A DYNAMIC TECHNOLOGICAL CAPABILITY (DTC) MODEL FOR THE NEXT GENERATION OF TECHNOLOGY EVOLUTION

BY

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Abstract

A Dynamic Technological Capability (DTC) model for the next generation of technology evolution

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The central question of this thesis is how should the managers and technologists of technological organisations decide on how to invest in the co-evolution of technologies and adapt their influences to the evolution of their organisational capabilities by knowing the benefits, opportunities, costs and risks of such an investment? In the context of this research the main drivers are recognized as:

- Variation in the accuracy and quality of technology
- Changing market and instability in the demand for technology
- Huge cost with less revenue from the technology
- Increasing influence of regulations

The issue of particular interest within this question includes creating a solution method for decision makers so that they can create value for their organisations by making a less risky investment decision in technology evolution, under the conditions that will be relevant to the next generation of technologies.

The research work uses a case study approach within the context of the UK mobile industry in order to answer the basic and problem-oriented questions, by which;

1. the characteristics of the future technological evolutions within which the next generation of technologies must be operated are identified.
2. related theories are identified in respect of the value creation for organisations with evolving capabilities in response to the dynamic environment.
3. emphasis is placed upon the contribution of the technology co-evolution towards the evolution of organisational capabilities, as a result of a critical view of the concept of dynamic capabilities.
4. a basis is developed for the need of a solution method, consistent with the characteristics of the next generation of technologies, which respond to the current

limitation of the theory of the dynamic capabilities, that must be overcome to achieve new requirements of the technology evolution.

The output from the research work includes:

I. A new framework, which exploits distinct technological roles: component, product and applications, support and infrastructure and integrates these technological capabilities from internal and external industries, following the four stages evolutionary cycle, including variation/reconfiguration, selection/search/learning, replication/leveraging, retention/integration. In this research, this new framework is called an evolutionary framework.

II. A new set of 52 factors which are organized with respect to their clusters: technological evolution (TE), organisational evolution (OE), resource evolution (RE); their drivers: accuracy and quality of technology, market demand for technology, cost of technology, self and governmental regulations; and their merits: benefits, opportunities, costs, risks. In this research, this new set of factors is called an evaluation method.

The fusion of the above concept and method places a new model, called the ***Dynamic Technological Capability*** model, within the context of technological organisations such as the UK mobile operators. The basis of the DTC model is that the exogenous industries are forcing the technology co-evolution, even if the previous generation of technologies remained unsuccessful in the dynamic market. To overcome the problems of making a less risky investment decision in the next generation of technology under such circumstances, the decision makers must have a model through which they can take measures of the investment decisions in the form of the *benefits, opportunities, costs* and *risks* values before making any investment decision.

These novel aspects of the DTC model are illustrated by applying it to the UK mobile operators: Vodafone, Orange and O2, for the process of making an investment decision in the next generation of Location Based Services (LBS), called Assisted-Global Positioning System (A-GPS) technology.

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Glossary

Analytic Network Process (ANP)	An analytic tool which assigns the quantitative data in the form of a nine point priority scale and performs pairwise comparison.
Assisted-Global Positioning System (A-GPS):	It is a technological method used to determine location of the mobile device by combining both the mobile networks and GPS satellite technologies to increase accuracy of LBS.
Co-evolution of technology:	Evolution of one technological role influences the evolution of other technological roles; where technology possesses component, product and application, support and infrastructure roles.
Complementary asset:	Some assets possessed by organisations which support other organisational assets as well.
Dependent innovative regime:	A regime which relies on endogenous firm's activities for its progress and where organisations face evolutions due to resources of the independent innovative regimes.
Dynamic Capabilities:	The capabilities of an organisation to reconfigure, learn, leverage and integrate its resources in response to the changing environmental conditions.
Dynamic Technological Capability Model:	A solution method for the managers and technologists of the technological organisations which will help them in making the investment decision in the next generation of the technologies.
Evolution:	A gradual development of phenomenon.
Fairly swift market:	A market in which technology co-evolutions occur due to the internal and external industrial resources and where investment decisions will completely rely on the historical knowledge of the previous generations of the technology evolutions.
Independent innovative regime:	A regime which does not rely on firm's endogenous activity for its progress and where organisations evolve at their own pace and do not consider evolutions in organisations of dependent innovative regimes.
Location Based Services (LBS):	An information and entertainment service, accessible with mobile devices through the mobile network and utilizing the ability to make use of the geographical position of the mobile device.
Resources:	The quality assets possessed by organisations.

Chapter 1: Introduction

1.1 Focus of the thesis

For organisations which are offering technology based products and services in the market, the process of making an investment decision in the next generation of these technologies is a complex but essential strategic operation. The next generation of technologies will depend upon co-evolution of the technological roles (component, product and application, support and infrastructure). These technological roles can emerge from the internal industries, inside which the organisations reside, or may sometimes emerge from the external industries. The technologies which emerge from internal industries are under the control of those organisations which offer technology based products and services, but technologies which emerge from the external industries are not under their control. Therefore making an investment decision for the next generation of technologies which will collectively emerge from internal as well as external industries needs a proper solution method which can identify merits of benefits, opportunities, costs and risks of investments for these organisations. On the basis of such decisions, organisations can identify a way of increasing value for them which will rely on the influences of the accuracy and quality of the technological roles, market demand for technological roles, cost of technological roles and their self and governmental regulations. To make a less risky investment decision, managers and technologists of these organisations will collectively need to identify the influencing aspects of evolutions within technology, organisational capabilities and resources. Under these influences they can decide on the best strategic alternative through the best understanding of their benefits, opportunities, costs and risks. These calculated decisions may carry some uncertainties but with a reduced amount of risk.

1.1.1 The research question

The research question of this thesis is: how should the managers and technologists of the technological organisations decide on how to invest in the co-evolution of technologies and adapt their influences to the evolution of their organisational capabilities by knowing the benefits, opportunities, costs and risks of such an investment within a ‘fairly swift market’? A fairly swift market is defined as those markets in which technology co-evolutions occur

due to the internal and external industrial resources and where investment decisions will completely rely on the historical knowledge of the previous generations of the technology evolutions. The concept of a fairly swift market is developed for this research by combining the characteristics of moderately dynamic and high velocity markets (Eisenhardt and Martin, 2000) and is discussed in more detail in chapter two. The drivers behind the selection of technologies are identified as; the increased level of accuracy and quality of the new technology; the increased market demand for the new technology; cost related issues of the new technology; and the influences of self and governmental regulations.

This research question will be answered by developing a Dynamic Technological Capability (DTC) Model as a solution method for the managers and technologists of the technological organisations which will help them in making the investment decision in the next generation of the technologies. During the thesis a group of managers and technologists will be represented as the decision makers. The DTC model at its first stage will develop an evolutionary framework with the help of organisational and technology related theories and will apply it in the practical domain of the UK mobile industry. At its second stage, the DTC model will identify a set of factors which will be drawn from the evolutionary framework and will measure the *benefits*, *opportunities*, *costs*, *risks* merits for making an investment decisions. The outcomes of the DTC model can be itemized as follows:

- Developing new conceptual evolutionary framework showing influences of the technology co-evolution on the evolution of dynamic capabilities of organisations;
- Identifying and defining the influencing factors for the investment decision in the technological and organisational resources by the decision makers of organisations;
- Calculating benefits, opportunities, cost and risks of the investment decision in a particular technology of the UK mobile industry, the Location Based Services (LBS);
- Measuring the effectiveness of appropriate alternatives for the UK mobile industry in making the investment decision in the A-GPS technology for LBS;

1.1.2 Structure of the thesis

Chapter one presents a complete executive overview of the research, including: a concise vision of the UK mobile industry facing challenges related to the investment in LBS

particularly in the A-GPS (Assisted-Global Positioning System) technology, a summary of ongoing major evolutions in the technological and organisational co-evolutions, and outline of the development of fundamental concepts and developed frameworks. The chapter also presents the theme, type and objectives of the research, the scientific methodology of the research, the DTC model and the research findings. At the end the table presents the flow of the research chapters with respect to their input and output towards other chapters and conclusion.

Chapter two presents a detailed literature review of theories and the development of an evolutionary framework as the first stage of the DTC model, including: reviews of technology co-evolution, resource based view, dynamic capabilities, investment decision-making, multi-criteria decision analysis, finding any research gap, development of an evolutionary framework, identification of drivers, review of the UK mobile industry practices with the examples of Location Based Services for an evolutionary framework.

Chapter three following the concept of an evolutionary framework introduces a set of factors for the second stage of the DTC model which is defined as the method for making the investment decision by the technological organisations. These factors are mainly categorized under clusters of technological evolutions (TE), organisational evolutions (OE) and resource evolutions (RE) and are defined individually. These clusters are organised with respect to four drivers of this research to measure benefits, opportunities, costs and risks of the strategic alternatives: A1, A2, A3. This is followed by the research methodology which integrates a case study approach with interviews and workshops with the help of the Analytic Network Process (ANP) tool. The influence of the defined factors on each other is presented with the ANP tool. Their definitions are supported with examples of the technology and organisational co-evolutions related to LBS.

Chapter four presents three case studies including Vodafone, Orange and O2. Vodafone is a pilot case study for this research followed by studies of Orange and O2. The second and third case studies present replication, in order to improve the validity. These case studies are supported with the industrial data. The chapter illustrates how the DTC model is utilized by the decision makers of these three organisations in order to complement their investment decision in the A-GPS technology for LBS. It focuses on the procedure and

analyzes the results which are inclined towards the strategic decisions of these organisations. The results of the DTC model support alternative decisions: *invest later* for Vodafone, *invest now* for Orange and *invest now* for O2 in making an investment in the A-GPS technology.

Chapter five analyzes the research findings, presents cross case study results of these three organisations, compares their calculated results and identifies the most influential factors which cause the decision makers to make less risky decision. The emergence of only those factors which either belong to the cluster of the technological evolution or are influenced by those factors which belong to the clusters of technological evolution validates the concept of Dynamic Technological Capability which is identified as a capacity of technology to create, extend or modify the resource bases of organisations. In the end, it provides the entire DTC model which is applied to the UK mobile industry and offers them implications regarding the investment decision in the next generation of LBS.

Chapter six presents some conclusions from the research and offers recommendations and findings, and the contributions to literature and industrial practices. This is followed by the limitation of the research and path forward for future work.

1.2 The background to the research

The adoption of technology co-evolutions for development of resources in terms of technological roles seems to be obligatory in the technological organisations. The cycle time of one generation of technology is between 3 and 5 years and therefore advancements in technologies continuously occurs. The advancements in technology co-evolutions depend upon the investment decisions of the managers and technologists of organisations which allow them to remain competitive within their industries. The decision of either investing now or investing later or not investing in any technology co-evolution is not new for these organisations, but the criteria which make this situation different from previous decisions are discussed below:

1. **The technology co-evolution emerges from exogenous industry resources. E.g., In the case of LBS the decision is for the technology of the satellite industry (A-GPS technology) not of the mobile industry.**
2. **The previous technological generation could not outperform in markets. E.g., In the case of LBS, since 2001 to 2007, LBS remained unable to promote promising growth.** *(LBS cannot be considered as a commercial success – Guenther Weber, Vodafone)*

The technology co-evolutions and evolutions of organisational capabilities for the development of LBS within the last few years emphasize a lack in the customers' demand due to lack of accuracy and quality of available technology, the Cell-ID. Now, a lack in customers' demand is itself a hindrance in investing further in technology co-evolutions to increase the accuracy and quality of technology. The dilemma of either investing or not investing in the next generation of the LBS technology by the UK mobile operators can be solved by understanding and measuring the influences of drivers behind this technology co-evolution.

1.2.1 Drivers: the reasons behind the evolution towards the next generation of technologies within a fairly swift market

In this research four drivers are considered hypothetically and practically to analyze their influence on making an investment decision in the next generation of the technology within a fairly swift market. These drivers are supported with examples from the UK mobile industry. These drivers include:

1. Accuracy and Quality of Technology: The availability of multiple technologies will be affecting the investment decision of the technological organisations. The multiple technologies vary in terms of their accuracies and qualities and before evolving towards any technology the decision makers will look for all feasible alternatives with respect to their accuracies and qualities. These technologies may emerge from internal (endogenous) industries or external (exogenous) industries. For example, with the launch of LBS, the mobile operators have selected Cell-ID and E-CID (Enhanced Cell-ID) technologies, which are endogenous to the mobile industry but offer a lower level of accuracy and quality (range 50m to 500 km). The recent development of the A-GPS technology provided mobile operators with the possibility of increasing the accuracy

and quality (within 10m) but at the cost of huge investment. In addition to this, the mobile operators in the UK will be facing (by 2010) the A-GNSS (Assisted-Global Navigation Satellite Systems) technology with the launch of Galileo, the European satellite system, with improved accuracy and quality.

