the organisation. Depending on the type and work of the contact centres, the information screen can be modified in order to satisfy the requirements of the user (advisor).

One of the key challenges these approaches poses to normal information modelling is of user behaviour requirements. Although the framework proposed within this research does include the element of the user behaviour segment, but from the user point, it must be required to use appropriately in order to maintain the relation of the customer to the company. The solution to this problem was identified by the author during the validation of the case studies conducted with the team leaders. The behaviour element within the information screen can only be changed by the advisor if the advisor notice any change in customer behaviour. Once this change is noticed, the advisor then selects the behaviour change and notifies within the system the reasons of this change. This does not affect in any way, the customer is treated during the next conversation. This information is then passed on the team leader to verify if the change of customer behaviour was justified. Its upto the team leaders descrition that the final change in customer behaviour should be entered onto the customer record.

Another important solution addressed through the proposed framework was of record of customer interaction. During the intital studies it was noted that only some systems have the method of recording all of the previous customer interaction records. Through the proposed framework, the advisor can record each and every details of the interaction that takes place during the call with the customer. This features enables the next advisor who is dealing with the same customer enquiry in future to refer the records and details about the interaction. Finally, the proosed framework has identified the use of customised information through which it enables the advisor to access the customer information in more efficient manner. Previous studies and through case study analysis it was identified by the author that the advisor face it difficult to access all areas of information at the same time when required. Some of the information is not available within the same screen, and they have to manage two to three different information screens to serve the customer query. The next section describes the use of this in more detail.

6.8. Proposed Intelligent Decision Support Framework

Through the proposed methodology for categorisation of customer and advisor, the author has demonstrated a way that can help to identify the right amount of information, which can enable the advisor to deal with the customer more efficiently and thus providing better customer satisfaction. The main parts that are discussed here for the development of intelligent decision support framework are as shown below in figure 6.14.

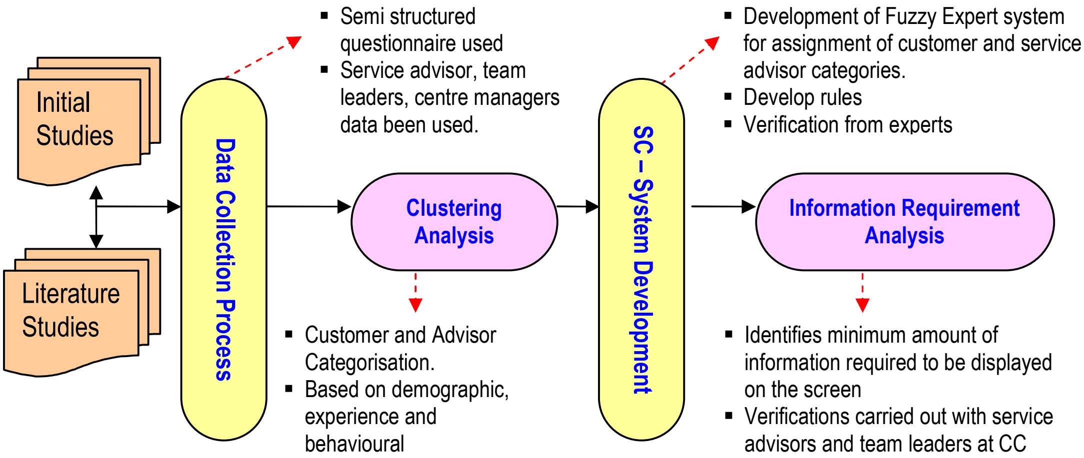


Figure 6-14: Development of Intelligent Decision Support Framework

Based on the understanding developed through literature and through the initial discussions, the author identified the requirements for the development of the simulation framework within this section. Based on the following design requirements the simulation framework will be developed. This will simulate the categorisation and information applications within any given customer – advisor situation within CC as shown in figure 6.17. The stages for development of simulation framework are discussed as follows:

Phase 1 **Data Reading (Customer/Advisor Database)**
The data for customer and advisor read from the database within the system.

Phase 2 **Categorisation**
Based on the data, the fuzzy expert system assigns each customer and advisor to that of a pre-defined category.

Phase 3 **Information Requirement**
Once the category is identified, the information requirement model will identify the screen required in that combination

Phase 1 – Data Reading (Customer and Advisor Database)

The first phase within the framework is to call (read) the data from the customer and advisor database. The data points entered within the database are based on the selection of attributes identified earlier in chapter 4 and 5. The data set are created in excel sheet to be read from the decision support framework during the simulation validation. The steps followed with this phase in figure 6.17 are: (1) Customer calls the contact centre with specific query about the service or product and (2) The system assigns each customer call to the next available advisor.

Phase 2 – Categorisation (Assignment of categories to customer and advisor)

Based on the data points for customer and advisor, the fuzzy expert system assigns each customer and advisor to that of a pre-determined category.

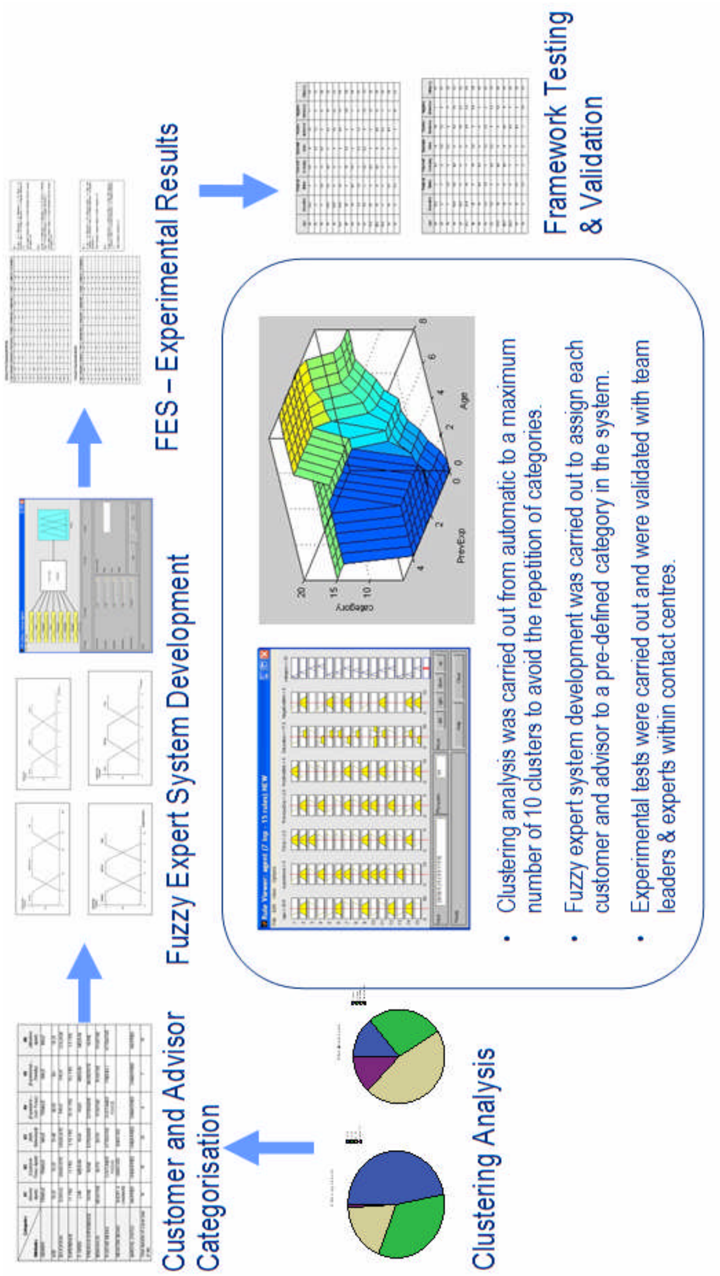


Figure 6-15: Phase (2) - Categorisation Framework (Chapter 5)

The assignment is then entered by the system to the decision support framework that would identify the information screen required for that particular combination of customer and advisor. The steps followed to the categorisation framework (chapter 5) are shown in figure 6.15. The steps followed within figure 6.17 are step no (3) the system assigns advisor to pre-defined category and (4) system assigns customer to pre-defined category.

Phase 3 – Information Requirement

The following phase (3) is the information requirement where based on the assignment of customer and advisor category, the information requirement will identify the screen required to be displayed to the advisor. The information is derived from the customer and advisor mapping combination which in the decision support framework will be created in an excel sheet with the entire customer advisor categorical list and the combination assigned to each set. The framework developed in chapter 6 to be used in the current framework is as shown in figure 6.16. Steps followed within figure 6.17 are step (5) the combination of customer and advisor is sent to mapping table and (6) based on customer/advisor combination the information screen is displayed on the screen. The main objective was to identify the minimum amount of information, which is required to be displayed on the screen to the advisor, which would enable the advisor to help the customer. This information should always satisfy the three important business aspects of customer contact that are:

- Customer Satisfaction
- Resolving the conflict and
- Cross Sell – Up Sell opportunities

The combination of all of three phases mentioned above will form the intelligent decision support framework, which is validated through simulation and expert judgement in contact centres. The complete framework development is as shown in figure 6.17. The framework comprises of the three frameworks mentioned earlier. Customer calls the contact centre with a query. The system assigns each customer call to the next advisor. The system assigns a category to customer and advisor derived from the fuzzy expert system. Based on the type of category assigned, the information is then collected by the mapping table, which identifies the type of information screen required to be displayed on the screen. The information screen for that particular customer and advisor combination is then shown to the advisor for him/her to serve the query more efficiently.

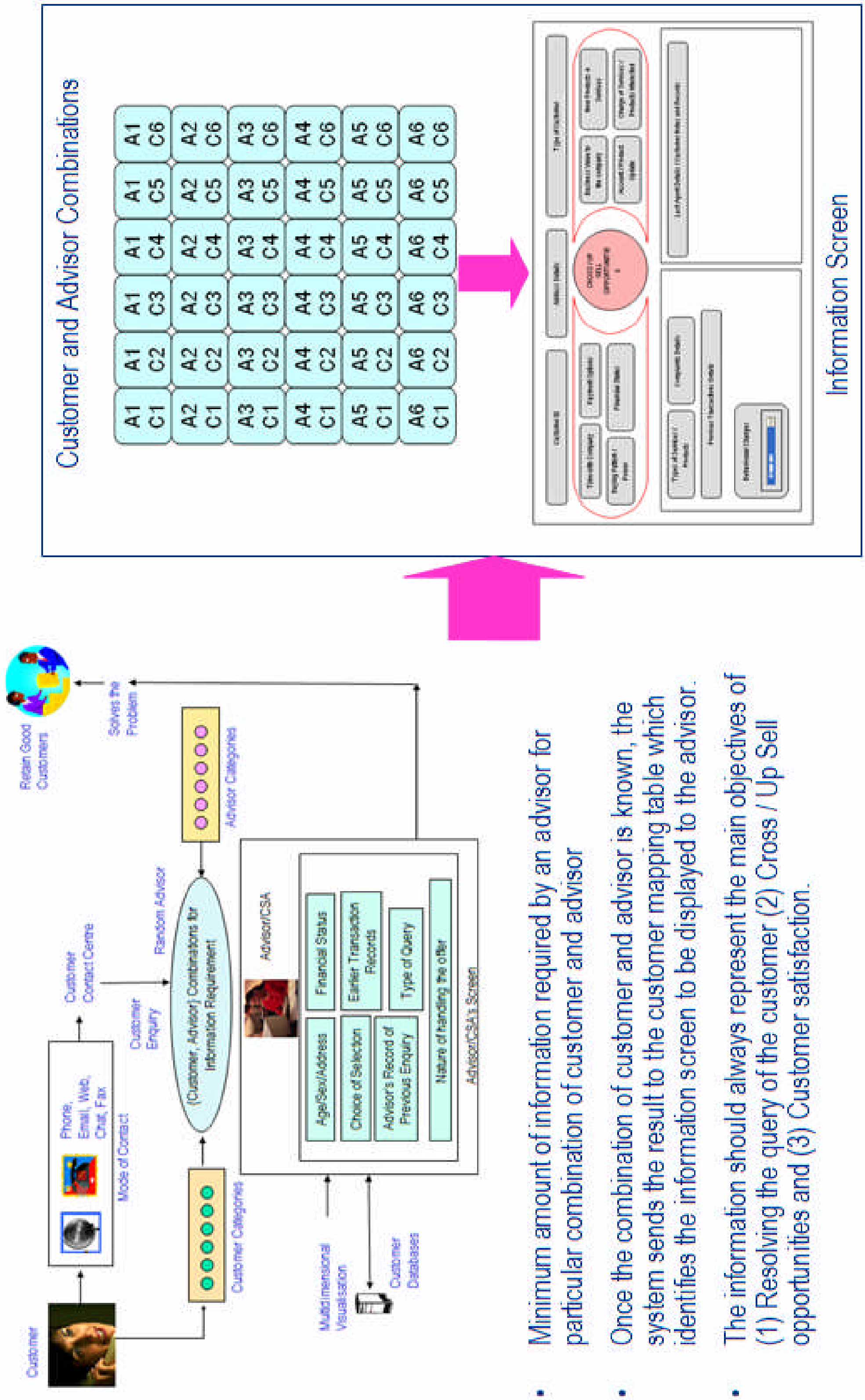


Figure 6-16: Information Requirement Framework (Chapter 6)

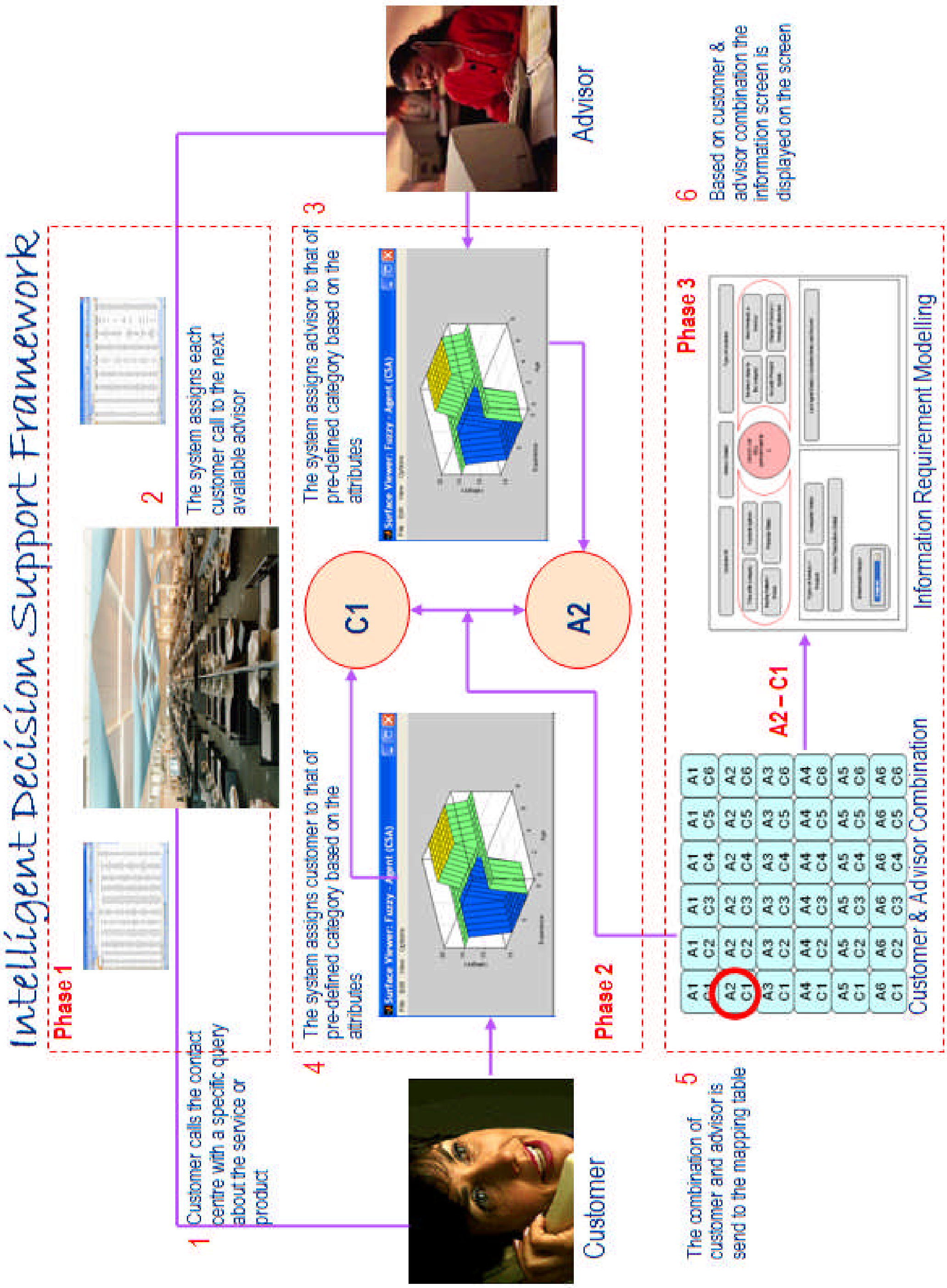


Figure 6-17: Proposed Intelligent Decision Support Framework

6.9. Summary

This chapter has demonstrated the successful application of an proposed information requirement framework for identifying and displaying the minimum amount of infomration required by the advisor. This information satisfies the important business requirements of the company and provides better information screens used by the advisors in contact centres.

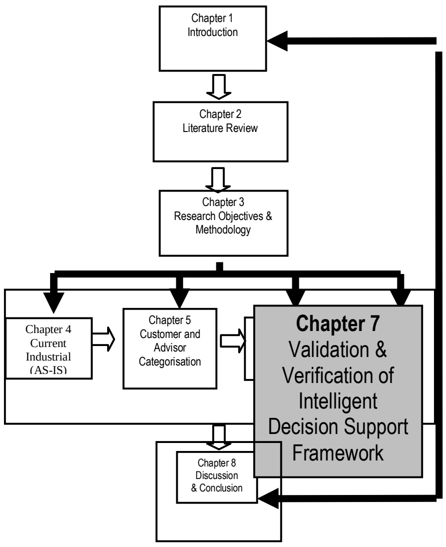
Two different levels of problems identified in previous chapters have been solved in this chapter namely: the information requirement within the contact centre domain and the advisor requirement of the information. Since these required information problems constitute a representative set of contact centre problems, it can be suggested that the successful application of the proposed information requirement framework ensures their success in solving other customer facing environment with related features. In this manner, this chapter has used real-life case studies to validate the observations made previously regarding the use of required information and the information overload problems. This chapter has achieved the following:

- Identified challenges posed by contact centres in information requirement from design objective.
- A solution to resolve the problem of information overload in any customer-facing environment.
- Identified challenges on the use of minimum amount of information provided to the advisors to serve the customer.

Finally, the results obtained from the validation studies were analysed in order to validate the proposed framework and to use it in the verification of the complete research explained in next chapter.

While this chapter has satisfied a key information requirement research objective for the contact centre problem, the next chapter presents the validation and verification of the research framework developed in simulated environment to validate the entire framework of categorisation and information requirement described within this research.

7. Validation and Verification of the Intelligent Decision Support Framework



Simulation techniques were introduced in Chapter 1 as a platform for verification of our customer and advisor categoristation frameworks. Simulation represents a way designer can verify their findings from the framework developed. The selection of simulation technique used to validate the frameworks was developed through the literature studies disucssed in chapter 2. The advantages of simulation over other techniques was the main reason for the selection of technique for validating the frameworks developed in the research. Simulation is the technique of building a model of a real or proposed system so that the behaviour of the system under specific conditions may be studied (Ball, 1996b). Simulation can be considered as a tool that is commonly used to assist with systems analysis. It is widely used in combination with other techniques such as linear programming, expert systems and neural networks. Morever, simulation can be thought to be the imitation of the operation of a real world process or system over time. The objectives for the chapter are as follows:

- Verification of the Intelligent Decision Support Framework discussed in chapter 6.
- Simulation used to visualise how the whole system may work.
- Validation of the entire framework with expert judgement from contact centre environment.

This chapter begins by outlining the summary of the validation of research frameworks explained in the thesis in section 7.1. Section 7.2 describes the motivation behind the verification of the intelligent decision support framework through simulation and expert judgement. Section 7.3 then focusses on the design of simulation framework with the examples of possible scenarios drawn in the earlier design stage. Section 7.4 discusses the development of the simulation framework. Section 7.5 describes the simulation framework testing within the eclipse environment. The steps followed for the test are shown in details within this section. Section 7.6 briefly overviews the validation of simulation. Section 7.7 describes the observations from the simulation framework. Finally section 7.8 summarises the chapter and the simulation framework.

7.1. Validation of the Research

An ongoing validation process with the experts from contact centre environment was followed for the research frameworks described in chapter four, five and six. The author discussed all the separate validations for the frameworks within each chapter individually earlier in the thesis. Through this section, the author aims on presenting a summary of the complete validation of the frameworks and the reasons for the verification and validation of the intelligent decision support framework discussed in this chapter.

Chapter 4 – AS – IS Study

- Validation of the data collected through semi structured questionnaire at the contact centres, was carried out with team leaders/managers and advisors.
- A group of team leaders and advisors from contact centre validated the behavioural analysis, which identified the types of behaviours for customer and advisors.
- Information on system functionalities at the centre was collected and validated as an ongoing process.

Chapter 5 – Categorisation Framework

- Expert judgment method used for customer and advisor attributes identified from the categorisation framework.
- Team leaders from the centre validated the categories for customers and advisors derived from the clustering analysis.
- Fuzzy expert system derived the rules used within the system were validated, and experimental tests were conducted to validate the fuzzy expert system framework.

Chapter 6 – Intelligent Decision Support Framework

- Experts validated the information required to display on the screen through semi-structured questionnaire described in chapter five and six.
- Based on the minimum amount of information required to display, customer-advisor mapping table was generated for identifying the type of information required for each combination (A1-A6 and C1-C6)
- As described in section 6.5 experts from contact centre validated the information screen displaying the information for each customer and advisor combination. Finally, experts validated the complete intelligent decision support framework.

Implementation of the intelligent decision support framework will be verified using simulation and expert based judgment explained in this chapter.

7.2. Motivation of Verification

The main objective of using simulation as a technique was to validate the Intelligent Decision Support framework through simulation and expert judgement. The steps followed for the design and development of the simulation framework are described below. The importance of using simulation environment within the research is as follows:

- Simulation models of business processes need to interact in complex ways with real-time information system components (Reiner, 2005).
- There is a lack of separation between visualisation and simulation in current environments. The place where the simulation executed is not always the place where people want to view the simulation. Moreover, due to the global and complex nature of current business systems or logistical systems, the number of stakeholders involved in these systems is large.
- There is a need to specify simulations of complex business systems. Gathering data from systems and databases, and carrying out measurements for the specification by hand is a costly procedure.

The steps followed for the development of simulation framework is as follows:

- Collection of customer and advisor data from the database
- Assignment of category to each customer and advisor data read from the database through fuzzy expert system
- Based on the categorisation, and from information mapping table (discussed in section 6.3.3) identifying the customer-advisor combination
- Display the information screen on the basis of the customer/advisor combinations
- Storing of the results in form of excel datasheet which will record the category assigned to customer and advisor and the type of information screen used.

7.3. Design of Simulation Framework

To simulate all the frameworks described earlier within the thesis, the use of simulation framework developed. It would simulate the type of caller, identify the customer category from the database and then automatically assign an advisor to that caller and will find category for the customer. Based on the type of the information required to be displayed; it would then display this information to the advisor on the screen. For example: If customer A calls, enter the details (customer id); automatically assigned an advisor for that customer, system model will find which category that customer belongs to, looks for possible combination of customer and advisors, and finally displaying the information to the advisor which would enable the advisor to deal with the customer. To carry out the contact centre simulation in some ways are as discussed below:

Scenario 1

In first case, the customer calls in; the ACD (Automatic call distribution) identifies the type of call, and the calls are placed in the queue, from where they are answered by the next available advisor.

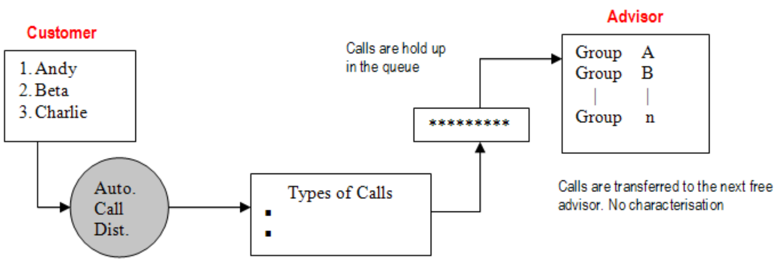


Figure 7-1: Simulation Framework – Scenario 1

Scenario 2

Second case followed the same method, but this time, transfer of the customer call from the queue to the advisor appropriate to receive the call.

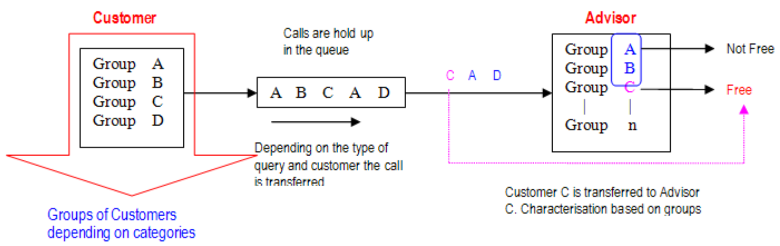


Figure 7-2: Simulation Framework – Scenario 2

Scenario 3

In the last case, intelligent information tool is been used and displayed. As mentioned in the previous two cases, there was no intelligent transfer or the use of customer information. In this case, however, we do make use of both of them; from the point where the call is transferred to the advisor who answers the calls.

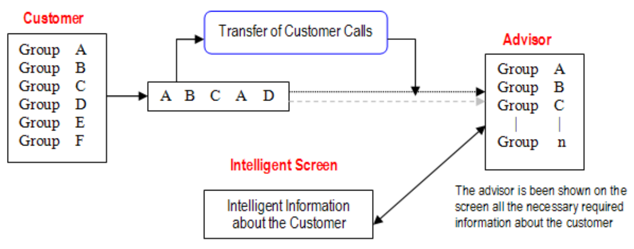


Figure 7-3: Simulation Framework – Scenario 3

7.4. Development of Simulation Framework

The simulation model was developed in three stages with three different levels of models. The initial model was derived using the AS-IS study analysis that can transfer the entire customer calls to the advisors. There were no means of any sort of customisation or categorisation of calls with regard to the customer or advisor and the information layout. The model was the basic call centre model, which picked up the calls (data from the database) and transferred it to the advisors.

7.4.1. Initial Model

Based on the AS-IS model, which already existed but still had errors within the Java platform, the first version identified as a model used to transfer all the calls to the advisors. Because of no prior identification of the calls and advisor, this model only has three classes and one main program. The three classes are Advisor. java, Call. java and Call_Source.java. The main program is Simul_1_model.java. This model simulates the service complaint of a call centre environment as shown in figure 7.5. From time to time calls arrive and deliver to the available service advisor of the contact centre. From here, calls transferred to different sets of advisor depending on the requirements of the call (e.g. Novice, Middle Age and Old). Advisor awaits a varying number of calls for them to get diverted. Each time one advisor is free, the call is transferred to the next advisor and the next awaiting call is transferred to the next advisor and accordingly.

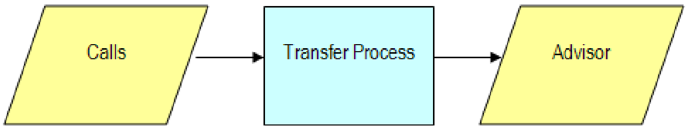


Figure 7-4: First level Simulation Model

7.4.2. Second Level Model

The main aim of the second version is to add all the attributes of the calls (customers) and the advisors. These attributes derived from the case study analysis and the clustering results are used to categorise each customer and advisor calls and when the categorisation framework in implemented in the complete version of the simulation model.

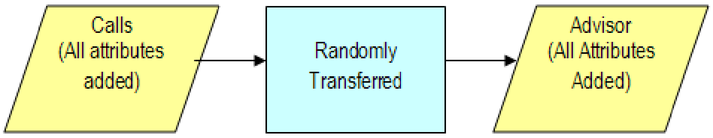


Figure 7-5: Second Level Simulation Model

When an advisor is free, the customer transferred to the best-experienced advisor and the next awaiting customer is transferred to the next advisor. The following figure (Figure 7.5 Second Version Process) described the process of this version simulation process.

7.4.3. Final Level Model

The final version of the simulation framework model was designed on an open source desktop application (eclipse) using out categorisation (fuzzy expert) and Java technology. The final level model proved a challenge in the beginning as it was making use of the merging Matlab based fuzzy expert system with java-based simulation. Although previous studies carried out within this area not been carried out at this domain. This section will explore the flexibility and capabilities of the technology. The complexity of the project is further enhanced with the attempt to make the system platform independent (that will be only provided by java), something which existing systems fail to accomplish. The problem has not been solved in the past so it be quite difficult to get understanding of the platform from literature studies and experts from the industry. These are limited and based on old technologies, with the advent of Matlab that are several fuzzy implementation that can only be possible in Matlab. This system can also be improvised and implemented in real environment and could be applied with modification to domains other than CC.

The overall aim of the simulation framework is to design and implement an open source desktop system using Matlab functionality and java based technologies. This also allows access and manipulation of data that is stored in excel database, fetch the data and apply fuzzy rules on that data according to data derived from fuzzy expert system. It works across the system through the combination of categorisation and information requirement frameworks described in earlier chapter. The system uses a JNI (Java native Interface) to invoke the Matlab functionality, such as applying fuzzy rules on FIS structure. The main advantages and of JNI interface is that it performs the same functionality that Matlab provides; and instead of running Matlab the same functionality is be provide in Programming in “C” (Native Code) that make system more efficient as well as it save more than 200 MB that be mandatory to run a Matlab studio. The specific objectives of this project are based on the features and functionality of the current convert the current system integration with Java – and GUI Desktop services so easy to handle by an End-User. The system should be able to:

- ✓ Interact securely with the excel database sheet,
- ✓ Provide functionality normally expected from a GUI based Environment, such as (1) Read Excel files, (2) Explicitly Create an Excel sheet files, (3) Applying Fuzzy Rules on fetched Data, (4) Simulate The Data, (5) Write Data to new Excel sheet, and (6) Perform Action on the basis of Combination (Open Particular File)s,

- ✓ Provide an intuitive user interface,
- ✓ Operate through any Platforms,
- ✓ Be open source,

7.4.4. Java Programming and Model Deployment

JNI sometimes referred to as the "escape valve" for Java developers because it allows them to add functionality to their Java Application that the Java API cannot provide. Java Native Interface (JNI) is a standard programming interface for writing Java native methods and embedding the Java virtual machine into native applications. The primary goal is binary compatibility of native method libraries across all Java virtual machine implementations on a given platform.

The JNI is a native programming interface. It allows Java code that runs inside a Java Virtual Machine (VM) to interoperate with applications and libraries written in other programming languages, such as C, C++, and assembly. The most important benefit of the JNI is that it imposes no restrictions on the implementation of the underlying Java VM. Therefore, Java VM vendors can add support for the JNI without affecting other parts of the VM. Programmers can write one version of a native application or library and expect it to work with all Java VMs supporting the JNI.

JNI Interface Functions and Pointers

Native code accesses Java VM features by calling JNI functions. JNI functions are available through an *interface pointer*. An interface pointer is a pointer to a pointer. This pointer points to an array of pointers, each of which points to an interface function. Every interface function is at a predefined offset inside the array figure 7.6 illustrates the organisation of an interface pointer. The JNI interface is organised like a C++ virtual function table or a COM interface. The advantage to using an interface table, rather than hard-wired function entries, is that the JNI name space becomes separate from the native code. A VM can easily provide multiple versions of JNI function tables.

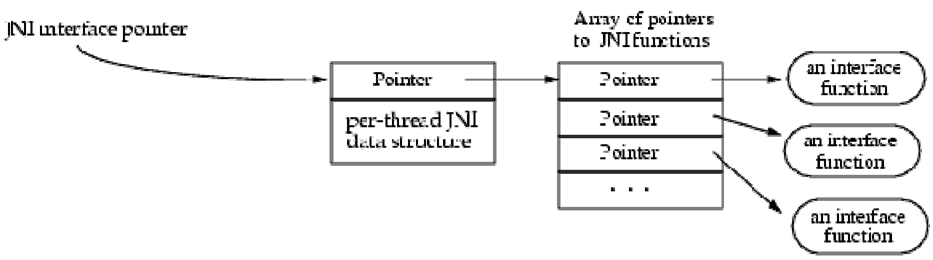


Figure 7-6: Interface Pointer

For example, the VM may support two JNI function tables:

- One performs thorough illegal argument checks, and is suitable for debugging;

The other performs the minimal amount of checking required by the JNI specification, and is therefore more efficient. The JNI interface pointer is only valid in the current thread. A native method, therefore, must not pass the interface pointer from one thread to another. A VM implementing the JNI may allocate and store thread-local data in the area pointed to by the JNI interface pointer. Native methods receive the JNI interface pointer as an argument. The VM is guaranteed to pass the same interface pointer to a native method when it makes multiple calls to the native method from the same Java thread. However, a native method can be called from different Java threads, and therefore may receive different JNI interface pointers.

The java classes used within the programming in java platform are as described below.

Variables:

- single word: fileName, tmp, ans
- multi word: ansCustomer (Ans of customer), dataCustomer (Customers' data), createStatement (Create Statemennt),
- constants: DEFAULT_FILE_NAME

Functions:

- single word: showData ()
- multi word: SimulationGUI ()

Classes:

As for modules, Names or those are in Packages for each category and For Common classes that are in Common Module.

Instance methods:

- public method: search (),search (String data[] [])
- private method: _isValid(), _Simul ()
- accessor methods same as Java: SimulationGUI (),showData (),showTable (),runfile ()

The flow within the simulation framework is described in the following steps:

1. First be the SimulationGUI.Java file run as Java Application it has several methods like:

   SimulationGUI.java Methods

   ```
   public SimulationGUI() {    }
   public void runfile(String fileName) {  }
   public String search(String data[][],String col1,String col2) {   }
   ```

```
public void setTableLook(String FileName,String SheetName) {   }
public void showData(String FilePath) {    }
public void showTable() {   }
```

2. From Which we will called **ExcelDemo's** .ReadFile() method which will read the Excel sheet through ODBC connection

ExcelDemo.java Methods

```
public static boolean createSheet(String path,String sheetName) {   }
public static String[][] readFile(String path,String sheetName){    }
public static boolean writeData(String path,String sheetName,String
data[][]){   }
```

3. After Reading of File **MyTable Class's Object** is created this will store this data (read from Excel files) in to new sheet without File Header (Ex. Age, Education, Financial Status, Time with Company, Time with Company)

MyTable.java Methods

```
public MyTable(String tdata[][],int colNo,int rowNo,String columnName[])
{   }
public int getColumnCount() {    }
public int getRowCount() {   }
public Object getValueAt(int rowIndex, int columnIndex) {  }
public String[][] getData() {   }
```

4. The simulation java method is used to start the simulation process within the model. It also calls upon the customer and advisor within the main method.

Simulation.java Methods

```
public static String[][] startSimulation(String customer[][],String advisor[][])
{  }
public static double[] simulateCustomer(String[][] customer) {   }
public static double[] simulateAdvisor(String[][] advisor) {   }
```

5. This method will return 2D Array having Customer & Advisor Combination it will call **DoubleToString** Class's advisorString() or customerString() method as selection that convert particular Double value to String Value

DoubleToString.java Methods

```
public static String customerString(double d)public static double[])
public static String advisorString(double d)
```

6. This Both method simulateCustomer () & simulateAdvisor() Call the DLL Function of **FISClass** class's runFuzzyRules() Method that will called tio GetAnswers() method

```
public static String[][] startSimulation(String customer[][],String advisor[][])
{ }
public static double[] simulateCustomer(String[][] customer) {   }
public static double[] simulateAdvisor(String[][] advisor) {   }
```

<u>FISClass.java Methods</u>

```
public double runFuzzyRules(String s, double [] params) {
public static native double getAnswer(String f, double[] p);
```

7. After words read **Combination.XLS** file through **ExcelDemo's ReadFile()** Method. Then we will compare data with our Result and the n create an N*4 Array which has this type of columns
   - Serial No.
   - Customer
   - Advisor
   - File Name (That Be Open)
8. The next step is to create sheet through **ExcelDemo's createSheet** () Method after words creating sheet data will be written in this sheet through **ExcelDemo's writeData** () Method
9. This will write the generated data into **Result.XLS** file. Then the next step to Control Jumps to **Result.java** file

<u>Result.java Methods</u>

```
Result(String title,String [][]result) {  }  //  Constructor
public void actionPerformed(ActionEvent ae) {  }
public void insert(String str[][])  {    }
public void runFile(String fileName)  {   }
```

Next step to Control Jumps to Run a Particular selected files. As Basis on result, User can execute more then one file also by Multi selecting file and Then Clicking On Execute Button. An UML use case diagram shows how the user interacts with the system and which type of process needs to run to fulfil the user's criteria. This shows role of user that user have to select a particular excel files for simulation process.

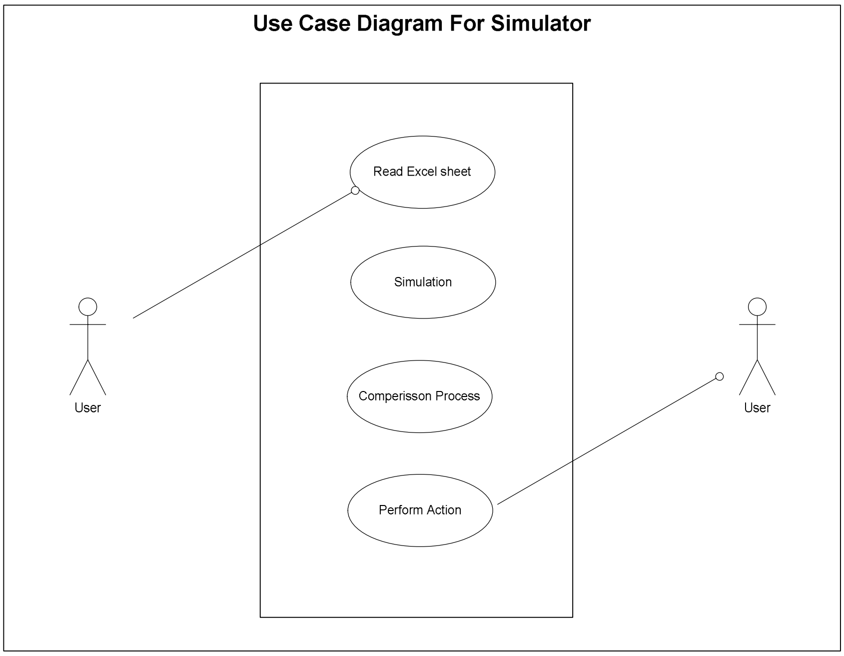


Figure 7-7: UML Use Case Diagram

UML class Diagrams shows how the class depends to another class the system.

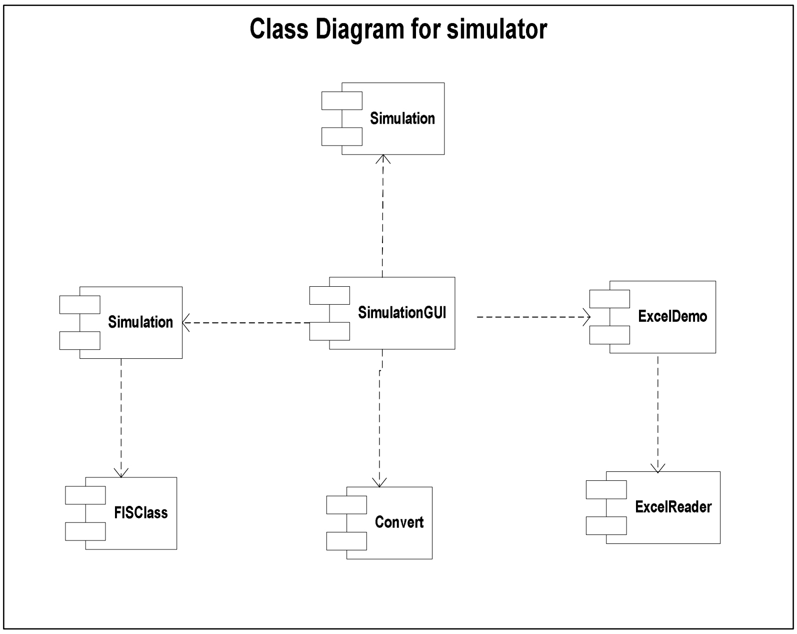


Figure 7-8: UML Class Diagram for Simulator

UML Sequence Diagrams shows that the sequence to Achieve a Specific Goal of the System.

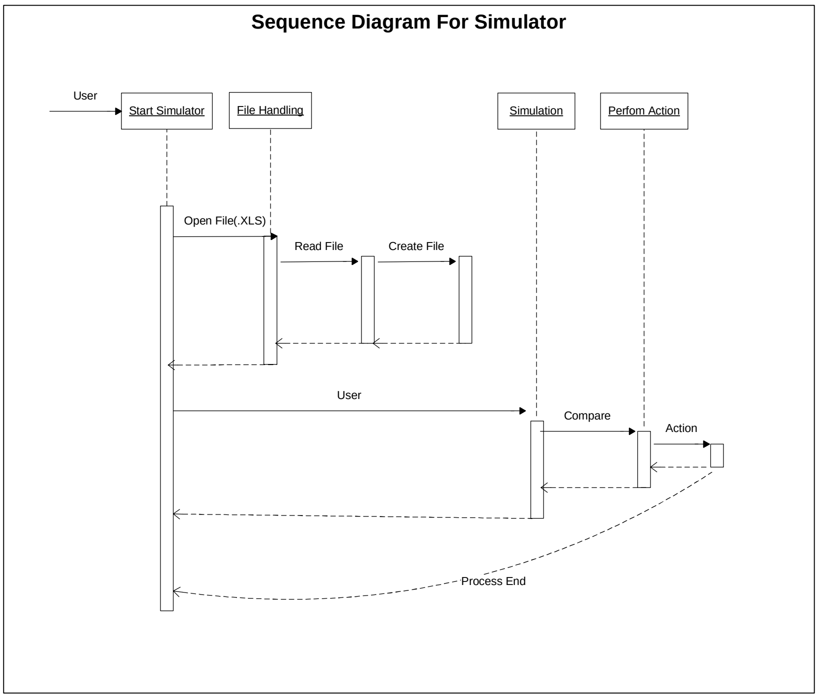


Figure 7-9: Sequence Diagram for Simulator

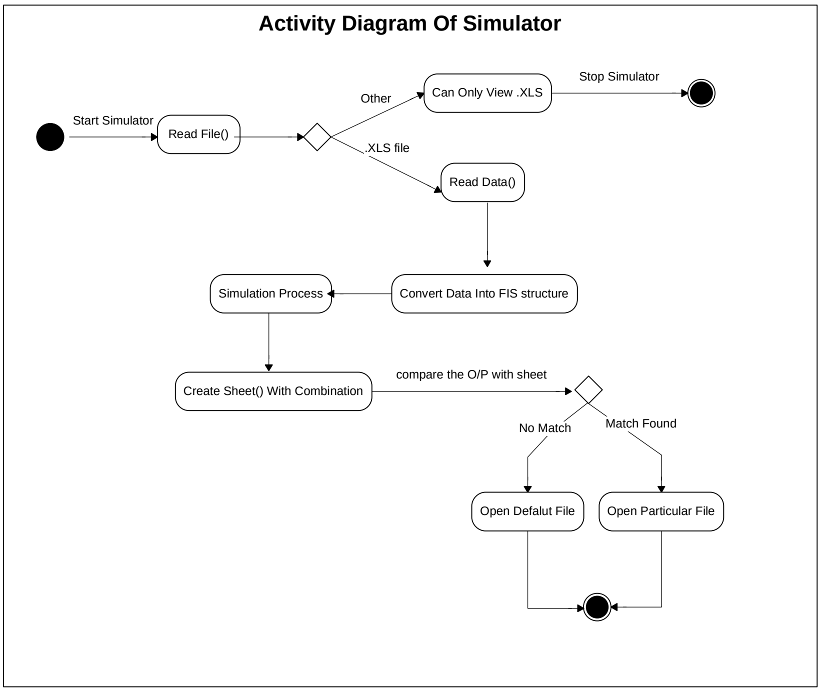


Figure 7-10: Activity Diagram of Simulator

UML activity diagrams shows that the activity of simulator system

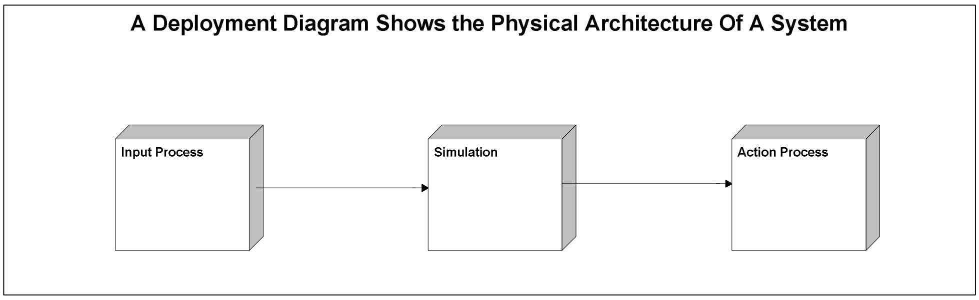


Figure 7-11: Deployment Diagram showing Physical Architecture of System

7.5. An Example Simulation Session

This section presents example simulation session for testing the categorisation and information requirement frameworks discussed in previous chapters. The simulation carried out to validate the frameworks in simulated environment. The session was also used to verify the results with experts from the CC where the case studies were conducted. The experts were shown different scenarios of customer and advisor combinations, and the data used which assigned a category to them. Based on the categories, the information screen required to serve that combination displayed on the screen of the advisor. The steps followed are as described below and shown in figure 7.12.

1. Select the workspace to work on the simulation
2. From the main window, select the run command to run the test simulation
3. Selection of the database window opens as the first stage
4. Select the database from the list on which the simulation is to be carried out
5. When customer/advisor database opens, select “Start Simulation”
6. Simulation then executed with results of the assignment of categories and the customer advisor mapping appears on the simulation platform.
7. Once the simulation stops, the results (customer/advisor) combination for each of the customer/advisor opens
8. Based on the selection the information screen required for the particular combination opens within the simulation
9. The results for each of the assignment are then stored within an Microsoft excel sheet.

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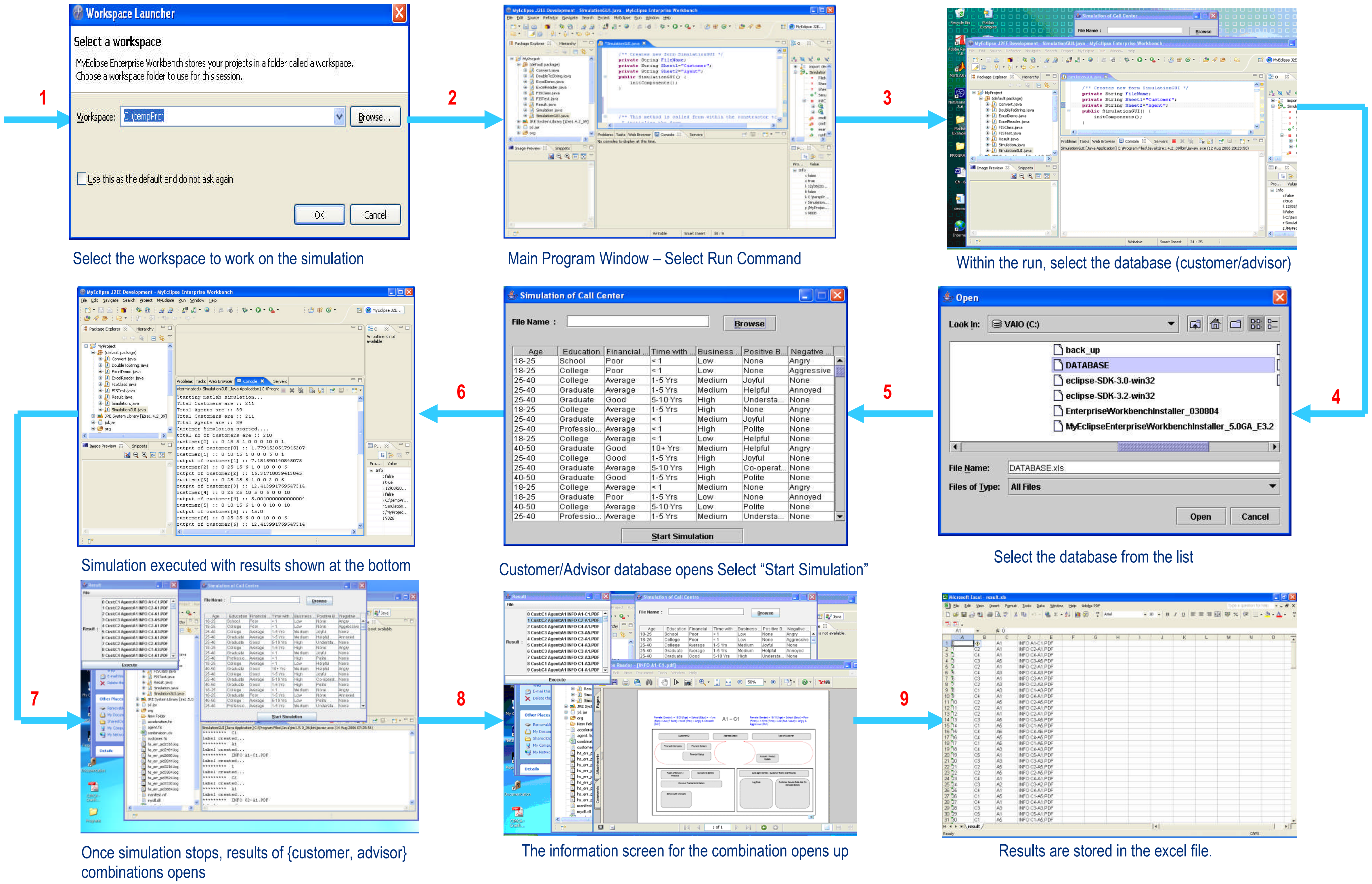

Figure 7-12: Simulation Framework Testing

The steps followed for the testing of the simulation framework is as described below.

Step 1: This is the main simulation framework window (figure 7.13) within the eclipse development. The code written in java programming language and the window shows the main project.

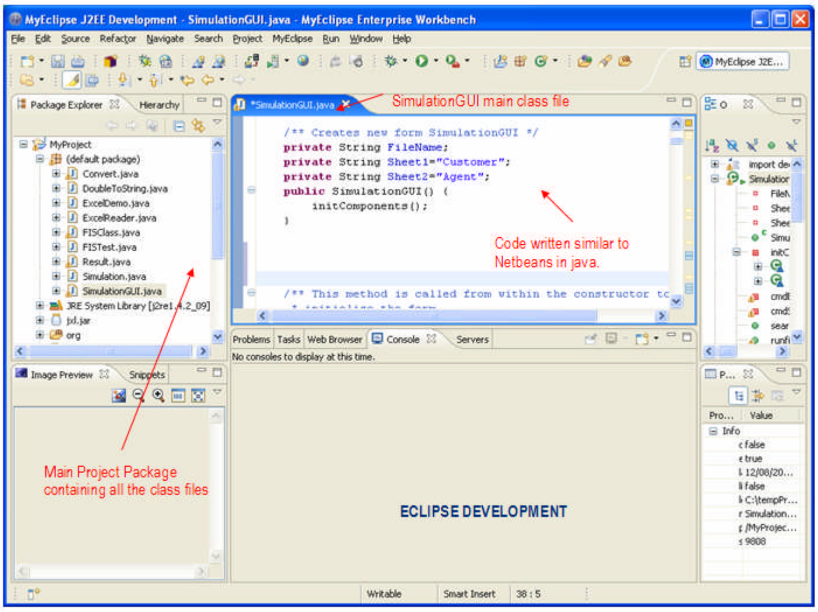

Figure 7-13: Main Simulation Framework – Eclipse Development

Step 2: Once the project opened, selection of the run command would open the required file (customer/advisor database).

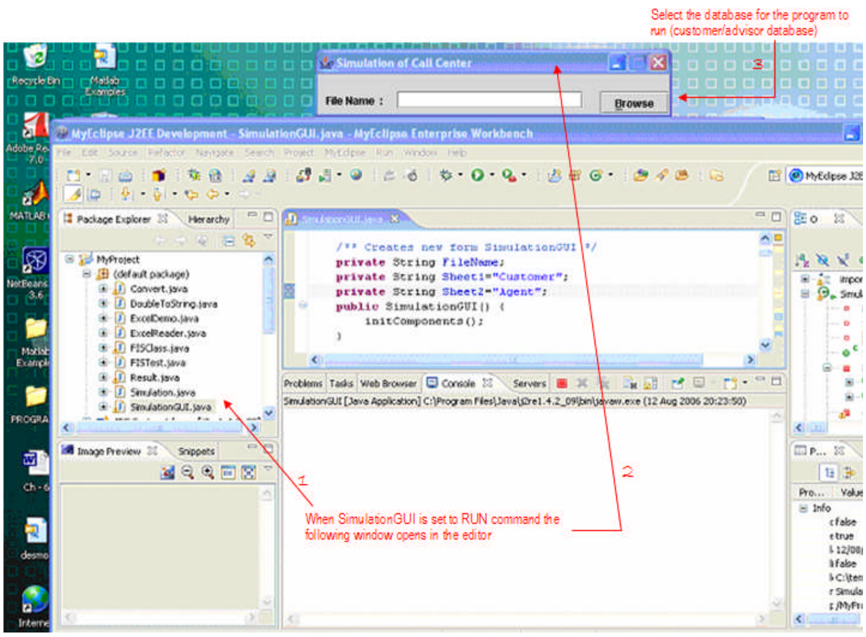

Figure 7-14: Run Command Screen

Step 3: Selecting the database from the files and opening the customer/advisor database

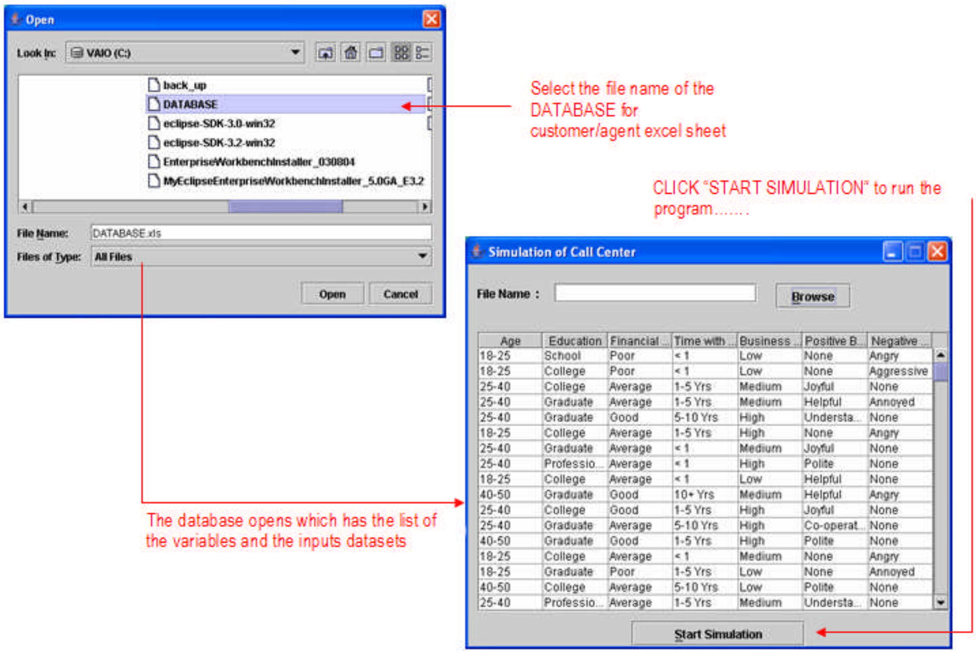

Figure 7-15: Database Selection

Step 4: Selection of customer and advisor database, where all the input variables data entered as shown below (advisor sample database).

Microsoft Excel - DATABASE

	A	B	C	D	E	F	G
1	Age	Education	Experience	IT Speed	Previous Experience	Positive Behaviour	Negative Behaviour
2	18-25	School	<1 Year	Low	None	None	Angry
3	18-25	College	1-5 Years	Medium	Little	None	Unaware
4	25-40	Graduate	1-5 Years	Low	Moderate	Friendly	Annoyed
5	25-40	Graduate	10-15 Years	High	Moderate	Customer Focus	None
6	18-25	College	<1 Year	High	None	None	Angry
7	25-40	Graduate	5-10 Years	Medium	None	Attentive	None
8	25-40	Professional	1-5 Years	Low	Little	Friendly	None
9	40-50	Graduate	10-15 Years	High	Little	Attentive	Angry
10	25-40	College	5-10 Years	Low	Moderate	Attentive	None
11	25-40	Graduate	1-5 Years	Medium	Little	Friendly	None
12	40-50	Graduate	5-10 Years	High	Moderate	Customer Focus	None
13	18-25	College	1-5 Years	Medium	Little	None	Angry
14	18-25	Graduate	<1 Year	Low	None	None	Annoyed
15	40-50	College	5-10 Years	Medium	Moderate	Friendly	None
16	25-40	Professional	10-15 Years	High	Little	Attentive	None
17	18-25	School	5-10 Years	High	Moderate	Customer Focus	Annoyed
18	40-50	Graduate	10-15 Years	Medium	Moderate	Friendly	None
19	40-50	College	5-10 Years	Medium	Moderate	Friendly	None
20	25-40	Professional	5-10 Years	Medium	Little	Attentive	None
21	18-25	School	1-5 Years	Low	None	None	Unaware
22	25-40	Professional	5-10 Years	Low	Little	Attentive	None
23	25-40	Graduate	10-15 Years	Medium	Moderate	Customer Focus	Annoyed
24	40-50	College	10-15 Years	High	Extensive	Customer Focus	None
25	18-25	School	<1 Year	Low	Little	None	Annoyed
26	18-25	Graduate	1-5 Years	Medium	None	Attentive	None
27	25-40	Graduate	1-5 Years	Medium	Little	Friendly	Angry
28	40-50	Professional	10-15 Years	High	Moderate	Attentive	None

Figure 7-16: Customer and Advisor Database

Step 5: The results from the simulation are shown in the window (figure 7.17). The results display the total number of customer and advisors used in the simulation, the input values send to the fuzzy expert system for customer and advisor, and the output category derived by the fuzzy expert system for each data entry. Each input value for the advisor and customer is the value from the database assigned within the fuzzy expert system in Matlab.

Once the expert system identifies the type of input variables, an output category assigned for particular customer and advisor. The value for the output of customer represents to that of the value assigned within the fuzzy expert system.

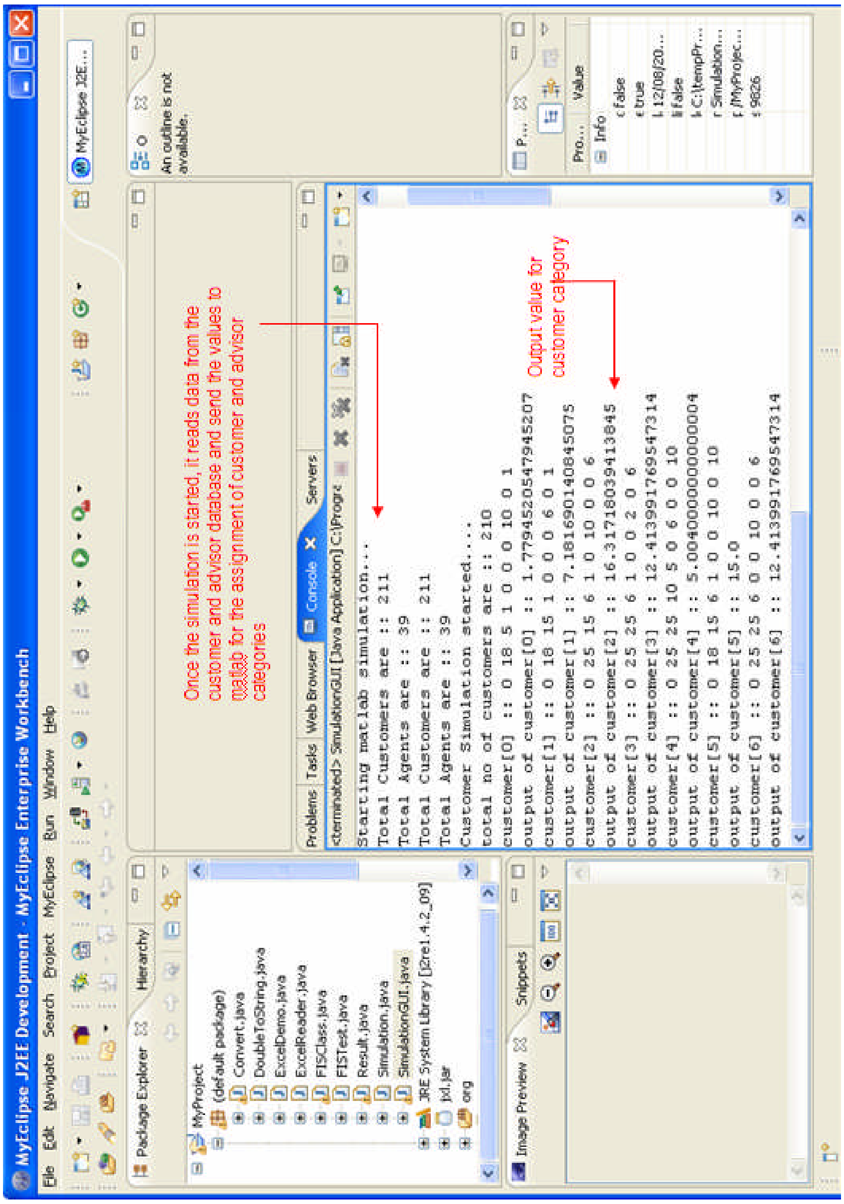

Figure 7-17: Results and Analysis of the Simulation Run

Step 6: Once the simulation stops the results of the combination is displayed within the desktop.

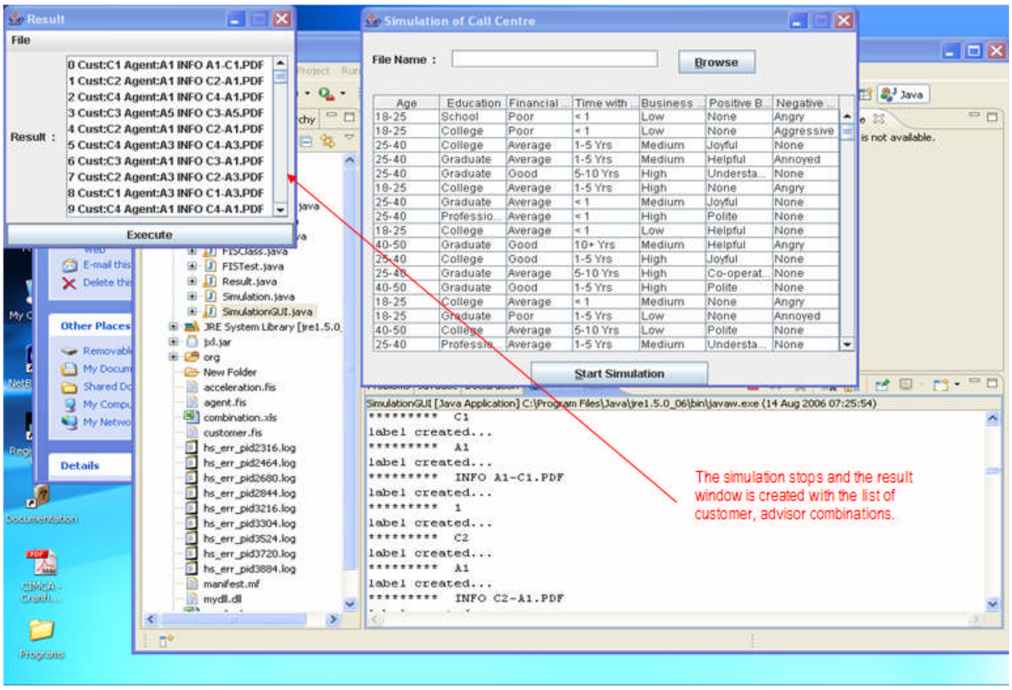

Figure 7-18: Results Output on the Screen

Step 7: Once the results are displayed, it then displays the information screen.

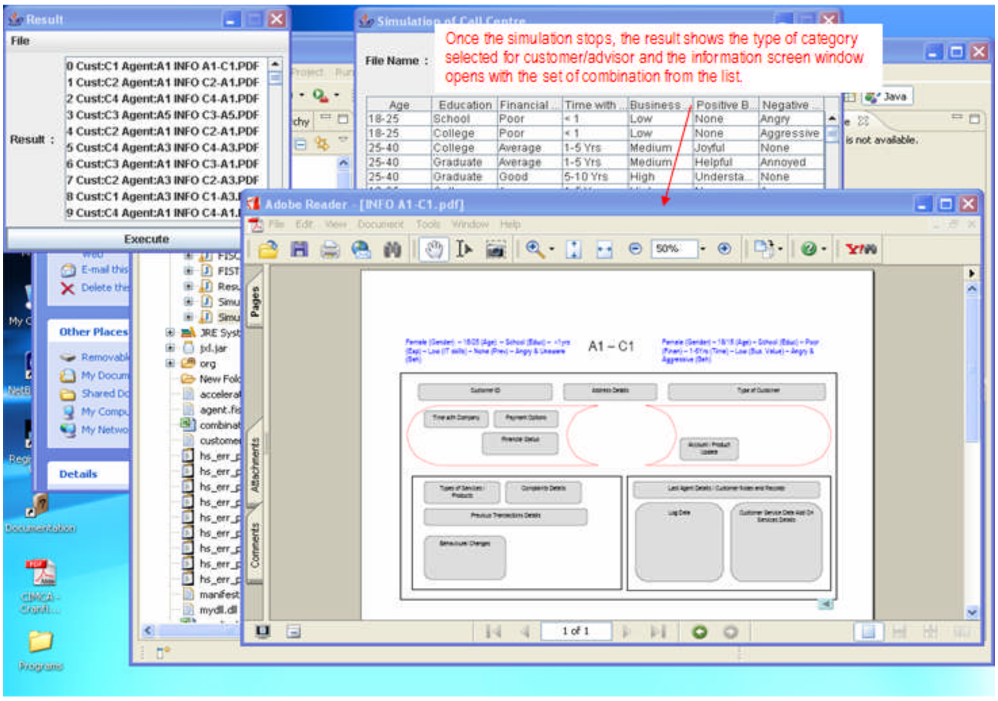

Figure 7-19: Information screen layout

Step 8: The information screen can be selected to view other combinations. By clicking on any of the customer and advisor combination, the information screen would automatically change to the new screen layout.