2. Market Demand for Technology: The market demand for technology can be observed through the historical knowledge of the previous generation of technologies and their temptations towards customers. In the case of LBS historical knowledge shows some insightful changes. The LBS has evolved from an application technology towards an enabler technology. At the time of launch, LBS were offered to the consumer segments to locate themselves or their POI (Point of Interest). Later, LBS were integrated with other mobile applications (SMS, MMS and Video) and were also offered to the business customers, particularly for the M2M (Machine to Machine) applications in the transport market. In addition to this, LBS appear in the market through the third party application developers, which utilized the technologies of mobile operators and offered their own applications. The recent change is the development of the A-GPS enabled handsets from handset manufacturers like Nokia, which can directly offer LBS to consumers and easily bypass the mobile operators. This historical knowledge affects the decision makers before making the investment decision in the A-GPS technology.
3. Cost of Technology: The investment decision in the next generation of technology relies on ROI (Return on Investment) possibilities. Some technologies appear in industries as killer applications and generate good revenue. However, some remain unable to catch customers' interest and as a result do not generate promising revenue. In the case of the UK mobile industry SMS, multimedia, mobile internet appear as killer applications but LBS is identified as 'Not Killer Application' and therefore is not proven to increase ARPU (Annual Revenue per User). Due to such uncertainties, the mobile operators hesitate to invest further in the next generation of the LBS technology which will require technological evolutions in most of the technological roles.
4. Self and Governmental Regulation: The technological convergences enhanced impact of regulations on technology evolution. In the case of LBS implementation of the A-GPS technology will face the governmental regulation by OFCOM (Office of Communication) the regulatory body in the UK. One of the reasons behind the emergence of LBS in the mobile market is 'DIRECTIVE 2002/22/EC' which introduced the single European emergency call number 112 from every publicly

available telephone service including mobile phones. The OFCOM enforced a law that whenever a person in an emergency situation calls 112, his location must be identified. It is stated that in Europe e-112 is on track to become law by 2011 (Wilde, G., 2004). Looking towards the accuracy and quality of the Cell-ID technology, it appears that this technology cannot fulfill the demands of emergency conditions and therefore A-GPS can be identified as a feasible alternative. In addition to governmental regulations, the mobile operators are also developing self regulations to manage some of the uncertainties related to LBS.

1.2.2 Understanding the new requirements from theoretical and practical perspectives

The basic attributes of this research such as evolutions in technologies, organisational capabilities, resources, and Location Based Services are adopted from the wide variety of theoretical literature and mobile industry practices.

The theoretical literature revolves around:

Evolutionary Cycle (1965) – to understand three stages of evolutionary cycle: variation, selection and retention.

RBV - Resource Based View (1984) – as a fundamental determinant of an organisational performance and a way of exploiting the existing organisational internal and external specific capabilities and developing new ones.

Capital Investment Decision making (1992) – as a framework for identifying influences of various quantitative and qualitative inputs before reaching an investment decision.

Dynamic Capabilities (1997) – to understand organisational processes, path dependency and its position and identifying it as a tool to manipulate resource configuration evolving the process through altering assets by creating, integrating, recombining and releasing resources.

MCDA - Multi-Criteria Decision Analysis (2002) – to use a methodology for evaluating options by taking into account decision makers' multiple objectives.

Eco-system of technology evolution (2005) – to understand the model of technology evolution highlighting interdependent relationships of different technological roles and observing their dependence on co-evolutionary sets of processes.

The practical literature revolves around:

Company Annual Reports (2001-2007) - to understand evolutions in technologies and organisational capabilities of the UK mobile operators.

Company Archives (2001-2007) – to observe technological progresses of the UK mobile operators.

Company Corporate Social Responsibility Reports – to understand previous strategic moves of the UK mobile operators.

Employees' Presentations: to understand previous and future possible changes.

Industry Insight Reports – to understand the evolving industrial practices and technological forecasts.

The theoretical literature identified some changes which required to be taken into consideration for the next generation of the technology within a fairly swift market.

- Integration of 'exogenous industry resources';
- Integration of dynamic capabilities and technology co-evolutions;
- Identifying linkages of distinct dynamic capabilities;
- Identifying need for a 'sharing strategy' amongst competitors of the industry;
- Utilization of dynamic capabilities for technology adaptors;
- Utilization of dynamic capabilities for making the investment decision in technology co-evolution;

The practical literature identified some questions required to be answered through this research.

- Map of historical evolutions of Location Based Services;
- Calculating the benefits and risks of the A-GPS investment for the UK mobile operators;
- Investment decision in the A-GPS technology by the UK mobile operators.

In chapter two, the mentioned limitations of theory and industrial practices will be underpinned by a detailed review of the significant theoretical literature followed by development of an evolutionary framework as the first stage of the DTC model and the analysis of the UK mobile industry in respect to the Location Based Services.

Under rapid technology co-evolutions, the investment decisions in a particular technology cannot be delayed for longer duration. At the same time, it is also difficult to achieve the exact measures of benefits, opportunities, costs and risks of any investment decision. The technological, organisational capabilities and resource factors influencing the investment decision cannot remain identical for all technologies, but understanding of their inter-relations can identify the changes required for different types of technologies.

In this connection, theories of RBV and dynamic capabilities have discussed a way of increasing value for organisations by manipulating organisational resources within the industry. The undergoing technological convergence reflects the blurring industrial boundaries and development of new industries by combining distinct industries together. Although the mentioned theories have been useful to organisations to remain competitive within industries, it seems they still need some clarifications to understand the future requirements of the next generation of technology, in which the investment decision will not only rely on endogenous technological resources but also technologies and competitors will appear from the exogenous industries.

1.2.3 Undergoing changes in the strategic management theories

The introduction of RBV provided an influential theoretical framework for organisations to achieve competitive advantage within the industry. The RBV balances the previous strategic theories of competitive advantage, showing influences of strategies on industrial structures and strategic positioning within these structures. The RBV developed by Barney (1991), defined a framework for organisations to achieve sustainable competitive advantages through the resources which are valuable, rare, inimitable and non-substitutable, which seems very difficult in today's rapidly changing technological environment. On the other hand in considering the dynamic environment, the theory of dynamic capabilities was introduced. The dynamic capabilities developed by Teece et al., (1997), defined a framework for organisations where exploitation of existing internal and external firm-specific competences appeared as a capability to address changing environments, where internal identified as within organisation and external identified as within industry.

The term 'dynamic' refers to the capacity to renew competences to achieve congruence with the changing business environment; certain innovative responses are required when

time-to-market and timing are critical, the rate of technological change is rapid, and the nature of future competition and markets difficult to determine. The term 'capabilities' describes the key role of strategic management in appropriately adapting, integrating and reconfiguring internal and external organisational skills, resources, and functional competences to match the requirements of a changing environment (Teece et al., 1997; p. 515). The dynamic capabilities framework addresses the strategic management question where the role of industrial structure within dynamic capabilities perspective remained endogenous. The dynamic capabilities approach faced a critique of being 'tautological' but has also been identified as a 'best practice'.

Later an environment of tight technological convergence appeared for technological organisations. To remain competitive, the term co-evolution became part of the theory of dynamic capabilities. The organisations co-evolved with respect to organisational knowledge, organisational products, organisational forms, and organisational functions. The organisational learning appeared as a source of dynamic capabilities. The importance of managerial capability to sense opportunities was also identified. In other words, dynamic capabilities appeared as the capacity of an organisation where resource bases are purposefully created, extended, or modified (Helfat, 2007).

On the other hand, as technology began to converge, the concepts of inter-related technological evolutions emerged in the theoretical literature. The concepts of technological forecasting, technology evolution and innovation were considered for modelling the technology ecosystem. While some useful theories, such as Population Perspective of Technology Evolution from evolutionary economics and Co-evolution within Product and Technology Hierarchy, contributed in building concepts of the technology eco-system. In this regard, the concept of technological roles (components, products and applications, and support and infrastructure) was also included in the context of the technology evolution. Technology in the context of dynamic capabilities is identified as one amongst several other resources which can be created, extended or modified within an organisation, but from the point of view of the investment decision, **can technology co-evolution, in particular, be identified as a source of dynamic capabilities?** To observe its possibilities, this research rips apart the technology resources from the dynamic capabilities and views it through the different lens of technology co-evolution.

The present concepts of dynamic capabilities provide organisations with a general understanding of evolutions in resources to cope with changing environmental conditions; it seems they are not particularly helping the decision makers of the technological organisations to make the investment decision in the next generation of technologies which are emerging due to the technology co-evolutions from exogenous industries. The inter-relation and inter-dependence of technological roles and influences of accuracy and quality, market demand, cost and self and governmental regulations over these roles can identify a set of issues for the development of the DTC model which can be utilized by managers and technologists of the technological organisations in making the investment decision.

Further discussion on the undergoing theoretical changes will be presented in much detail in chapter two. Chapter three will present the complete DTC model as a solution method of responding to the required changes identified in chapter two.

1.2.4 The development of an evolutionary framework for the DTC model in making the investment decision

An effective model for making an investment decision in the co-evolution of exogenous technology must provide the decision makers of technological organisations with the capability to cope with the changing technological demands and organisational capabilities so that the decision makers will be able to increase value for their organisations by making less risky investment decisions for the best available technology with improved accuracy and quality, improved market demand, less cost and precisely defined regulations.

On the other hand, there is no certainty that investment decision in the technology selection will increase the value for an organisation. Every investment decision possesses its own benefits, opportunities, costs and risks (BOCR) merits. Some factors directly identify their benefits and risks, but for others their benefits and risks rely on their inter-relation with other factors.

Therefore the second stage of the DTC model for the investment decision must respectively present a method for calculating these BOCR merits. The BOCR merits will also demonstrate the following observations:

- Classifying a set of factors for the investment decision with respect to their clusters. They are: Technological evolutions, Organisational evolutions and Resource evolutions;
- Identifying linkages of technological, organisational and resource evolutions;
- Providing empirical evidence for technology co-evolution as a source of dynamic capabilities;
- Measuring values for clusters with respect to drivers. They are: accuracy and quality, market demand, cost, self and governmental regulations;
- Developing optimum investment strategy in respect of dynamic changes in the technologies of exogenous industries.

It seems that an evolutionary framework and its empirical evidence in the context of the UK mobile industry for the investment decision in the A-GPS technology will emerge with the development of the DTC model. This case study of LBS must also bring a basis for generalizing the DTC model for making the investment decision for other technologies that can continually create value for technological organisations within the fairly swift market.

The present research is the first study in the field that brings the concept of the dynamic capabilities in context of the UK mobile industry for LBS and recognizes the effects of the technology co-evolution on the evolution of organisational capabilities in making the investment decision for the technologies of exogenous industries. The incorporation of the above concerns identified the need of a fundamental framework which is required to describe all previous related evolutions before making an investment decision. The main concept of the framework relies on discussed theoretical literature which will be covered in much detail in chapter two followed by chapter three to discuss the research methodology and the DTC model itself.

1.3 Theme and type of the research

The thesis is entitled ‘‘***Dynamic Technological Capability (DTC) model for the next generation of technology evolution***’’. The research can be defined as a combination of both ‘basic or fundamental’ and ‘problem-oriented’ research. The basic research identifies some relations in developed concepts of theoretical and practical domains. The problem-

oriented research develops a solution method for a particular problem in a real and practical environment. This research examines a set of all factors required for the investment decision in the A-GPS technology by the UK mobile operators. Therefore, it is defined as a problem-oriented research. But at the same time, a set of factors proves the relation between concepts of technology co-evolution and evolutions of the organisational capabilities, so it is also defined as a basic research.

In relation to presenting a new perception of the dynamic capabilities, the research assembles a number of fundamental concepts within the context of the dynamic capabilities: New combinations; Technology evolution; Combinative capabilities; Technology forecasting; Technology Fusion; Technology Analysis; Technology eco-system; Investment decision; Multi-criteria investment analysis.