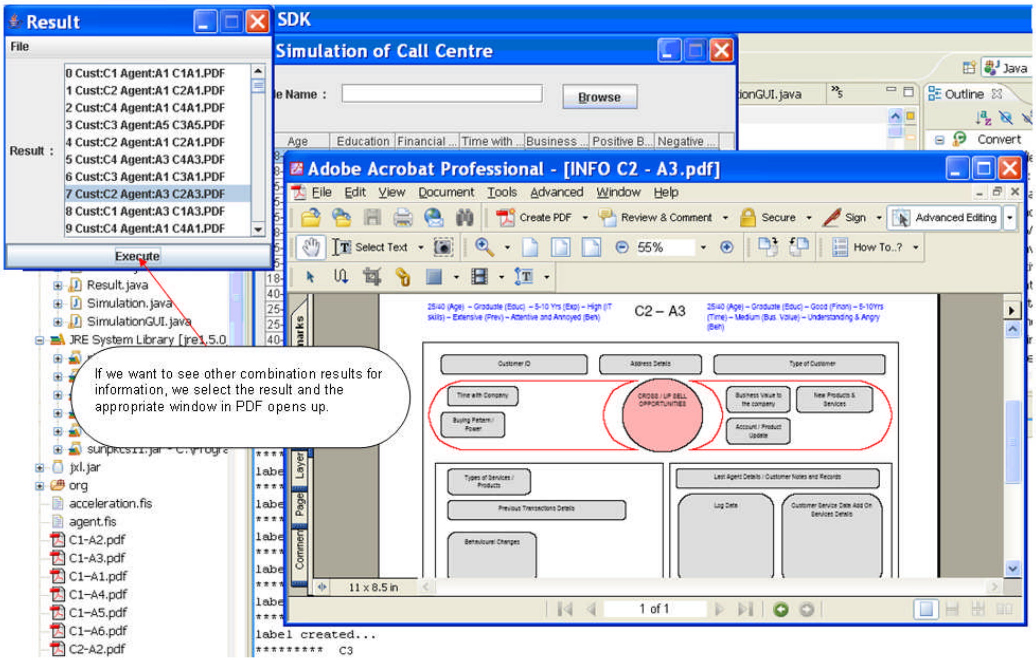

Figure 7-20: The information selection within the model

Step 9: The results of the combination of the simulation are then stored within the database for future use of the results. The datasheets records each entry read from the database, with the category (output) assigned to customer and advisor and the info screen selected.

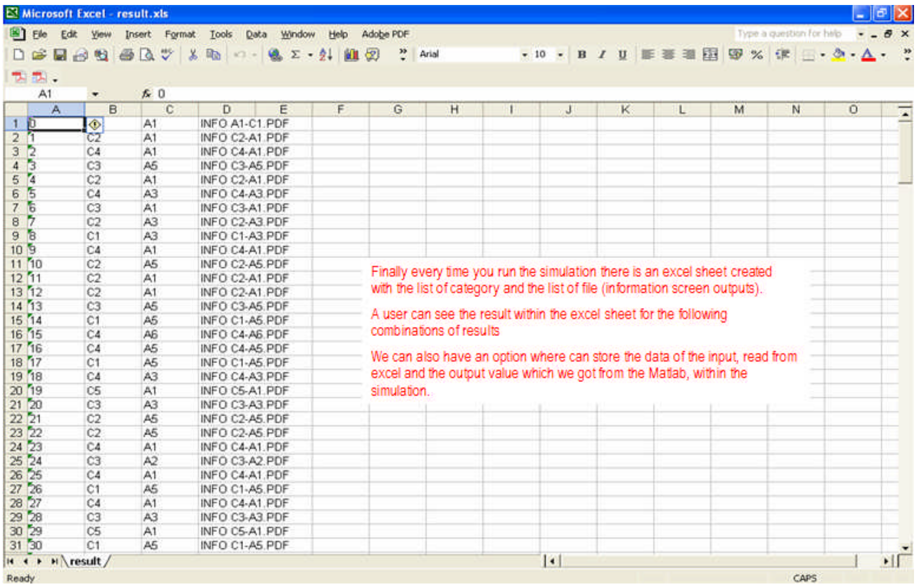

Figure 7-21: Storing of results

7.6. Validation of the Simulation Framework with Expert Judgement

The simulation framework was validated at two contact centres with total of five team leaders and four advisors showing the details of the framework, with examples of customer and advisor, categories assigned to each, and the information screen displayed on the screen when the simulation was completed.

Table 7-1: Simulation Validation Interview Details

	Simulation Validation Interview Details – Team Leaders and Advisors		
	CC – Role	Age Group	Experience
Contact Centre (A)	Team Leader (TL) (3) Advisor (A) (2)	28 and 33, and 40 yrs 18-25 (1), 25-40 (1)	1 TL – 2/4 yrs, 1 TL – 6/8 yrs and 1 TL – 8-10 yrs 1-5 (1), 5-10 (1)
Contace Centre (B)	Team Leader (2) Advisor (2)	30 and 38 yrs 18-25 (1), 25-40 (1)	TL -3/5 yrs and 1TL – 6-8 yrs 1-5 (1), 5-10 (1)
TL – Team Leader, Manager – M			

A set of five questions were asked to each individual about the validity of the framework, and how it would correspond if implemented in the existing contact centre environment. The steps followed for the validation of the framework within contact centres are:

1. Selection of customer and advisor datasets from the sample database
2. Identifying random customer and advisor samples
3. Once the simulation started, identification of category assigned to customer and advisor.
4. Based on the category assigned, the information screen that is displayed on the system is verified with the experts.

The questions used for validation of the framework are as described in table 7.1.

Table 7-2: Questions used for Validation of Simulation Framework

Section 1: Simulation Framework
1. Please provide your views about the complete simulation framework based on the demo shown to you.
2. Based on the time it took to display the information screen, please provide your views about the results shown
Section 2:Information Screens
3. Is the information screen provided after the simulation appropriate within the applied case?
4. Do you think that the information displayed on the screen can be improved?
Section 3: Examples of Customer – Advisor Datasets
5. Given the examples of customer –advisor combinations and the screen displayed, please provide your feedback on the output of the system?

The observation from the validation of the simulation framework with the experts at contact centres is as shown below in table 7.2.

Table 7-3: Results from the Experts on Validation of Simulation Framework

	Results from the Experts on Validation of the Simulation Framework			
Questions	Contact Centre (A)		Contact Centre (B)	
	Team Leader	Advisor	Team Leader	Advisor
1. Please provide your views about the complete simulation framework based on the demo shown to you	Based on the combination given, it looks appropriate if the information provided is suitable to given centre.	Looks nice. If all the information that is required in any situation is provided on one screen, it would reduce a lot of time	Its faster than I thought it would be. But I still don't understand the concept of categorising in this way. Although from research point, it is suitable to the given environment	The information displayed on the screen is somewhat similar to the type of information we have to look on different screens to serve the system. So when is this system going to be in use over here.
2. Based on the time it took to display the information screen, please provide your views about the results shown	The timing is reduced considerably. And the model to group the customer and advisor is also very much appropriate to our environment, as we do have to seek a lot of customer background knowledge from other systems.	Yes, it would effect the overall time taken to serve the customer query	It depends on the nature of the customer query, and the time would soley depend on that factor as well as others.	If the screen provides all the information required in that situation, then yes; it would reduce the time overall.
3. Is the information screen provided after the simulation appropriate within the applied case	Yes, for the applied case it is okay	Yes, it does look quite okay when you are having all the details in front of you that to on one screen	It might be useful to have some level of difference in the information screen, otherwise each of the screen look similar from design point	Yes, the information is complete in the given case
4. Do you think that information displayed on screen can be improved	Yes, more added features about the system help menu could make some difference to the advisor	Yes, the screen is more than enough to serve the customer in any given situation and there is no need of any improvement	Although there is an element of behaviour modelling, some extra feature of how this would effect should be added	Some information about the system and other product detail should be useful
5. Examples of customer and advisor combinations shown to you, provide your views about the information displayed.	Yes. All the examples are quite satisfactory in terms of the information provided. The best example is the A1-C1 where you have a non experienced advisor with a very rough customer	Yes, but example of A3 – C6 fits to my profile, and I don't have any level of annoyed behaviour as such. Yes angry sometime, but not on customer	The example of A4 C2 is quite unique, because clthough the advisor is quite experienced (10yrs) it still provides the details of the financial status of the customer, which in this case might not be required	Yes. Example A5-C1 is very appropriate . Only if you would find someone of that age and that experience is very rare.

7.7. Observations from Simulation

Based on the verification carried out in simulation for categorisation and information requirement frameworks described within the research, there were some observations from the simulation, which are:

- For a given set of data for customer and advisor, fuzzy expert system assigns a category to each customer and advisor entry,
- Based on the categorisation, the information requirement framework, then identifies from the mapping table, the combination required to display the information on screen,
- Once the combination is derived, the simulation then displays the information screen on to the advisor which helps them to serve the customer
- The results of the customer and advisor combination is also stored within an excel sheet with the set of information screens displayed

Due to the nature of implementation required at contact centres and the availability of the research, the simulation framework was not applied within a real contact centre working to identify and validate the results. The implementation of the following frameworks is identified in chapter 8 as future research. The advantage of conducting this simulation framework was to identify the requirements of the information to be used in any given customer-advisor combination.

The simulation framework used to verify the research objectives and validate other frameworks within the contact centre domain. Expert judgement used a semi-structured questionnaire described in appendix I. The analysis of the validation from the team leaders and advisors at the contact centres as shown in appendix I of the thesis. In this manner, this chapter has used simulation framework test case to validate the observations made previously regarding the categorisation capabilities of the proposed framework to deal with information modelling and customer-advisor categorisation objectives in contact centre environment.

7.8. Summary

This chapter has demonstrated the application of the categorisation and information requirements frameworks within a simulated environment for verification to be carried out at the contact centres. The simulation framework were developed in two stages as the initial model development and idea generation of the model and the framework development within the eclipse platford which simulated the entire research frameworks. The steps involved within the simulation framework are as follows:

- Model development with java platform in eclipse development

- The model then selects the database to perform the simulation and once the database (customer calls) is selected, it is then transferred to the categorisation framework (fuzzy expert system) in Matlab
- Once the identification of the categories for customer and advisor is derived, the simulation then identifies the combination of customer/advisor to be used to display the information.
- On the basis of this combination, the information is then displayed on the output screen, and the results is stored within an excel database file.

This chapter has achieved the following:

- Identified challenges posed by the categorisation and information requirement frameworks on the research objectives.
- Verification of intelligent decision support framework within simulated environment.
- Verification of the frameworks described in the research through simulation and expert judgement from the industry.

Finally, the results obtained from the simulation test were analysed in order to validate the performance of the proposed solution framework. The next chapter concludes the thesis with a discussion of the main research findings.

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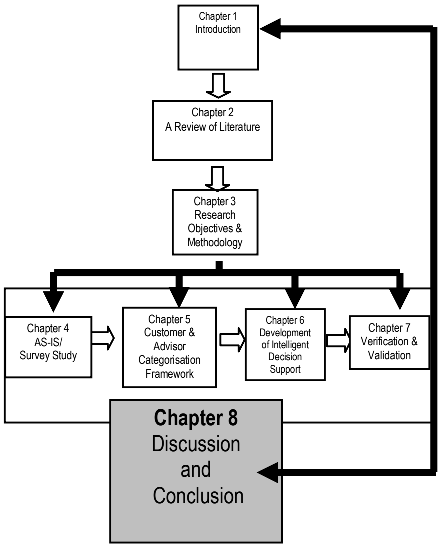
8. Discussion and Conclusion



This chapter concludes the thesis with a detailed discussion of the findings of the research with respect to the aim and objectives set in the initial chapters. This chapter is organised as follows. Section 8.1 summarises the key research findings and observations. The research contributions and business impact analysis are outlined in sections 8.2 and 8.3 respectively in relation to the research objectives. The limitations of the research are discussed in section 8.4 followed by future work in section 8.5. Finally, the conclusions drawn against the research objectives are discussed in section 8.6.

8.1. Key Research Observations

Existing contact centre systems are not capable of categorising customer and advisor and providing customised information to enable any advisor to serve any customer in the most efficient manner. Through research it was highlighted that although research studies suggested in the use of categorising customer, there was little or no research within the area of advisor categorising and also from the behavioural modelling. The contact centre face a major problem of advisor retention and information overload. The key observations of this research are summarised as follows.

8.1.1. Literature Survey

The review presented in this thesis has identified features of customer categorisation problems and information requirement to enable the advisor serve any customer at any given time. In the first Section (2.1), the author explains the call and contact centre environment briefly. Understanding of the contact centre environment is discussed with the help of the history of call / contact centres and the technologies behind the CC. In Section 2.2 the author explains the need and use of customer and service advisor (CSA) categorisation within contact centre environment. The list of human behaviour modelling methods is also represented within the section which looks on some of the techniques which are available.

The key observations observed through the categorisation literature studies were the importance of customer categorisation and human behaviour modelling techniques for development. In addition, the main highlight is the importance of customer and service advisor categorisation within the CC environment. Literature identifies a distinct lack to model human behaviour with respect to behavioural aspect. The importance of customer satisfaction and customer / advisor interaction within the service industry was the focus of the study within the research.

Another important aspect of the research identified within the research objective earlier in the section was to identify the ways to model the human behaviour. Through literature studies, the author identifies some of the key techniques that could be applied within any behaviour modelling in any context. One of the method reviews was a fuzzy cognitive map that combines the use of fuzzy logic and neural networks. A fuzzy cognitive map is consisted of concepts in order to illustrate different aspects in the behaviour of the system, with each concept representing a characteristic of the system, and these concepts interact with each other showing the dynamics of the system. Multiple classifier method uses the prediction of customer purchase behaviour as a classification problem. There are two families of combining multiple classifiers, which are serial combination and parallel combination. This method is because different classifiers potentially offer complementary information about the patterns to be classified. In addition, one of the methods to model human behaviour identified through research was case based reasoning (CBR) which shows significant promise for improving the effectiveness of complex decision-making. Although CBR is mostly used paradigm for computer based problem solvers and human cognition models. Another method identified was the living systems, which recognises the system as collection of elements interrelated together.

Soft computing methodology also provided the author a broader understanding of the subject area and on the use of the technique for modelling customer and advisor within the categorisation frameworks of the research. Some of the soft computing modelling techniques include fuzzy logic (FL), neural networks (NN) and probabilistic reasoning (PR). Neural networks (NN) have the ability to learn from input output functions. Moreover, Neuro fuzzy systems have the ability to incorporate human knowledge. Further analyses of soft computing techniques are discussed in section 2.4 and appendix A.

The author discussed the approaches for human categorisation process that can be used to categorise customer and service advisor (CSA) within contact centre environment. Major approaches such as business and marketing approach, cognitive modelling approach, sociological and clustering approaches are discussed which were identified through the literature studies available.

Also through the research, some of the soft computing techniques used in telecommunications industry are highlighted. The key observations from the following study are:

- ✓ Service encounters based on contact centres have raised new issues about the management of services.
- ✓ Soft computing provides an attractive opportunity to represent the ambiguity in human thinking with real life uncertainty.
- ✓ SC provides set of flexible tools to perform the approximate reasoning and search tasks.
- ✓ Fuzzy technology can be used for combining different models that provide partial solutions.
- ✓ GA's have been used for recommendation in the form of rules, which can capture user goals and preferences. Expert systems solve problems that are normally solved by human experts. Fuzzy expert system is defined if and only if the rule sets and membership functions associated with their fuzzy sets. Different examples of design and development of expert systems with the help of soft computing are discussed within the section.

In summary, the author has presented a structured account of the human behaviour modelling techniques. The importance of customer and service advisor categorisation within the CC service industry is also observed. The author identified lack of research as to the segmentation of customers and advisors with respect to behavioural attributes been seen within their interaction and communication during the service encounter.

The author conducted an AS IS study (Chapter 4) that addresses these issues and provides some insights to the problem. Many other issues were highlighted suggesting areas for future research. In subsequent Chapters, many of these issues are addressed. In particular, the development of a framework that categorise the customer and service advisor with demographic, experience, behavioural aspects will be presented, and which is going to be the base of the information requirement analysis system prototype that would identify the type of information to be presented to the service advisor based on the categorisation done.

8.1.2. Gap Analysis

No literature on simultaneous classification of customers and advisors for customising the information provided to the advisors. Literature shows that contact centre environment is lacking the new support of the intelligent tools to improve the services for the customer services advisor's (CSA) to handle the customer requests more efficiently; thus improving better customer service and satisfaction across the centres.

Through these points into the literature analysis the author has analysed the next possible outcomes of the research:

- Behaviour and preferences for advisor and customer within the contact centre environment are identified
- Categorising customer and advisor behaviour in contact centre through different soft computing techniques.
- An information requirement framework that enables any advisor to serve any customer effectively.

There is also a lack of research done to categorise the customer service advisor (CSA, advisor) to help them properly understand the situation so that they can serve their customer respectively

Through the information requirement modelling, the author identified that due to lack of research in the area of customised information modelling within customer facing environment, the identification of this information would be entirly based upon the case studies conducted by the author at contact centres.

8.1.3. Categorisation of Customer and Advisor in Contact Centres

This section discusses the categorisation frameworks for customer and advisor in contact centres. The categorisation was carried out by conducting case study analysis and data was analysed with the use of clustering technique which identified the categories to be used in further framework development. The results from the clustering identified that the selection of custer number should be kept to a maximum of six numbers of clusters. The cluster number was limited to six to enable each cluster to have the right number of cases to avoid repetition of categories from each cluster for customer and advisors.

With cluster selection set to automatic number of cluster, it was creating only two clusters for customers who were having cases divided equally within clusters, and there was only two categories derived from clusters. With cluster selection set to three or four, there was a repetition of male and female values for each cluster, and the categories were either too low or too high and also opposite to each other. For cluster selection set to more than six number of clusters, it was thoroughly noticed that as it was increased, the distribution of number of cases was reduced, there was a repetitions of categories from each clusters, and they were not significant for both customer and advisors.

So it was more feasible to select the total number of clusters to six, as the distribution was of somewhat equal proportion, and the categories derived from each cluster was having equal number of all the cases.

8.1.4. Development of Fuzzy Expert System Model Framework

This section evaluates the suitability of the proposed fuzzy expert system model framework to other service based industries. Chapter 2 reviewed the literature for the following service industries; customer facing, service sales support, services and repairs and manufacturing service based industries and evaluates the suitability of the proposed approached to these industries.

Since the following proposed methodology can be applied to other areas of service focussed environments, the limitation can mostly depend on the nature and type of environment. The membership function and rule based within the expert system can be modified and applied to other domains in customer facing environments. The validation of the rule base was done through expert judgement from the experts of the industry. With the addition of more rules within the system and fine tunning of the rules might enable to add more categories within the categorisation framework which would then enable to provide results according to the industry requirements.

8.1.5. Development of Information Requirement Framework

The section discusses research observations made during the identification of the information used within any CC domain by the advisor to serve the customer. Through case study anlaysis it was observed that current information screens were not capable to provide sufficient information to the advisor required in any given situation. Also the problem of customised information which can enable the advisor to access the information required was not possible due to the systems platforms used by the companies reviewed during the case studies.

As highlighted earlier in the literature studies, there has not been any substantial amount of studies carried out to identify the information requirement used within any customer CC environments. Based on the case study analysis, the author identified the minimum amount of information requried by the advisor and the customised information screen was designed within the information requirement framework.

8.1.6. Development of Simulation Framework

The development of a simulation framework was carried out for to verify the categorisation and information requirements frameworks. The simulation framework were developed in two stages as the initial model development and idea generation of the model and the framework development within the eclipse platford which simulated the entire research frameworks. The advantage of conducting this simulation framework was to identify the requirements of the information to be used in any given customer-advisor combination. The simulation framework was also used to verify the research objectives and validate other frameworks within the contact centre domain. Expert judgement was used using a semi-structured questionnaire described in appendix G. The analysis of the validation from the team leaders and advisors at the contact centres is also shown in appendix G of the thesis.

Validation

The research validates and tests the simulation framework using a semi-structured questionnaire and for eight different test scenarios. The validation was carried out to determine that each customer and advisor was assigned with a predefined category from the fuzzy expert system. Based on this categorisation an information screen is presented which enables any advisor to serve the customer. Verification must prove that the information model suitably represents the intended information screen as recognised by the team leaders. The questionnaire requested five different team leaders and advisors to identify and use the information screen. The selection of the use of the information screen; based on the ease of use, information relevance and the element of behavioural analysis within the system. The simulation framework allowed the author to validate the observations made previously regarding the categorisation capabilities of the proposed framework to deal with information modelling and customer-advisor categorisation objectives in contact centre environment. The overall purpose of the validation was to test the information model for consistency with the domain expert knowledge.

8.1.7. Application of Frameworks to other CC and Service Industries

This section evaluates the suitability of the proposed framework approaches to other service based industries. This research investigate the feasibility of categorising customer and advisor and the development of information requirement to enable a advisor to effectively deal with any type of customer in CC sector. However, the findings can have implications far beyond this specific case study. The reported results are considered significant for a number of reasons.

Firstly, the study involved a real life problem. This means that the data used, the requirements and objectives set and the scale of the experiment corresponds to a real problem, as defined by a major telecommunications operator. Since modern telecommunication companies have similar characteristics in terms of services provided to their customers, databases and information systems design for monitoring customer characteristics used, the findings of the experiment are applicable to other sectors of service industry.

Secondly, throughout this study, it recognises that domain experts were continuously providing expertise and intuition by directing and pointing to the matters that were important for the company and its customers. It shows that the original steps of the process required a mixture of tools and experts intuition, relating to the problem of defining the data set and selection of variables describing the required modelling features.

8.2. Research Contributions

Through the literature studies, the author identified the key areas towards his contribution to knowledge for the research. To date there has been little academic research into the use of intelligent decision support for call/contact centre environment. There are recent developments in the business / consultancy area into the area of categorising customer behaviour in the market. Here the novelty within the research is to categorise advisor (CSA) and customer together and identify the minimum amount of information required for the screen to display. This enables the advisor to serve any customer more efficiently and satisfying the three business aspects of the contact centre environment (1) customer satisfaction, (2) resolving the conflict and (3) cross – up sell opportunities. After reviewing the literature, the author gained an understanding about the current trends of call and contact centre environment, and the possible techniques and tools that can be used to characterise customer and human advisor behaviour. The following section outlines the contributions made to knowledge from the research reported in this thesis.

The key contribution to knowledge through this research is:

Development of the methodology that can categorise any customer and advisor and identifies the minimum amount of information required to serve for that particular instance.

- Critical analysis of existing CC: The literature review carried out in this thesis compares the human behaviour modelling techniques used within the categorisation framework for customer and advisor. The analysis from the literature review reveals the lack of suitable techniques to deal with the advisor categorisation features. This has led to development of the frameworks reported in this thesis.
- The research has identified the current practice in handling customer enquiries within the CC environment through AS – IS studies described in chapter 4.
- The research into soft computing techniques in telecommunications is not a new or recent phenomenon. What is new is the application of this knowledge, into contact centre environment. The research contributes new knowledge into the field of customer and advisor categorisation together with respect to demographic, experience and behavioural attributes.
- The research has developed an intelligent decision support framework for the CC that can identify the amount of information required for any given customer and advisor combination.
- Development of a simulation environment that can assign any customer and advisor to that of the pre-defined categories and display the minimum amount of information required based on the customer-advisor combination.

8.3. Business Impact Analysis

The details of customer-advisor categorisation and information requirement modelling have been presented in this thesis. The authors have also identified the use of Soft computing based methodology to classify customer and human advisor behaviour within contact centre environment. As shown from the literature it was observed that the reasons for the service industries to operate on issues and challenges faced were to provide better customer service and increase the satisfaction levels of their customers. The main business benefits of the proposed use of soft computing based methodology such as fuzzy logic, and neural networks are as shown below (Roy, Shah, Tiwari, and Hadden, 2006).

- **Proper Use of Information**

  There can be proper use of information which the service provider has about the customer and which would enable the service advisors to efficiently use this information and provide better customer service.

- **Customised Information**

  Presenting customised information on the screen based on both customer and advisor categories derived from categorisation.

- **Customer Handling**

  With the help of proposed soft computing methodology, levels of customer handling can be improved where customers are provided with the service they expect from their service provider.

- **Customer & Advisor Categorisation**

  The important attributes such as demographic and experience levels of customer and advisor are categorised along with behavioural variables, which enables the service providers to identify their key customer and advisors.

- **Any Advisor and Any Customer Situation**

  Any advisor should be able to serve any customer and provide good service.

- **Real Time**

  A further benefit for a company using the proposed method is it could be implemented using real time monitoring.

These advantages have potential benefits for customising the information used within the business. In order to demonstrate how this can benefit the business, it is important to analyse its impact on the business. Therefore, this section presents a brief analysis of the business impact of these categorisation and information requirement frameworks in CC environments.

8.3.1. Implementation Issues

The results of this research provide information requirement to be customised within CC environment. This provides various benefits already outlined in the previous sections. However, several issues need to be considered in order to realise these benefits. This section outlines the technical and cultural change management issues that are likely to influence the successful implementation of the proposed intelligent decision support frameworks.

Technical Issues

A choice would need to be made with respect to how the information requirement tool should be developed. In this research, an excel database was used to demonstrate the concept. This provides an inexpensive method for developing and testing the information requirement tool before proceeding to a full-scale software development.

Companies using existing information analysis software may prefer to consider having “customised information” implemented as a custom feature. This would provide a useful integration with an existing process of accessing customer information. Implementation into commercial software will add many new features such as a customised information screen, addition of behavioural element within information, access of required information within a single platform, and combination of other customer database into this. These features will further the cause of the information requirement and help to reduce the time taken by the advisor to search for relevant information.

Maintenance Issues

Maintenance issues will need to be considered to ensure that both the information requirement and the data stored remain useable and accessible. If a vendor supplies the software, these issues are less pertinent. However, if the company creates an information requirement framework, it needs to be aware of effects from hardware changes, operating system changes, and user request changes. Such changes need to manage to ensure that the framework remains operational and accessible to end users.

Financial Issues

The further development and implementation cost needs to be critically evaluated. Initial development work is required to customise the tools and a significant training resource is required to adopt the tool. The customisation efforts need to ensure that user requirements and interface issues are captured, understood and reflected in the interface design stage. Since the advisors can be major stakeholders, it is important to engage the advisors in the development phase to establish buy-in from the onset. Creative approaches should also be sought to promote a culture that embraces customised information and behaviour modelling as a philosophy. Other related technical cost includes increased training overheads.

Cultural Issues

Perhaps the largest hurdle to implementing the information requirement tool is 'selling' the approach to end users. Change can invoke unpredictable responses especially with a current climate of high uncertainty in the organisation. It should be emphasised that during testing and validation, the users responded positively to the effectiveness of the information tool. It is also important to test for relevance of the tool with other businesses within the organisation. This can improve the user's interest to embrace the technology.

8.4. Research Limitations

8.4.1. Research Methodology

The use of qualitative research is prone to several forms of interpretation and bias as described in chapter 3 of the thesis. It is difficult to replicate compared to quantitative research. As such, there are several areas of concern, which should be realised when reading this thesis.

The case study option was predetermined. Due to the nature of contact centres reviewed, there was no control over the choice of case study for the author. Therefore, the reason for bias in the results is due to the people and processes used as the basis to develop ideas and influence the results.

Although the author spent some time at the sponsor premises, prolonged involvement can increase researcher bias. This is because the researcher began to form opinions and ideas about the processes, and people within the company. These opinions can be positive or negative, which can affect and bias the results. Nonetheless, in an attempt to provide reliability and validity, the author made use of multiple sources of data collection, maintained a chain of evidence, and recorded (audio) interviews where possible. This does eliminate the bias and interpretation of the author but does provide a means for other researchers to examine how the results obtained.

8.4.2. Human Behaviour Analysis

Identifying the behavioural elements of the user (customer and advisors) derived through extensive literature studies. Although the author's main intention in identifying the user behaviours was to identify the key attributes to use within the categorisation framework for the assignment of categories to customer and advisors. However, this research addresses this problem by deriving a short list of the most important behaviours of customer and advisors identified during the case study analysis and verified through experts from the industry.

This human behaviour modelling approach incurs a significant handling time due to manual identification and manipulation of data gathered from the literature and from the industry experts and advisors within the contact centres. The analysis was also used different techniques for identification of these behaviours.

8.4.3. Clustering Analysis Framework

Clustering analysis framework used to derive the categories based on the data collected from the case studies. Through literature, the author for use within the framework reviewed different techniques. This clustering approach is particularly suited for large-scale databases where there is no problem of number of clusters due to the size of databases. The approach does not require a full knowledge of the problem space and as such, incompleteness in the rule definition could be accommodated. In the case of applying the incomplete rule definition for optimisation problems, this is dealt with by penalising those areas of the search space that are not covered by the rule set within the categorisation module

8.4.4. Fuzzy Expert System Framework

It was also noticed within the fuzzy expert system devlopment that the data used from case study analysis needs to be accurate and in appropriate propotion. Any partial data would not enable the system to work accordingly. Development of the fuzzy system can also be applied to any other platform other than matlab as applied by the author within this research. During the validation of the fuzzy expert system framework, the link between the simulation and the matlab proved to be a real challenge due to the connection and simulation problems.This can render a single search point invalid and it can deceive the fuzzy categorisation direction.

8.4.5. Information Requirement Framework

Business needs to assign any available advisor to a customer and provide consistent and good quality of service. The author has focussed some of the market opportunities where intelligent customised information can be used and its advantages within the intelligent decision support framework. However to achieve the required results from the framework, some of the observations identified within the research as limitations are as follows:

- For an understanding of how customers behave and continue to enhance this by learning service levels, communication methods and channels affect different customers.
- The framework needs to adapt market and customer knowledge that will provide a link to corporate survival and market dominance that was not possible to review within this research.
- Service providers are limited to maximise the use of information about the customer and to exploit opportunities to sell other products.
- To resolve the problem that service advisors are forced to limit their call duration for the reason of attending the next call in queue; and therefore it is vital importance that they try to resolve the customer query as efficiently as possible

8.4.6. Simulation Framework

The application of the intelligent decision support framework within a simulated environment proved to be difficult in the beginning due to the limitation of the linkage between the expert system platform and the simulation platform. During the literature study, the author identified that discrete event simulation technique was the most appropriate technique when modelling involves the customer analysis. However when the simulation framework was started, the fuzzy expert system framework was not able to link with the platform used for the simulation. There was also less amount of research and literature available which could identify and resolve the problem faced. During the simulation framework, the author looked on the JVM based windows platoform where the linkage between matlab (fuzzy expert system) and the simulation platform was possible and which were having the appropriate results.

8.5. Future Research

Further research should develop a framework to map customer and advisor behavioural and demographic information directly to the type of information required that required presenting on the screen; rather than a fixed template based approach.

The research activities relating to the future development of the **categorisation of customer and advisor within customer facing environments** are as follows.

- Based on the data requirements the model be further developed with more of the attributes including the demographic, experience and behavioural attributes highlighted within the research.
- Elements of behavioural analysis for customer and advisor could increase according to the industry requirements.
- In addition, for the specific problem of behavioural modelling of customer and advisor within contact centres, the methodology described in reuse the research, except of definition of the advisor data.

The research activities relating to the future development of the **clustering analysis framework** are as follows.

- Some of the findings and specific techniques used are of general value such as the clustering approach used for customer and advisors and the discussion on the use of soft computing based approach to assign each customer and advisor to a pre-defined category.
- More specifically, a large area of problems related to the identification of information and categorisation of customer in the service industry rules.
- They bear many similar characteristics to the one described here, and can be based on very similar process, where apart from the initial stages of problem definition and original variables selection, the rest of the process can be

repeated. A data mining tool to handle such exception of data can be used as one of the objective for further research.

The future activities for further development of **development of fuzzy expert system** within categorisation framework are as follows.

- Development of a fuzzy expert system to assign any customer or advisor to that of the pre-determined category from the clustering analysis by adding more attributes to the system.
- Addition of extra rules to the existing or modified structure of the expert system framework to achieve results that are suitable to the industry section based on their requirements.
- Application of the proposed methodology in any customer-facing environment to minimise the problems of information overload, right amount of information at the right time, retention of staff, and customer satisfaction through speed of response.

The research activities relating to the future development of the **intelligent decision support framework** are as follows.

- An interesting discussion concerns the degree to which the study can be generalised and reused in other problems in service industry.
- Implementation of the use of information available within the company database more efficiently.
- Future focus on intended use of addition and modification of the behavioural segments within the framework. Allowing the advisor to change any behaviour of the customer during the interaction with the customer is taking place.
- By changing the behaviour of the customer, the information screen can automatically change to the new information screen based on the modifications.

The future activities for further development of **simulation framework** within a validation and simulated frameworks are as follows.

- With the use of simulation framework, the results derived from the simulation, can be stored in excel database which can provide details of each of the values for customer and advisors.
- Improvising the information screen within the simulation framework to provide better results to the advisor.
- Use of research frameworks implementation in real contact centre environment as one of the future research developments.

8.6. Conclusions

The purpose of this section is to state how the aim and objectives of the thesis have been achieved. The aim of the research is **to develop an intelligent decision support framework for effective engagement between any customer and advisor within the contact centre environment.** The research has satisfied all the research objectives highlighted in chapter 3. The first objective was **to identify the current practice in handling customer enquiries within contact centre environment**. Based on the analysis of literature the author identified that:

- There is a lack of research to categorise customer and advisor together within contact centre environment.
- There is limited amount of research carried out to categorise customer and advisor with respect to behavioural attributes in contact centre domain.
- Through AS-IS study it was identified that there was alack of proper handling of customer requests due to insufficient knowledge available to advisors.
- Due to the problem of information overload within the CC, the overall time taken by the advisor is also increased. There is also lack of information about the customer provided to the advisor, which makes it difficult to serve the customer efficiently.

The second objective was **to identify and categorise generic groups of customer and advisors (CSA) within CC environment**. Based on the analysis of literature the author identified that:

- Customer and advisors can be categorise from generic groups of population within contact centre environment.
- Observation of high volumes of mixed data collected from contact centres, which are of different aspects of interactions between the company and its customers.
- Some of the important variables used within the research to categorise customer and advisors are age, experience, IT experience, financial status (customer), previous experience, etc.
- Two step clustering analysis used within the research works accurately with mixed data and large datasets. Due to the limited amount of qualitative data available within the research, the total number of cluster selection was set to six for proper allocation of cases to each of the cluster.

The third objective was to identify the key issues related **to identify how soft computing techniques used for categorising customer and CSA within CC**. The author identified that for categorisation of customer and advisors:

- There are different soft computing techniques available, used to categorise customer and advisor such as fuzzy logic, neural networks, and genetic algorithms.
- Fuzzy logic proved to be an appropriate technique for the development of the system, which can identify and assign categories of customer and advisors.
- With the help of proposed fuzzy expert system, levels of customer handling can improve with the provision of right level of service to the customers.
- The framework assigned appropriate category for each customer and advisor data, validation from experts agreed to 80% of the cases used during the validation.

The fourth research objective was to **identify the minimum amount of information that is required by the advisor to serve the customer and to develop an intelligent decision support framework** more efficiently thus providing better customer satisfaction levels. The author identified that:

- There is limited use of customised information screens, which led to the development of intelligent decision support framework.
- The proposed framework will identify the right amount of information required by the advisor at the right time.
- This framework would enable any advisor – any customer situation within contact centre environment. Any novice advisor is able to resolve any customer query in limited amount of time.
- The framework validated with experts from the contact centres including the team leaders, managers and advisors.

The final objective was to represent the **frameworks within a simulation framework environment** within a prototype system and test whether the framework applied to real life CC environments. To achieve this objective, the author:

- The simulation environment used within the research simulated the complete research framework and intelligent decision support framework.
- Based on type of customer and advisor; the categorisation identified the category of customer and advisor to be used within the framework.
- Once the identification of categories carried out, the simulation framework provided the minimum amount of information that is relevant within that combination of customer and advisor.

In summary, the thesis has achieved the stated aim and objectives by developing an intelligent decision support framework that enables any advisor to effectively deal with any customer in contact centre environment.

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Appendices

Appendix A: Contact/Call Centre Technology Overview

CC Technology	Description	Focus on Effectiveness	Focus on Efficiency	Focus on Cost Reduction	Reference
Self-serve telephone (IVR)	▪ Use of 'automated greeting' software that uses pre-recorded messages to allow callers to define the nature of their call using their voice or touch-tone phone. ▪ Can also be used to 'screen' calls and complete simple activities without the need for human interface (call avoidance). ▪ Company automated telephone system enables customer self-service for a relatively low transaction cost.	●	●	●	(Suhm and Peterson, 2002)
Automatic Call Distributor (ACD)	▪ Hardware or software based system used in inbound contact centres. A programmable device automatically answers, queues and distributes calls to advisors. ▪ Presents recorded announcements to callers and provides real-time and historical reports on multi-channel transaction activities. ▪ An ACD also provides detailed reports on every aspect of the interaction, including how many calls were connected to the system, how many calls reached the advisor, how long the longest call waited for the advisor and the average length of each call. ACDs also have the capability to conduct skills-based routing to have highly skilled advisors deal with complex calls. ACDs allow for the blending of email/fax/ call back/inbound/outbound/chat/VOIP allowing the maximization of efficiencies in meeting transaction volumes during peaks and valleys though more effective staff utilization.		●		(Fischer, et al. 1998) (IT Com , 2002)
Computer Telephony Integration (CTI)	▪ A term for connecting computer workstations and file servers through a local area network to a telephone switch and allowing the computer to issue the switch commands to route calls. ▪ Technological tool for increasing customer satisfaction at a reduced cost. Customers are routed through the organisation in a way, which is based on a set of criteria appropriate to that organisation's business – such as its market segment, the skill set of the customer contact advisor, customer profile attributes and transactional need.	○	●	●	(Anton, 2000) (Bernett and Gharakhanian, 1999)
CRM Software	▪ Software used for managing all aspects of a customer interaction with an organisation	●	○		(Meltzer, 2001)
Predictive Dialling	▪ A system that automatically places outbound calls and delivers answered calls to advisors. When the dialler detects busy signals, answering machines or no answer, it puts the number back in queue.		●	○	(Mehrotra and Fama, 2003) (Samuelson, 1999)
Internet – Web	▪ Content on a website that helps customers get answers to their inquiries. May be as simple as				(Bernett and

Self-Help	Frequently Asked Questions (FAQ) pages or more sophisticated search question & answer tools (Yahoo Answers).	○	○	○	Gharakhanian, 1999)
Internet – VOIP	▪ Use of the Internet rather than telephone lines for voice communication – may be limited due to bandwidth restrictions.			●	(Anton, 2000)
Direct PC	▪ Direct communication between two computers over a dedicated network (i.e., not over the Internet). ▪ Electronic Data Interchange or EDI is an example.				(Strathmeyer, 2002)
Email Response Systems	▪ Software that is used to automate the management of and responses to email that enters into a contact centre.		●	●	
Speech Recognition Software	▪ Software used to decipher spoken words and phrases. ▪ Has also been used for streamlining the authentication process ▪ Potential to reduce cost of operation	○	●	○	(Suhm and Peterson, 2002b) (Deng and Huang, 2004) (Bae et al, 2005)
Automated Wrap Up	▪ It is difficult and expensive to modify existing applications to send data to each other, it is much easier to program a personal computer to fetch data from one system to another; saving time for CSA to avoid wrap up time they carry out after finishing the call with the customer	●	○	●	(Strathmeyer, 2002)
Knowledge Base	▪ A helpdesk or technical support team. It is a collection of information about a particular subject, usually in question and answers format, or a series of if-then statements. ▪ The system uses artificial intelligence to mimic human problem solving. It applies the rules stored in the knowledge base engine and the data supplied to the system to solve a particular business problem or to answer a specific question.	●			(Shaw, et al. 2001)
Workforce Management Software	▪ Software used to forecast call load, calculate staff requirements, organize schedules and track real-time performance of individuals and groups.	○	●	○	(Lin, 1999) (Stockford, 2003)
Quality Monitoring Software	▪ Software that assists supervisors in evaluating the performance of customer service representatives. Focused on the quality of their interaction with customers rather than quantitative metrics such as call handle time.				(Foss, et al. 2002) (Chen, 1999)
Sales Automation Software	▪ A program that allows for rapid and orderly maintenance of contact records by salespeople either at the office or in the field. It should allow them to send follow-up literature, schedule calls and letters, and access a customer's history. Many configurations of sales automation software, which ranges from a simple record keeping program on a PC to a complex and multi-user database that connects LANs and Laptops.	●	○		(Strathmeyer, 2002)
● Primary Focus ○ Secondary Focus					

Appendix B: Contact Centre Companies/Vendors

Company/Vendor	Description and Type of Services
Alcatel Telecom	http://www.alcatel.com/enterprise Alcatel's e-Business group focus on Enterprise Network Solutions and offers a complete line of seamlessly linked voice and data solutions for enterprise.
Avaya	http://www.avaya.com Avaya is a global leader in communication systems, applications and services. We design, build, deploy and manage networks for enterprises. **Contact Centre/CRM** – Multimedia Contact Centre, Proactive Contact Management, Multivantage Contact Management, Conferencing, Unified Communication, System & Network Management, Telephones and end user services, VPN & Security.
Apropos	http://www.apropos.com Multi-Channel Interaction Management, Contact Centre Solutions, Network Based, Client Server Contact Centre.
Altitude Software	http://www.altitude.com Altitude Software provides state-of-the-art contact centre solutions. The Altitude uCI 6.2, the new release of the Altitude uCI product suite, allows companies to interact with their customers in a personalized way by keeping the history of previous interactions and maintaining the context of interactions with the customer, while moving from one channel to the other.
Armstrong Communications	http://www.acplc.com Armstrong Communications plc provides voice and data solutions in the business market place. The Advisor Suite software has been developed to interact with the Inter-Tel Axxess Telephone system via the Open Architecture Interface. These products are designed to increase the productivity of inbound and outbound Call Centres, and can be integrated with management software to provide real-time and historical reports.
Aspect Communications	http://www.aspect.com Aspect Communications is the leading provider of business communications solutions "Aspect is the only company that provides the mission-critical software platform, development environment, and applications that seamlessly integrate voice over IP, traditional telephony, e-mail, voicemail, Web, fax, and wireless business communications, while guaranteeing investment protection in a company's front-office, back-office, Internet, and telephony infrastructures".
Blue Pumpkin Software	http://www.bluepumpkin.com Blue Pumpkin's Services are designed to help you optimize your workforce by leveraging your investments, people, processes, and technology. They offer a comprehensive set of services to ensure successful implementation and execution of your workforce optimization initiatives.
BT Ignite	http://www.ignite.com/uk/products/contact_centre_service/ BT Contact Centre Service, part of the BT Voice Services portfolio, is a world-class, end-to-end managed voice solution that enables high-volume global contact centres to operate more efficiently and serve their customers better than ever before. Benefits: Improved customer service, Simplified contact centre management, Greater cost effectiveness, Increased efficiency and advisor productivity, Increased resilience and

	reliability.
BT Contact Central	http://www.contactcentral.co.uk Contact Central is a prepackaged solution that can be implemented in days or weeks rather than months and will allow you to communicate with your customers in completely new ways. It is simple really. Contact Central views all forms of in and out-bound communication as events, whether they are phone calls, faxes, emails, text messages or web chats. By tailoring different communication events to particular customers, advisors or processes, your business can talk to customers in the way that suits them, while at the same time making the most cost-efficient use of your resources.
Business Systems UK Ltd	http://www.businesssystemsuk.com BSL delivers call recording, (including VoIP recording), data recording & web recording software and hardware to meet these needs. We help these companies capture, store and analyse vital business interactions, whether via telephone calls, email, web chat, VoIP or web transactions
Cisco	http://www.cisco.com Through its Contact Centre, Cisco is delivering new-generation Customer Contact solutions that enable enterprises, service providers, and application vendors to realise the full potential of converged voice and data networks. Cisco Intelligent Contact Management (ICM) software delivers an integrated suite of capabilities that enables a company to interact with its customers via phone, Web, and e-mail across an enterprise of automatic call distributor (ACD), private branch exchange (PBX), interactive voice response (IVR), database, and desktop applications
CCA	http://www.cca.org.uk/ CCA is the professional body for the call and contact centre industry. An independent organisation with over 600 public and private sector members, its key objective is to improve standards from both the user and employee perspective.
Concerto Software	http://www.concerto.com Concerto Software's Contact Centre solutions are designed to meet the needs of both new and existing contact centres. EnsemblePro™ Contact Pro™ is real-time knowledge software about customer relationships to deliver a personalized and consistent customer experience across all communication channels (i.e., voice, fax, email and the Web). Ensemble™ - integrates inbound and outbound calling. Unison®LYRICall™
Consorte	http://www.consorte.co.uk Consorte is a leading supplier of advanced intelligent network solutions. They develop, customise and implement telephony solutions designed to help their clients improve the speed, efficiency and quality of service they provide to their customers. Virtual Call Centre Solution – Consorte PULSE is a virtual, network based call centre solution that is skill based and completely web based. Consorte Sonar is our web based statistics solution enabling customers to generate detailed statistics on-demand.
Convergent Systems	http://www.convergentsystems.uk.com/ Call media Multi-media contact centre supporting the blending of different contact media types using Convergent Labs' Task Allocation Engine (Patent Pending).It will take inbound contact requests such as telephone calls, voice mails, emails, faxes and chat sessions and route the most appropriate task to the most appropriate user, depending on the business rules defined.

Convergys Customer Management	http://www.convergysemea.com/ Convergys is the world's leading billing and customer care specialist. Convergys EMEA in Cambridge, supplies software and services to major companies in more those 20 countries across Europe, the Middle East and Africa. Convergys offers high-quality labour, multi-channel CC technology solutions and the expertise of our proven UK operational processes adapted to the Indian environment: Computer-telephony integration (CTI), Voice-over-IP (VoIP) solutions over private circuits, Integrated voice, e-mail and Web chat, Sophisticated data analysis tools.
CosmoCom	http://www.cosmocom.com/ CosmoCall Universe™ is a carrier-class system providing true next generation capabilities for mission critical contact centre applications. **Unifies All Customer Contact Options in a Single all-IP System** • Inbound Telephone Calls with Interactive Voice Response and Live Advisors • Outbound Telephone Calls with Preview and Predictive Dialling • Computer Calls from the Web with Keyboard Chat, Joint Browsing, Voice, Video, and Collaboration • E-Mail Messages • Voice and Fax Messages • Wireless
eGain Communications	http://www.egain.com/ eGain is the leading provider of eService software for the Internet. We help businesses transform their traditional Call Centres into multi-channel eService networks. eGain solutions for email management, interactive Web collaboration, intelligent self-help advisors, knowledge management and proactive online marketing can measurably improve operational efficiency and customer retention - resulting in significant return on investment (ROI).
ERA Technology	http://www.era.co.uk/ ERA developed, integrated, tested and rolled-out the new infrastructure using the latest CISCO internet protocol (IP) telephony and contact centre technology. ERA's contact centre solution integrated consumer to business (and business to business) contact channels, including telephone access, automated answering services and web based interaction channels into a virtual, multi-site, enterprise-wide answering and interaction resource.
Eyretel plc	http://www.eyretel.com The Eyretel™ Contact 7000™ suite of customer contact monitoring, recording, quality and analytics products is designed to help you optimize the operation of your contact centers: helping you to better **understand** what is happening in your interactions with your customers and **why.**
Energis	http://www.energis.co.uk/ Energis Contact Centre Solutions connect, automate, and manage inbound and outbound customer communication. They We offer a full range of solutions from multi-site Contact Centres for large enterprises to income generating premium rate information services or simple Free phone numbers for small businesses. Customers include BBC, Boots, Eurostar, Nortel Networks, Renault, & Thomas Cook.
Front Range Solutions	Combine GoldMine Sales & Marketing with HEAT® Service & Support™ or HEAT® PowerDesk™ for an integrated service and support solution that enables everyone within the organisation to view a single picture of your prospects and customers. HEAT Software delivers an easy-to-use, full-featured customer service and support solution with a single view

HEAT. Service & Support.	of the customer, enabling your organisation to reduce labour and systems costs, streamlines customer support.
Genesis Telecommunications	http://www.greatcommunication.co.uk ▪ Genesis offers partial or total end-to-end solutions for call centres and contact centres. ▪ Providing development, centre support, maintenance and integration of call centres and multimedia contact centres, Genesis will tailor solutions to include email management, text chat and screen popping to meet your medium to large call centre or contact centre CRM strategy. ▪ Solutions designed with company's call centre advisors and customers in mind by working with their partners that include Avaya and Calcom who are leaders in call centre and CRM consultancy, and call centre hardware and software.
Genesys Telecommunications	http://www.genesyslab.com/ Genesys' Contact Centre solutions enable businesses to intelligently route customer interactions across all communications channels to the appropriate advisor or company resource based on business drivers such as service levels, revenue goals, individual customer value and demographic information, advisor skill sets and company-wide business processes.
KANA	http://www.kana.com KANA provides software solutions to the largest businesses in the world. KANA's e-business applications uniquely enable your customers to do business with you when, where, and how they want, whether that means Web contact, Web collaboration, e-mail, or telephone. They make it possible to increase interactions and improve customer experiences while decreasing costs in Contact Centres and Marketing Departments. KANA iCARE delivers a complete solution for managing the customer relationship.
Lucent Labs	http://www.lucent.com The ClientCare® line of contact centre products addresses the needs for both network service providers and enterprises of all sizes. Client Care mainly designed for the enterprise; and leverages the carrier network to achieve a virtual contact centre operation without the complex integration of multiple platforms. Its centralised, integrated platform provides next-generation con-tact-centre capabilities without the need for continual acquisition and integration of traditional call-centre equipment.
MCK Communications Ltd	http://www.mck.com/ MCK Communications develops and markets distributed voice solutions that cost-effectively create a more open and interconnected business telephony environment. Services include call management systems, call centre services, web enabled services, & workflow automation.
Mercom Systems	http://www.mercom.com/ Mercom Systems, Inc. is a leading provider of powerful, easy-to-use recording, retrieval and evaluation tools for call centres and public safety organisations. Mercom's solutions are installed in thousands of leading call centres, government agencies, utilities, and financial institutions around the world. Audiolog integrates seamlessly into contact centres and public safety environments, either as a standalone recorder/playback unit, or as a dedicated server in an established network.
NICESystems	http://www.nice.com/ NICE Systems is a worldwide leader of multimedia digital recording solutions, applications and related professional services for business interaction management. Capture, evaluate, analyze and improve the customer experience in voice, voice over IP, e-mail and Web interactions. Outsourced. Inbound. Outbound. Web-enable Contact Centre. Build lifelong customer loyalty. Bring decision-makers closer to customers. Empower Your Advisors. Exceed profitability. Surpass customer satisfaction

	objectives. All with CEM solutions from NICE.
Noetica	http://www.noetica.com Noetica is a software development company specialising in Customer Interaction Management (CIM) software tools. Their flagship product, Synthesys™ manages the day-to-day running of a contact centre, placing the control of Customer Interaction in the hands of the business managers. Noetica CR is a software package that allows non-technical people create and deploy highly interactive web self-service applications called "web flows", using a simple graphical user interface.
Pivotal Corporation	http://www.pivotal.com Pivotal Corporation is the leading provider of clear, complete and sensible customer relationship management (CRM) software. Integrated communication platform, Intelligent interaction routing & assignment, Universal interaction queuing (web chat, phone, email, fax), Intuitive, all-in-one user interface, Integrated with CRM, CTI (Screen Pops)
Rockwell First Point	http://www.rockwellfirstpoint.com Rockwell First Point Contact was the first to develop the technology to help automate customer Call Centres over 30 years ago. Blended, inbound and outbound. Provide tools for proactive customer contact, including previewed and predictive dialling. Seamlessly blended calls enable your advisors to be more productive and enhance the success of your outbound campaigns.
Servion Global Solutions	http://www.servion.com Serviont has revolutionized customer experience through its Contact Centre suite of products, solutions and Systems Integration services. Self service solutions (prepaid & post paid solutions), Calling Card solutions (Interactive Voice Response system), Contact Centre solutions, Computer Telephony Integration, Customer Relationship Management, Outcalling & Multimedia Notification (Telemarketing campaigns), Natural Language Speech Recognition.
Sterry Communications	http://www.sterry.co.uk Sterry Communications are a professional telecom services organisation that provides voice and data products and services to enterprises and SME's across a variety of industry sectors. Index – Contact Centre Solutions. Automatic Call Announcement (ACA) cassette, Wallboards, Call Centre view, report manager, networked administrator, queue manager, advisor assist, workflow manager, digital recorder, voice recorder.
SIEBEL	http://www.siebel.com The Siebel Communications Server provides a powerful framework for Multichannel Contact Centres by seamlessly integrating all of the channels that organisations use to communicate with customers. The Siebel Communications Server provides integrated out-of-the-box support for queuing, routing, tracking, and automated screen-pop capabilities. Siebel CTI enables Call Centres to increase telephone calls per advisor, decrease average call times, and provide effective customer service
Syntellect	http://www.syntellect.com Syntellect is the global leader in providing enterprise and voice portal solutions. It develops and delivers software and hosted services that empower large and mid-size enterprises to become more responsive to customers, employees, suppliers, partners, and investors. The solutions cover multimedia systems - telephone, email, fax, and web - to allow access to real-time information, self-service applications, and online transactions.
Teleopti	http://www.teleopti.com Teleopti is one of the world's leading providers of solutions for strategic workforce management in contact centres, as well as accounting and cost and quality control of voice and IP enterprise networks. Key features includes: Dynamic multi-skill forecasting and scheduling, Virtual call centre planning, Dynamic multi-channel support, Outbound project planning Scheduling of all contact centre activities, Extensive web-enabled analysis tools,

	Simulation and cost-benefit analysis.
TeleWare plc	http://www.teleware.com/ TeleWare plc is the computer telephony division of TeleWork Systems plc. TeleWare plc, the computer telephony division, develops and sells a highly resilient suite of software applications including computer control of telephony, unified messaging, interactive voice response and related applications. TeleWare provide solutions for four different scenarios within the inbound call centre/contact centre environment: Departmental Call Centres / Help Desks, ACD-Based Inbound Call Centres, Self Service Solutions, Web-Enabled Contact Centres
Ventura	http://www.ventura-uk.com Ventura is the UK's leading provider of outsourced customer CC solutions. Ventura has a record of accomplishment of managing customers' accounts with over 30 year's experience of delivering contact centre solutions on behalf of some of the biggest names in British business. Ventura's 3000+ call centre advisors are the first line of contact for their clients' customers, utilising an excellent infrastructure. The voice and data switching, call distribution and telephony across the company's sites is provided by Ventura using Lucent Definite technology.
Verint Systems	http://www.verintsystems.com Verint Systems is a global organisation providing analytic software solutions for communications interception, digital video security and surveillance, and enterprise business intelligence. They generate actionable intelligence through the collection, retention and analysis of voice, fax, video, email, Internet and data transmissions from multiple types of communications.
Vertex	http://www.vertex.co.uk Vertex is an international business process outsourcer with particular expertise in customer management. They develop and implement a range of outsourcing solutions Vertex has the capability and experience to provide a full range of contact centre management outsourcing services. Customer Data Handling, Data Analysis.

Appendix C: Human Behaviour Modelling Techniques

This section outlines the different techniques, which can be used to model customer and CSA's behaviour within contact centre environment. The analysis briefly describes the techniques used for human behaviour modelling (Shah *et al.* 2006a)

Human Behaviour Modelling Techniques Summary

Requirements → Technique ↓	Customer Mood	Customer Purchase Behaviour	CSA's Behaviour	Customer / CSA's Performance/	Customer Need Pattern
Soft Computing Tech (Neuro Fuzzy Systems, Genetic Algorithms, Fuzzy Cognitive Maps, NN, Tree structure)	**Neuro Fuzzy Systems** They have been proposed as advanced techniques in the modelling and control of real world problems that are usually imprecisely defined and require human intervention	**Multiple Classifier System based on Genetic Algorithm** Integrated measurement level classification results generated by multiple classifiers into single result.	**Fuzzy Cognitive Map** This technique gives more attention to human experience, rather than to the controlled process.	**Neural Networks (NN)** NN is quick in predicting new cases if properly trained.	**Tree Structure Approach** It is the easiest to understand. Tend to excel when a particular target attribute value is based on a complex, set of attributes with particular values.
Ethos	**Modelling Human Social Behaviour & Culture change** Ethos provides basic building blocks the kind of entities a modeller is likely to consider.	Ethos uses a simple discrete time step scheme to trigger events. Limitations – It extends from the traditional features of MAS (Multi advisor system).	Behavioural responses triggered by stimulus generated by the physical or social environment.		
Cognitive Process	**Modelling Human Behaviour** where under collective behavioural situations the characteristics on cognitive psychological aspects and human interactions observed.	The crucial issues of treatments are: **1**. Physical, Physiological, psychological and informational interactions among persons. **2**. Vagueness, ambiguity, uncertainty of human inner states and knowledge. **3**. Flexible information processing in human cognitive processes	The cognitive system performs the higher mental processes of understanding, evaluating, planning, deciding, and thinking, whereas affect refers to feeling responses	For modelling cognitive process of interpersonal interactions, it has to embed existing qualitative knowledge on social psychological characteristics and to treat vague cognitive states.	Limitations It depends upon the kinds of experience that come from having a body with various capacities and embed in a more encompassing biological, psychological and cultural context.

Living Systems Theory	**Customer Behaviour** – Elements, relations & wholes are expressed with different notion	Limitations: Its philosophical approach to understand and model customer behaviour because of its ability to explain the behaviour of human beings as biological system			
CUBES Simulation	**Customer Behaviour** – Based on behavioural models concept. Software for simulating customer behaviours.	Ccustomer cognitive functions derive generic behavioural components intrinsically related to the interaction aspect.		Not targeted on a given population segment and a given type of product.	It introduces stimuli based on promotional offers, brand loyalty, and innovation but does not consider the price as a determinant factor to the customer choice
Case Based Reasoning (CBR) Approach	**Discovery, Predictive modelling & Forensics Analysis**. CBR is both a paradigm for computer based problem solvers and a model of human cognition	GA- CBR to enhance the case matching process GA-CBR system is used to predict customer purchasing behaviour	Retrieving past cases that resemble the current problem. Adapting past solutions to the current situation.	Better learning and testing performance. Difficult for mining customer purchasing insights that are complex, unstructured, and mixed with qualitative and quantitative information.	
Multiple Classifier Combination Methods	**It is widely used in prediction of purchase behaviour** within any sales environment. Commonly used methods for combining classifiers majority voting, Bayesian, Borda Count	To enhance the accuracy in predicting the propensity of customer purchase by combining multiple classifiers based on genetic algorithms.			Voting is most common method to combine more than one decision.
CDM Method	**Categorise, Describing & Modelling Method**	It allows the system to be customised to facilitate desired behaviour and optimise pre-existing behaviour		The CDM method has only applied to the sales negotiation systems.	The purpose of CDM method is to build set of precise and accurate models that represent the interaction of diverse user behaviours.
Specific Emotions	**Customer Behaviour** – Based on behavioural models concept.	This approach leans heavily on the appraisal theory of emotions.		Specific emotions are responses to specific situations	

The table describes the research examples for the human behaviour modelling techniques described within the thesis (Shah *et al.* 2006b)

Human Behaviour Modelling Technique	Research Example	Reference
Fuzzy Technique	An expert system for evaluation of the unemployed for certain posts is an example of using fuzzy technique. It uses Neuro – fuzzy techniques for analysing corporate database of unemployed and enterprises profile data. The process of matching an unemployed with an offered job is performed through a Sugeno type Neuro – Fuzzy inference system **Fuzzy Expert System** - The development of fuzzy expert system for hotel selection called HAS (Hotel Advisory System). It assists the tourists in conducting hotel selection using fuzzy logic. **Fuzzy Clustering Technique** - A methodology to cluster customers based on their demand attributes, rather than the static geographic property that is considered extensively in most published vehicle routing algorithms. **Fuzzy Cognitive Maps** - Used for modelling the supervisor of complex manufacturing systems, which best utilises existing experience and knowledge in the operation of system. This methodology gives more attention to human experience, rather than process being controlled.	(Drigas *et al.* 2004) (Ngai and Wat, 2003) (Tung-Lai and Jiuh-Biing, 2003) (Stylios and Groumpos, 2000)
Neural Networks	An example of NN is the analyser tool. It was designed for solving management problems concerning the employee's classification into several projects. It combines neural networks and rule based analysis to match the employee of a company with certain jobs of new projects. **Neuro – Fuzzy Approach** - Framework of using fuzzy logic and neural networks in handling supply chain management has been described. Proposal of a solution to improve the efficiency of complex systems (supply chain), by automating the selection of suppliers, and adjustment of order.	(Labate and Medsker, 1993)
Decision Trees	A framework, which predicts, manages, visualises and explains travel patterns of a mobile workforce using decision trees is explained. It provides colour coded geographical visualisation of travel patterns. It uses decision trees and Neuro-fuzzy systems that display rule based information about individual journeys.	(Martin and Azvine, 2003)
Genetic Algorithms	GA approach is used and applied to bankruptcy prediction modelling. It is capable of extracting rules that are easy to understand for users like expert systems. GA is applied to extract rules that can predict corporate failure. **GA – CBR Approach** – GA based approach to determine the fittest weighting values for improving the case identification accuracy. GA based CBR system is employed to classify potential customers in insurance direct marketing.	(Shah *et al.* 2007) (Chaochang, 2002)
Living Systems Theory	Customer behaviour modelling in customising products using living systems is presented in this example. The authors illustrate it as an philosophical approach to model customer behaviour because of its ability to explain the behaviour of human as biological system	(Kurniawan *et al.* 2003)
Ethos Modelling	Ethos framework provides basic building blocks the kind of entities a modeller is likely to consider when thinking intuitively about human social behaviour and culture. It includes objects describing the structure and topology of physical spaces, entities places in the space.	(Simao and Pereira, 2003)
Critical Incident Technique	The study examines service encounters within help desks at IT centres to understand the events and behaviours that can cause customers to identify their satisfaction levels from satisfactory to dissatisfactory with the use of critical incident technique.	(Heckman and Guskey, 1998)
CuBeS Simulation Approach	The following example proposes a consumer behavioural model based on a set of behavioural primitives such as imitation, conditioning and innovative; which are founded on the new concept of behavioural attitude.	(Ben Said *et al.* 2002)

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Appendix D: AS – IS Questionnaire

Managers and Supervisors

Customer Contact Centres Visit Questionnaire

Development of Intelligent Decision Support Framework in Contact Centre (***I – Contact*** Project)

Project Sponsor: BT and EPSRC

Customer Contact Centre Overall Operations Questionnaire

Mr. Satya. R. Shah Investigator Enterprise Integration, Cranfield University, Cranfield, Bedfordshire, MK43 0AL. UK Tel: +44(0)1234 754194 Fax: +44(0)1234 750852 Email: s.shah@cranfield.ac.uk satya.shah@bt.com	**Dr. Rajkumar. Roy** **Dr. Ashutosh. Tiwari** Supervisors Enterprise Integration, Cranfield University, Cranfield, Bedfordshire, MK43 0AL. UK Tel: +44(0)1234 752423 Fax: +44(0)1234 750852 Email: r.roy@cranfield.ac.uk a.tiwari@cranfield.ac.uk

Name: ____

Title: ____

Organisation: ____

Department: ____

Address: ____

____

Telephone Number: _________________________Fax Number: __________________

Email: ____

*The information provided is held in the strictest of confidence, desensitised, and use for academic and research purposes **ONLY**.*

Thank you for answering the questionnaire. Its aim is to develop the understanding of the overall operations of the Customer Contact Centre environment, the bottlenecks, and the gaps within the technological and management aspects of the centre

No individual results shall be disclosed to third parties. Personal details shall only be used to send you any updates on the progress of the research and their outcomes.

Section 1: Profile of CCC

1. Could you give me a brief overview of the experience in CCC environment?

2. What kind of calls do you handle?

3. What type of services does the company offer? And what are the hours of operation?

4. What are the communication channels used (IVR, live voice, fax, internet, email, others)?

5. Are there any specific languages offered the service in to the customers.

6. Section 2: The Workforce

7. What is the employment lifecycle of the workforce (advisors) in CC?

8. What is the staff structure within your CC, and what is the percentage of advisors within this?

9. Of the employees you have hired in last 2 years, what is the level of education they typically posses. (Options given with the type/nature of work?

10. For each of the given set of skills, please state the current workforce meets the business requirements (Customer service, using technology, product awareness, etc)

Skills	To a great extent	To some extent	Not at all
Customer service			
Customer problem resolution			
Using technology			
Telephone skills			
Writing skills			
Product knowledge			
Management/Supervisory skills			
Coaching and training skills			
Monitoring/measuring quality			
Database management skills			

11. Do you categorise your advisors? If yes, please provide details.

12. Is there any particular method used to manage the working nature or behaviour of advisors while dealing with the customer?

13. How is the performance of the advisor measured?

14. Do you categorise your customers within the centres?

Section 3: Recruitment and Retention

15. What programs and processes are in place to attract applications?

16. What factors influence your ability to recruit (unqualified, competitive salary, location)?

17. Does your organisation (CC) able to attract the quality of candidates required to maintain and improve the service efficiency provided to the customers?

18. What strategies you have in place to retain the advisors?

19. On average, how long does your full time advisor remain employed with your CC?

Section 4: Skills

20. What skills are most important for your advisor to possess?

21. What major shifts have been there in the skills requirement of the centre over the last three to five years? What is driving this change and is this pressure likely to continue over time?

22. Are there any skills gaps faced within your centre?

Section 5: Education Levels

23. What are the current expectations/requirements for educational attainment of your advisors?

24. What sort of product knowledge or industry expertise do your advisors require?

25. Has there been a significant change in the educational attainment or skills levels of the advisors?

26. Do they require attaining any contact centre certifications?

27. What is the relationship between the wages and educational level requirement within your centre?

Section 6: Training

28. What kind of training is provided to the advisors?

29. How do you insure that your advisor possess the following (product knowledge, customer relationship skills, knowledge of using systems and technology and communication skills)?

30. What type of training is provided to the advisors and its period (in house, external providers)?

31. Which of the following have you experienced because of implementing new channels?

▪ Our customer service representatives/advisors need significant upgrading in technology skills	☐Yes ☐ No
▪ Our customer service representatives/advisors have become specialists versus generalists	☐Yes ☐ No
▪ We have experienced a reduction in the number of customer service representatives/advisors	☐☐Yes ☐ No
▪ We have had to create new jobs to manage the technology	☐Yes ☐ No
▪ We have experienced an increase in customer self-service	☐☐Yes ☐ No
▪ Our customer service representatives/advisors are dealing with more complex customer issues	☐Yes ☐ No

Section 7: Systems and Technology

32. What is the type of system used within this centre?

33. What technologies do you think that the company would be implementing in the centre in short term/long term?

34. What do you see as the most important technology trend or development within the contact centres?

35. Do the changes you foresee have any implications for the skills, qualifications or characteristics of the current or future workforce (advisors, support staff)?