The methodological steps of the research can be specified as below:

1. Identify an original research topic within the context of dynamic capabilities by combining a number of aspects from the context of technology co-evolution and investment decisions, to meet the challenges of ever increasing technology convergence, blurring industrial boundary conditions and less risky investment decisions for the technological organisations.
2. Propose the research problem for theoretical and practical domains and define the corresponding solution methods.
3. Analyze the research problem through developed theoretical concepts, frameworks and industrial practices and define the characteristics of the research problem.
4. Specify the significant changes required in the current context of the theoretical concepts and the practical domains.
5. Develop an evolutionary framework as the first stage of the DTC model on the basis of identified changes.
6. Develop a set of factors as the second stage of the DTC model, based on an evolutionary framework and industrial practices.
7. Implement an evolutionary framework and a set of factors in the practical domain through some case studies to identify their investment decisions.

8. Compare investment decisions of case studies to achieve the implications for industrial practices.
9. Evaluate the generality of the DTC model, in terms of practical significance, and investigate its competency for the theoretical concepts of the dynamic capabilities and the technology co-evolution.

1.4 The research objective

As technologies grow and converge a rationale behind the technology integrations is recognized, which is necessary for the technological organisations to create value under the circumstances of the next generation of technology. This research, by an empirical study of the UK mobile operators and the critical analysis of theoretical and practical aspects has proved the influence of technology co-evolutions on evolution of organisational capabilities. This influence is required for the development of an evolutionary framework and for the identification of a set of factors for making the investment decision through calculating the BOCR merits.

As the research question asks about: *how should the managers and technologists of the technological organisations decide on how to invest in the co-evolution of technologies and adapt their influences to the evolution of their organisational capabilities by knowing the benefits, opportunities, costs and risks of such an investment within a fairly swift market?*, the main objective of this research is to develop a solution method named the Dynamic Technological Capability (DTC) model which can measure benefits, opportunities, costs and risks of technological investment by identifying the related technological and organisational evolutions for the next generation of technology within a fairly swift market. The DTC model by definition will refer towards the capacity of endogenous and exogenous technologies to create, extend and modify the resource base of organisations.

1.5 The research methodology

The major groundwork of this research is based on a ‘case study approach’ to identifying and solving the research problem. The methodology follows five stages. The stages include; i- defining the research question, ii- instrument development, iii- data gathering, iv-

analyzing data, v-dissemination. In respect of this research the route goes through the following steps.

I. To define the basic research problem, a conceptual evolutionary framework is generated which graphically identifies the linkages of technological and organisational capabilities, presenting their related evolutions, and reflecting exogenous resources.

II. To use basic research for problem-oriented research, a conceptual evolutionary framework is utilized in the contexts of the UK mobile industry for the identification of all related evolutions since 2001 to 2007 in respect to LBS.

III. Then to solve the problem-oriented research, the research places emphasis on the development of a set of factors with respect to their clusters and uses an analytical tool for the identification of their interrelation and interdependence and their corresponding effective measures for the investment decision. It follows the steps through:
    1. Identifying sources for collecting qualitative data and information related to LBS which mainly relies on interviewing the UK mobile operators and other mobile and satellite industry experts and observing their industrial archives including documents and web based news to create a set of factors.
    2. Classifying a set of factors with respect to three main clusters which are technological, organisational and resource evolutions under the four drivers of this research.
    3. Grouping of drivers with respect to their visualized benefits, opportunities, costs and risks.
    4. Utilization of Analytic Network Process (ANP), as an analytic tool to assign the quantitative data in the form of a nine point priority scale and pairwise comparison by groups of managers and technologists of the UK mobile industry.

IV. Then to utilize the results of problem-oriented research for the basic research, the collection of qualitative and quantitative data is analyzed and their findings are evaluated to prove the required influences of theoretical concepts.

The research methodology is discussed in more detail in chapter three.

1.6 Major research findings and contributions to knowledge

The research findings represent an original model, called the Dynamic Technological Capability (DTC) model for the technological organisation within a fairly swift market for making an investment decision for the next generation of technology. Alongside this, the DTC model also proves the capabilities of technology to be identified as a source of dynamic capabilities. It is an extension in the current framework of the dynamic capabilities with the integration of a new concept and then utilizing it for a new, practical context. To date, most research on dynamic capabilities has addressed the questions of '*what*' defines dynamic capabilities, '*what*' distinguishes them from other types of capabilities and '*what*' their effect is on organisational outcomes. Attention to the issues of 'how' is only starting to gain momentum (Helfat et al., 2007; p. 37). This research will contribute towards the '*how*' side of the dynamic capabilities.

The DTC model first develops an evolutionary framework and then identifies the set of factors required for the investment decision. Then it calculates the relative importance of these factors by assigning weights and analyzing priorities. In the end, it measures these priorities to calculate BOCR merits and to make the decision which either allows the decision makers to invest now, invest later or do not invest in the investigated technology.

The evaluation of the investment decision in the A-GPS technology through the DTC model, using multiple-criteria logic supported with ANP – analytic tool, copes with the future requirements of highly converging technologies for the UK mobile operators; Vodafone, Orange and O2, contribute towards assessing the benefits and risks of the A-GPS technology in particular and for other future technologies in general. The case studies of Vodafone, Orange and O2 are discussed in detail in chapter four. A detailed review of the research contribution to the literature and industrial practices is presented in chapter six.

1.7 Literature and resources

The DTC model is developed by integrating the concepts from several theoretical concepts and industrial practices. The literature which contributed towards the development of the DTC model emerged from:

a- Evolutionary economics;
b- Resource based view;
c- Strategic management;
d- Capital investment decision making;
e- Strategic decision making;
f- Technology analysis;
g- Dynamic capabilities;
h- Technology co-evolution;
i- Multi-criteria decision analysis;

In addition to this the following resources also contributed towards the development of the DTC model:

- European Navigation Conference (ENC), 2006;
- Mobile and GPS/GNSS – Marriage on the rocks?, Joint Location and Timing KTN and Mobile Data Association LBS Event, Jan 2007;
- Location applications and positioning technologies, Joint Location and Timing KTN and Mobile Data Association LBS Event, July 2007;
- Meetings with several satellite and mobile industry experts: Professor Terry Moore, IESSG, University of Nottingham; Professor Mark Jackson, GeoSpatial Science, University of Nottingham; Professor Nick Von Tunzelmann, SPRU, University of Sussex; Bryan Jenkins, Project Manager, ESYS Consultancy; Daniel Arthur, Member of CCSR, University of Surrey; Richard Mackie, BNSC; Pat Norris, Business Development Manager, Logica CMG; Bob Cockshott, Technology Translator, Location and Timing KTN; James Holt, Technology and Operations Manager, e-Courier; Niccola Binucci, Technologist, 3 UK; Professor Jonathan Raper, City University;
- Meetings with individuals and group of Tim Williams, Guenther Weber, Christian Birle, Reg Cox, Simon Ryder, Scott Carrick, Adamantia Alexandraki, Prof. Michael Walker, Markus Muenkler, Mark Lewis, Andrew Swainston, Vodafone UK;
- Meetings with individuals and group of Dr. Chris Sims, Daniel Walsh, Gareth Williams, Rob Allen, Rosie Srao, Orange UK;

- Meetings with individuals and group of Ian Curran, Martin Butler, Adrian Coles, Rafael de Ory, O2 UK;
- Company archives and Annual Reports;
- Web based news of 3G Insights, 3G News, BBC News, Cellular Newsletters, CTIA Smart Brief, Direction Magazine, LBS Insight, ZDNet News;
- White papers and Industry surveys by TruePosition, Berg Insight, MapInfo, ESRI, BWCS and Juniper Research.

1.8 An executive summary of the chapters

The table below shows the executive summary of the thesis chapters in correspondence to their input and output related to other chapters and conclusion.

Focus of the Thesis			
Chapters	**Background information input**	**Fusion of outcomes**	**Key drivers**
One: **Introduction**	An executive summary of the research	Summary of; • The research question • Structure of the thesis • The background of the research • Theme and type of the research • The research objective • The research methodology • Major research findings and contributions to knowledge • Major literature and resources of the research	Synopsis; • The research objective • Solution for combination of basic and problem-oriented research • Methodological procedure of the research An insight into the scope and issues within the research context • Characteristics of the next generation of technology • Drivers; accuracy and quality of technology, market demand, cost, and self and governmental regulations • Theories; dynamic capabilities, technology co-evolution and investment decision • Development of the DTC model

Focus of the Thesis			
Chapters	**Theoretical Background information input**	**Fusion of outcomes**	**Key drivers**
Two: **Literature review and development of an evolutionary framework as the first stage of the DTC model**	Literature on; 1. Theories and frameworks for organisations • Strategic management • Evolutionary economics • Organisational learning • Technology co-evolution • Investment decision-making • Multi-criteria decision analysis (MCDA) 2. Identification of required changes and integration of required theories 3. Influence of drivers within the context of the next generation of technology 4. Development of an evolutionary framework as the first stage of the DTC model	• Analyzing the theoretical concepts and frameworks in responding to the changing needs of the next generation of technologies • Building a concept around characteristics of the next generation of technologies within a fairly swift market • Discussing the required changes in developed theoretical concepts for the context of the next generation of technologies • Integrating discussed and new technological concept for the next generation of technologies • Introducing an evolutionary framework with examples of the practical domain of UK mobile industry	1. The research foundations on the investment decision for the next generation of technologies within a fairly swift market as: • Technologies are converging very fast • Industrial boundaries are becoming thin and sometimes invisible • Previous knowledge contributes towards making an investment decision within a fairly swift market • Major drivers; accuracy and quality, market demand, cost, self and governmental regulation are causing rapid changes • Current theories of: dynamic capabilities, technology co-evolution and investment decision making need an integration to visualize the change in the next generation of technologies within a fairly swift market 2. Development of an evolutionary framework for visualizing links of: variation, selection, replication, retention stages with reconfiguration, learning, leveraging and integration capabilities

Focus of Thesis			
Chapters	**Backgrounds information input**	**Fusion of outcomes**	**Key drivers**
Three: **Development of an evaluation method as the second stage of the DTC model and the Research methodology**	• Development of a set of factors through the practical analysis of the UK mobile industry • Assessment of practical problems in the context of Location Based Services • Contribution of an evolutionary framework for identification of a set of factors in the second stage of the DTC model • Background information of research methodology; five stage case based research • Background information of Analytic Network Process (ANP) tool	Dynamic Technological Capability (DTC) Model for making an investment decision in the next generation of technologies by the UK mobile operators; • Definition of factors • Allocation of factors • Influences of clusters • Influences of drivers Utility of ANP – analytic tool – for the DTC model	1. Definition of factors: Based on variation, selection, replication, retention, reconfiguration, learning, leveraging and integration themes 2. Allocation of factors: Based on Technological evolution, Organisational evolution and resource evolution 3. Influence of cluster: Showing influences of Technology co-evolution on the evolution of organisational capabilities as a support to a developed theoretical concept of an evolutionary framework
Four: **Case studies - Vodafone, Orange, O2 UK – Application of the DTC model**	Implementation of the DTC model in terms of evolutionary framework and the BOCR merits for the investment decision in the A-GPS technology by Vodafone, Orange and O2	An illustration of the DTC model applicability in the practical domain of the UK mobile operators Measures of decision in terms of benefits, opportunities, costs and risks for Vodafone, Orange and O2	To prove the utility of both stages of the DTC model in the practical domain and to improve its validity

Focus of Thesis			
Chapters	**Backgrounds information input**	**Fusion of outcomes**	**Key drivers**
Five: **Analysis of the second stage of the DTC model**	Validation of an evolutionary framework of the first stage of the DTC model Implication of the whole DTC model for the investment decision in the A-GPS technology by the UK mobile industry	Finalizing an illustration of the DTC model working in a practical domain	A proved utility of the DTC model in the practical and industrial domain
Six: **Conclusion and contributions of the research**	Summary of the research work and contributions to literature and knowledge of dynamic capabilities and practical implications for the UK mobile operators	• Summary of the research work • Research findings and contributions	• Executive summary of the research • Contributions to knowledge of theoretical and practical domain • Limitation of the study • Path forward • Conclusion

Chapter 2: Literature Review and Development of an Evolutionary Framework as the First Stage of the DTC Model

2.1 Introduction

The decision making for the technological investments in the era of technology convergence is a question to organisations and particularly to the decision makers consisting of managers and technologists of organisations which they respond to through their strategic intelligence. In the next generation of technology where technologies are crossing the industrial boundaries, the key question is: how do organisations design their strategies to judge the importance of the investment decision and to identify the positive aspects of the exogenous technologies and their influences on organisations?