36. What do you see in changes to the current system used that would be useful to the advisors?

Section 8: Behaviour Categorisation

37. Do you categorise your advisor within the centre?

38. Do you use experience and education level for categorisation?

39. Do you record any changes of advisor behaviour during and after the conversation with the customer?

40. What are the specific behaviours noticed within the advisors in the centre?

41. Do you categorise your customers within the centre?

42. On what basis the customer are categorised?

43. Do you record any changes of customer behaviour during the call conversation with the advisors?

44. What are the different types of behaviours noticed within the customer calling the centre?

Customer Service Advisor (CSA/CSA)

Customer Contact Centres Visit Questionnaire

Customer Service Advisor / Representative (CSA/CSR)

Development of Intelligent Decision Support Framework in Contact Centre (***I – Contact*** Project)

Project Sponsor: BT and EPSRC

Customer Contact Centre Overall Operations Questionnaire

Mr. Satya. R. Shah Investigator Enterprise Integration, Cranfield University, Cranfield, Bedfordshire, MK43 0AL. UK Tel: +44(0)1234 754194 Fax: +44(0)1234 750852 Email: s.shah@cranfield.ac.uk satya.shah@bt.com	**Dr. Rajkumar. Roy** **Dr. Ashutosh. Tiwari** Supervisors Enterprise Integration, Cranfield University, Cranfield, Bedfordshire, MK43 0AL. UK Tel: +44(0)1234 752423 Fax: +44(0)1234 750852 Email: r.roy@cranfield.ac.uk a.tiwari@cranfield.ac.uk

Name: ____

Title: ____

Organisation: ____

Department: ____

Address: ____

____

Telephone Number: __________________________Fax Number: ___________________

Email: ____

*The information provided will be held in the strictest of confidence, desensitised, and use for academic and research purposes **ONLY**.* Thank you for answering the questionnaire. Its aim is to develop the understanding of the overall operations of the Customer Contact Centre environment, the bottlenecks, and the gaps within the technological and management aspects of the centre

No individual results will be disclosed to the third parties. Personal details will only be used to send you any of the documents if required.

Customer Contact Centre (CCC) CSA's

Section 1: Employee Profile
1. Advisor details (gender, age, experience)
2. What first attracted you to work for contact centres?
3. What is your job profile and level of work carried out at this centre?
Section 2: Contact Centre Perception
4. What do you think about the customer and public views of the level of service that contact centres should provide?
5. Did this image influence your decision to join this sector?
Section 3: Job Satisfaction
6. What are the most positive aspects of working in contact centres?
7. What are the negative aspects of working in contact centres?
8. What makes your work challenging?
Section 4: Customer Categorisation
9. Is there any sort of categorisation used for your customers?
10. Are these categorising of customers divided based on experience, behaviour/trend of customer?

11. Do you look on any historical data of the customer to serve their query while having conversation?

12. Do you do any modifications in the customer data after the conversation? Do you have any levels, which can record the customer behaviour or mood patterns?

Section 5: Career (Training and skills development)

13. What levels of educational background do you posses?

14. What skills do you possess or plan to acquire that can improve your service level within the centre?

15. In you opinion, what are the strengths and weaknesses of the following in your organisation?

Section 6: Systems and Technology

16. What systems and technologies do you use within your working environment?

17. What are the capabilities of these systems been used?

18. Do you think that there is any specific changes required within the current system been used?

19. Does the current environment provide any levels of categorisation of the caller details?

20. Do the current systems provide any mapping (similarities) across group of customers?

21. Does the current system identifies the type of caller and the type of information required for the advisor dealing with particular customer in the instance?

Section 7: Behaviour Categorisation

22. Do you use any categorisation for your customers within the centre?

23. On what basis the customer are categorised?

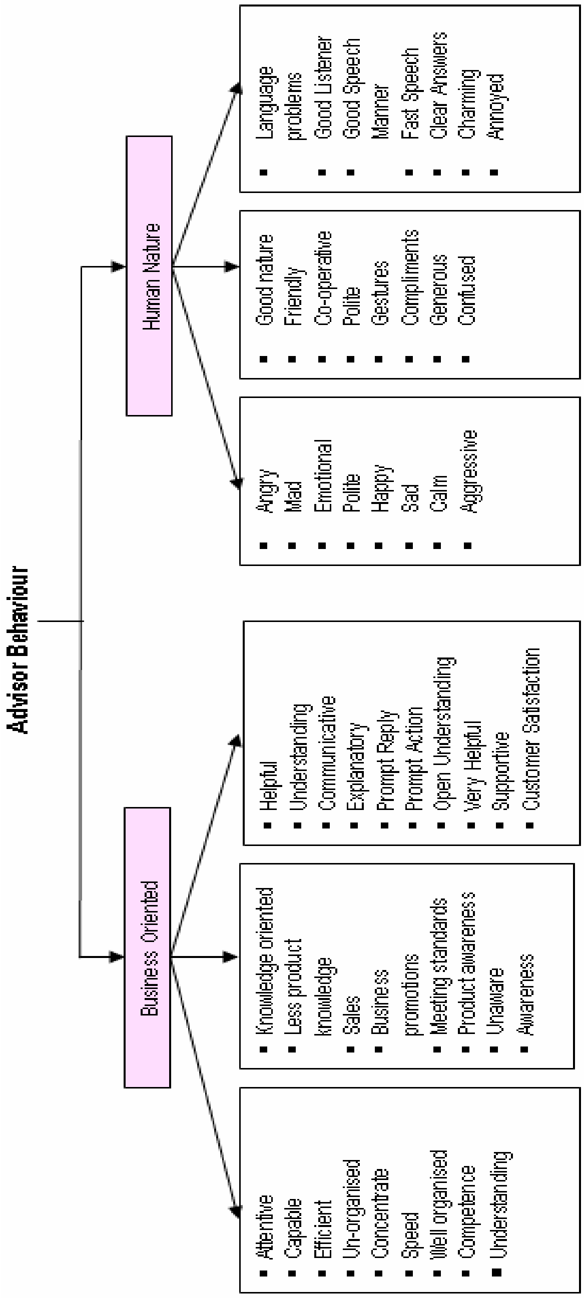
24. Do you record any changes of customer behaviour during the call conversation?

25. What are different types of behaviours noticed within the customer calling the centre?

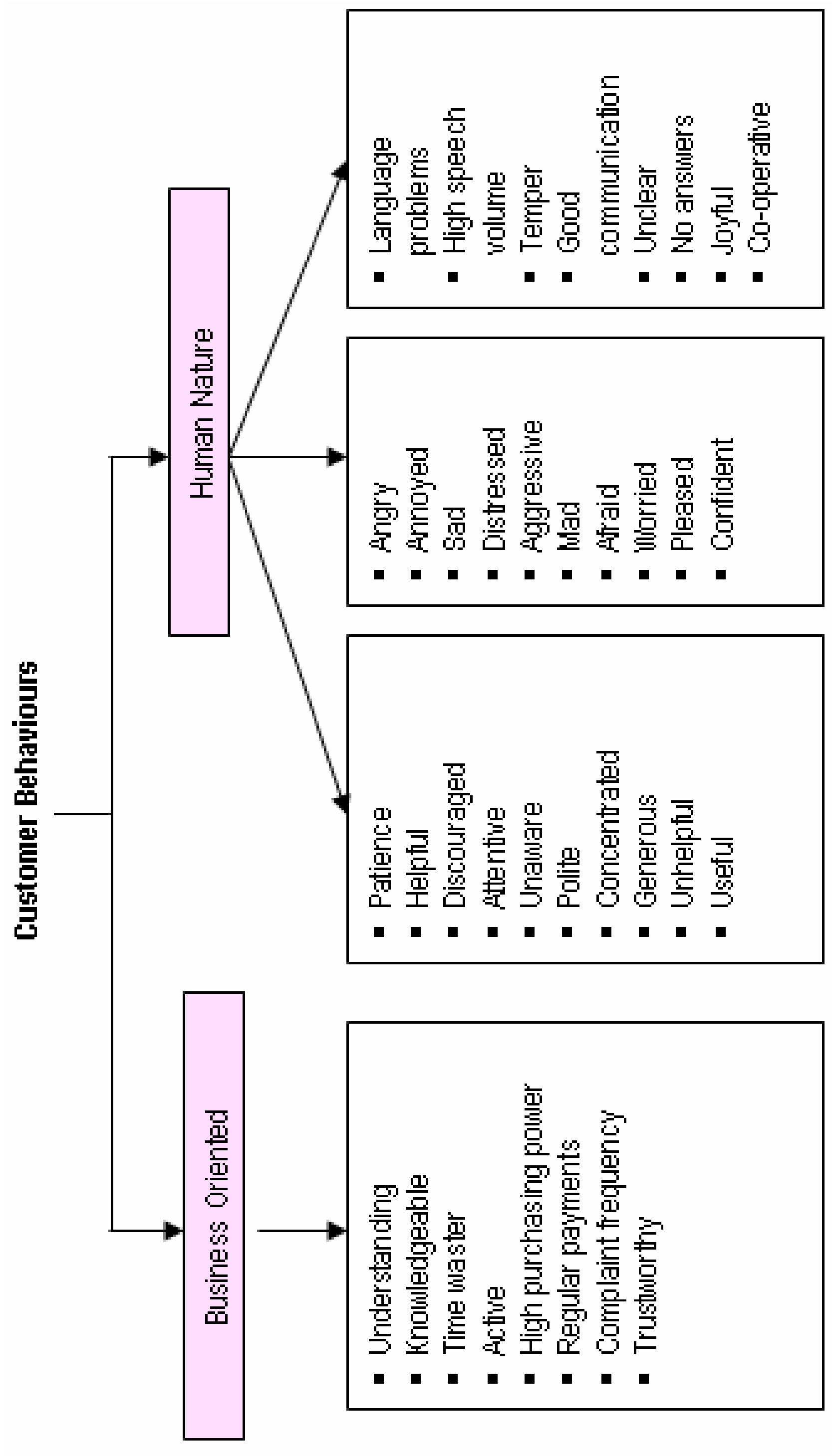
26. What are the specific behaviours experienced by you during any customer conversation?

Appendix E: Behavioural Analysis – Customer / Advisor

This appendix provides a brief description of customer and advisor behaviour analysis conducted to identify the key behavioural attributes to be used within the categorisation frameworks. The behaviours identified through the case study analysis from six different customer contact centres, were authors own observations and feedback provided by the advisors on customer's behaviour. Analysis was then verified through the experts at the contact centres.



Customer Behaviour Analysis



No	ADVISOR BEHAVIOUR	DESCRIPTION	GROUP
1	ATTENTIVE	Was listening to the calls properly and efficiently to the customer query	Working Behaviour
2	CAPABLE	Was capable enough to understand the situation and query and resolve the customer's concern	Working Behaviour
3	EFFICIENT	Was efficient with his/her work, with through knowledge about the situation	Working Behaviour
4	UNORGANISED	Was not organised in the way of work	Working Behaviour
5	LESS PRODUCT KNOWLEDGE	Less knowledge or understanding of the product, which are to offered to the customers	Business Oriented Behaviour
6	HELPFUL	Trying to resolve the problem in the best efficient manner	Business Oriented Behaviour
7	UNDERSTANDING	Had an understanding nature while speaking to the customer regarding the query	Satisfaction Behaviour
8	ANGRY	Angry with the service, type of customer, the query of customer	Satisfaction Behaviour
9	MAD	Mad about the delay the system or customer is taking to make him understand the situation	Mood & Emotions Behaviour
10	LANGUAGE PROBLEMS	Cannot efficiently understand the language of the customer - the manner the customer communicated with the agent	Mood & Emotions Behaviour
11	GOOD NATURE	Always have pleasant nature towards the customer , work, calls, team, environment	Speech and Language Behaviour
12	CONCENTRATED	Focused on the work and the concern of the customer	Nature, Phycial and Personality Behaviour
13	COMMUNICATIVE	Talked through the customer all the time	Working Behaviour
14	EXPLANATORY	Explained to the customer about the situation, and the possible solutions to the query	Satisfaction Behaviour
15	SPEED WITH SERVICE	Very fast in service with the system and understanding and following up the customer query	Satisfaction Behaviour
16	KNOWLEDGE ORIENTED	Spending time in understanding and looking on products knowledge and awareness of customer situation	Working Behaviour
17	WELL ORGANISED	Organised the work and customer situation with follow up of query process	Business Oriented Behaviour
18	COMMUNICATION	Communicated well with the customer	Working Behaviour
19	POLITE	Very polite in nature while speaking to the customer	Satisfaction Behaviour
20	GOOD LISTENING	Always listen to the customer query more efficently with asking questions to understand the situation completely	Nature, Phycial and Personality Behaviour
21	PROMPT REPLY	Replying to the customer in the most fast and efficient manner	Speech and Language Behaviour
22	PROMPT ACTION	Taking the necessary action towards the customer query as soon as the situation is properly understood	Satisfaction Behaviour
23	ANNOYED	Annoyed with the type of customer, working environment, wrong calls been transferred	Satisfaction Behaviour
24	BUSINESS SALES	Asking customers about the new services and products all the time	Mood & Emotions Behaviour
25	FRIENDLY	Friendly easy going with customers	Business Oriented Behaviour
26	CO-OPERATIVE	Always coperating with the customer during and after the conversation is finished	Nature, Phycial and Personality Behaviour
27	HAPPY	Happy and joly nature	Nature, Phycial and Personality Behaviour
28	EMOTIONAL	Agent emotions attached to the caller and interacting with their emotional conversation	Mood & Emotions Behaviour

26	CO-OPERATIVE	Always coperating with the customer during and after the conversation is finished	Nature, Phycial and Personality Behaviour
27	HAPPY	Happy and joly nature	Nature, Phycial and Personality Behaviour
28	EMOTIONAL	Agent emotions attached to the caller and interacting with their emotional conversation	Mood & Emotions Behaviour
29	BUSINESS PROMOTIONS	Always having the knowledge and awareness of business promotions towards the customers	Speech and Language Behaviour
30	MEETING STANDARDS	Keeping to the business values and goals and delivering the right business standards towards their customers	Nature, Phycial and Personality Behaviour
31	GOOD SPEECH MANNER	Good speech (tone) & clear communication with the customer	Working Behaviour
32	FANTASTIC CHARMING	Always having a charming and pleasant nature within the work environment - lifestyle	Satisfaction Behaviour
33	COMPETENCE	Was having the competence to serve the customer in the best possible manner	Mood & Emotions Behaviour
34	OPEN UNDERSTANDING	Understand the situation and reply to the customer in an open manner with all the possible outcomes	Business Oriented Behaviour
35	SAD	Sad with the service, while speaking to the customer, because of personal or work problems	Business Oriented Behaviour
36	VERY HELPFUL	Trying to resolve the customer query in the best possible manner	Satisfaction Behaviour
37	PRODUCT KNOWLEDGE	Awareness to the types of products and services which are offered by the company	Business Oriented Behaviour
38	GESTURES	Human gesturs during the working situation, like noding the head and explaining to the customer as they were in front of them	Nature, Phycial and Personality Behaviour
39	COMPLIMENTS	Always sending the compliments to the customer - thank you and sorry about the situation	Nature, Phycial and Personality Behaviour
40	FAST SPEECH MANNER	Very fast in the speech which made the customer sometimes unable to understand properly	Speech and Language Behaviour
41	AWARENESS	Having complete awareness towards the customer past query and trying to understand the type of customer	Business Oriented Behaviour
42	UNDERSTAND THE SITUATION	Understanding the situation about the customer, looking at previous records and problems encountered	Working Behaviour
43	CLEAR ANSWERS	Giving clear answers to the customers, rather than confusing them into other things	Speech and Language Behaviour
44	GENEROUS	Generous towards to the customer about the situation and explaining the outcome	Nature, Phycial and Personality Behaviour
45	CALM	Silent and calm towards to the customer	Mood & Emotions Behaviour
46	SUPPORTIVE	Always supportive to the customer in the best possible manner	Satisfaction Behaviour
47	UNAWARE	Good with the customer service, working pattern, customer satisfaction	Business Oriented Behaviour
48	CONFUSED	Confused about the type of service required, or the customer query and how to deal with the situation	Nature, Phycial and Personality Behaviour
49	CUSTOMER SATISFACTION	Looking towards the customer has been satisfied completely with the type of services been offered.	Business Oriented Behaviour

No	CUSTOMER BEHAVIOUR	MEANING	GROUP
1	UNDERSTANDING	Having understanding nature towards the query and the delay its taking to resolve the problem	Business Values Behaviour
2	KNOWLEDGEABLE	Quite knowledgeable with the products and services offered by the company	Business Values Behaviour
3	PATIENCE	Having patience while the agent is taking the information, and trying to identify and resolve the problem	Human Nature and Personality Behaviours
4	HELPFUL	Helpful nature towards the agent for the concern and query giving all the details which are asked for	Human Nature and Personality Behaviours
5	DISCOURAGED	Because of the time it takes to resolve a problem, the customer is discouaged with the service and company	Human Nature and Personality Behaviours
6	ANGRY	Angry with the time kept on hold, time waiting in queue to be answered by an agent	Mood and Emotions Behaviours
7	ANNOYED	Annoyed with the delay in service	Mood and Emotions Behaviours
8	JOYFUL	Joyful nature with easy going personality, while talking to the agent	Mood and Emotions Behaviours
9	ATTENTIVE	Always attentive towards what the agent has to say to him/her about the situation and the concern about the services	Human Nature and Personality Behaviours
10	UNAWARE OF SITUATION	Totally unaware of the situation, with less information about the condition of the problem	Human Nature and Personality Behaviours
11	CO-OPERATIVE	Cooperative nature with trying to co-operate with the agent in the best efficient manner possible	Mood and Emotions Behaviours
12	PLEASED	Quite pleased with the services been offered to him/her from the agent and the centre	Human Nature and Personality Behaviours
13	POLITE	Polite nature with the agent with soft and low tone voice	Human Nature and Personality Behaviours
14	SAD	Quite sad with the services been offered, and the delay in time for resolving the conflict	Mood and Emotions Behaviours
15	TIME WASTER	Just passing the time with the agent, with no concern about the agent time with less information about the account and type of problem	Business Values Behaviour
16	ACTIVE	A good active customer with very high profile of business value to the company	Business Values Behaviour
17	HIGH PURCHASING POWER	A very high purchasing power of the customer	Business Values Behaviour
18	REGUALR PAYMENTS	No payment difficulty or financial problems towards the payments for the services of the company - regualar payments	Business Values Behaviour
19	COMPLAINT FREQUENCY	Type of complaint frequency of the customer	Business Values Behaviour
20	CONCENTRATED	Concentrated to what the agent has to say about the problem and the solutions available towards the problem	Human Nature and Personality Behaviours

No	CUSTOMER BEHAVIOUR	MEANING	GROUP
20	CONCENTRATED	Concentrated to what the agent has to say about the problem and the solutions available towards the problem	Human Nature and Personality Behaviours
21	GENEROUS	Quite generous towards the agent and the company	Human Nature and Personality Behaviours
22	LANGUAGE PROBLEMS	Language and speech problems - not been able to make understand the agent the problem and current situation	Speech and Language Behaviours
23	DISTRESSED	Bit distressed with the type of services from the company or the contact centre	Mood and Emotions Behaviours
24	HIGH SPEECH VOLUME	Very high volume indicating the mood of the customer	Speech and Language Behaviours
25	TEMPER		Mood and Emotions Behaviours
26	AGGRESSIVE	Aggresiveness shown towards the agents and the company because of the time its taking to resolve the conflict	Mood and Emotions Behaviours
27	GOOD COMMUNICATION	Good communicator with the agent with giving all the necessary information	Speech and Language Behaviours
28	MAD	Mad with the delay in answering the call by the agent, and the time its taking to solve a particular problem	Mood and Emotions Behaviours
29	UNCLEAR	Not clear with the type of problem he/she is compalining about, or type of services which are required or products wanted	Speech and Language Behaviours
30	NO ANSWERS	With no answers to the information been asked by the agent to support the query for the customer	Speech and Language Behaviours
31	AFRAID	Afraid of the situation and the seriousness of the problem	Mood and Emotions Behaviours
32	WORRIED	Worried about the services been discontinued and account transaction problems	Mood and Emotions Behaviours
33	UNHELPFUL	Not helpful to the agent in some ways which would enable the agent to deal with the particular customer and his/her concern more efficently	Human Nature and Personality Behaviours
34	UNSURE	Customer is not sure about the types of products or services required, which in turn is holding back the agent to provide with sufficient information about the services	Human Nature and Personality Behaviours
35	CONFIDENT	Confident in nature with helping the agent to deal with the problem as faster it can be resolved	Human Nature and Personality Behaviours
36	USEFUL	Usefulness to theagent in each and every possible manner the customer can be by providing all the necessary information which is required by the agent	Human Nature and Personality Behaviours
37	TRUSTWORTHY	Customer who can be trusted based on the information which he/she is providing to the agent which would enable the agent to deal with the customer call more easily	Business Values Behaviour

Appendix F: CC System Analysis

System No.	Systems Overivew	Type	Functional Specifiaction & Capabilities	Customer Details	Advantages	Disadvantages	Customer Mapping	Information Available
1	**CSS**	CUSTOMER RECORD DETAILS, BACK END SYSTEM, LOTS OF CODES TO BE USED,	OFFERS CUSTOMERS DETAILED RECORDS, ABOUT CURRENT ACCOUNT DETAILS, SERVICES BEEN USED, BILLING INFORMATION (cannot accept payments), ADD ON SERVICES, SERVICES CAN BE UPDATED OR MODIFIED, CHANGE OF DETAILS	ACCOUNT DETAILS, ADDRESS DETAILS, PREVIOUS SERVICES, TIME WITH THE COMPANY, CURRENT SERVICES BEEN USED, ANY FAULTS IF MENTIONED, BILLING TRANSACTION DETAILS	IT CAN DO LOT OF THINGS ON THE CUSTOMER RECORDS, ADD AND REMOVE ON SERVICES,	NEED TO HAVE A GOOD PRACTISE BEFORE BE ABLE TO USE IT COMPLETELY, LOTS OF CODES TO REMEMBER	NO	YES
2	**Minerva**	INTERNAL STAND ALONE SYSTEM………UPGRADE VERSION OF LIBERTY SYSTEM…….DRAG AND DROP OPTION FOR SERVICES BEEN ADDED TO CUSTOMER ACCOUNTS, AND LOTS MORE	IT ENABLES OFFLINE ORDER PROCESSING. IT ALLOWS THE ADVISOR TO CAPTURE ALL OF THE CUSTOMER INFORMATION ON THE CALL WITH THE CUSTOMER. NO TIME DELAY WHILE THE ADVISOR HAS TO WAIT FOR CONFIRMATION OF ORDER NUMBER	CUSTOMER PREVIOUS TRANSACTIONS…….TYPES OF SERVICES ALREADY INSTALLED,…….NEW PRODUCTS REQUESTED…….	EASE OF USE, KNOWLEDGE LOADED, DROP AND DRAG MENU, SO DON'T NEED TO REMEMBER ALL THE TYPES OF PRODUCTS AVAILABLE.	YOU REALLY CANNOT LOOK BACK ON THE TRANSACTION DETAILS OF THE PREVIOUS SERVICES………MORE HELP OPTIONS RELATED TO THE PRODUCT SPECIFIC KNOWLEDGE		YES
3	**Elixir**	FRONT END SYSTEM WITH CSS ON THE BACK. CAN , DESKTOP APPLICATION, ENABLES REPORTING OF THE FAULT, CORRECT DIAGNOSIS, KEEPING CUSTOMER INFORMED	LINE TESTING FOR THE CUSTOMER FAULT IN THE LINE, IDENTIFICATION OF THE FAULT, NOTIFICATION OF THE FAULT TO THE ENGINEER, POSSIBLE DATE OPTION TO REPAIR THE SERVICE, KEEPING CUSTOMER INFORMED, KEEPING ENGINEERS UP TO DATE ABOUT THE SITUATION	CUSTOMER ACCOUNT DETAILS (name, address, line details), PREVIOUS FAULTS DETAILS, CUSTOMER NOTES AND COMPLAINTS DETAILS	USER FRIENDLY, EASE OF USE. DOES A LOT OF THINGS FOR THE ADVISOR RELATING TO THE CUSTOMER QUERY, IDENTIFIES THE FAULT IN THE LINE WITHIN 1 MINUTE. MORE EFFICIENT CALL HANDLING. IMPROVED ORDER QUALITY	SOMETIMES IT FREEZES, IT DOESN'T ALLOW TO WRITE THE MESSAGE ON THE BOARD, WHEN IT IS DOING OTHER THINGS WITH THE SERVICE RELATED	NO	YES
4	**Queue Buster**	STAND ALONE SYSTEM - INTELLIGENT TELEPHONY SYSTEM	OFFERS CUSTOMERS WHO CALLED THE CENTRE TO HAVE AN CALL BACK OPTION IF THEY DON'T WANT TO STAY IN THE QUEUE. THE MESSAGE IS RECORDED IN THE QUEUE BUSTER, AND WHEN THE NEXT AVAILABLE ADVISOR IS FREE, IT PLAYS THE CALLERS DETAILS TO THE ADVISOR	CUSTOMER NAME AND DETAILS OF THE TELEPHONE NUMBER ON WHICH THEY WOULD LIKE TO RECEIVE THE CALL FROM THE ADVISOR	IT ALLOWS THE CUSTOMER TO RECORD THE MESSAGE, RATHER THAN WAITING IN THE QUEUE. THEY WILL RECEIVE THE CALL WHENEVER THE ADVISOR IS FREE. IT ALSO GENERATES DAILY, WEEKLY REPORTS ON HOW MANY MESSAGES WERE LEFT, HOW MANY CALLS WERE ANSWERED AND SO ON	SOMETIMES THE MESSAGES RECORDED BY THE CUSTOMER ARE NOT IN CLEAR SPEECH, SO THE ADVISOR DOESN'T KNOW WHOM TO SPEAK TO WHEN THE CALL IS BEEN DIALED.	NO	YES

5	**Smart**	STAND ALONE SYSTEM - USED FOR STOPPING THE SERVICES FOR RESIDENTIAL CUSTOMERS, BILLING SERVICES, ACCOUNT TRANSACTION DETAILS	OFFERS THE ADVISOR TO STOP ANY PARTICULAR SERVICE AFTER THE CONFIRMATION FROM THE CUSTOMER, IT ALSO CAN ACCEPT ANY FINAL PAYMENT, REQUEST FOR THE INSTALLATION OF THE SERVICE AT NEW PREMISES	CUSTOMER ACCOUNT DETAILS (name, address, line details), PREVIOUS TRANSACTION DETAILS, BILLING INQUIRES, NEW PREMISES ALLOCATION AND SET OF THE SERVICES	IT ALLOWS THE ADVISOR TO DO MANY THINGS ON ONE SCREEN, WITH THE USE OF MOUSE AND CLIKCING CHECK BOXES AND ACCEPTING IT	SOMETIMES IT DOES NOT ALLOW THE ADVISOR TO CARRY FORWARD A PARTICULAR SERVICE IF IT GETS STUCK IN BETWEEN	NO	YES
6	**Dice**	MOBILE COMMUNICATIONS RECORDS SYSTEM - USED FOR USER INFORMATION RECORDING AND TRANSACTION	IT ALLOWS THE ADVISOR TO LOOK ON THE SERVICES BEEN OFFERED TO PARTICULAR CUSTOMER AND MODIFY/CHANGE IN IT, BILLING AND TRANSACTIONS DETAILS, SERVICES BEEN USED, UPDATES	CUSTOMER ACCOUNT DETAILS (name, address, type of account - single/business, billing information) FAULT IDENTIFICATION, STOP OF THE SERVICES, ADD ON SERVICES, CHANGE OF PACKAGES	IT ALLOWS THE ADVISOR TO DO MANY THINGS ON ONE SCREEN, IT ALSO ALLOWS TO LOOK AND AMEND ANY OF THE DETAILS RELATED TO CUSTOMER ACCOUNT WITHOUT PRIOR AUTHORISATION	FOR ANY OF THE FAULT RELATED PROBLEMS, IT HAS TO FILL UP A FORM AND THEN RECORD IT FOR CHECKING PURPOSES	NO	YES
7	**Frontline**	SYSTEM THAT ENABLES THE ADVISOR TO CHECK THE DETAILS OF THE PARTICULAR CUSTOMER CALLING REGARDING A QUERY, AND ALLOWS THE ADVISOR TO FILL UP VARIOUS FORMS ON BEHALF OF CUSTOMERS	RECORDS CUSTOMER DETAILS NAME, ADDRESS, AND CONTACT DETAILS. CUSTOMER ENQUIRY, PROVIDE SUPPORTIG SCRIPTS, PROVIDE SUPPORTING INFORMATION, PROVIDE MANAGEMENT INFORMATION ON CALL VOLUMES	CUSTOMER DETAILS CAN BE CHECKED, ADDRESS SEARCH, TELEPHONE LINE SEARCH AND VERIFIED, NEW CUSTOMER DETAILS ADDED, NEW COMPANY DETAILS, ADDRESS CHANGE	ONLINE FORMS CAN BE FILLED, CUSTOMER QUERY CAN BE RECORDED	GETS STUCK SOMETIMES AND ALSO A BIT SLOW WHEN DOING THINGS FASTER FROM THE ADVISOR SIDE	NO - BUT ADDRESS CAN MATCH UP OF POSSIBLE CUSTOMER WITHIN THE SAME AREA	YES
8	**DMS**	DOCUMENT MANAGEMENT SYSTEM DELIVERS ELECTRONIC DOCUMENTS TO THE DESKTOP OF THE ADVISORS	IMPROVEMENT TO THE ACCESSIBILITY OF CASE INFORMATION, FASTER RESPONSE TO ENQUIRIES FROM CUSTOMERS, IMPROVED MANAGEMENT CONTROL OVER PROCESSING ACTIVITIES, IMPROVED DOCUMENT SECURITY	RECORDS ALL OF THE COPIES OF THE TRANSACTION SEND BY THE CUSTOMER TO THE COMPANY IN A ELECTRONIC FORMAT	DELIVERS A SYSTEM THAT MANAGES DATA ORGINALLY KEPY IN PAPER FORMAT AND WILL GIVE ACCESS TO ALL ADVISORS CONCERNED WITH THE CUSTOMER QUERY WITHOUT THE NEED TO HAVE PHYSICAL FILES AVAILABLE	IT NEEDS TO BE UPDATED REGULARLY AND SOMETIMES THE FORMAT IN WHICH THE DOCUMENT IS KEPT IS NOT CLEAR UNTIL AND UNLESS CLEARLY SEEN	NO	YES

9	**Equifax**	EQUIFAX - CREDIT REFERENCE AGENCY. CUSTOMER SECURITY SEARCH - ADDRESS AND PERSONAL DETAILS SEARCH	BUSINESS INFORMATION SERVICES, DIRECT MARKETING SERVICES, ID VERFICATION AND FRAUD PREVENTION, CONSUMER CREDIT DATA SERVICES	RECORDS OF NEARLY MANY CUSTOMERS ON DETAILED REPORT BASED, ABOUT THEIR CREDIT HISTORY, ANY COURT JUDGEMENTS. THE AGENCY ONLY GIVES THE INDICATION OF WEATHER TO PROCEED WITH A PARTICULAR CUSTOMER OR NOT	THIS GIVES THE COMPANY TO MAKE ANY JUDGEMENTS REGARDING TO PROVIDING SERVICES OR PRODUCTS TO NEW BUSINESS AND NEW CUSTOMERS BASED ON THE INFORMATION PROVIDED BY THE CREDIT AGENGY	SOMETIMES IT TAKES LONG FOR THE AGENCY TO SEND THE DECISION ABOUT THE CUSTOMER, AND THAT ANNOYS THE CUSTOMER, AS HE/SHE ARE WAITING FOR THE SERVICES TO BE CONNECTED.	DON'T KNOW - BUT THERE MIGHT BE SOMEWAY TO IDENTIFY IN SOME FORM OF SCORE CARDS	INTERNET INFORMATIO N - AS IT IS QUITE SECURED.
10	**Inform - E**	TYPE OF CALL MONITORING SERVICE	MONITORS THE TYPES OF CALLS WHICH ARE ANSWERED BY THE ADVISOR. HE/SHE HAS TO MANUALY FILL THE FORM AFTER EACH CALL IS FINISHED. IT SHOWS THE POSSIBLE OPTIONS OF WHAT SORT OF CALLS THAT ARE AVAILABLE	NA	IT ALLOWS THE MANAGERS TO IDENTIFY WHETHER OR NOT THERE ARE RIGHT AMOUNT OF CALLS COMING IN TO THE CENTRE AND TRANSFERRED TO THE ADVISORS	IT SOMETIMES DOESN'T WORK, AND IT IS ALSO UPTO THE ADVISORS TO FILL IT OR NOT	NO	YES
11	**MBAS**	SYSTEM USED FOR BENEFITS SERVICES FOR PRECESSING HOUSING AND COUNCIL TAX BENEFITS CLAIMS	IT ALLOWS THE USER TO RECORD AND AMEND THE DETAILS OF INDIVIDUAL CUSTOMER CLAIMS AND BENEFITS CASES	IT HOLDS ALL OF THE NECESSARY INFORMATION FOR CUSTOMER, INCLUDING THE ADDRESS DETAILS, CONTACT DETIALS, FINANCIAL STATUS, CLAIMS REASON,	IT ALLOWS THE ADVISOR TO DO MANY THINGS AT ONE TIME. NEED TO REMEMBER THE CODES WHICH ARE NEEDED TO ACCESS THE SYSTEM	SYSTEM IS DOING LOT OF THINGS - SO PATIENCE IS THE KEY. ALSO IT SOMETIMES DOESN'T DISPLAY ALL OF THE NECESSARY INFORMATION ON ONE SCREEN .	NO - BUT IT CAN IDENTIFY ALL OF THE POSSIBLE CLAIMS MADE FROM ONE PARTICULAR PREMISES	YES

Appendix G: Questionnaire for Categorisation

Categorisation Questionnaire for Manager/Team Leaders

Managers and Team Leaders

Categorisation Visit Questionnaire

Managers/Team Leaders

Development of Intelligent Decision Support Framework in Contact Centre (***I – Contact*** Project)

Project Sponsor: BT and EPSRC

Customer Contact Centre : Categorisation & Information Requirement Questionnaire

Mr. Satya. R. Shah Investigator Enterprise Integration, Cranfield University, Cranfield, Bedfordshire, MK43 0AL. UK Tel: +44(0)1234 754194 Fax: +44(0)1234 750852 Email: s.shah@cranfield.ac.uk satya.shah@bt.com	**Dr. R. Roy and Dr. A. Tiwari** Supervisors Enterprise Integration, Cranfield University, Cranfield, Bedfordshire, MK43 0AL. UK Tel: +44(0)1234 752423 Fax: +44(0)1234 750852 Email: r.roy@cranfield.ac.uk a.tiwari@cranfield.ac.uk

Name: ____

Title: ____

Organisation: ____

Department: ____

Address: ____

____

Telephone Number: _________________________Fax Number: __________________

Email: ____

The information provided will be held in the strictest of confidence, desensitised, and use for academic and research purposes ***ONLY****.*

Thank you for answering the questionnaire. Its aim is to develop the understanding of the overall operations of the Customer Contact Centre environment, the bottlenecks, and the gaps within the technological and management aspects of the centre

No individual results will be disclosed to the third parties. Personal details will only be used to send you any of the documents if required.