This chapter is intended to develop a basic theoretical background input to analyze developed theories and frameworks and use them to build a concept around the characteristics of the next generation of technologies, to identify the required changes, integrate them with already developed theories, and to develop an evolutionary framework as the first stage of the DTC model for the next generation of technologies within a fairly swift market.

The chapter begins with a review of theories of strategic management, evolutionary economics, technology co-evolution, organisational learning, investment decision-making, multi-criteria decision analysis and their integration for the concept of dynamic capabilities. Then it identifies the influence of technology co-evolution on the evolution of dynamic capabilities through the concept of complementary assets and asset orchestration. In the next part, the chapter presents the development of an evolutionary framework which will present the discussed influences and will make the previous technological evolutions transparent to the decision makers. Along with this, an evolutionary framework will function as a road map to construct a set of factors for the second stage of the DTC model for making an investment decision by the decision makers in the next generation of technology within a fairly swift market.

2.2 Theoretical review of the dynamic capabilities

The theory of dynamic capabilities has been identified as an effective way of creating value for organisations through the maximum utilisation of their resource. The technological resources among all others play a vital role in achieving value for organisations. These resources evolve or sometimes co-evolve with respect to other resources and as a result can cause evolution in the organisational capabilities. The developed theories, based on strategic management, resource based view and evolutionary economics, are discussed here in detail to present this concept.

Schumpeter (1934) defines the contribution of "new combination" towards the exploitation of existing internal and external firm's specific resources. Penrose (1959) identifies that the exploitation of a firm's resources and their core and integrative knowledge can lead towards the development of new resources. Wernerfelt (1984) describes the resource based view (RBV) as a fundamental determinant of a firm's performance. Teece (1986) defines 'complementary assets and resources' which are required to capture technological know-how. All these theories have proved the significance of multiple resources and their combinations towards the value creation and achieving competitive advantages for organisations.

Particularly, in terms of technological resources, Conlisk (1989) proposes that use of resources for technological progress is modelled as incremental improvements in existing technologies and dependent on a firm's own effort and investments. Kodama (1992) identifies a way to revolutionise a market through 'technology fusion' which combines existing technologies into hybrid technologies which are non-linear, complementary and co-operative. Saviotti (1996) defines an evolutionary economics perspective to view multiple inter-related technologies through a 'population approach' whose characteristics and members evolve with time. These theories also prove the significance of resources, particularly the technological resources towards organisational progress.

These resources are not considered in isolation but at the same time theories have discussed their evolutions inside organisations. Nelson and Winter (1982) identify that firms change over time in terms of 'process innovation', and finding organisations as a set of

interdependent operational and administrator routines which slowly evolves on the basis of performance feedback. Following the conceptual trajectory of evolutionary economics, RBV and strategic management, Teece et al (1997) develop a conceptual framework of dynamic capabilities to discuss the firm's abilities in order to respond to the changing environmental conditions by integrating, building and reconfiguring its own internal and external competencies (p. 516) particularly to create values for organisations or to achieve the competitive advantages. It seems possible through the combination of managerial and organisational processes, shaped by asset position, and the path available to it.

These terms are defined by the theory of dynamic capabilities as:
Managerial and organisational processes: refers to the way things are done in the firm e.g. routines or patterns of practice and learning.
Position: refers to specific endowment of technology, intellectual property, complementary assets, customer base, and external relationship with suppliers and complementors.
Path: refers to strategic alternatives available to the firm, and the presence and absence of increasing returns and attendant path dependencies (pp. 518).

In precise terms, the dynamic capability theory is identified as a source of value creation by honing internal technological, organisational and managerial processes inside the firm.

This concept of dynamic capabilities is being judged by several authors and mostly identified as the important theoretical and empirical work in the field of organisational strategies. At the same time, the concept of dynamic capabilities received the critiques of being tautological like RBV. In terms of RBV, concern was raised that 'value' remains outside the RBV and for dynamic capabilities 'value of capabilities' is defined in terms of their effect on performance (Priem et al., 2001b; Priem et al., 2001a; Williamson, 1999). Priem et al (2001b) also identify that RBV is descriptive and explanatory and lacking in providing answers to 'how' questions. The concern about the answers of 'how' questions has recently been raised by Helfat el al. (2007) in terms of dynamic capabilities.

The contribution of Eisenhardt and Martin (2000) towards the theory of dynamic capabilities has been identified as refined and expanded (Helfat et al, 2007). They claimed that dynamic capabilities are a set of specific and identifiable processes such as product

development, strategic decision making and alliancing. They are neither vague nor tautological. Although they are idiosyncratic in their details and path dependent in their emergence, they have significant commonalities across firms (popularly termed 'best practice'). This suggests they are more homogenous, fungible, equifinal, and resemble the traditional conception of routines (pp. 1105). These arguments also clarified the contribution of the creation of resource configuration towards the dynamic capabilities.

Eisenhardt and Martin (2000) extended the concept of dynamic capabilities towards market change and response to exogenous resources. They discussed two different types of markets. One is defined as moderately dynamic and other is defined as high-velocity (Eisenhardt, 1989). Moderately dynamic markets were defined as those with a stable industry structure, defined boundaries, clear business models, identifiable players, and with linear and predictable changes; where as high velocity markets were defined as those with ambiguous industry structure, blurred boundaries, fluid business models, ambiguous and shifting players, with non linear and unpredictable changes (Eisenhardt and Martin, 2000; pp.1115). In terms of dynamic capabilities, Eisenhardth and Martin (2000) also described their reliance on existing knowledge. This reliance is identified as heavy in the moderately dynamic markets and as less in the high velocity markets. But can a new market be introduced which combines characteristics of both of these markets? This is a market which may possess blurred industrial boundaries due to the selection of exogenous resources but at the same time has heavy reliance on existing knowledge where managers and technologists cautiously decide either to invest or not to invest in these exogenous resources on the basis of their previous knowledge. With respect to this research, such a type of market is defined as a ***fairly swift market***.

Considering Location Based Services as an example of a fairly swift market matches it with characteristics of both the high velocity and the moderately dynamic markets. In LBS, the industry structure is getting ambiguous with the integration of resources from satellite industry to the mobile industry; and where managers of the mobile industry have adopted multiple business models but are still looking for the most suitable one. These radical transformations of this industry has not only failed many tested business models but at the same time related frameworks, tools and techniques have become obsolete (Ballon, 2004; Li and Whalley, 2002). But all these transformations and changes are completely

influenced by the previous knowledge of little market growth and therefore hinder managers and technologists in making an investment decision for future evolutions related to the dynamic capabilities of these organisations.

These two market types can also be seen through a different lens described by the theoretical concepts of Nelson and Winter (1982). They identified differences in industrial dynamics between different innovative regimes; where science based regimes were defined as those which do not rely on firms activities for their progress and cumulative regimes which rely on the endogenous firm's activities for their progress. The moderately changing markets where industrial structure is stable and industrial boundaries are defined, organisations and their resources belonging to these industries, contribute towards the progress of these cumulative regimes. However, in high velocity markets where industrial boundaries blur, regimes need to be defined first before organisations and their resources could contribute towards their progress. In short, the resources which do not belong to the industry where organisations reside do not depend upon activities of organisations for their progress. Winter (1984) also differentiates the characteristics of regimes with respect to the differences in the role played by external and internal sources of technologies.

With respect to the LBS technologies, the decision makers of the mobile industry face the investment decision for exogenous resources of the satellite industry but resources from the satellite industry do not rely on the mobile industry for their progress. This concept guides towards regimes which are considered as ***dependent and independent innovative regimes***. Dependent innovative regimes are those in which organisations face evolutions due to resources of the independent innovative regimes. Independent innovative regimes are those in which organisations evolve at their own pace and do not consider evolutions in organisations of dependent innovative regimes. **So within a fairly swift market of LBS, evolutions in the dynamic capabilities of the mobile operators rely on technologies from dependent and independent innovative regimes.**

Following the concept of evolution in the dynamic capabilities, Helfat and Raubitschek (2000) develop a product sequencing model that provides a dynamic framework to track, step by step, the co-evolution of organisational knowledge, dynamic capability, activities and products over long time spans across markets to achieve competitive advantage through

innovation and strategic linkage of products. Rindova and Kotha (2001) also introduce the concept of continuous morphing to describe the comprehensive ongoing transformation through which the focal firms sought to regenerate their transient competitive advantage on the internet. This study shows the dynamic co-evolution of organisational form, function and competitive advantage. However, none of these theories particularly considered the co-evolutions of dynamic capabilities with respect to the technology co-evolutions.

Zollo and Winter (2002) identify organisations learning as a source of dynamic capabilities which is defined as a learned and stable pattern of collective activity through which organisations systematically generate and modify their operating routines in pursuit of improved effectiveness (pp. 340). Teece, Pierce and Boerner (2002), identify the importance of information processing capabilities to enable the firm to identify the nature of changing market environment and sense opportunities that it holds. They also identify the importance of managerial capabilities to sense these opportunities. Adner and Helfat (2003; pp. 1012) defines dynamic managerial capabilities as a capacity of managers to create, extend or modify the resource bases of organisations. To achieve competitive advantages, Zott (2003) proves a link between dynamic capability and firm performance. So far, discussed theories showed the influences of information, learning and knowledge as a capacity of managers towards the evolution of dynamic capabilities but are lacking in terms of identifying the capacity of technology co-evolution to create, extend or modify the resource bases of organisations.

Tushman and Rosenkopf (1992) identify ‘technologies as system’, where evolution of the leading component or core subsystem influences the evolution in other technologies at the same level of hierarchy. This concept is improved by Rosenkopf and Nerker (1999) whose technological evolution moves inside these hierarchies to components, products and system levels. Ziman (2000) shows these technological evolutions as occurring in ecological system of co-evolving artifacts. Adomavicius et al. (2005) describes the model of technology eco-system in which technologies possess certain roles and these roles co-evolve with respect to each other due to their inter-relation. The technology eco-system model shows three technological roles: components; product & application; and support & infrastructure. These roles are defined as:

Component: identifies technologies that are used as components in more complex technologies. Defining component technology for LBS can identify GPS chip, Location Enabling Server (LES), Location Platforms (LP), Digital maps.
Product and Application: identify technologies that use component to perform a set of functions or satisfy a set of needs. These technologies are defined by their components and services. Defining them in the context of LBS identifies mobile handsets as products which use GPS chips to offer multiple location based applications through GPS signals.
Support and Infrastructure: identify technologies that work in conjunction or collaboration with other technologies. They add value to technologies they support. With respect to LBS, the mobile networks act as a basic infrastructure which offers the Cell-ID technology which provides location based applications even in the absence of the GPS signals but with least precision and accuracy.

Identifying the influence of these technological roles on each other and their relevance to dependent and independent innovative regimes can converge the scope of this research work towards exploring the influence of the technology co-evolutions on the evolution of organisational capabilities and can lead towards an interesting research question in industrial dynamics around which this research work evolves.

The recent definition of dynamic capability guides towards the identification of capacities by organisations through which resource bases are purposefully created, extended, or modified (Helfat et al., 2007); where *resource base* includes all tangible, intangible and human assets (or resources); *capacity* is defined as ability to perform a task in at least a minimally acceptable manner; and *purposefully* indicates that dynamic capabilities reflect some degree of intent, even if not fully explicit (Helfat et al., 2007; pp. 5). But what are the contributions of these resources towards the development of dynamic capabilities of organisations? As a part of tangible resource the technology can be created, extended or modified by an organisational capacity. The recent trend of technological convergence and technology co-evolution capabilities has instigated a rationale to explore the possibilities of identifying influence of these technological resources on the dynamic capabilities. Technology was the driving force in the 20th century and it promises to hold the same during the 21st (Antoniou and Ansoff, 2004; pp. 275). Such concepts can be seen as a

contribution towards this research. The technological resources in the context of this research are considered particularly in terms of technology co-evolution.

Considering these theories in the empirical domain of the UK mobile industry helped in building an argument around dynamic capabilities which appeared as those capacities of organisations through which they integrate, build, and reconfigure technological co-evolutions of dependent and independent innovative regimes within a fairly swift market. This argument specifies the technology co-evolution as one of reasons behind the adoption of resources which alter the dynamic capabilities. Dynamic capabilities are drivers behind the creation, evolution and recombination of resources into new sources of competitive advantage (Henderson and Cockburn, 1994; Teece et al., 1997) but on the basis of the above argument can also be driven by the technology co-evolution within a fairly swift market.

Dynamic capabilities are practiced through managerial and organisational processes as a result of technology co-evolution and appeared in the shape of complementary assets. Further these processes integrate complementary assets in order to improve the dynamic capabilities and to develop distinct resources. If these assets belong to an independent regime, they do not rely on organisations for their developments. However organisations which belong to dependent regimes can rely upon them for their development. Depending upon the decisions of either investing or not investing in these resources, organisations need to reconfigure through internal and external transformation (Amit and Schoemaker, 1993; Langlois, 1992).

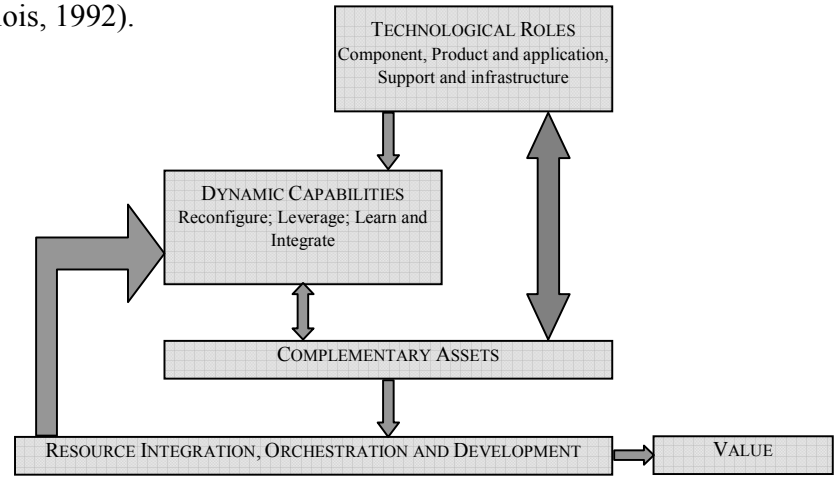


Figure 2-1: A link between technological and organisational capabilities and resources

Fig 2.1 shows linkages between dynamic capabilities and technological co-evolutions in terms of their roles. Dynamic capabilities evolve with co-evolving technological roles which are adopted in the form of evolving complementary assets for the further development of resources. Once these resources are developed they create value to organisations and the dynamic capabilities become tools to manipulate these resources configuration (Eisenhardt and Martin, 2000). The value can be seen by customers as benefit for which they are willing to pay. The technological roles if internal to organisations can easily be identified and adopted but if external, adoption is based upon 'prior commercialisation' (Teece, 1986). The adoption of technological resources (tangible resources) also brings in their knowledge (intangible resources). Because many intangible assets are idiosyncratic, they may be more valuable when they can co-evolve in a coordinated way with other assets. The ability to assemble unique configuration of co-specialized assets therefore can enhance value (Helfat et al., 2007; pp. 23). This process of assembling and orchestrating particular constellation of assets for economic gain is a fundamental function of management (Helfat et al., 2007; pp. 23) which they perform with cautiously making investment decisions.

The investment decision making in the next generation of technologies within a fairly swift market needs to explore deeply the industrial and organisational conditions. Literature identified multi-criteria logic as the way to view problems in a holistic way (Saaty, 1996; pp. 1). The multi-criteria decision analysis (MCDA) is defined as a methodology which allows decision makers to consider multiple and conflicting objectives before making any investment decision (Belton and Stewart, 2002; Goodwin and Wright, 2004). It also provides a strong framework for supporting a design for better and more robust options, as it permits decision makers to analyze the performance of each strategy on each of the organisation's objectives and identify its weaknesses and opportunities for improvements (Montibeller et al., 2006; pp. 5).

Decision making is defined by Saaty (1996; pp.7) as a process that leads one to:

- Structure a problem as a hierarchy or as a network with dependence loops
- Elicit judgments that reflect ideas, feelings and emotions
- Represent those judgments with meaningful numbers

- Synthesize results
- Analyse sensitivity to changes in judgment

For asset orchestrating, decision makers need information about changing consumers' need and technology. Such information is not always available; or if it is available, the decision maker must collect information, analyze it, synthesize it, and act on it inside the firm (Helfat et al., 2007; pp. 26). In order to make such information transparent to the decision makers within a fairly swift market, the previous knowledge of the industrial and organisational practices can contribute towards selecting the most beneficial strategic alternative. If this knowledge can be represented in a flow showing historical evolutions of a particular technology, this can help in building up a set of multi-criteria for decision making and analysis and can also help in foresighting the future evolutions which a particular technology will follow through the evolutionary path and therefore can be considered as a roadmap for the decision makers. The literature identified dynamic capabilities as the complicated routines that emerge from a path dependent process (Nelson and Winter, 1982; Teece et al., 1997; Zollo and Winter, 1999) which is more accurately described in terms of learning mechanisms to guide the evolution of dynamic capabilities (Eisenhardt and Martin, 2000).

In order to employ these learning mechanisms for the better understanding of the decision makers and to represent the historical knowledge of evolutions, this research work develops an evolutionary framework which is defined as the first stage of the DTC model. This evolutionary framework will also be helpful in developing a set of factors for analyzing benefits, opportunities, costs and risks of making an investment decision in the exogenous technologies during the second stage of the DTC model.

2.3 The first stage of the DTC model - Development of an evolutionary framework

The knowledge contributes towards accumulation of the organisational experience and the organisational learning (Argyris and Schon, 1978) which facilitates the decision makers to select a significant strategic alternative to create value for their organisations. Growing evidence suggests that organisations must efficiently and effectively create, capture and share knowledge to solve problems and exploit opportunities (Brown and Duguid, 1991;

Drucker, 1991; Kogut and Zander, 1992; Davenport et al., 1996). As knowledge possesses tacit and explicit characteristics (Polyani, 1966; Brown and Duguid 1991, Nonaka, 1994; Romer, 1996), its utility for better understanding and future developments requires a proper way of presentation.

The presentation of historical knowledge of technology co-evolutions and its respective evolutions in the organisational capabilities can help the decision makers in foresighting the future technological and organisational evolutions. These evolutions occur in technological roles, which act as assets to organisations, and as a resultant alter other organisational assets by creating, integrating, recombining and releasing resources (Eisenhardt and Martin, 2000). In the context of mobile industry, investing in these technological roles and other organisational assets need evolutions in several dynamic capabilities like strategies, supply chain, value chain, Research & Development (R&D), organisational structure, customers care, regulations, retailing and billing. In order to make the less risky investment decision, the decision makers require identification of these capabilities and their relative influences on the investment decisions. The evolution of organisational capabilities with respect to the technological roles, for the creation of assets and resources to enhance the value for organisations, are explored in detail under the headings of reconfiguration, leveraging, learning and integration as discussed by Bowman and Ambrosini (2003).

2.3.1 Reconfiguration capabilities

Reconfiguration transforms and recombines assets and resources (Bowman and Ambrosini, 2003; pp. 293) which will cause variations in organisational routines. In terms of technological roles, the decision makers can make the operational make-buy decision on the basis of transaction cost (Williamson, 1981), capabilities and core competencies of the firm (Prahalad and Hamel, 1990) or contemporary supply chains by considering myriad uncertainties in the supply market or the strategic vulnerability pose to the buyer (Quinn and Hilmer, 1994; Tayles and Drury, 2001; McIvor, 2005). The organisations can simultaneously make and buy if organisations and their suppliers both possess expertise in a technology. Simultaneously making and buying is defined as concurrent sourcing (Parmigiani, 2007).

If technology possesses a component role, it can be transformed and recombined with assets either developed inside or bought from outside. If developed inside, the organisational capabilities will face transformation in the R&D capabilities and employees know how, particularly the knowledge of developers. If bought from outside, the transformation will mainly take place in the supply chain capabilities. However, it can also affect R&D capabilities. It seems wise that before buying a new component technology, the intensive research about the identification of its expected market value, best available supplier and identification of customer segments, which will find this technology beneficial, must be done. The transformational extent depends upon the level of change. An abrupt change may lead towards building up completely new components with new skilled developers. However, slow and progressive change may lead towards upgrading or reconfiguration of old with new component technologies.

For the product technology, organisations also vary its capabilities related to its development or procurement. The development of new products results in invention which can be conceived from search and combination of new components and new configuration of previously combined components (Fleming, 2001). If developed inside, and possesses some distinctive capabilities, the product technology acts as a resource. If obtained from outside, the product technology must be recombined with a distinct application to make it a distinct resource. The development of a distinct application will cause evolution in organisational capabilities related to evaluation of market segments, customers' demand and competitors' capabilities. To create value for organisations, the developed application must be unique and idiosyncratic. To make applications unique, organisations need to identify and specify those assets which will recombine to make an application distinct. Asset specificity refers to the degree of idiosyncrasy of an investment required by organisations; the more idiosyncratic the investments required, the more likely the firm will prefer to develop itself since the cost of protecting against potentially opportunistic suppliers is greater than the cost of producing internally (Williamson, 1975).

The transformation in the support and infrastructure roles can also create resources. The support technology which might be endogenous or exogenous in characteristics enhances the scope of the basic technology. The recombination of support technology might not always be required by organisations but in some scenarios it may become so important that

organisations willingly recombine it to survive. The strategic decision of either adopting or not adopting the support technology relies on the knowledge of those who are involved in this process and through other organisational capabilities, can identify the real need of such technology. When transforming the infrastructure, organisations must check their available infrastructure and in continuation to deploy from the existing, the transformation allows organisations to achieve maximum benefits of previous ones. However, in the process of creative destruction (Schumpeter, 1942) where a new infrastructure replaces an older one, organisations face huge investments.

2.3.2 Learning capabilities

Learning is a process by which repetition, imitation or experimentation, enable tasks to be performed better and quicker and that enables new opportunities to be identified (Teece et al., 1997; Zott, 2003). Once transformation and recombination of assets occur the result may increase the learning of those who performed these transformations. Learning influences all technological roles at the level of organisational capabilities and individuals' know-how.

In the context of rapid technological change, systemic changing efforts are needed to track the environmental change through learning capabilities (Zollo and Winter, 2002). The learning capabilities of decision makers increase opportunities of selecting the appropriate technologies. According to Eisenhardt and Martin (2000), the key to effective evolution in the high velocity market is based on carefully managed selection. The fairly swift markets also carry the attributes of a high velocity market, therefore the investment decision of evolution towards the next generation of technology within this market also relies on a careful selection of technological roles.

In terms of component, the value of individual skill, which may be involved in designing new components or selection of old ones, depends on the particular settings of organisations. These learning skills help decision makers in leveraging and replicating resources with less time and cost investments. These skills also define the utilisation of components for better products. Henderson and Clark (1990) note that an individual product comprises multiple components, each of which has a separate 'component knowledge' consisting of basic knowledge underlying the component. Similarly the

combination of multiple products and each with its separate product knowledge can lead to distinct application resource. This core knowledge in designing a new component reduces joint cost of production via sharing of intangible assets such as technological know-how (Bailey and Friedlander, 1982; Teece 1980).

The evolution in the product technology causes variation in learning capabilities through the product sequencing. Helfat and Raubitschek (2000) classifies product sequencing strategies in: new generation of existing products, replacement products, horizontal expansion, vertical expansion and complex combination of sequences. The product sequencing brings in the knowledge of existing products which when combined with new knowledge lead towards a new generation. It relies on experience accumulation (Zollo & Winter, 2000) as well as future expanding technological knowledge which may result through the R&D capabilities. The selection of already developed products and components from dependent and independent innovative regimes might rely more on experience accumulation and less on R&D capabilities. Here, the main concern evolves around maximum interoperability of components and products towards required applications.

Similarly, in terms of infrastructure and support, the selection relies upon knowledge of pros and cons of all available alternatives in markets and their best possible configuration with old infrastructure. Developing these technological roles inside might influence the learning capabilities more as compared with buying them from outside. The knowledge and skills gained through learning by doing cannot be replicated through outside supply relationships (Pisano, 1994) but both of these knowledge areas possess their own contributions towards technology evolution. Learning in general, does create ideas but for technology evolution the distinction between an idea and practical capabilities is crucial (Fleck, 2000). If technology is about anything, it is about effective action in the real world, and not just about ideas and ideas (Fleck, 2000; pp. 255). Therefore, in the context of this research, learning is considered as an integral part of the technology co-evolution but it is not the only capability affecting and affected by the technology co-evolution.