Section 1:Manager/Team Leader Details

1. What is your job role within your centre?
2. Personal Details (Demographic, experience and educational background)

Section 2: Advisor Information

3. How many advisors do you have within your centre?
4. What are the demographic details about these advisors?

Section 3: Experience and Knowledge Levels

5. What is the experience background of the advisors within the centre?
6. Do you look on any IT specific skills within the advisors? (IT efficiency, speed with service, other)

Section 4: Advisor Categorisation

7. What is the educational background of the advisors at the centre?
8. What skills are most important for your advisor to possess?
9. Do you group or categorise your advisors based on their work, demographic and experience variables?
10. Do you record any advisor behaviour during the call conversation with the customer at the centre?

Section 5: Customer Information

11. What types of customers are calling the contact centres? (Business, residential and others)
12. Do you categorise your customer according to the type of services offered by the centre?
13. What data do you record for each individual customer?
14. Do you categorise your customer based on their financial details, type of products/services currently taken by the customer and others?
15. Do you record any behavioural attributes of customer anytime during conversation with the advisors?

Section 6: Information Requirement

16. What type of information displayed on the screen of the advisor to serve the customer query?
17. Do you record any customer behavioural changes on the customer accounts?
18. Is there any record of historical data of the customer?
19. Does the information presented on the screen of the advisor an customised information screen?
20. Does the advisor have to look on other systems (information screens) to find the relevant information?

Categorisation Questionnaire for Advisor

Customer Service Advisor

Categorisation Visit Questionnaire

Service Advisor/Service Representative

Development of Intelligent Decision Support Framework in Contact Centre (***I – Contact*** Project)

Project Sponsor: BT and EPSRC

Customer Contact Centre: Categorisation & Information Requirement Questionnaire

Mr. Satya. R. Shah Investigator Enterprise Integration, Cranfield University, Cranfield, Bedfordshire, MK43 0AL. UK Tel: +44(0)1234 754194 Fax: +44(0)1234 750852 Email: s.shah@cranfield.ac.uk satya.shah@bt.com	**Dr. R. Roy and Dr. A. Tiwari** Supervisors Enterprise Integration, Cranfield University, Cranfield, Bedfordshire, MK43 0AL. UK Tel: +44(0)1234 752423 Fax: +44(0)1234 750852 Email: r.roy@cranfield.ac.uk a.tiwari@cranfield.ac.uk

Name: ____

Title: ____

Organisation: ____

Department: ____

Address: ____

____

Telephone Number: _________________________Fax Number: ___________________

Email: ____

The information provided will be held in the strictest of confidence, desensitised, and use for academic and research purposes ***ONLY****.*

Thank you for answering the questionnaire. Its aim is to develop the understanding of the overall operations of the Customer Contact Centre environment, the bottlenecks, and the gaps within the technological and management aspects of the centre

No individual results will be disclosed to the third parties. Personal details will only be used to send you any of the documents if required.

Customer Contact Centre (CCC) CSA's

Section 1: Advisor Profile

1. Advisor details (gender, age, experience)
2. What is your job profile and level of work carried out at this centre?

Section 2:Experience and Knowledge Levels

3. What experience background do you have for working at the centre?
4. Does the environment require any specific knowledge/skills appropriate for working? (IT skills, others)

Section 3: Customer Categorisation

5. What are the different types of customer calling at your centre?
6. What type of customer data is available to you to serve the customer query?
7. Are the customer call conversations with you recorded by the centre for monitoring purposes?
8. Do you notify any change of customer behaviours within the customer data?
9. Do you look on any historical data available to you for customer during the call conversation?

Section 4: Information Screens

10. Is there any sort of categorisation used for your customers?
11. Are these categorising of customers divided based on experience, behaviour/trend of customer?
12. What is the generic information screen presented to you at any time to serve the customer query?
13. Is this information screen a "customised information" screen?
14. What type of system would be more useful in your current environment?
15. Can you provide me a with a list of information displayed on your screen?

Appendix H: Clustering Analysis

Because of the size of the customer and advisor data, the author realised that it was necessary to identify the number of clusters to be used for the clustering analysis. With two-step clustering method, the author first derived the number of clusters using the automatic clustering selection, which gave only two sets of clusters for customers and three sets of clusters for the advisors. Based on these results, the author had to identify what would be the right number of cluster to be used for the analysis. For this reason, the author then did the clustering analysis ranging from automatic to a maximum of ten clusters within the clustering tool. Examples of automatic, four clusters, five clusters, six clusters, and tenth clusters are shown below.

Advisor – Automatic Clustering (derived only two clusters)

Cluster	Age				Education				Experience				IT Speed			Prev Experience				Behaviour						
	18-25	25-40	40-50	50+	School	College	Grad	Prof	1 to 5	5 to 10	10 to 15	15+	Low	Medium	High	None	Little	Moder	Ext	Postive			Negative			Both
																				Attentive	Friendly	Cust.Sat	Angry	Annoyed	Unaware	
1	94.4	0.0	0.0	0.0	76.9	61.1	32.5	0.0	72.0	5.0	10.0	0.0	66.7	45.7	14.3	83.3	55.2	9.7	0	25.0	27.3	41.2	69.2	43.8	60.0	34.6
2	5.6	100.0	100.0	100.0	23.1	38.9	67.5	100.0	28.0	95.0	90.0	100.0	33.3	54.3	85.7	16.7	44.8	90.3	100	75.0	72.7	58.8	30.8	56.3	40.0	65.4

Customer – Automatic Clustering

Cluster	Age			Education				Financial Status			Time With Company				Behaviour							Business Value		
	18-25	25-40	40-50	School	College	Graduate	Profess.	Poor	Average	Good	>1	1-5 Yrs	5-10 Yrs	10+ Yrs	Postive			Negative			Both	Low	Medium	High
															Understand	Joyful	Co-operat	Angry	Annoyed	Aggressive				
1	60.0	0.0	0.0	70.0	33.3	8.0	0.0	71.4	15.2	0.0	28.6	36.4	10.0	0.0	0.0	0.0	57.1	60.0	30.0	85.7	33.3	55.6	14.8	6.7
2	12.0	30.0	6.7	0.0	0.0	36.0	14.3	0.0	15.2	38.5	14.3	18.2	20.0	14.3	30.0	9.1	0.0	40.0	50.0	14.3	53.3	0.0	29.6	13.3

Advisor Clustering (4 Clusters)

With four number of clustering in two-step, clustering analysis the number of case distribution varied according to the clusters.

Cluster	Age				Education				Experience				IT Speed			Prev Experience				Behaviour						
	18-25	25-40	40-50	50+	School	College	Grad	Prof	1 to 5	5 to 10	10 to 15	15+	Low	Medium	High	None	Little	Moder	Ext	Postive			Negative			Both
																				Attentive	Friendly	Cust.Sat	Angry	Annoyed	Unaware	
1	55.6	3.3	0.0	0.0	46.2	33.3	22.5	0.0	40.0	0.0	0.0	0.0	61.9	20.0	3.6	55.6	31.0	6.5	0.0	9.4	13.6	11.8	69.2	37.5	60.0	30.8
2	44.4	3.3	5.9	0.0	30.8	27.8	22.5	0.0	36.0	20.0	15.0	0.0	14.3	31.4	14.3	38.9	24.1	12.9	0.0	21.9	22.7	35.3	0.0	12.5	0.0	7.7
3	0.0	43.3	17.6	0.0	0.0	11.1	30.0	15.4	12.0	30.0	30.0	16.7	4.8	22.9	25.0	0.0	20.7	25.8	33.3	34.4	13.6	11.8	30.8	50.0	40.0	61.5
4	0.0	50.0	76.5	100.0	23.1	27.8	25.0	84.6	12.0	50.0	55.0	83.3	19.0	25.7	57.1	5.6	24.1	54.8	66.7	34.4	50.0	41.2	0.0	0.0	0.0	0.0

Rules for 4 Cluster Analysis

IF	AGE	EDUCATION	EXPERIENCE	IT SPEED	PREV EXP	BEHAVIOUR	Type
1	18-25	school	1-5 yrs	low	None	Negative Behaviour (100%)	angry and unaware
2	50+	profess	15+ yrs	high	None	Positive Behaviour	friendly & cust. Satis
3	25-40	graduate	10-15 yrs	medium	Extensive	both	attentive and annoyed
4	18-25	college	1-5 yrs	low	Extensive	Positive Behaviour	attentive and friendly

Customer Clustering (4 Cluster Analyses)

Cluster	Age			Education				Financial Status			Time With Company				Behaviour							Business Value		
															Postive			Negative			Both			
	18-25	25-40	40-50	School	College	Graduate	Profess.	Poor	Average	Good	>1	1-5 Yrs	5-10 Yrs	10+ Yrs	Understand	Joyful	Co-operat	Angry	Annoyed	Aggressive		Low	Medium	High
1	60.0	0.0	0.0	70.0	33.3	8.0	0.0	71.4	15.2	0.0	28.6	36.4	10.0	0.0	0.0	0.0	57.1	60.0	30.0	85.7	33.3	55.6	14.8	6.7
2	12.0	30.0	6.7	0.0	0.0	36.0	14.3	0.0	15.2	38.5	14.3	18.2	20.0	14.3	30.0	9.1	0.0	40.0	50.0	14.3	53.3	0.0	29.6	13.3
3	28.0	15.0	26.7	10.0	38.9	24.0	0.0	28.6	30.3	0.0	33.3	22.7	10.0	14.3	0.0	45.5	14.3	0.0	0.0	0.0	0.0	22.2	25.9	20.0
4	0.0	55.0	66.7	20.0	27.8	32.0	85.7	0.0	39.4	61.5	23.8	22.7	60.0	71.4	70.0	45.5	28.6	0.0	20.0	0.0	13.3	22.2	29.6	60.0

Rules for 4 Cluster Analysis

IF	AGE	EDUCATION	FINANCIAL	TIME WITH COMPANY	BUSINESS VALUE	BEHAVIOUR	TYPE
1	18-25	school	poor	1-5 yrs	low	negative behaviour	angry & aggressive
2	25-40	graduate	good	5-10 yrs	low	both	understanding & annoyed
3	18-25	college	average	>1 yr	medium	positive behaviour	joyful
4	40-50	profess	good	10+	medium	positive behaviour	joyful & understanding

Advisor Clustering (5 Cluster Analyses)

Cluster	Age				Education				Experience				IT Speed			Prev Experience				Behaviour						
																				Postive			Negative			Both
	18-25	25-40	40-50	50+	School	College	Grad	Prof	1 to 5	5 to 10	10 to 15	15+	Low	Medium	High	None	Little	Moder	Ext	Attentive	Friendly	Cust.Sat	Angry	Annoyed	Unaware	
1	47.2	3.3	0.0	0.0	46.2	33.3	15.0	0.0	36.0	0.0	0.0	0.0	52.4	17.1	3.6	44.4	27.6	6.5	0.0	9.4	13.6	0.0	69.2	18.8	60.0	23.1
2	25.0	3.3	5.9	0.0	15.4	0.0	22.5	0.0	8.0	15.0	10.0	0.0	14.3	17.1	7.1	27.8	13.8	6.5	0.0	6.3	0.0	47.1	0.0	31.3	0.0	15.4
3	0.0	43.3	17.6	0.0	0.0	11.1	30.0	15.4	12.0	30.0	30.0	16.7	4.8	22.9	25.0	0.0	20.7	25.8	33.3	34.4	13.6	11.8	30.8	50.0	40.0	61.5
4	5.6	50.0	76.5	100.0	30.8	27.8	27.5	84.6	16.0	55.0	55.0	83.3	19.0	28.6	60.7	5.6	24.1	61.3	66.7	34.4	59.1	41.2	0.0	0.0	0.0	0.0
5	22.2	0.0	0.0	0.0	7.7	27.8	5.0	0.0	28.0	0.0	5.0	0.0	9.5	14.3	3.6	22.2	13.8	0.0	0.0	15.6	13.6	0.0	0.0	0.0	0.0	0.0

Rules

Based on the percentage of the cluster distribution for each cluster on the basis of the variables been used, general if then rules were derived based on the clustering results which are as shown below.

IF	AGE	EDUCATION	EXPERIENCE	IT SPEED	PRE EXP	BEHAVIOUR	Type
1	18-25	school	1-5 yrs	low	None	Negative Behaviour	angry and unaware
2	50+	profess	5-10 yrs	medium	None	Positive Behaviour	friendly
3	25-40	graduate	10-15 yrs	medium	Exetensive	both	attentive & annoyed
4	18-25	college	1-5 yrs	low	Exetensive	Positive Behaviour	attentive and friendly
5	40-50	profess	10-15+ yrs	high	None	Positive Behaviour	cust satisfaction

Customers (5 Cluster Analyses)

Cluster	Age			Education				Financial Status			Time With Company				Behaviour							Business Value		
															Postive			Negative			Both			
	18-25	25-40	40-50	School	College	Graduate	Profess.	Poor	Average	Good	>1	1-5 Yrs	5-10 Yrs	10+ Yrs	Understand	Joyful	Co-operat	Angry	Annoyed	Aggressive		Low	Medium	High
1	60.0	0.0	0.0	70.0	33.3	8.0	0.0	71.4	15.2	0.0	28.6	36.4	10.0	0.0	0.0	0.0	57.1	60.0	30.0	85.7	33.3	55.6	14.8	6.7
2	12.0	25.0	6.7	0.0	0.0	36.0	0.0	0.0	15.2	30.8	14.3	13.6	20.0	14.3	20.0	9.1	0.0	40.0	40.0	14.3	46.7	0.0	25.9	13.3
3	28.0	15.0	13.3	10.0	33.3	20.0	0.0	28.6	24.2	0.0	28.6	22.7	0.0	14.3	0.0	36.4	14.3	0.0	0.0	0.0	0.0	16.7	22.2	20.0
4	0.0	25.0	46.7	20.0	5.6	24.0	42.9	0.0	27.3	23.1	28.6	0.0	10.0	71.4	10.0	45.5	14.3	0.0	0.0	0.0	0.0	11.1	22.2	26.7
5	0.0	35.0	33.3	0.0	27.8	12.0	57.1	0.0	18.2	46.2	0.0	27.3	60.0	0.0	70.0	9.1	14.3	0.0	30.0	0.0	20.0	16.7	14.8	33.3

Rules

IF	AGE	EDUCATION	FINANCIAL	TIME WITH COMPANY	BUSINESS VALUE	BEHAVIOUR	TYPE
1	18-25	school	poor	1-5 yrs	low	negative behaviour	angry and aggressive
2	25-40	graduate	good	5-10 yrs	medium	both	understanding & angry
3	18-25	college	poor	>1 yrs	medium	positive behaviour	joyful
4	40-50	profess	average	10 + yrs	high	positive behaviour	joyful
5	25-40	profess	good	5-10 yrs	high	both	understanding & annoyed

Advisor Clustering (6 Cluster Analyses)

Cluster	Age				Education				Experience				IT Speed			Prev Experience				Behaviour						
																				Postive			Negative			Both
	18-25	25-40	40-50	50+	School	College	Grad	Prof	1 to 5	5 to 10	10 to 15	15+	Low	Medium	High	None	Little	Moder	Ext	Attentive	Friendly	Cust.Sat	Angry	Annoyed	Unaware	
1	47.2	3.3	0.0	0.0	46.2	33.3	15.0	0.0	36.0	0.0	0.0	0.0	52.4	17.1	3.6	44.4	27.6	6.5	0.0	9.4	13.6	0.0	69.2	18.8	60.0	23.1
2	25.0	3.3	5.9	0.0	15.4	0.0	22.5	0.0	8.0	15.0	10.0	0.0	14.3	17.1	7.1	27.8	13.8	6.5	0.0	6.3	0.0	47.1	0.0	31.3	0.0	15.4
3	0.0	43.3	17.6	0.0	0.0	11.1	30.0	15.4	12.0	30.0	30.0	16.7	4.8	22.9	25.0	0.0	20.7	25.8	33.3	34.4	13.6	11.8	30.8	50.0	40.0	61.5
4	0.0	10.0	41.2	0.0	15.4	5.6	7.5	30.8	0.0	10.0	40.0	0.0	0.0	0.0	35.7	0.0	0.0	19.4	66.7	15.6	0.0	29.4	0.0	0.0	0.0	0.0
5	5.6	40.0	35.3	100.0	15.4	22.2	20.0	53.8	16.0	45.0	15.0	83.3	19.0	28.6	25.0	5.6	24.1	41.9	0.0	18.8	59.1	11.8	0.0	0.0	0.0	0.0
6	22.2	0.0	0.0	0.0	7.7	27.8	5.0	0.0	28.0	0.0	5.0	0.0	9.5	14.3	3.6	22.2	13.8	0.0	0.0	15.6	13.6	0.0	0.0	0.0	0.0	0.0

IF	AGE	EDUCATION	EXPERIENCE	IT SPEED	PRE EXP	BEHAVIOUR	Type
1	18-25	school	1-5 yrs	low	None	Negative Behaviour	angry and unaware
2	50+	profess	5-10 yrs	medium	None	Positive Behaviour	friendly
3	25-40	graduate	10-15 yrs	medium	Exetensive	both	attentive & annoyed
4	18-25	college	1-5 yrs	low	Exetensive	Positive Behaviour	attentive and friendly
5	40-50	profess	10-15+ yrs	high	None	Positive Behaviour	cust satisfaction
6	18-25	college	1-5 yrs	medium	None	Positive Behaviour	attentive and friendly

Customers (6 Cluster Analyses)

Cluster	Age			Education				Financial Status			Time With Company				Behaviour							Business Value		
															Postive			Negative			Both			
	18-25	25-40	40-50	School	College	Graduate	Profes s.	Poor	Average	Good	>1	1-5 Yrs	5-10 Yrs	10+ Yrs	Understand	Joyful	Co-operat	Angry	Annoyed	Aggressive		Low	Medium	High
1	60.0	0.0	0.0	70.0	33.3	8.0	0.0	71.4	15.2	0.0	28.6	36.4	10.0	0.0	0.0	0.0	57.1	60.0	30.0	85.7	33.3	55.6	14.8	6.7
2	12.0	25.0	6.7	0.0	0.0	36.0	0.0	0.0	15.2	30.8	14.3	13.6	20.0	14.3	20.0	9.1	0.0	40.0	40.0	14.3	46.7	0.0	25.9	13.3
3	28.0	15.0	13.3	10.0	33.3	20.0	0.0	28.6	24.2	0.0	28.6	22.7	0.0	14.3	0.0	36.4	14.3	0.0	0.0	0.0	0.0	16.7	22.2	20.0
4	0.0	25.0	46.7	20.0	5.6	24.0	42.9	0.0	27.3	23.1	28.6	0.0	10.0	71.4	10.0	45.5	14.3	0.0	0.0	0.0	0.0	11.1	22.2	26.7
5	0.0	30.0	13.3	0.0	5.6	12.0	57.1	0.0	6.1	46.2	0.0	27.3	20.0	0.0	50.0	9.1	14.3	0.0	10.0	0.0	6.7	0.0	11.1	33.3
6	0.0	5.0	20.0	0.0	22.2	0.0	0.0	0.0	12.1	0.0	0.0	0.0	40.0	0.0	20.0	0.0	0.0	0.0	20.0	0.0	13.3	16.7	3.7	0.0

Rules

IF	AGE	EDUCATION	FINANCIAL	TIME WITH COMPANY	BUSINESS VALUE	BEHAVIOUR	TYPE
1	18-25	school	poor	1-5 yrs	low	negative behaviour	angry and aggressive
2	25-40	graduate	good	5-10 yrs	medium	both	understanding & angry
3	18-25	college	poor	>1 yrs	medium	positive behaviour	joyful
4	40-50	profess	average	10 + yrs	high	positive behaviour	joyful
5	25-40	profess	good	5-10 yrs	high	both	understanding & annoyed
6	40-50	college	average	5-10 yrs	low	both	understanding & annoyed

Advisor Clustering (9 Clusters)

It was observed that as the number of clusters were increased from five onwards, the distribution of cases within each cluster was decreasing and also that the number of advisors in each cluster was lower for making it a significant cluster. When the if then rules were derived from the results of 8/9/10 clusters, the author noticed that there were few rules which were repeated more than once, and some of the rules had no significance compared to rules derived from other cluster analysis. The author then just concluded that for the distribution of cases within the database to work properly it was more significant to use only a maximum of five clusters within the clustering analysis of two-step cluster.

Cluster	Age				Education				Experience				IT Speed			Behaviour						
																Postive			Negative			Both
	18-25	25-40	40-50	50+	School	College	Grad	Prof	1 to 5	5 to 10	10 to 15	15+	Low	Medium	High	Attentive	Friendly	Cust. Sat	Angry	Annoyed	Unaware	
1	32.3	0.0	0.0	0.0	54.5	9.5	5.1	0.0	25.8	8.0	0.0	0.0	17.6	11.1	9.7	2.6	0.0	7.1	37.5	23.1	44.4	9.1
2	9.7	8.8	22.2	0.0	18.2	9.5	15.4	0.0	6.5	20.0	13.6	0.0	5.9	25.0	0.0	7.7	21.7	14.3	0.0	0.0	0.0	0.0
3	6.5	8.8	0.0	0.0	0.0	0.0	12.8	0.0	6.5	0.0	13.6	0.0	5.9	5.6	6.5	2.6	8.7	14.3	0.0	23.1	22.2	22.7
4	0.0	14.7	5.6	0.0	0.0	0.0	12.8	7.7	9.7	8.0	4.5	0.0	5.9	2.8	12.9	5.1	13.0	7.1	37.5	7.7	22.2	27.3
5	41.9	0.0	0.0	0.0	9.1	42.9	7.7	0.0	35.5	4.0	4.5	0.0	29.4	19.4	3.2	20.5	21.7	0.0	0.0	0.0	0.0	0.0
6	0.0	20.6	44.4	0.0	18.2	4.8	15.4	46.2	3.2	8.0	50.0	16.7	0.0	2.8	45.2	23.1	0.0	42.9	0.0	0.0	0.0	0.0
7	3.2	17.6	11.1	0.0	0.0	14.3	12.8	7.7	3.2	16.0	13.6	16.7	0.0	19.4	6.5	23.1	0.0	0.0	25.0	46.2	11.1	40.9
8	3.2	11.8	16.7	0.0	0.0	4.8	17.9	0.0	3.2	20.0	0.0	33.3	0.0	8.3	16.1	0.0	26.1	14.3	0.0	0.0	0.0	0.0
9	3.2	17.6	0.0	100.0	0.0	14.3	0.0	38.5	6.5	16.0	0.0	33.3	35.3	5.6	0.0	15.4	8.7	0.0	0.0	0.0	0.0	0.0

Rules – Advisor (9 Clusters)

IF	AGE	EDUCATION	EXPERIENCE	IT SPEED	BEHAVIOUR	Type
1	18-25	school	1-5 yrs	low	Negative Behaviour	angry and unaware
2	40-50	school	5-10 yrs	medium	Positive Behaviour	friendly
3	25-40	graduate	10-15 yrs	high	both	cust. Satis & annoyed
4	25-40	graduate	1-5 / 5-10 yrs	high	both	friendly and angry
5	18-25	college	1-5 yrs	low	Positive Behaviour	attentive and friendly
6	40-50	profess	10-15 yrs	high	Positive Behaviour	cust. Satisfaction
7	25-40	college / graduate	5-10 / 10-15 yrs	medium	both	attentive and annoyed
8	40-50	graduate	15+	high	Positive Behaviour	friendly
9	50+	profess	15+	low	Positive Behaviour	attentive

Appendix I: Fuzzy Expert System

Fuzzy sets are highly model dependent, having meaning within the context in which it is defined. For example the actual definition of what high temperature is depends on the context in which it is used. For some models, 18 - 20 $^{\circ}$C is a cold whether for some hot countries where the idea of cold whether in countries likes Canada occurs at temperature range of 3 - 5 $^{\circ}$C.

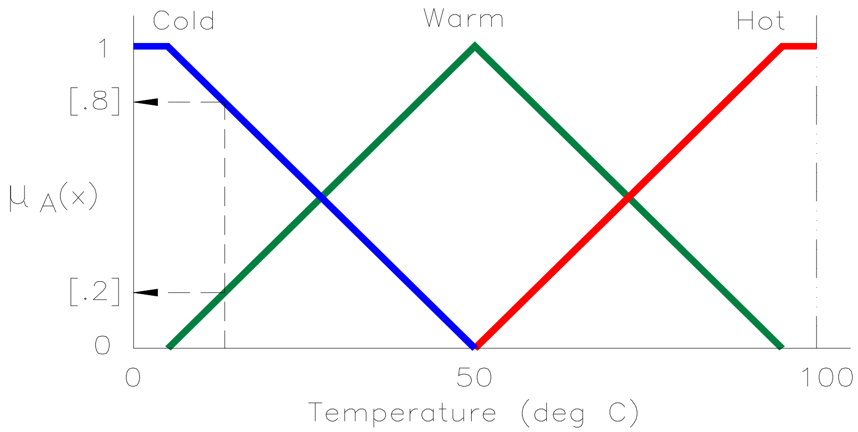


Figure F.1: Fuzzy Set Describing 'Temperature'

In most real world models, the variables are decomposed into a number of different overlapping fuzzy sets. The overlap reflects the fuzziness in the information. It also signifies that elements can belong to various fuzzy sets with varying degrees. Multiple opinions, which often can be contradictory, can be accommodated by taking an average of the opinions, and that can be represented in the fuzzy sets. Figure F.1 shows an example of fuzzy variable 'temperature' described with three fuzzy sets *cold*, *warm* and *hot*. When multiple fuzzy sets are defined on the same universe of discourse, the fuzzy literature refers to them as *fuzzy subsets*. Figure F.1 shows that a temperature of 12.5 $^{\circ}$C, is a member of the fuzzy set *cold* with membership value of 0.8, and at the same time a member of the fuzzy set *warm* with a membership value of 0.2. Consequently, a single object is considered a partial member of multiple sets. This property can model ambiguities in human thinking. A formal definition of FS can be described as follows:

If X is a collection of objects denoted generically by x then a fuzzy set $\tilde{A}$ in X is a set of order pairs: $\tilde{A} = \{(x, \mu\tilde{A}(x)) \mid x \in X\}$

$\mu\tilde{A}(x)$ is called the membership function or grade of membership (also degree of truth) of x in $\tilde{A}$ which maps X to the membership space M. The range of the membership function is a subset of the nonnegative real numbers whose supremum is finite. Elements with zero degree of membership are normally not listed.

Fuzzy Modelling

Fuzzy Modelling (FM) is an approach to develop system models using natural language based on fuzzy logic and fuzzy predicates. In a broader sense, FMS can be viewed as Q^L modelling scheme that qualitatively describes system behaviour using natural language. In a narrow sense, FM is a collection membership functions and fuzzy rules that are used to reason about data.

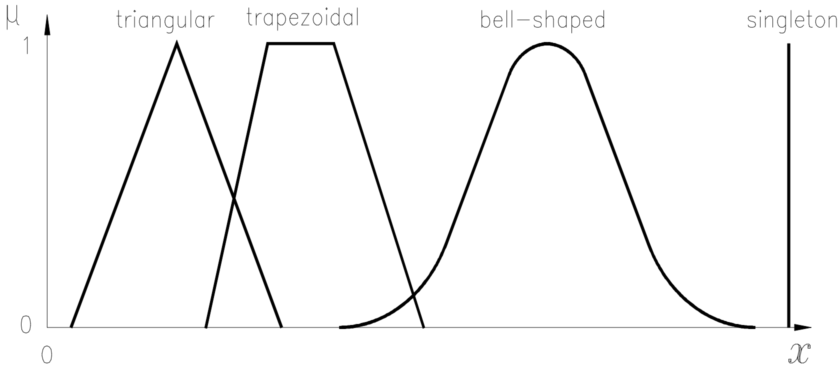


Figure F.2 : Shapes of Membership Functions

Engineers can use their Q^L information to develop linguistic description of system behaviours where precise models are ill-defined or may not be available. This linguistic description represents the fuzzy model which consists of a set of if-then rules that makes use of fuzzy propositions. A typical form of these rules is exemplified by the rule:

If the temperature is high and the pressure is low then the heat change is very high

The if-then rule expresses the relationship between variables in FM. They are of the general form:

If *p_1 is* $\tilde{P}_1$ *and … p_M is* $\tilde{P}_M$ ***then*** $q_{j\ is}$ $\tilde{Q}_j$, *Equation F.1*

Fuzzy prepositions are statements like "*heat change is very high*", where "*high*" is a *linguistic term*, defined by a fuzzy set on the universe of discourse of variable *x*. *Linguistic term* are Q^L values (information granulae) used to describe a particular relationship by rules and it allows the engineers to write propositions about related concepts. *Linguistic term* is the name of a fuzzy set also referred to as fuzzy term, fuzzy constant or fuzzy notions. It carries with it the concept of fuzzy set qualifiers (hedges). The qualifier *very* is a hedge that changes the shape of the fuzzy set *high*. Temperature, pressure and heat change are observable *linguistic variables* that assumes linguistic values.

A general fuzzy modelling approach consists of four modules: a fuzzy rule base, a fuzzy inference engine, fuzzification and defuzzification modules. A detailed description of these modules is presented in the following sections.

Fuzzification

Fuzzification is the process of converting the input variables into fuzzy terms. Here the membership functions defined on the input variables are applied to their actual values to determine the degree of truth for each rule premise. This process establishes a mapping between values of the design variables and fuzzy sets defined in the universe of the corresponding variables.

Fuzzy Inference

The purpose of the fuzzy inference is to derive an output fuzzy set from the given the rules and inputs. Fuzzy inference attempts to establish a degree of belief in a rule's consequent by aggregating the fuzzy spaces produced by the interacting fuzzy propositions in the rule's antecedent. The way a rule is evaluated in the inference engine is influenced by a number of factors such as: nature of the rule (simple or complex), condition of the rule and the method of fuzzy inference.

If a rule has only one antecedent then the rule is a simple rule. However, if a rule contains more than one antecedent then the rule is regarded as a complex rule. The condition of the rule dictates if the rule is fired or not. If the antecedent part of a fuzzy rule matches or partially matches existing information, then the rule is fired.

There are several fuzzy inference methods in fuzzy systems. These methods differ in the way the output fuzzy set is updated. They can be classified into the non-compensatory and the compensatory-based operators. Two of the most non-compensatory methods are the max-min and the max product. The need to adopt alternative methods for interpreting the union and the intersection is more evident in complex fuzzy models. Since a model often combines design variables in an *n*-dimensional Cartesian space through the intersection of their respective fuzzy regions, the behaviour of the non-compensatory operator (AND and OR) directly affects the model performance. Here the minimum of any predicate expression controls the truth value of the entire expression. A single low truth value in any of the predicate propositions will ripple through the antecedent and suppress the truth function of the consequent fuzzy region. The following multiple antecedent rule illustrates this limitation.

Alternative compensatory operators includes: the mean operators, bounded sum, bounded difference, Yager operators and many more. The compensatory operators tend to compensate for the strict minimum, maximum, and complement of the compensatory operators. They generally provide a weaker or less sensitive relationship among propositions when their truth-values are widely separated. The mean compensatory operator is adopted in this thesis. This was adopted since it is desirable to ensure that the cumulative effect of all the rules influences the determination of the output fuzzy set.

Defuzzification

The result of the fuzzy inference is an output fuzzy set specifying the fuzzy distribution of the evaluation of the propositions. However, in most applications a scalar value that best represents the information contained in the output fuzzy is required. Defuzzification is the process that transforms a fuzzy set into a single numerical value representative of that fuzzy set. Two of the most commonly used method of defuzzification is the centre of gravity (COG) and the mean of maxima (MOM). These methods of interpreting the out fuzzy region are shown in Figure F.3. The COG method finds the balance point of the solution fuzzy region by calculating the weighted mean of the fuzzy region.