2.3.3 Leveraging existing resources

Once identified transformation leads towards learning and development of new resources, the recognition of the required resources for further evolution seems to be the next feasible

strategy. Organisations can create new resources by leveraging existing ones. This can be done by extending the scope of these resources into other market domains (Bowman and Ambrosini, 2003). The same component can be offered to multiple product developers from different market domains. To make a component technology usable for different products and distinct markets, organisations can evolve R&D capabilities further. Alongside, the developed expertise as an intangible asset can also be leveraged and with little amendments may further evolve towards new components. If these components are just bringing in from dependent or independent innovative regimes, the capabilities of exploiting them in distinct products can also be leveraged. The developed products can be leveraged for new applications and new products can be developed more efficiently and at less cost due to the previous investments and experiences.

The infrastructure is considered as the most expensive asset of organisations and its leveraging as an incremental evolution utilises most of the available resources to support product and application developments. But if new technological opportunities are created where the chances of resource creation are better than previously, leveraging and routines for replication (Hansen, 1999; Szulanki, 1996; Teece et al., 1997) become unable to achieve distinct resources and may sometimes become a liability (Eisenhardt and Martin, 2000) for organisations. The organisations in these situations face huge switching cost (Bresnahan and Greenstein, 1996). In such situations, the investment decision makers identify the best possible alternative and decide either to replicate resources or move towards new resources.

2.3.4 Integration capability

The integration is concerned with the firm's ability to co-ordinates and integrates its resources and assets (Bowman and Ambrosini, 2003). If these assets are components they can be integrated and linked together into a coherent whole (Henderson and Clark, 1990) to make a product. The integration of these components utilises co-ordination of developers' skills and manufacturing assets. The end product can further be integrated with the exceptional application, provided by the adopters of these products from dependent or independent innovative regimes, to make the end product more valuable. This integration can also bring manufacturers, suppliers and customers together to achieve a highly customised product which acts as a resource for both the manufacturers and adopters. These

players might belong to the same industry or may sometimes belong to different industries. Their integration is based on networking among them. Networks are a group of firms with restricted membership and specific, often contractual, business objectives, in which the members choose each other and agree explicitly to co-operate in some way (Brown and McNaughton, 2003), which allows them to access more external resources to further enhance their resources. The most effective organisational capability in these networks is the development of the value chain through which these firms share their value. The resultant resource is therefore based on the re-definition of the products and services organisations provide, changes in the resource and capabilities deployed, and a mode of organising that facilitates creating and using new resources and capabilities (Rindova and Kotha, 2001).

Integration of new infrastructure with previously owned also relies on various components which can either be replaced or enhanced as required by the service. Infrastructure is usually a high cost asset and its evolution is highly dependent on the exact selection. Selecting the wrong technology can lead to a decline of an organisations' profitability (Ansoff and Sullivan, 1994). Therefore, following the technological trajectory (Dosi, 1982) for continuous evolution or creating a new technological paradigm (Dosi, 1982) for discontinuous evolution, identifies the level of integration performed by organisations. Due to the high cost of the infrastructure, organisations which make investment in the next generation of technologies seem to be integrating their infrastructures with the competitors' infrastructure by keeping all other organisational capabilities distinct.

These discussed dynamic capabilities collectively allow organisations to alter their assets and resources in order to create new for the value creation. In particular, these capabilities consider different technological roles. These concepts become more related if technological roles evolve simultaneously, and in a way that their evolution co-evolves other technological roles and the organisational capabilities.

2.4 The co-evolution of technological and organisational capabilities

The discussion about organisational capabilities and the evolution of technology has so far created a background which needs further explanation towards the co-evolution of

technology and organisational capabilities. Devezas (2005) discusses 'evolutionary theory of technological change' where technological evolution appears as the fastest and more energetic among a broad 'innovation driven' and 'co-evolutionary set of processes'. In the context of this research, the technology evolution is considered with the concept of Campbell (1965) of variation, selection and retention processes. Historically speaking, the key factor in variation, selection, and retention is the selection which shows how historical change could be shaped by selection rather than by instruction. But selection necessarily implies the variation and retention in equal measure (Ziman, 2000). Zollo and Winter (2002) add 'replication' as a new mechanism to the standard variation-selection-retention triumvirate of the evolutionary model. This concept is used to develop an evolutionary framework for this research. The evolutionary framework consists of related multiple evolutionary cycles, where each cycle possesses four stages. These stages are described below.

The first stage of an evolutionary framework is termed as variation. This stage initializes the evolutionary cycle, where individuals or groups from organisations generate a set of ideas on how to approach old problems in novel ways or to tackle relatively new challenges (Zollo and Winter, 2002). The new resources from dependent or independent innovative regimes make it essential for organisations to adopt new technologies and make them their part. Simply adopting technologies as a resource is not enough to fulfil innovative demands. The organisations need to check available resources and complementary assets which can become interoperable with newly adopted resources and hence therefore require opting to reconfiguration capabilities. Reconfiguration provides a way of modifying one technological role with the evolution of other technological roles. This variation in organisational routines and its capabilities relies on these technological roles and based on their adoptions, organisations decide to develop products and applications as the distinct resources. These resources can either become available in the market as a separate product or application or may be selected by organisations for further evolutions.

The second stage of an evolutionary framework is termed as selection. The efficiency of selection depends upon the search strategy (Ziman, 2000) for resources and therefore highly influenced by the prior learning and knowledge of those who are involved in the selection stage. The selection should not always rely on available resources but it is useful

to consider the alternative sources of ideas or skills that an individual organisation might draw upon in its searches and the effect that adoption of an idea from any of these sources has on the subsequent evolution of the system (Winter, 1984) comprising of all the technological roles. As this selection stage is concerned with the practice aspect of technology, which presumes that users and the market select on new technologies (Nelson, 2000), the decision makers which perform selection identify these needs first. The search for new techniques is clearly motivated, in some sense, by needs and opportunities (Ziman, 2000; pp. 55) and can therefore rely on historical selection of these technologies. The learning from these histories can help the decision makers to make their selection strategy more effective. The learning not only makes the selection stage convenient, but also makes it possible to conveniently evolve the technological roles with respect to the available ones.

The third stage of an evolutionary framework is termed as replication. This stage examines the re-utilization of evolved roles in different parts of organisations. The replication of the developed components for different products and applications makes resource leveraging possible. The selection for the adoption of resources from dependent and independent innovative regimes needs investment and their replication can bring benefits to organisations. Replication does not only reutilise the co-evolution of technological roles but at the same time can also reutilise the complementary assets and which will further create co-evolution in other technological roles. In developing new resources organisations' brand can be extended across wider range of technological roles. But as these resources emerge from dependent and independent innovative regimes, it is also required to replicate the knowing expertise to manage and monitor the required changes in a way that does not diminish the brand value (Bowman and Ambrosini, 2003).

The fourth stage of an evolutionary framework is termed as retention. This stage retains these evolved technological roles as the resources for future applications. Apart from replicating these roles, organisations also integrate them to start the next evolutionary cycle. At this stage various technological roles can be integrated and orchestrated from suppliers and customers of dependent and independent innovative regimes. These resources can integrate customers' experiences which will create ideas at the initial stage of second evolutionary cycle and will further cause some variation at the beginning of the second cycle.

Each of these stages delivers a new resource to organisations. As these resources develop due to the technology co-evolution and related evolutions in organisational capabilities, they enhance understanding of the decision makers and knowledge of developers. Each stage in itself constructs a reason for the decision makers to clearly identify influences of these stages with respect to the technological and organisational capabilities before making an investment decision. The decision makers identify the possibilities of reconfiguration, selection, leveraging, retention and integration. At the end of each stage if organisations manage to develop a distinct resource may clearly lead to the value creation. If decision makers fail to recognize value of the resource bundles they cannot identify them as a source of a firm's competitive position (Dierickx and Cool, 1989; pp. 1504).

Once these resources have developed, they become the complementary assets for the next stages which further need evolutions to create additional value for organisations. Only retaining these resources without further evolutions can present no advantage to organisations. Sometimes a firm's previous investments and its repertoire of routines (its 'history') can constrain its future behaviour (Teece et al., 1997; pp. 523). These resource bundles sometimes stop future evolution, as developers and the decision makers still find them useful and remain unable to identify the future possible improvements.

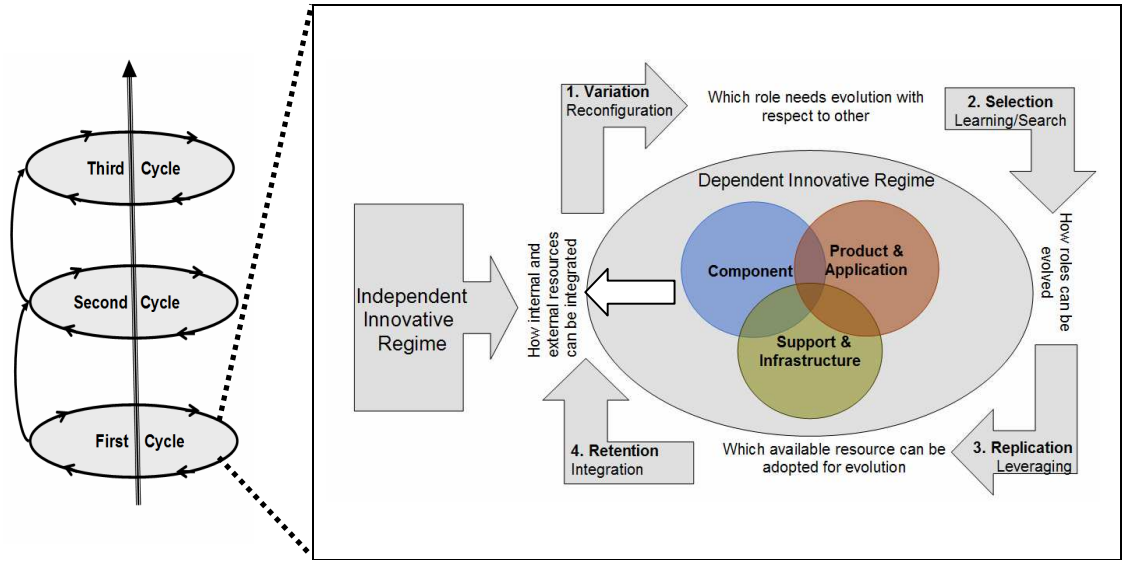


Figure 2-2: The evolutionary framework

In such situations the independent innovative regimes can generate ideas and opportunities for organisations of a dependent innovative regime. The properties of roles possessed by technology from an independent innovative regime might help decision makers to develop their own resource by utilising these exogenous resources. The discussed evolutionary framework is shown in fig 2.2 presenting the evolutionary cycle of organisational capabilities and inter-related technology co-evolution.

The evolutionary framework presents the relationship of technology co-evolution and evolution in the organisational capabilities. Rosenkopf and Nerkar (1999) mentioned that for each component technology a broad community of organisational actors produces variation. Further, multiple communities are involved in the technological evolution of products composed of several components, and because components are bundled into products, the interdependence between components strongly affects the evolution of products. If these components and products are supported by infrastructure then their evolution is also affected by the variation in infrastructure. The organisations select and bundle together the required components for a product which again provides variation at the product level and this variation is maintained due to the path dependent processes of exploration and exploitation (Cohen and Levinthal, 1990; Helfat, 1994; March 1991; Nelson and Winter, 1982). According to Zollo and Winter (2002) exploration is closely associated with variation and selection stages, and exploitation with replication and retention. However, whatever the technological role the resource possesses inside organisations, its evolution is influenced not only by the interdependence on other technological roles but also upon the selection done by the decision makers of organisations and it relies upon their prior learning and understandings of market demands.

During the variation and selection stages, the decision makers achieve benefits from the reconfiguration capabilities for the development of their technological resources and adopt new ones and learn about these new resources. The reconfiguration increases the technological complexity because innovations result from nested combinations of simpler technologies. This indeed, is a much more important mode of variation and evolution in the technology development (Fleck, 2000; pp. 258). The technological complexities do create the evolution inside organisations but at the same time also increase the learning capabilities of these organisations. Better understanding of technology provides relatively

strong guidance regarding how to improve practice (Nelson, 2000; pp. 68). The understanding developed from these stages helps in replication and retention stages where the decision makers try to get benefits from re-using their existing resources and keeping them for a future evolutionary cycle.

During the initial stages the decision makers are influenced more by the dynamic environment and therefore respond to them through rapidly changing capabilities. In later stages these capabilities become part of organisations and embed resources within the organisation to use them as complementary assets for the next evolutionary cycle. Through this detailed demonstration the evolution of organisational capabilities appears to be influenced by inter-related technological roles and their co-evolutions.

In order to validate the conceptual evolutionary framework, the research has chosen the empirical domain of the UK mobile industry. The mobile industry is identified as a fastest evolving industry and therefore offers a way of exploiting the concept of this research for the practical domain. The research work exploits the 60% of the UK mobile industry in order to validate the concepts of endogenous and exogenous technological resources through the empirical studies. Every empirical study possesses its own drivers which impact the decision makers before investing in their relative technologies. At present, the most conflicting technology which needs mobile operators' consents in the UK mobile industry is related to Location Based Services (LBS). LBS rely on the interdependence of technological roles, their co-evolution and related evolution of the organisational capabilities of the mobile operators. The mobile operators are handling a plethora of companies focused on one or more segments: position-determining technology, location gateways, middleware products offering applications management, mapping and privacy, applications and contents. Understanding of all these technological roles in terms of investment and selection of appropriate partner is a major exercise for the mobile operators (Finney, 2002b). Today, LBS are enriched with additional information and are termed as Location aware services (Kaasinen, 2003). The mobile operators being a part of the mobile industry need to understand in detail about all related technological roles under certain drivers which are influencing their investment decision. In short, they need to check capabilities of the technological roles before making or buying these technologies. By answering such questions as: what types of benefits are required from these technological

co-evolutions? what types of changes are expected from these technological and organisational evolutions? what levels of returns are expected from these investments?, the mobile operators can identify the potentials of technologies for which they need to make an investment decision. In order to identify the influence of these drivers on the strategic decision-making of the mobile operators, the following section discusses four drivers in the empirical context of LBS.

2.5 The influence of drivers in the empirical domain of the UK mobile industry

The following discussion identifies the influencing reasons for making or buying various technological roles upon which organisational capabilities of the UK mobile operators depend. The UK is one of the pioneers in the introduction of mobile services (Oftel, 2003) and currently has a mobile penetration rate of 135%. Generally, making or buying decision relies on issues like cost, quality, delivery time, reliability or technical capability (McIvor and Humphreys, 1997, 2000; Probert, 1996, 1997; McIvor, 1997, 2000; Platts et al., 2000). In the context of LBS four influencing drivers have been identified which influence the investment decision of the strategic decision-makers. The first is related to the cost of the technology or how much a mobile operator can invest in technology co-evolution for a particular application. The second is the level of accuracy and quality of the technology or how efficiently the evolved technology can provide a quality application. The third is the market demand for technology or how much consumers are willing to use the evolved application and are ready to pay for it. The fourth relates to the power of self and governmental regulations or how regulations influence the adoption of an application. All these drivers are elaborated distinctly in the following discussion.

2.5.1 Cost of technology

Increasing speed and cost of technological development promise an increasingly uncertain environment for firms (Hagedoorn and Schakenraad, 1994). Whenever organisations face technology evolution the issue of investment requires concentration. Investment in the technology evolution mainly relies on the expected returns on investments. An organisation's financial position and its cost related strategies identify the investment capacity. The investment in component role may be the lowest amongst all. The

development of a component needs designing skills and manufacturing facilities. Once these capabilities are developed, organisations need evolution in software which relies upon the learning level of skilled workers. Therefore huge investments on hardware might not be always required. Once these components are developed, they can be reused in multiple products for similar types of applications.

In the context of LBS, the GPS chip acts as a component technology. To receive the satellite signals the GPS chips are integrated in the mobile handsets (HP iPAQ 6515, Nokia N95, Sony Ericsson K530, Nokia N6110, Nokia N81, Nokia 6210, Samsung i550). The same chip is also a part of car navigation products (TomTom, NavTeq, Navman). The developers of these chips (Qualcom, CSR, NXR) require the knowledge of the product in which that component will reside, and based on such information evolution on other roles will take place. If cost of making or buying the component technology is adequate for organisations, it can help the decision makers to make an investment decision.

Most of the products are composed of multiple components: the evolution of these components also evolve the product. The investment in evolving a product is a bit higher than the evolving component. The organisations investing in products are concerned with the cost of individual components, because it makes a complete product. Products like components also develop in modular innovation (Henderson and Clarks, 1990) but their evolution, as based upon multiple components, require larger investment as compared with single component evolution. In the context of LBS, the TomTom device when modified needs only software modification of digital maps as all other components like LCD screen, receiving chips, memory devices are already available. However a mobile handset requires both hardware and software modification in order to integrate a GPS chip to receive the position from satellite signals with the digital maps and user friendly interactive software. The result is the increased cost of the mobile handset.

Similarly to support applications, further investment in the infrastructure evolution is required. Infrastructure is also the combination of components and products, and as many components and products comprise the infrastructure a much higher investment is required. In the context of LBS, the adoption of a GPS chip in the mobile handset requires support from the additional infrastructure. The mobile operators who are providing the application

based on 3G (Third Generation) technology need support from A-GPS infrastructure which relies on components like A-GPS server and antennas for connection to the satellite signals.

These technological roles are resources to the mobile operators and their organisational capabilities rely on commitments to these resources. The more pervasive and detailed the patterning of the activity involved, the higher the cost of the commitments tend to be (Winter, 2003). Making or buying these resources and capabilities is a costly endeavour (Barney, 1986; Dierickx and Cool, 1989) therefore evolution of these committed resources raises the question of return on investment and the mobile operators think about the cost of these resources. If the investment is practicable and valuable, it may lead towards quick evolution.

2.5.2 Accuracy and quality of technology

The second important driver is the level of accuracy and quality of technology. If the technological role is providing an application already in some market, its level of accuracy can easily be judged. Before adopting that technology the decision makers compare all feasible alternatives, if they exist. The selection from available technologies results from a search process. Selection from alternatives also depends upon the organisational path trajectories, which organisations may decide to change to achieve a better level of accuracy and quality.

In the context of LBS, the navigation applications are provided by the space industry, based on signals received by GPS, and this application is widely accepted by users in the transport segment. The GPS system integrates both terrestrial and satellite systems and provides basic functionality with augmented accuracy and integrity (Special issue on GPS, 1999). However, a major disadvantage of the GPS signals is a very weak signal and provides the least accuracy in areas which are surrounded by huge buildings and indoors (Casal, 2004). Therefore the level of accuracy of the GPS signals for LBS inside buildings is visibly less. Bringing the same application to the mobile industry for pedestrian navigation is highly dependent upon the level of accuracy of the GPS signals. The mobile operators compare the accuracy level of the GPS signals with other available alternative location technologies (Enhanced Cell-ID) which are not as accurate as GPS but provide indoor applications. However, the combined technique, A-GPS (Assisted GPS), has the

indoor availability of terrestrial technique and the high accuracy of the satellite solution (Casal, 2004) seems to be the best available option.

The accuracy level of the component becomes visible when it supports a product and provides an application. Products can deploy components from distinct manufacturers, and based on their response to the desired application organisations make the investment decision. The adopted product when accompanied by infrastructure becomes more purposeful for organisations. An application can sometimes be achieved without selecting the most accurate component. By not adopting the accurate component, however, an organisation diminishes the quality of an application and may after some time demolish its existence. On the other hand, the selection of the most accurate component for an application can lead towards a satisfactory level for consumers and as a result increases the chances of return on investment.

The consumers' satisfaction level appears from the customers' functional threshold which specifies the minimum level of performance below which a consumer will not accept a product regardless of its price (Adner, 2002). In the context of LBS, if a GPS enabled mobile device does not provide LBS inside the building, no matter how cheap, the consumer will not find it useful and therefore will not pay for this application. On the other hand, if that same device can provide accurate application in the areas where GPS signals are strong enough, e.g. outdoors, customers willingly pay for these applications. In this context, the concept of Christensen (1997), about the trajectories of performance demanded by different market segments, increases the chance of application absorption by identifying the segments of consumers.

Due to the technology co-evolution the addition of a simple component requires a huge investment in infrastructure which, when combined, increases the level of accuracy of a particular application. When organisations become satisfied with the level of accuracy and quality of technology, through distinct complementary assets, it appears to encourage the decision to adopt that technology and appreciates the related evolutions.

2.5.3 Market demand for technology

Some technologies emerge in the market to fulfil the consumers' demand. At the other extreme, some technologies appear in the market to create the consumers' demand. The organisations developing the latter technologies might find these technologies already accepted in other markets or may create them based upon their novel ideas. Whatever the reason, the vision of organisations behind the technology evolution is always accompanied by the consumers' and market demand. This suggestion showed that technology innovation is driven by the external requirements of the market (Schmookler, 1966). Market demands through influence of consumers' needs have contributed towards the change of technological trajectories (Abernathy and Clark, 1985; Malerba, 1985; Christerisen, 1997; Sutton, 1998; Malerba et al., 1999; Tripsas, 2001; Adner and Levinthal, 2002). Market demand is created due to the enhancement in the level of consumers' needs. The consumer of the technology can either be an individual entity or an organisation. However, the resultant focus of a consumer organisation is ultimately to fulfil the individual customer's demand.

If technology possesses the component role then its potential consumers are mostly those organisations which need these components to develop their products. The end product can be demanded by the individual consumer or by an organisation which can exploit the product and integrate it to enhance its application. The product combined with application enhances the demand for combined technology and therefore may increase the level of adoption by the individual consumer. In the context of LBS, the demand for a GPS chip in the road navigation market is created by, for example the TomTom manufacturers and in the personal LBS is created by the mobile device manufacturers. The mobile device can be demanded by the individual user or by the mobile operators who further enhance their value with the addition of personal LBS applications.

If the demand for the same application emerges from a different market, then the combined technology might not receive a high demand. In such a scenario organisations have to monitor the 'preference overlap' (Adner, 2002) to identify the extent of development activities in all markets. In the context of LBS, mobile operators are not the only providers of LBS to consumers; several other organisations e.g. TraceAMobile, mapAmobile, Trisent, Matrix, CellTrack, ChildLocate etc are also providing it by using the infrastructure

of the mobile operators with their own products and applications. These developers can catch the consumers' preference before the mobile operators. Therefore mobile operators need to monitor their development activities along with customers' interest towards their services. Rosenberg (1982) proposed learning by using. In terms of applications, the customer experience with others' products and applications can provide information about the relationship between specific product characteristics and product performance (Helfat and Raubitschek, 2000) which can help the mobile operators to develop distinct applications to create customers' demands.

If the demand of an individual consumer is fulfilled from other markets then some additional capabilities are required to capture the attention of consumers. The support technology can play a crucial role at that point. The support technology can increase the performance of that application and may resultantly increase the demand level. The high efficiency of technology based on collective roles can create high demand. As demand increases and if organisations can foresee these requirements, they find it easy to accept these complementary assets with respect to the technology evolutions.

2.5.4 Self and governmental regulations

As technologies are converging, the issue of standards and interoperability have caught the maximum attention. The developers of technologies therefore produce the technological roles, which become operational in various contexts. To make technology applicable for distinct environments, the technology developers follow some standard formats. These formats are either produced by the technology developers themselves or special forums are working to produce these formats. These formats need authorisation from government and regulatory bodies before being available to the technology adopters.

Whenever organisations decide to adopt the standard technologies, they need to learn about their formats. These formats, based on cost, accuracy and quality criteria, provide classification of all alternative technologies. Depending upon the exact demand of an application, the organisation selects one technology.

In some situations governmental regulations influence organisations to adopt certain technologies which cause tremendous evolution. These regulations play the power role and

force organisations to evolve. As a result, organisations positively respond to them, even if these evolutions are not effective for organisation in-terms of fulfilling additional criteria. Nonetheless this influential power helps promote action in the sense of transformative capacity (Giddens, 1984) and therefore evolves technology. In the context of LBS, the reason behind the emergence of LBS in the mobile market is also influenced by 'DIRECTIVE 2002/22/EC'. Article 26 of the directive talks about the single European emergency call number 112 from every publicly available telephone service including mobile phones. Whenever a person in an emergency situation calls 112 from a mobile device, location must be identified through the LBS. In 2005, the number of mobile users in Europe was 669 million and is expected to grow to 779 million by 2011 (Portio Research mobile fact book 2006). Nearly 50% of emergency calls emanate from mobile networks and that percentage will continue to rise as more people purchase and use mobile phones (TruePosition, 2004). Due to the regulation, and the ever increasing number of mobile users, the mobile operators have to provide LBS on their mobile handsets.