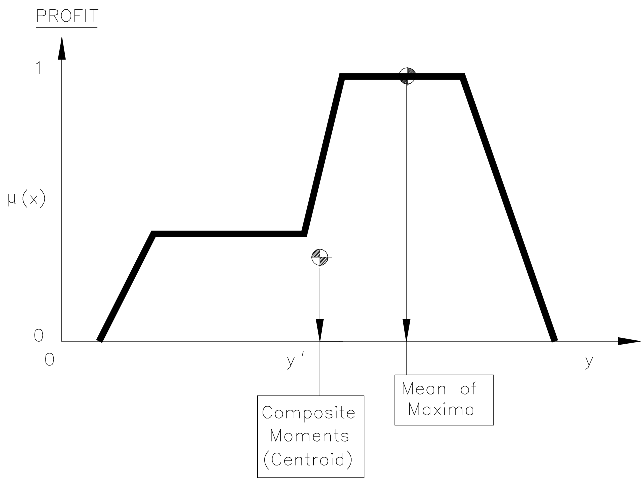


Figure F.3: Centre of Gravity Method of Defuzzification

Changes in fuzzy set topology from one model frame to the next usually result to a smooth change in the expected value; and it is applicable to both fuzzy and singleton output geometries. The COG is commonly used in control engineering problem due to its smooth varying output. This is suitable for control type problems where a smooth varying output is desirable for a stable process control. The MOM finds the domain point with the maximum truth. Unlike the COG method, the MOM has some desirable attributes that are generally applicable to search space with discontinuities. These attributes include (1) the expected value is sensitive to a single rule that dominates the fuzzy rule set and (2) the expected value tends to jump from one frame to the next as the shape of the fuzzy region changes (Cox, 1999).

Fuzzy Expert System

The following screenshots are presented from the fuzzy expert system within matlab environment for customer and advisor.

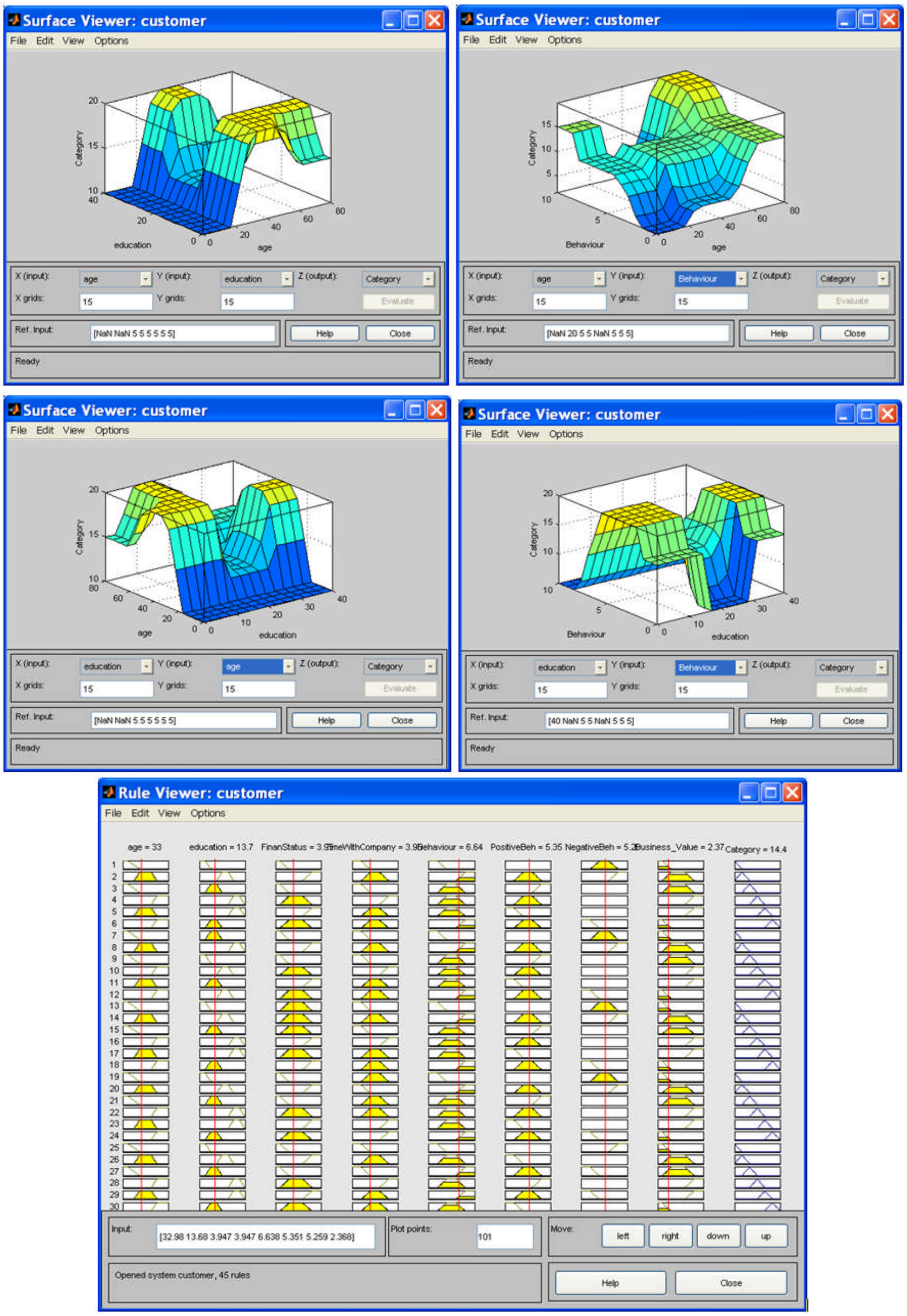


Figure F.5: Screenshots for Customer output from Fuzzy Expert System

Advisor Screenshots of FES

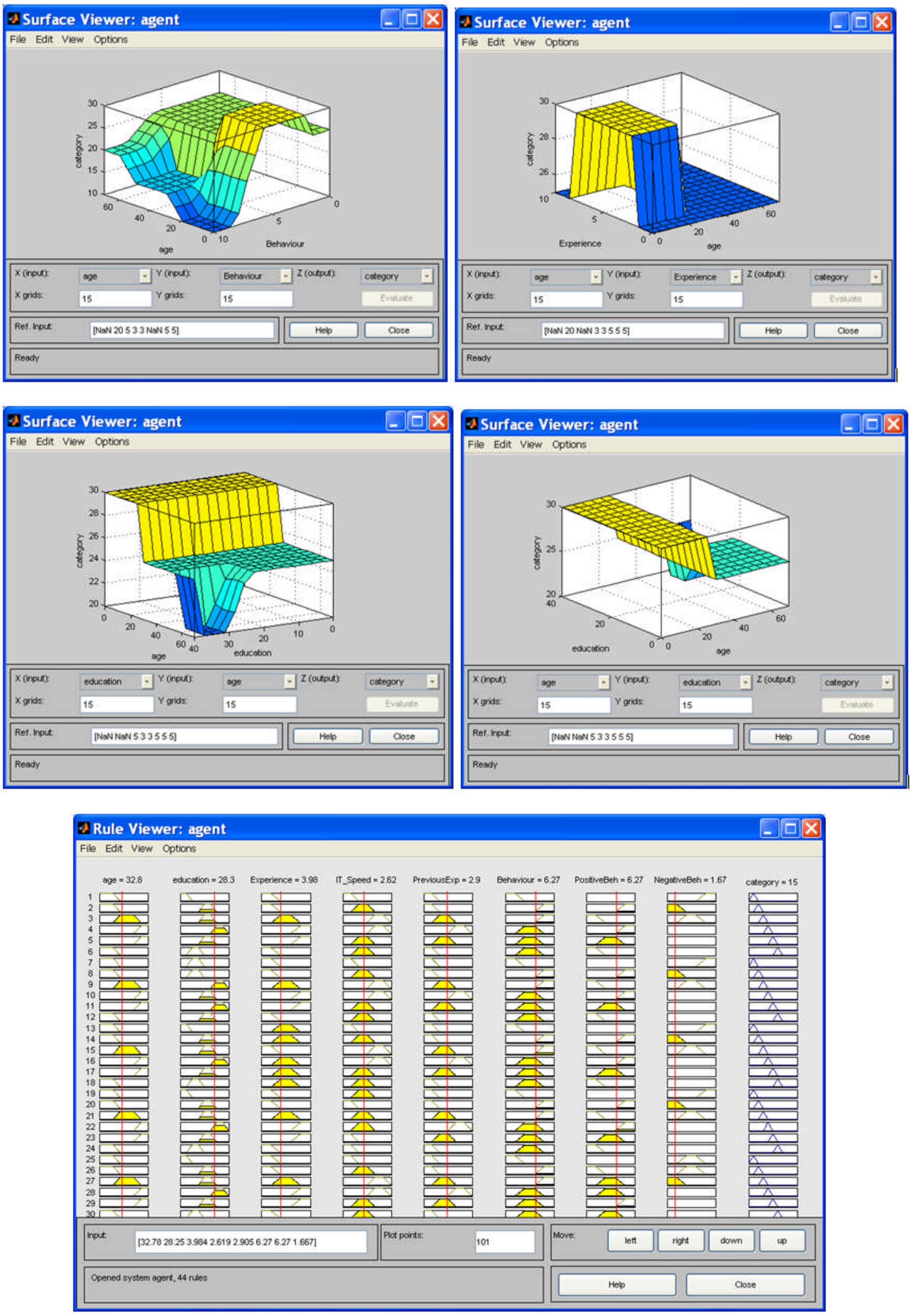
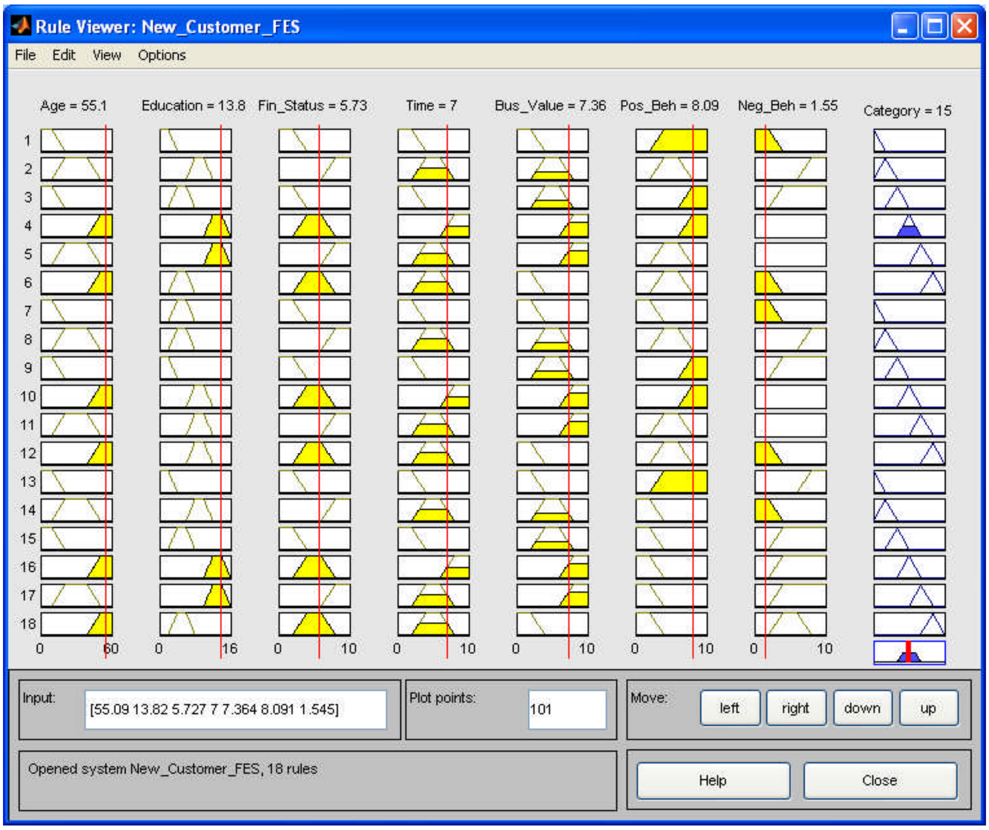
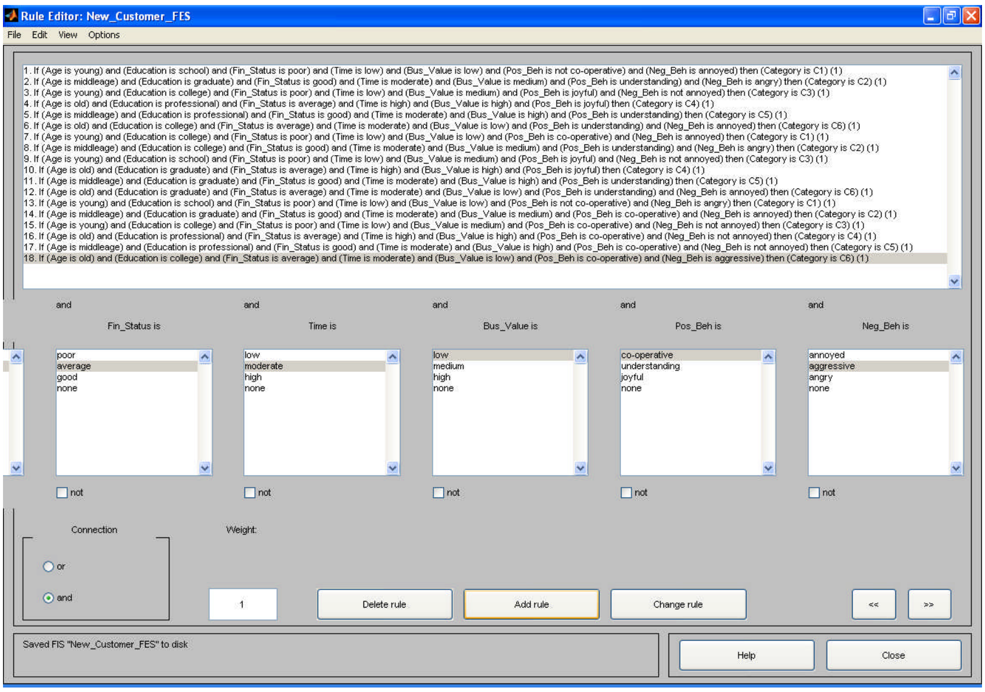


Figure F.6: Membership Functions for Advisor

FES – Rule Viewer and Experimental Tests





Customer and Advisor Rules (FES)

									Advisor If Then Rules for Fuzzy Expert System
No	Age	Education	Exp.	Previous Exp.	IT Speed	Behaviour	Positive Behaviour	Negative Behaviour	Output Category
1	Young	School	Novice	low	Low	Both	Friendly	Unaware	A1
2	Middle age	Graduate	Medium	Moderate	Medium	Both	Attentive	Annoyed	A3
3	Old	Professional	Senior	Extensive	Medium	Positive	Customer Focus	None	A5
4	Young	College	Novice	Moderate	High	Positive	Customer Focus	None	A6
5	Young	Graduate	Novice	Low	High	Both	Attentive	Annoyed	A2
6	Middle age	Graduate	Medium	Extensive	High	Both	Attentive	Angry	A3
7	Old	College	Medium	Moderate	High	Both	Friendly	Annoyed	A5
8	Old	Graduate	Senior	Extensive	High	Positive	Friendly	None	A4
9	Middle age	School	Medium	Moderate	Medium	Both	Friendly	Unaware	A3
10	Young	Graduate	Medium	Moderate	High	Positive	Attentive	None	A2
11	Old	Graduate	Medium	Low	Medium	Both	Friendly	Annoyed	A4
12	Middle age	Professional	Senior	Moderate	High	Positive	Friendly	None	A5
13	Young	School	Medium	Low	High	Positive	Satisfaction	Non	A1
14	Middle age	School	Senior	Low	Medium	Both	Satisfaction	Annoyed	A2
15	Old	School	Senior	Moderate	High	Both	Friendly	Annoyed	A5
16	Old	Professional	Medium	Extensive	High	Positive	Customer focus	Non	A4
17	Old	Graduate	Medium	Moderate	Medium	Positive	Friendly	None	A5
18	Young	College	Medium	Little	Medium	Positive	Attentive	None	A6
19	Young	School	Novice	Little	Medium	Both	None	Angry	A1
20	Young	Graduate	Novice	Little	Low	Both	Customer focus	Unaware	A2
21	Middle	Graduate	medium	Moderate	Medium	Both	Attentive	Annoyed	A3
22	Old	professional	Senior	Extensive	Medium	Positive	Customer focus	none	A4
23	Old	Graduate	Senior	Moderate	Low	Positive	Friendly	none	A5
24	young	College	Novice	Little	Low	Positive	Attentive	none	A6
25	Young	School	Novice	Little	Low	Negative	None	Annoyed	A1
26	Young	Graduate	Novice	Little	Medium	Both	Attentive	Annoyed	A2
27	Middle	Graduate	Medium	Moderate	High	Both	Friendly	Unaware	A3
28	Old	Professional	Senior	Extensive	High	Positive	Friendly	None	A4
29	Old	Graduate	Senior	Moderate	Medium	Positive	Customer focus	None	A5
30	Young	College	Novice	little	Medium	Positive	friendly	none	A6
31	Young	School	-	-	-	Negative	-	-	A1
32	Young	College	-	-	-	Negative	-	-	A1
33	Young	Graduate	-	-	-	Both	-	-	A2
34	Middle	Graduate	-	-	-	Both	-	-	A3
35	Middle	College	-	-	-	Both	-	-	A3
36	Young	College	-	-	-	Positive	-	-	A6
37	Old	Professional	-	-	-	Positive	-	-	A4
38	Old	Graduate	-	-	-	Positive	-	-	A5
39	Young	-	Novice	-	-	Negative	-	-	A1
40	Young	-	Novice	-	-	Both	-	-	A2
41	Young	-	Medium	-	-	Positive	-	-	A6
42	Middle	-	Medium	-	-	Both	-	-	A3
43	Old	-	Medium	-	-	Both	-	-	A4
44	old	-	senior	-	-	Both	-	-	A5

Customer If Then Rules for Fuzzy Expert System

No	Age	Education	Financial Status	Time with Company	Business Value	Behaviour	Positive Behaviour	Negative Behaviour	Output Category
1	Young	School	Poor	low	Low	Negative	None	Aggressive	C1
2	Middle age	Graduate	Good	Moderate	Low	Negative	None	Annoyed	C2
3	Old	Graduate	Average	Moderate	Medium	Both	Understanding	Angry	C6
4	Young	College	Poor	Low	Medium	Positive	Co-operative	None	C3
5	Middle age	Professional	Good	Moderate	High	Positive	Joyful	None	C5
6	Young	Graduate	Average	Moderate	Medium	Negative	None	Angry	C2
7	Middle age	Graduate	Good	Low	High	Both	Co-operative	Aggressive	C6
8	Old	Professional	Average	High	High	Both	Joyful	Annoyed	C4
9	Middle	School	Poor	High	Medium	Negative	None	Aggressive	C1
10	Middle age	Graduate	Good	Moderate	High	Both	Understanding	Angry	C2
11	Old	Graduate	Good	Moderate	High	Positive	Joyful	None	C4
12	Old	College	Average	Low	Medium	Positive	Co-operative	None	C6
13	Young	Graduate	Average	Low	Medium	Positive	Understanding	None	C2
14	Middle age	Professional	Good	Moderate	High	Positive	Joyful	None	C4
15	Old	College	Good	Moderate	Low	Positive	Co-operative	None	C6
16	Old	Professional	Good	Senior	High	Positive	Understanding	None	C4
17	Middle age	Professional	Average	Moderate	High	Positive	Co-operative	None	C5
18	Old	College	Good	Moderate	Low	Both	Understanding	Annoyed	C6
19	Young	School	Poor	Moderate	Low	Negative	None	Aggressive	C1
20	Middle age	Graduate	Good	Low	Medium	Both	Understanding	Angry	C2
21	Young	College	Poor	medium	Medium	Positive	Joyful	None	C3
22	Old	Professional	Average	Medium	High	Positive	Understanding	None	C4
23	Middle age	Professional	Good	Senior	High	Positive	Co-operative	None	C5
24	Old	College	Average	Senior	Low	Both	Understanding	Annoyed	C6
25	Young	School	Poor	Novice	Low	Negative	None	Angry	C1
26	Middle age	Graduate	Good	Medium	Medium	Positive	Co-operative	None	C2
27	Young	College	Poor	Novice	Medium	Both	Understanding	Annoyed	C3
28	Old	professional	Average	Senior	High	Positive	Joyful	None	C4
29	Middle age	Professional	Good	Medium	High	Both	Understanding	Annoyed	C5
30	Old	college	average	medium	Low	Positive	Co-operative	None	C6
31	Young	-	-	-	-	Negative	-	-	C1
32	Young	-	-	-	-	Positive	-	-	C3
33	Middle age	-	-	-	-	Both	-	-	C2
34	Middle age	-	-	-	-	Positive	-	-	C5
35	Old	-	-	-	-	Positive	-	-	C4
36	Old	-	-	-	-	Both	-	-	C6
37	Young	School	Poor	-	-	-	-	-	C1
38	Young	College	Poor	-	-	-	-	-	C3
39	Middle age	graduate	Good	-	-	-	-	-	C2
40	Middle age	Graduate	Average	-	-	-	-	-	C2
41	Middle age	Professional	Good	-	-	-	-	-	C5
42	old	Professional	Average	-	-	-	-	-	C4
43	Old	Graduate	Average	-	-	-	-	-	C4
44	Old	professional	Good	-	-	-	-	-	C4
45	old	College	average	-	-	-	-	-	C6

Appendix J: Customer and Advisor Categorisation

Table J.8-1: Summary of Case Studies in Contact Centres

	Centre Manager – AS IS Study Summary		
Contact Centres	**Type of CC**	**Interview Details**	**Description**
1. Contact Centre A	Telecoms Fault Contact Centre	25 Advisors and 4 Managers – 20 Customer Calls	Advisors range from age group in between 18-25 and 25-40 with higher percentage of advisors educated to graduate level. From the behaviour side, it was a mixture of positive and negative behaviours among them
2. Contact Centre B	Telecoms Sales Contact	Centre – 14 Advisors and 3 Managers – 12 Customer Calls	Advisors mostly range from majority of 18-25 age groups and with a mixture of education level and experience level among them. From the behaviour side, majority of the advisors were having positive behaviour
3. Contact Centre C	Telecoms Business Solution	22 Advisors and 3 Managers- 13 Customer calls	Business solutions team were having a mixture of advisors with age group from 18-25 to maximum of 40-50 and more male than females within the group. From the behaviour side, only 7 people out of 22 were having negative behaviour with the rest of them having positive behaviours.
4. Contact Centre D	Help Desk Contact Centre –	14 Advisors and 5 Team leaders - 9 Customer calls	A good collection of female advisors noticed within this centre. The education and experience level were high compared with other centres from college to graduate levels of education. Behavioural aspects were also a mixture of behaviours
5. Contact Centre E	City Council Contact Centre	9 Advisors and 4 Team leaders - 13 Customer calls	With the city council, because of the complexity of work environment, not much advisors monitored. Out of 9 advisors spoken to 5 were male and 4 were female, with age ranging from college to professional level. Behaviour attributes were also mixture of positive and negative behaviour

Appendix K: Validation Questionnaire

The following semi-structured questionnaire was used for validation of the categorisation and information requirement framework within contact centres. The experts from the industry were shown the categories derived from the research and on the basis of the categorisation, the information framework was validated. Based on this information provided by the experts, the author then analysed the information and are discussed in chapter 8.

Development of Intelligent Decision Support Framework in Contact Centre (***I – Contact*** Project)

Project Sponsor: BT and EPSRC

Customer Contact Centre: Categorisation & Information Requirement Questionnaire

Mr. Satya. R. Shah Investigator Enterprise Integration, Cranfield University, Cranfield, Bedfordshire, MK43 0AL. UK Tel: +44(0)1234 754194 Fax: +44(0)1234 750852 Email: s.shah@cranfield.ac.uk satya.shah@bt.com	**Dr. R. Roy and Dr. A. Tiwari** Supervisors Enterprise Integration, Cranfield University, Cranfield, Bedfordshire, MK43 0AL. UK Tel: +44(0)1234 752423 Fax: +44(0)1234 750852 Email: r.roy@cranfield.ac.uk a.tiwari@cranfield.ac.uk

Name: ____

Title: ____

Organisation: ____

Department: ____

Address: ____

____

Telephone Number: __________________________Fax Number: ___________________

Email: ____

*The information provided will be held in the strictest of confidence, desensitised, and use for academic and research purposes **ONLY**.*

Thank you for answering the questionnaire. Its aim is to develop the understanding of the overall operations of the Customer Contact Centre environment, the bottlenecks, and the gaps within the technological and management aspects of the centre

No individual results will be disclosed to the third parties. Personal details will only be used to send you any of the documents if required.

Section 1: Complete Information Screens
8. Is the minimum information displayed on the screen appropriate for the given customer-advisor combination?
9. Is there any specific information that is not specified?
10. What do you think about the list of complete information shown here?
11. What are your views regarding the information "master screen" shown here?
Section 2:Examples of Information Screens
12. Do you agree to the type of information been shown for the examples given? If No – Explain
Section 3: Modifications/Suggestions to the Framework
13. Are there any modifications required to the information requirement framework provided here?
14. Any suggestions.

The experts were presented with the following screenshots of the advisor and customer categorisation.

Categories / Attributes	A1 *(Novice Agent)*	A2 *(Customer Focus Agent)*	A3 *(Both Behaviours)*	A4 *(Experience – Cust. Focus)*	A5 *(Experienced – Friendly)*	A6 *(Attentive Agent)*	***NEW***	***NEW***
AGE	18-25	18-25	25-40	40-50	50+	18-25		
EDUCATION	SCHOOL	GRADUATE	GRADUATE	PROFESSIONAL	PROFESSIONAL	COLLEGE		
EXPERIENCE	>1 YRS	>1 YRS	5-10 YRS	10-15 YRS	15+ YRS	1-5 YRS		
IT SPEED	LOW	MEDIUM	HIGH	HIGH	MEDIUM	MEDIUM		
PREVIOUS EXPERIENCE	NONE	NONE	EXTENSIVE	EXTENSIVE	MODERATE	NONE		
BEHAVIOUR	NEGATIVE	BOTH	BOTH	POSITIVE	POSITIVE	POSITIVE		
POSITIVE BEHAVIOUR	-	CUSTOMER FOCUS	ATTENTIVE	CUSTOMER FOCUS	FRIENDLY	ATTENTIVE		
NEGATIVE BEHAVIOUR	ANGRY & UNAWARE	ANNOYED	ANNOYED	-	-	-		
Total number of Cases (out of 84)	16	18	20	4	7	19		

CUSTOMER CATEGORISATION

Categories / Attributes	C1 (Angry Customer)	C2 (Both Behaviours)	C3 (Joyful Customer)	C4 (Good Customer)	C5 (Understanding Customer)	C6 (Old Customer)	***NEW***	***NEW***
AGE	18-25	25-40	18-25	40-50	25-40	40-50		
EDUCATION	SCHOOL	GRADUATE	COLLEGE	PROFESSIONAL	PROFESSIONAL	COLLEGE		
FINANCIAL BACKGROUND	POOR	GOOD	POOR	AVERAGE	GOOD	AVERAGE		
TIME WITH COMPANY	1-5 YRS	5-10 YRS	>1 YRS	10+ YRS	5-10 YRS	5-10 YRS		
BUSINESS VALUE	LOW	MEDIUM	MEDIUM	HIGH	HIGH	LOW		
BEHAVIOUR	NEGATIVE	BOTH	POSITIVE	POSITIVE	POSITIVE	BOTH		
POSITIVE BEHAVIOUR	-	UNDERSTANDING	JOYFUL	JOYFUL	UNDERSTANDING	UNDERSTANDING		
NEGATIVE BEHAVIOUR	ANGRY & AGGRESSIVE	ANGRY	-	-	-	ANNOYED		
Total number of Cases (out of 60)	12	9	13	6	11	9		
OTHER								

The business capture analysis was conducted to identify the minimum amount of information that is required to be presented on the screen based on the following combination of customer and advisor.

BUSINESS STRATEGY CAPTURE

CUSTOMER

ADVISOR	C1	C2	C3	C4	C5	C6	
A1							
A2							
A3							
A4							
A5							
A6							

Advisor (CSA) Rules

Age	Education	Experience	Previous Exp	IT Speed	Positive Behaviour	Negative Behaviour	Category
Young	School	Novice	Low	Slow	Friendly	Unaware	A1
Middle age	Graduate	Medium	Moderate	Medium	Attentive	Annoyed	A3
Old	Professional	Senior	Extensive	Medium	Focus	-	A5
Young	College	Novice	Moderate	Fast	Focus	Unaware	A6
Young	Graduate	Novice	Low	Fast	Attentive	Annoyed	A2
Middle Age	Graduate	Medium	Extensive	Fast	Attentive	Angry	A3
Old	College	Medium	Moderate	Fast	Friendly	Annoyed	A5
Old	Graduate	Senior	Extensive	Fast	Friendly	-	A4
Middle Age	School	Medium	Moderate	Medium	Friendly	Unaware	A3
Young	Graduate	Medium	Moderate	Fast	Attentive	-	A2

Customer Rules

Age	Education	Financial Status	Time with Company	Business Value	Positive Behaviour	Negative Behaviour	Category
Young	School	Poor	Low	Low	-	Aggressive	C1
Middle Age	Graduate	Good	Moderate	Low	-	Annoyed	C2
Old	Graduate	Average	Moderate	Medium	Understanding	Angry	C6
Young	College	Poor	Low	Medium	Co-operative	-	C3
Middle Age	Professional	Good	Moderate	High	Joyful	-	C5
Young	Graduate	Average	Moderate	Medium	-	Angry	C2
Middle Age	Graduate	Good	Low	High	Co-operative	Aggressive	C6
Old	Professional	Average	High	High	Joyful	Annoyed	C4
Middle Age	School	Poor	High	Medium	-	Aggressive	C1
Middle age	Graduate	Good	Moderate	High	Understanding	Angry	C2

Advisor (CSA) Experimental Results

Age	Education	Experience	Previous Exp.	IT Speed	Positive Beh.	Negative Beh.	Output	Category	CC Validation
21.5	12	5	1.8	1.5	8.5	2.1	30	A6	
30	21	4.2	5	4	1.8	5	10	A3	
33.8	17.2	5.5	4.2	3	3.5	4	10	A3	
20	5	1	0.5	1.3	1.2	1.8	5	A1	
24	11	3	0.2	2	2	0	25	A6	
28	24.6	0	1.5	3	8	4	5	A2	
32.4	19.8	4.8	4	5	2	6.2	10	A3	
51.2	27	8.6	5	2.8	5	1.2	20	A5	
39.2	16.5	7	3.8	4.2	10	2	15	A4	
22.8	18	2	2.1	2.5	3.2	1	26.1	A6	
15	2	1	1	0.8	7	0	2.33	A1	
50	31.2	7.8	4.2	4	8	6	15.8	A4	
48.7	27	10	5	3.2	10	8	21	A5	
34.3	21	6	4	4	3	5	15	A3	
19.9	4	4	0.8	1.5	2	4	25	A6	

Ex. 1

If Age = 21.5, Education = 12, Experience = 5, IT Speed = 1.5, Previous Exp = 1.8, Positive Behaviour = 5.5, Negative Behaviour = 3.8

Then Agent Category output is 25 which determines that the category for agent is A6

Ex.2

If Age = 30, Education = 21, Experience = 4.2, IT Speed = 5, Previous Exp = 4, Positive Behaviour = 1.8, Negative Behaviour = 5

Then Agent Category output is 10 which determines that the category for agent is A3

Customer Experimental Results

Age	Education	Financial	Time	Business Value	Positive Beh.	Negative Beh.	Output	Category	CC Validation
20	10.2	2	0.8	4	10	1	15	C3	
25	5	3	5	2.5	1.2	5	5	C1	
30	7	8.9	9	6.8	5	0	25	C5	
36	16.5	6.5	4.5	5	6.2	10	10	C2	
28	10.7	0	0	5	10	2.1	15	C3	
32.1	27.6	10	7	9	5.6	1.5	25	C5	
40	25	5	10	8.5	9	0.4	20	C4	
50	10	4.3	6.5	0	5	3	30	C6	
18	1.2	1.5	3	1.2	1.2	8	5	C1	
23	7.5	2	0.5	5.2	9	1.5	15	C3	
31.6	35	8	4.8	8	6	1.5	25	C5	
45.2	15	4	4.5	4	4.8	4	20	C6	
52.8	5	6	7	6	5.2	7	10	C2	
28	18	9.1	2	3	4.1	2	25	C5	
16	6	1.8	0	5	3	10	5	C1	

Ex. 1

If Age = 20, Education = 10.2, Financial Status = 2, Time with company = 0.8, Business Value = 4, Positive Behaviour = 10, Negative Behaviour = 1

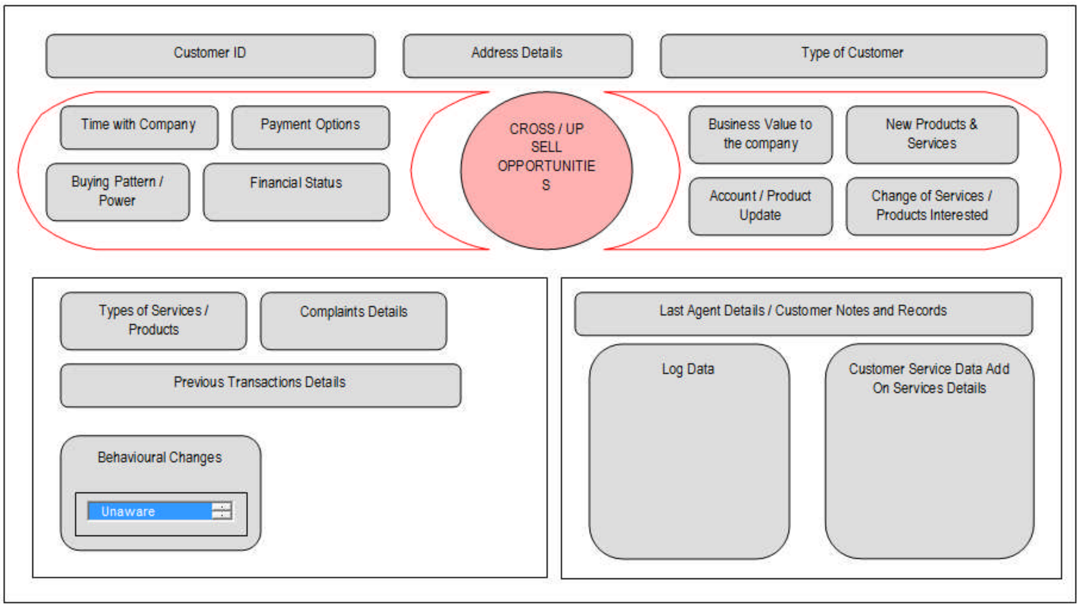
Then Customer Category output is 5 and the category is C3

Ex.2

If Age = 25, Education = 5, Financial Status = 3, Time with company = 5, Business Value = 2.5, Positive Behaviour = 1.2, Negative Behaviour = 5

Then Customer Category is C1

Information Requirement Framework (Master Screen)



Appendix L: Validation of Frameworks – Information Requirement

This section shows validation of the categorisation and information requirement frameworks summary as the information was gathered through questionnaire data at contact centres.

ADVISOR \ CUSTOMER	C1	C2	C3	C4	C5	C6
A1	Customer ID, Address details, Type of customer, Time with company, payment options, financial status, account update, type of services, complaints details, previous transactions, behavioural changes, last advisor details, log data, customer service data	Customer ID, Address details, Type of Customer, Time with company, buying pattern, financial status, cross/up sell opportunities, business value to the company, new products and services, change of services, type of services, previous transaction details, behavioural changes, last advisor details, log data, customer service data	Customer ID, Address details, Type of Customer, time with company, financial status, cross/up sell opportunities, account update, new products and services, type of services, previous transaction details, behavioural changes, last advisor details, log data, customer service data	Customer ID, Address details, Type of Customer, buying pattern, financial status, cross/up sell opportunities, business value to company, new products and services, change of services, previous transaction , behavioural changes, last advisor details, log data, customer service data	Customer ID, Address details, Type of Customer, time with company, buying pattern, cross/up sell opportunities, business value to company, new products and services, account update, previous transaction details, behavioural changes, last advisor details, log data, customer service data	Customer ID, Address details, Type of Customer, payment options, financial status, account update, type of services, complaints data, previous transaction details, behavioural changes, last advisor details, log data, customer service data
A2	Customer ID, Address details, Type of Customer, time with company, payment option, account update, type of services, complaints data, previous transaction details, behavioural changes, last advisor details, log data	Customer ID, Address details, Type of Customer, financial status, cross/up sell opportunities, business value to company, new products, change of services, type of services, previous transaction details, behavioural changes, last advisor details, log data	Customer ID, Address details, Type of Customer, payment options, account update, type of services, previous transaction details, behavioural changes, last advisor details, log data, customer service data	Customer ID, Address details, Type of Customer, time with company, buying pattern, cross/up sell opportunities, business value to company, new products, change of services, previous transaction details, behavioural changes, last advisor details, log data, customer services data	Customer ID, Address details, Type of Customer, time with company, buying pattern, cross/up sell opportunities, business value to company, new product and services, account update, type of services, previous transaction details, behavioural changes, log data, customer services data	Customer ID, Address details, Type of Customer, payment options, account update, type of services, complaints data, previous transaction details, behavioural changes, last advisor details, log data, customer services data
A3	Customer ID, Address details, Type of Customer, payment options, financial status, account update, complaints data, previous transaction details, behavioural changes, last advisor details, log data, customer services data	Customer ID, Address details, Type of Customer, time with company, buying pattern, cross/up sell opportunities, business value to company, new products, account update, type of services, previous transaction details, behavioural changes, last advisor details, log data, customer services data	Customer ID, Address details, Type of Customer, payment options, account update, type of services, previous transaction details, behavioural changes, last advisor details, log data, customer services data	Customer ID, Address details, Type of Customer, buying pattern, cross/up sell opportunities, business value to company, new products, change of services, type of services, previous transaction details, behavioural changes, last advisor details, log data, customer service data	Customer ID, Address details, Type of Customer, payment options, buying pattern, cross/up sell opportunities, business value to company, new product, type of services, previous transaction details, behavioural changes, last advisor details, log data, customer services data	Customer ID, Address details, Type of Customer, time with company, financial status, account update, type of services, complaints details, previous transaction details, behavioural changes, last advisor details, log data, customer services
A4	Customer ID, Address details, Type of Customer, time with company, financial status, change of services, type of services, complaints details, previous transactions details, behavioural changes, last advisor details, log data, customer services data	Customer ID, Address details, Type of Customer, time with company, payment options, business value to company, account update, type of services complaints details, previous transaction details, behavioural changes, last advisor details, log data, customer services data	Customer ID, Address details, Type of Customer, payment options, account update, type of services previous transaction details, behavioural changes, last advisor details, log data, customer services data	Customer ID, Address details, Type of Customer, payment options, cross/up sell opportunities, change of services, account update, type of services previous transaction details, behavioural changes, last advisor details, log data, customer services data	Customer ID, Address details, Type of Customer, time with company, buying pattern, cross/up sell opportunities, account update, business value to company, type of services previous transaction details, behavioural changes, last advisor details, log data, customer services data	Customer ID, Address details, Type of Customer, time with company, financial status, account update, type of services, complaints details, previous transaction details, behavioural changes, last advisor details, log data, customer services data
A5	Customer ID, Address details, Type of Customer, time with company, payment options, account update, type of services, complaints details, previous transaction details, behavioural changes, last advisor details, log data, customer services data	Customer ID, Address details, Type of Customer, financial status, time with company, buying pattern, cross/up sell opportunities, business value to company, change of services, type of services previous transaction details, behavioural changes, last advisor details, log data, customer services data	Customer ID, Address details, Type of Customer, payment options, time with company, account update, type of services previous transaction details, behavioural changes, last advisor details, log data, customer services data	Customer ID, Address details, Type of Customer, payment options, , buying pattern, cross/up sell opportunities, business value to company, new product, change of services, type of services previous transaction details, behavioural changes, last advisor details, log data, customer services data	Customer ID, Address details, Type of Customer, payment options, financial status, business value to company, new product, account update, type of services previous transaction details, behavioural changes, last advisor details, log data, customer services data	Customer ID, Address details, Type of Customer, payment options, time with company, account update, type of services previous transaction details, behavioural changes, last advisor details, log data, customer services data

A6	Customer ID, Address details, Type of Customer, time with company, payment options, financial status, account update, type of services, complaints details, previous transaction details, behavioural changes, last advisor details, log data, customer services data	Customer ID, Address details, Type of Customer, time with company, payment options, cross/up sell opportunities, account update, type of services, complaints details, previous transaction details, behavioural changes, last advisor details, log data, customer services data	Customer ID, Address details, Type of Customer, time with company, payment options, account update, type of services, complaints details, previous transaction details, behavioural changes, last advisor details, log data, customer services data	Customer ID, Address details, Type of Customer, time with company, buying pattern, financial status, cross/up sell opportunities, business value to company, new product, change of services, type of services previous transaction details, behavioural changes, last advisor details, log data, customer services data	Customer ID, Address details, Type of Customer, time with company, buying pattern, financial status, cross/up sell opportunities, business value to company, new product, type of services previous transaction details, behavioural changes, last advisor details, log data, customer services data	Customer ID, Address details, Type of Customer, time with company financial status, account update, change of services, type of services previous transaction details, behavioural changes, last advisor details, log data, customer services data

Validation Questionnaire - Summary

CC – Validation Overview	**Team Leader 1 (Milton Keynes)**	**Team Leader 2 (Milton Keynes)**	**Team Leader 3 (Brentwood)**	**Summary**	**Conclusions & Critical Analysis**
Questions: a. Please provide your view on the list of groups of customers and advisors?	Customer and Advisor Groups mostly cover all the aspects of the real environment. Ethnic minority of the customer and advisor should be considered.	The groups cannot be said as the complete list, but depending on your requirements, it looks satisfactory.	Advisor groups should also focus on training, specialities, and nature of work. Age and Gender of advisor doesn't matter within the current CC environment.	▪ Consideration of ethnic background variable ▪ Training and specialities of the advisor should have been taken.	It was not possible to consider ethnic variable for present model. It is difficult to identify training level for each advisor
b. Do you have any new categories for customers?	Customer male categories between the ages of 30 – 40 tend to have some aspect of negative behaviour.	There should be a new category for female customer with age group of 18-25 with medium financial background, and with positive behaviour rather than negative behaviour	Male Category with 18-25 ages, 1-5 yrs with company and negative behaviour seen more often.	▪ Behavioural changes within male categories for ages 18-25 and 30-40 can be considered ▪ Female category with 18-25 ages, medium financial and positive behaviour.	The behavioural changes were made within the categories. There were already three categories each for male and female and so it was not possible to add another female category to model.
c. Do you have any new categories for advisors?	There is no category for advisor between 30 – 40 ages (male / female) who share some aspect of negative behaviour group.	Female category with 18-25 ages, with 1-5 yrs of experience within the CC, medium IT speed and more attentive behaviour.	Female category with 25-40 is not shown, which can share some of the attributes with other categories.	▪ New Category – 30 – 40 ages & negative beh. ▪ New Category – Female, 18-25 & 1-5 yrs experience	Some of the attributes were changed to match with that of the comments from the centres (team leaders)
d. How about people who doesn't belong to this category? Any new category for them?	The categories shown here covers mostly all of advisor groups that are present within the current CC. Customer groups can be classified in many other different ways.	The model should have a way in which if the attributes doesn't match to that of the existing ones, a new category can be selected.	Don't know – Maybe depending on the type of person, it can be kept into either of the following categories.	▪ New category to be selected if either of the attributes doesn't match to existing ones.	Option of the expert system to try to identify the type of customer and advisor based on the nearest value for the new ones.
e. What would be the minimum amount of Info. Required by advisor to deal with customer?	Depending on the type of the customer and the nature of the query, advisor needs the required information that can be helpful to them.	Mostly depends on the type of call the advisor is suppose to handle.	Information which is required by the advisor to serve the customer query. Account details, payment details, products and services, etc.	▪ Selection of information depends on type of customer and query. ▪ Basic info. needed	All the areas of information, and type of scenarios were considered to identify the complete list of information.
f. Any other information which is relevant to the model or info. Req. frameworks?	More scenarios or combinations of customer and advisor should be done which would enable to see the broad picture of the information requirement analysis.	There should be more rules which can cover all the attributes and categories shown here.	Skills and training should be taken into consideration for one of the attributes of the advisors, as they are of much importance.	▪ Skills and training level ▪ More rules ▪ More scenarios	It was not possible to identify the skills and training level for each of the advisor.

Customer & Advisor Categorisation : a. What do you think about the list of customer categories shown here?	C1 Yes C2 Yes C3 Yes C4 Yes C5 Negative Beh. Missing. C6 Yes	C1 Yes C2 Yes C3 Yes C4 Co-operative Beh. Seen C5 Yes C6 Yes	C1 Yes C2 Yes C3 Understanding Beh. C4 Never Seen C5 Don't know C6 Yes	▪ Category C5 – needs to have some negative behaviour. ▪ Category C4 – co-operative behaviour seen. ▪ Category C3 – Understanding behaviour. ▪ Mostly related to behaviours.	Changes were made to that of the behavioural attributes to match with the results from the centres. And after the changes were made, the categories derived from the system were identical to ones derived from the expert opinion.
b. What do you think about the list of advisor categories shown here?	A1 Yes – a lot times seen A2 Yes A3 Yes A4 Yes – less –ve behaviour A5 Yes A6 Yes	A1 Yes A2 Yes A3 Yes A4 Annoyed behaviour A5 Yes A6 Unaware behaviour	A1 Don't Agree A2 Yes A3 Yes A4 Yes A5 High IT speed A6 Annoyed Behaviour	▪ Category A4 – less negative behaviour & annoyed behaviour. ▪ Category A6 – negative behaviour. ▪ Category A1 – don't agree.	Changes were made with respect to the experts and behavioural attributes were change to give the categories.
c. Is the list of customer and advisor categories sufficient?	For advisor categorisation, the list provided is quite sufficient which covers all the aspects.	Yes – the list provided here looks sufficient, with a female category between the ages of 18-25 to be considered.	Female category between the ages of 25-40 can be taken into account depending on the requirements.	▪ Female Category of 25-40 ages is not there. ▪ The rest of categories are satisfactory.	It was not possible to add another female category to the existing list of categories.
Generic Rules a. Are the customer and advisor rules sufficient and satisfactory for the required model?	Yes – There can be more combinations of advisors with age, education and experience.	There should be more of the rules covering the behavioural aspect of the customer and advisor	Don't Know – Depends on your requirements.	▪ More rules covering the behavioural aspect for customer and advisor.	More rules were written which covered most of the types of customer and advisors within the model.
b. Do you have any other rules or new sets of data points for customers and advisors?	No – not aware of any which are missing. There can be more rules which can focus on the experience and IT speed of the advisors. For the customer, rules, which focus on the behaviours, can be considered.	Different age groups of advisors work within the centre, so rules covering all the ages of them can be taken.	Don't Know.	▪ No. The given rules are okay at the moment, but more rules can be considered.	Rules were fine tune with respect to experience and IT speed of the advisors.
c. Shown here are some of the experimental results carried out with the model? Your views about them.	Looks fine to check with new data points. For example the advisor case of age 51, education 27 etc, the type supports to that of A5, but it should be rather A4 because of the customer focus behaviour of the advisor	For customer examples, the age group of 40 -50 can be more improved in ways of the behavioural aspect. Age 40, education professional etc, the category should be C6 for understanding behaviour rather than C4 which shares joyful behaviour.	There needs to be a better explanation of each of the experiments to understand them properly. Advisor example age 22.8, education is graduate and behaviour is customer focus; which can be type A2 rather than A6.	▪ Changes for advisor examples from A5 to A4 ▪ Changes for customer example from C6 to C4 ▪ Changes to advisor category from A2 to A6. ▪ Mostly because of the change in the behaviour, the above changes were seen.	Rules were changed and new rules were added to match with the requirements suggested by the experts to identify the right type of category for the given customer and advisor
Information Requirement Framework: a. What do you think about the list of complete information shown here?	This is an exhaustive list which may not be necessary for the advisor during each customer interaction, but yes it does covers most of the aspects of customer –	The division of the type of information is a good way to identify the complete set of info. The cross – up sell option shown can tell the advisor	This may not be required in all of the cases. The advisors are experts in their working environment, and if they are there to sell the	▪ Cross and Up sell opportunities may not be required in every case, and also to that of the	Cross & Up sell opportunities were selected carefully for new advisors and advisors with less

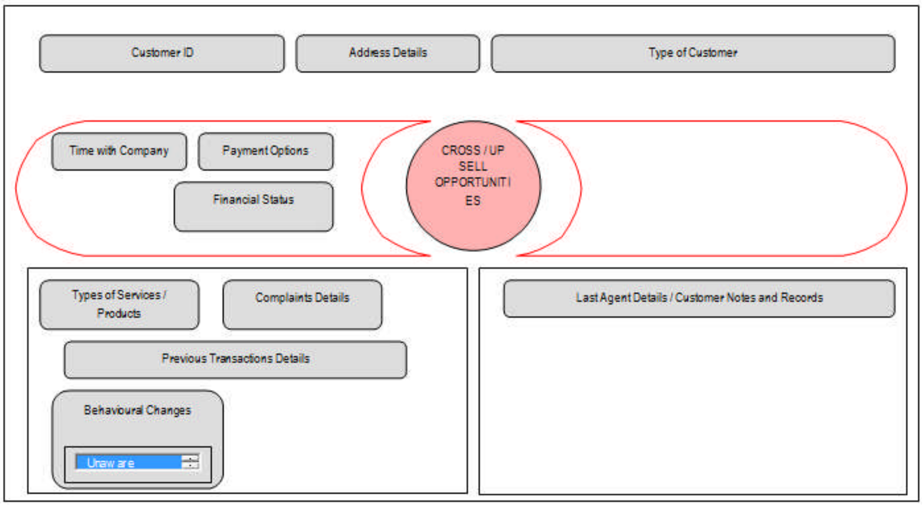
	advisor communication.	(new) about the possible chances for advising the customer with new products and services	products, they don't need to be shown about the "cross – up sell opportunities" option.	experienced advisors.	knowledge about the customer type.
b. What are your views for the Information "Master Screen" shown here?	Some of the information shown in the master screen may not be required for the current working environment (ex. Financial details of the customer)	This is something we always have thought about, but the problem of the amount of information which is relevant for the particular case should be the main focus.	The master screen shows all sorts of various CC environments. Faults team may no require the payment options and so on. Looks descriptive and quite helpful.	▪ Master screen shows all sorts of information which might be required in some of the cases	Changes were made within the master screen on the basis of the feedback provided through earlier question (a) of the section with regards to cross – up sell opportunities.
c. Do you agree to the type of information been shown for the scenarios shown? If no - Explain	Scenario 1 – (A1 – C1) – The financial status of the customer is not required by the advisor to solve the customer query. Payment options list is sufficient. Scenario 2 – (A1 – C4) – Unique combination. The cross – up sell section can be very well used within this case. Scenarios 3 – (A4 – C4) – Cross sell sections may not be required for an experienced advisor Scenario 4 – (A3 – C6) – Satisfied with the overall information been displayed in this scenario. Scenario 5 – (A4 – C2) –Complaint details are very less of importance within this scenario. Scenario 6 – (A5 – C1) – Cross Sell section not required for experienced advisor	Scenario 1 – (A1 – C1) – Looks okay with the option of previous transaction details for this type of customer Scenario 2 – (A1 – C4) –. Behavioural details are missing. Scenarios 3 – (A4 – C4) – More focus should be given on previous transaction details. Scenario 4 – (A3 – C6) – The buying pattern and payment options are not required for this type of customer. Scenario 5 – (A4 – C2) – For experienced advisor, cross sell option may not necessarily required. Scenario 6 – (A5 – C1) – New products and services not required for this type of customer.	Scenario 1 – (A1 – C1) – Cross sell option not required in this case. Scenario 2 – (A1 – C4) –. Account update details are required for this type of customer. Scenarios 3 – (A4 – C4) – Cross Sell option not required. Scenario 4 – (A3 – C6) – Business value to the company of the customer not required. Scenario 5 – (A4 – C2) – Cross sell option and buying pattern not required. Scenario 6 – (A5 – C1) – Business value and new products details are not required for this customer.	▪ Financial status and cross sell options are not required. ▪ Behavioural and Account update details can be considered ▪ Cross sell can not be required for more experienced advisor ▪ Business value option can be eliminated ▪ Cross sell option can be considered only for new advisors ▪ Business value, new products and service options are not required.	Financial status remains unchanged due to the type of customer Account update details are added within the screen Cross sell is left to ensure enough product information. Business value is removed from the screen. Cross sell is required for novice advisor serving the customers. Business value is left and new products/services option removed.

- A detailed record of the validation results is secured through the questionnaire sheets and the recordings (where it was allowed) is stored and maintained.

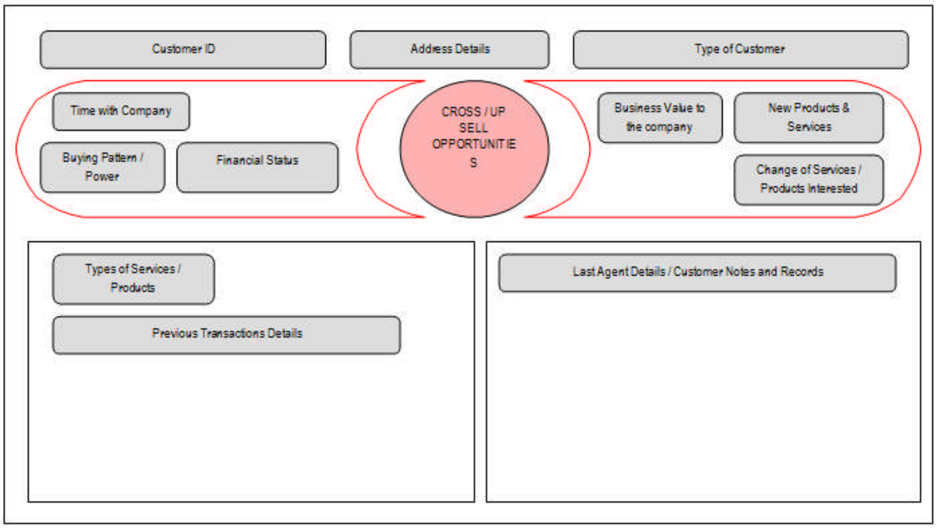
Appendix M: Information Requirement Framework

The following scenarios were used for the validation of the information requirement framework developed within the research in contact centres.

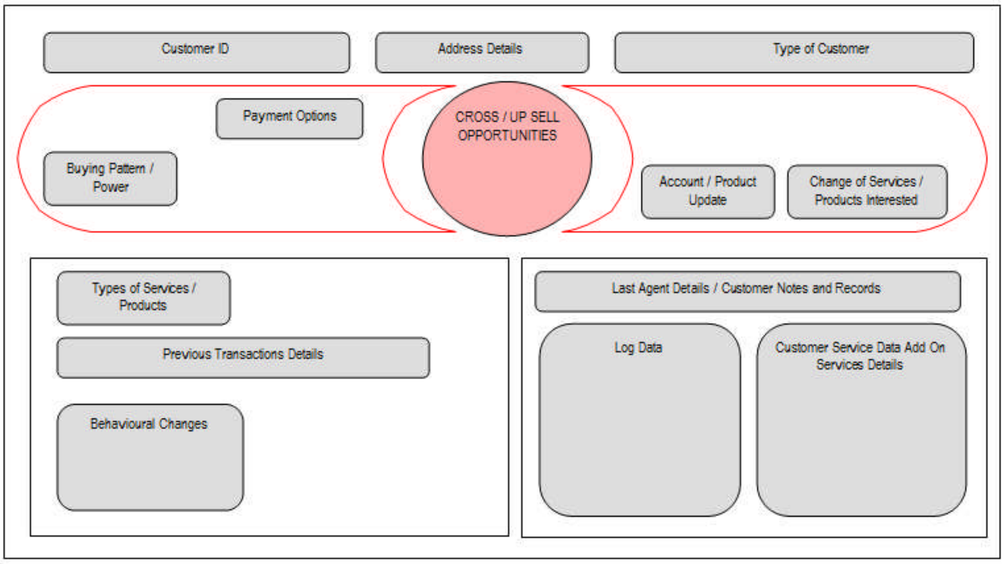
<u>Scenario 1 (A1 – C1)</u>
Category A1 – 18-25, School, >1yrs experience, Slow IT speed, None Previous experience, Angry and Unaware behaviour
Category C1 – 18-25, School, Financial = Poor, Time with company = 1-5 yrs, Business Value=Low, Angry and Aggressive behaviour



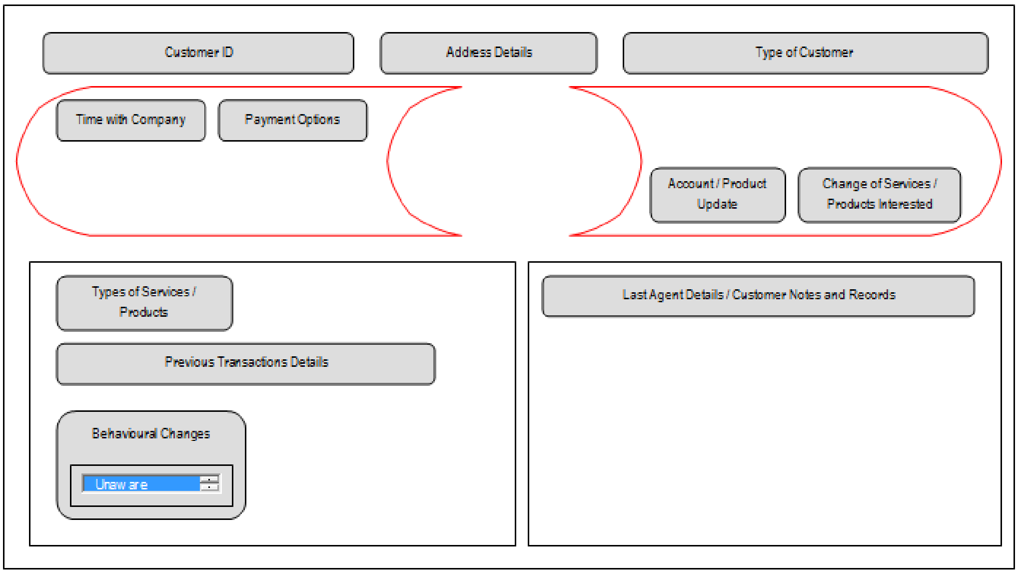
<u>Scenario 2 (A1 – C4)</u>
Category A1 – 18-25, School, >1yrs experience, Slow IT speed, None Previous experience, Angry and Unaware behaviour
Category C4 – 40-50, Professional, Financial = Average, Time with company = 10+ yrs, Business Value = High, Joyful behaviour



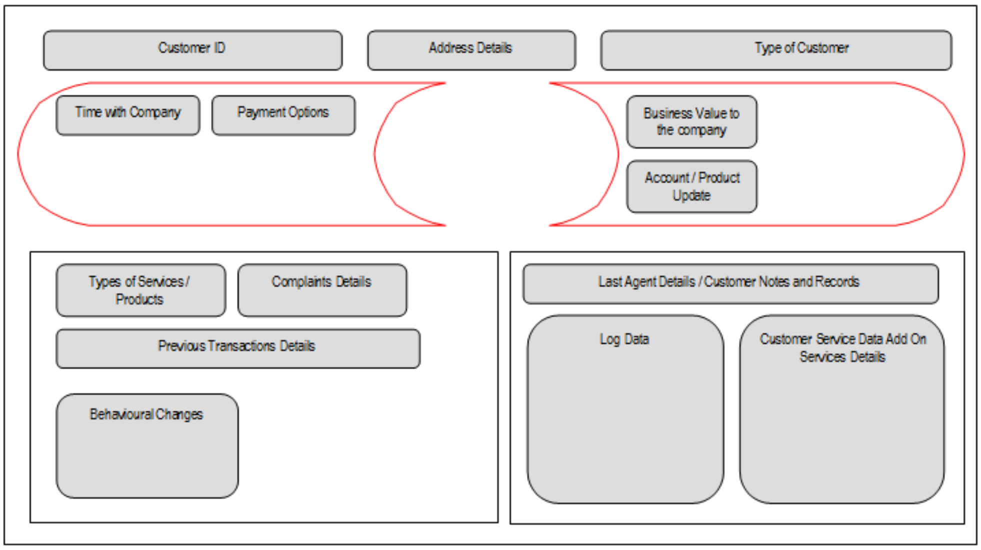
Scenario 3 (A4 – C4)
Category A4 – 40-50 yrs, Professional, Experience=10-15yrs, IT speed = Fast, Previous Exp = High, Customer Satisfaction behaviour
Category C4 – 40-50, Professional, Financial = Average, Time with company = 10+ yrs, Business Value = High, Joyful behaviour



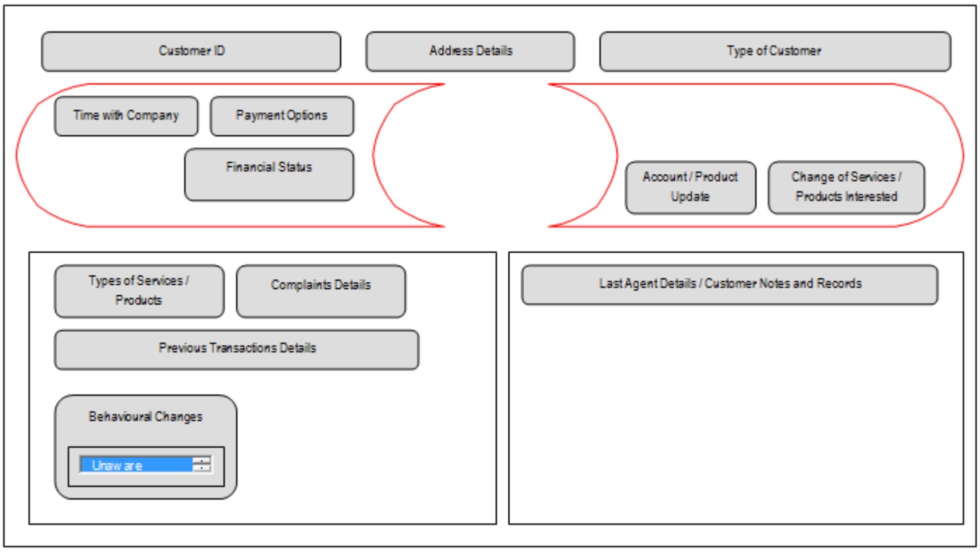
Scenario 4 (A3 – C6)
Category A3 – 25-40, Graduate, Exp = 5-10 yrs, IT Speed = Fast, Previous Exp = Extensive, Attentive and annoyed behaviour
Category C6 – 40-50, College, Financial = Average, Time with company = 5-10 yrs, Business Value= Low, Understanding and annoyed behaviour



Scenario 5 (A4 – C2)
Category A4 – 40-50 yrs, Professional, Experience=10-15yrs, IT speed = Fast, Previous Exp = High, Customer Satisfaction behaviour
Category C2 – 25-40yrs, Graduate, Financial = Good, Time with company=5-10yrs, Business Value=medium, Understanding and angry behaviour



Scenario 6 (A5 – C1)
Category A5 – 50+, Professional, 15yrs, IT Speed = medium, Previous exp=moderate, Friendly behaviour
Category C1 – 18-25, School, Financial = Poor, Time with company = 1-5 yrs, Business Value=Low, Angry and Aggressive behaviour



Appendix N: Simulation Framework

Excel Database for Advisor

Microsoft Excel - DATABASE [Read-Only]

	A	B	C	D	E	F	G
1	Age	Education	Experience	IT Speed	Previous Experience	Positive Behaviour	Negative Behaviour
2	18-25	School	<1 Year	Low	None	None	Angry
3	18-25	College	1-5 Years	Medium	Little	None	Unaware
4	25-40	Graduate	1-5 Years	Low	Moderate	Friendly	Annoyed
5	25-40	Graduate	10-15 Years	High	Moderate	Customer Focus	None
6	18-25	College	<1 Year	High	None	None	Angry
7	25-40	Graduate	5-10 Years	Medium	None	Attentive	None
8	25-40	Professional	1-5 Years	Low	Little	Friendly	None
9	40-50	Graduate	10-15 Years	High	Little	Attentive	Angry
10	25-40	College	5-10 Years	Low	Moderate	Attentive	None
11	25-40	Graduate	1-5 Years	Medium	Little	Friendly	None
12	40-50	Graduate	5-10 Years	High	Moderate	Customer Focus	None
13	18-25	College	1-5 Years	Medium	Little	None	Angry
14	18-25	Graduate	<1 Year	Low	None	None	Annoyed
15	40-50	College	5-10 Years	Medium	Moderate	Friendly	None
16	25-40	Professional	10-15 Years	High	Little	Attentive	None
17	18-25	School	5-10 Years	High	Moderate	Customer Focus	Annoyed
18	40-50	Graduate	10-15 Years	Medium	Moderate	Friendly	None
19	40-50	College	5-10 Years	Medium	Moderate	Friendly	None
20	25-40	Professional	5-10 Years	Medium	Little	Attentive	None
21	18-25	School	1-5 Years	Low	None	None	Unaware
22	25-40	Professional	5-10 Years	Low	Little	Attentive	None
23	25-40	Graduate	10-15 Years	Medium	Moderate	Customer Focus	Annoyed
24	40-50	College	10-15 Years	High	Extensive	Customer Focus	None
25	18-25	School	<1 Year	Low	Little	None	Annoyed
26	18-25	Graduate	1-5 Years	Medium	None	Attentive	None
27	25-40	Graduate	1-5 Years	Medium	Little	Friendly	Angry

Excel Database for Customer

Microsoft Excel - DATABASE [Read-Only]

	A	B	C	D	E	F	G
1	Age	Education	Financial Status	Time with Company	Business Value	Positive Behaviour	Negative Behaviour
2	18-25	School	Poor	< 1	Low	None	Angry
3	18-25	College	Poor	< 1	Low	None	Aggressive
4	25-40	College	Average	1-5 Yrs	Medium	Joyful	None
5	25-40	Graduate	Average	1-5 Yrs	Medium	Helpful	Annoyed
6	25-40	Graduate	Good	5-10 Yrs	High	Understanding	None
7	18-25	College	Average	1-5 Yrs	High	None	Angry
8	25-40	Graduate	Average	< 1	Medium	Joyful	None
9	25-40	Professional	Average	< 1	High	Polite	None
10	18-25	College	Average	< 1	Low	Helpful	None
11	40-50	Graduate	Good	10+ Yrs	Medium	Helpful	Angry
12	25-40	College	Good	1-5 Yrs	High	Joyful	None
13	25-40	Graduate	Average	5-10 Yrs	High	Co-operative	None
14	40-50	Graduate	Good	1-5 Yrs	High	Polite	None
15	18-25	College	Average	< 1	Medium	None	Angry
16	18-25	Graduate	Poor	1-5 Yrs	Low	None	Annoyed
17	40-50	College	Average	5-10 Yrs	Low	Polite	None
18	25-40	Professional	Average	1-5 Yrs	Medium	Understanding	None
19	18-25	School	Poor	< 1	Low	Co-operative	Aggressive
20	40-50	Graduate	Average	10+ Yrs	Medium	Joyful	None
21	40-50	College	Poor	1-5 Yrs	Medium	Polite	None
22	25-40	Graduate	Average	10+ Yrs	Medium	Helpful	None
23	25-40	Professional	Average	< 1	High	Helpful	None
24	18-25	School	Poor	1-5 Yrs	Medium	None	Aggressive
25	25-40	Professional	Good	1-5 Yrs	Medium	Understanding	None
26	25-40	Graduate	Average	5-10 Yrs	Medium	Joyful	Annoyed
27	40-50	College	Average	5-10 Yrs	Low	Polite	None