The uncertainties in these enforcing regulations sometimes stop organisations evolving their technologies. Before the clear appearance of regulations, organisations consider, several times prior to the adoption of any technological evolutionary path, which suits their requirements. In the context of LBS, the directive for the emergency number does not clearly define the level of accuracy which the mobile operators need to provide for LBS to end users and also does not specify any time limitations for these evolutions. The only specification given by EU (European Union) is the availability of LBS even on the least accurate technology the 'Cell-ID'. The Cell-ID (cell-identification) is the main terrestrial technique which identifies the cell that is providing coverage to the target user equipment and those based on triangulation (Casal, 2004). Due to incomplete regulations the mobile operators are hesitating to invest in any of the available alternative technologies which might fulfil their requirement but might not satisfy the future regulatory body specifications. Once these regulations are made clear, organisations respond to them by evolving their technologies and adopting those complementary assets which are required by the government.

On the other hand, in order to handle some standards, organisations develop certain self regulations. Rapid technology evolutions make it difficult to achieve a suitable balance

between security and privacy. LBS provide a clear example of the privacy versus security issue. It can clearly support security by providing the emergency services with accurate positioning information but it is also a privacy invasive as the user's daily movement can be tracked and a profile built up which facilities both spamming and discrimination (Casal, 2004). The UK mobile operators handle this situation by developing the industry codes because technology as well as regulation together could help protect citizens' rights and balance the inherent tension between privacy and security in the evolving information society (Casal, 2004).

The discussed combination of these drivers and their influences on the decision makers in order to reach the investment decision and to identify required technological and organisational evolutions rely on the literature review and industrial practices. This stage helps the decision makers to approach the investment decision strategically. But in order to reach any decision the discussed stage needs support of certain measures which can provide values of BOCR (benefits, opportunities, costs and risks) of the investment decisions. Several methods have been proposed for the analysis of decision makers. SWOT (Strength, Weaknesses, Opportunities, Threats) analysis is one of them. It is an example of a perspective that has improved strategy, scholars' understanding and has been useful for practitioners (Priem and Butler, 2001; pp. 31). Traditional strategy research suggests that organisations need to seek a strategic fit between internal characteristics (strengths and weaknesses) and their external environment (opportunities and threats) (Dodourova, 2003). Similarly like SWOT, BOCR merits also help the decision makers to deterministically identify measures of investments. The BOCR constructs classify a set of factors which appears from the analysis of an evolutionary framework. The combination of these two stages develops the DTC model for organisations in order to reach the investment decision in the next generation of technology within a fairly swift market.

2.6 Conclusion

The investment decision for the next generation of the technology within a fairly swift market will be characterized by inter-relation of technological roles and their co-evolutions, by knowing their historical evolutions and by identifying their influences on the evolution of the organisational capabilities. In order to create a value for organisations, the decision

makers will identify the potential of technologies before making an investment decision. In this respect the framework defined for these decision makers in making the less risky investment decision will radically differ from the characteristics defined by theoretical literature. The frameworks that are currently defined for creating value for technological organisations are not sufficient to meet new requirements of the next generation of the technology within a fairly swift market. The new framework, called an evolutionary framework, needs a new concept, and a method in theory of the dynamic capabilities and consequently in the approach of making an investment decision.

A new concept that is featured to accommodate the next generation of the technology evolution within a fairly swift market identifies the potential of technology that forces the decision makers to make an investment decision and evolve their organisational capabilities in regard to these potentials. The characteristics of that concept include: a shift from the technological resources of endogenous industry towards exogenous industry; shift from moderately dynamic and high velocity dynamic markets towards a fairly swift market; reliance on the historical knowledge of technological and organisational evolutions; and influences of four drivers. In this chapter, a new concept has developed a new evolutionary framework which will be considered as the first stage of the solution method, called the DTC model, for the decision makers.

In chapter three the second stage of the DTC model is discussed with respect to the empirical domain of LBS. The chapter also provides details of the research methodology. In the end, the DTC model is presented which combines the concepts of an evolutionary framework along with the BOCR merits to help the decision makers to reach an optimum decision for particular technological and organisational evolutions.

Chapter 3: Development of an evaluation method as the second stage of the DTC Model and the Research Methodology

3.1 Introduction

The evaluation of strategic alternatives for making the investment decision in the technology co-evolution for the next generation of technologies is in principle a complicated task. This complexity increases within a fairly swift market where decision makers need to measure benefits, opportunities, costs and risks of the exogenous technologies. The evaluation method must consider a set of factors with the relevant influences of technological, organisational and resource evolutions. The multi-criteria decision analysis as a feasible methodology allows the decision makers to evaluate their strategic alternatives by considering a set of related factors and their influencing drivers.

This chapter intends to develop a set of factors with respect to their technological, organisational and resource evolution clusters under the influence of four drivers of this research to evaluate the benefits, opportunities, costs and risks (BOCR) of three strategic alternatives: A1, A2, A3. This evaluation method is the second stage of the DTC model. The set of factors are particularly developed by exploiting the conceptual evolutionary framework in the context of the mobile industry practices for Location Based Services.

The chapter begins by identifying the feasibility of multi-criteria decision logic for the technology co-evolution and it reviews the mobile industrial practices to define the set of factors with respect to clusters: technological, organisational and resource evolutions. Then it identifies the influence of these clusters on each other in order to validate the concept of an evolutionary framework. These clusters are grouped with respect to four drivers (accuracy and quality of technology, market demand for technology, cost of technology, self and governmental regulation) and are assigned with respect to their BOCR merits. The chapter then identifies the feasibility of the ANP tool to evaluate the BOCR merits of the investment decision. In the end, it presents the DTC model by combining both stages together.

In the second part, the chapter presents the research methodology which relies on the case study approach. The case study approach gathers qualitative data through interviews and quantitative data through workshops with the UK mobile operators. The qualitative data will validate the first stage of the DTC model and the quantitative data will validate the second stage of the DTC model.

3.2 Evaluation of the strategic alternatives in making the investment decision with Multi Criteria Logic

The convergence in technology and the technological co-evolutions in the next generation of technologies increase the level of difficulty in making the investment decision. The investment decision for any technology is a kind of strategic decision as it is undertaken within an organisation to improve its competitive advantage. Once the investment decision about technology is undertaken, organisations transform and selectively employ resources in order to pursue various strategic objectives (Dodourova, 2003). So the decision making process should therefore be based on a strategic point of view (McIvor, 2000).

On the basis of strategies the decision makers have to select the most feasible technology which on one hand increases the level of benefits and opportunities (e.g. return on investment, retention of customers, capturing new market segments, etc) and on the other hand reduces the level of costs and risks (e.g. accuracy and quality deficiency, less market growth, regulation enforcement, etc). If the investment decision is considered on the basis of technologists' perception, than their emphasis is more on the thrill of discovery that is translated in the optimization of knowledge, research, social progress and the professional prestige associated with it. However, managers' emphasis is more on profitability which stifles the development process, questioning the researchers' reasoning of further exploration in every step (Antoniou and Ansoff, 2004). The influence of several of these reasons on the investment decision promotes the need for developing a set of factors to present a holistic view of a particular technology to the decision makers including both the technologists and the managers of the organisation which help them in prioritizing the strategic alternatives of the investment decision.

The multicriteria logic is identified as the way to view problems in a holistic way (Saaty, 1996). Molenaar and Songer (1998) suggested that multicriteria are suitable for the selection decision where variables are large in number and possess complex relationships. The technology co-evolution and its complex relationship with the evolution of organisational capabilities and resources therefore create the need for identifying all possible factors for the decision makers through which they can reach the most feasible investment decision. Saaty (1996) proposed that in multicriteria logic all the factors are laid out in hierarchy or a network system that allows for dependencies where judgment and logic are used to estimate the relative influence from which the overall answer is derived (pp. 1). In a hierarchy system, dependencies of factors are uni-directional, however, the network system allows for feedback. Feedback enables factoring the future into the present to determine what we have to do to attain the desired future (Saaty, 1996; pp. 75).

3.2.1 The second stage of the DTC model - Development of an evaluation method with a set of factors

The strategic decision making environment is defined through a set of factors inside and outside the organisation that should be considered during the process of strategic decision (Tavana and Banerjee, 1995). However, every empirical domain possesses its own set of factors with certain commonalities. The objective of developing this set of factors is to address the question: 'How should the managers and technologists of the technological organisation (mobile operators) decide on how to invest in the co-evolutions of technologies and adapt their influences to the evolution of their organisational capabilities by knowing the benefits, opportunities, costs and risks of such an investment within a fairly swift market?'. Therefore this set of factors is mainly based upon research of mobile industrial practices with the help of theoretical concepts which present the benefits, opportunities, costs and risks involved in making a decision for the A-GPS technology to offer LBS. The terms LBS encompasses an ever increasing set of applications that use a basic combination of positioning information with mobile communications to deliver a variety of value added services to the user (Swann et al., 2003). In Europe, most of the mobile operators are offering LBS through Cell-ID and enhanced Cell-ID technologies, but many are leaning towards A-GPS for high accuracy positioning in the future (Gibson and Cory, 2005). This research is particularly measuring the BOCR merits for the UK mobile operators who may or may not invest in the A-GPS technology.

3.2.1.1 Alternative decisions

The investment decision in technology co-evolution faced by the decision makers can be answered by knowing the benefits, opportunities, costs and risks of the following strategic alternatives.

A1. Invest now in the technological co-evolutions

A2. Wait until exogenous technological co-evolutions become a commodity

A3. Do not invest in the technological co-evolutions

The A1 alternative is defined as a strategy which prefers a recent investment in technology co-evolution. In terms of A-GPS technology this alternative will cause the mobile operators to invest now in A-GPS infrastructure, mobile handsets, software components, development of new applications and some other exogenous industry resources. The alternative A2 is defined as a strategy which prefers to wait before investing in technology co-evolution. In terms of A-GPS technology this alternative will cause the mobile operators to wait until 2010. The year 2010 is expected to be the year of the operational launch of Galileo (Jenkins et al., 2005). Galileo is to be the European contribution to a global navigation system under civil control which will be an independent satellite system but interoperable with GPS. It is expected that Galileo will contribute to improve the availability and accuracy for LBS (Swann et al., 2003). Therefore the mobile operators can wait and instead of investing in the A-GPS technology they can invest in the A-GNSS (Assisted-Global Navigation Satellite Systems) technology. The alternative A3 is defined as a strategy which prefers no investment in the technology co-evolution. In terms of A-GPS technology this alternative will cause the mobile operators to continue using their endogenous technology, the Cell-ID, and not to invest in exogenous technology, the A-GPS. Fig 3.1 presents these three alternatives for the technology co-evolution.

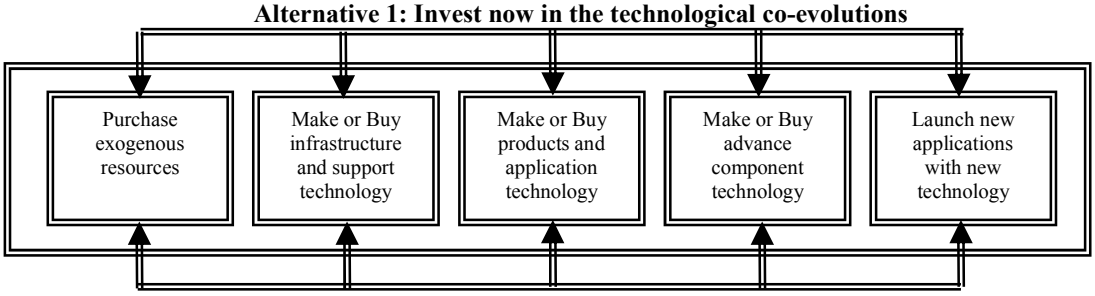


Figure 3-1: Strategic alternatives: A1, A2, A3

Either alternative A1 or A2 is chosen by the decision makers will cause investments in distinct technological roles as shown in fig 3.1 but if alternative A3 is chosen then it will lead towards no investment. The detailed analysis of the mobile industry practices and qualitative interviews with the mobile and satellite industry experts helped in developing a set of 52 factors which can influence the strategic decision of the mobile operators for making an investment in the A-GPS technology. The validity of these factors was achieved by sharing it with the mobile operators and adding a few more with their consents. Their classification is in table 3.1 and their discussions are under 3.2.1.2. As discussed these factors are grouped with respect to: three clusters - Technological evolutions, Organisational evolutions, Resource evolutions; four drivers - Accuracy and Quality of technology, Market Demand for technology, Cost of technology, Self and Governmental regulations; to measure the values of Benefits, Opportunities, Costs and Risks merits.

Table 3-1: Classification of multi-criteria factors with respect to their clusters, drivers and merits

BOCR	Drivers	Clusters	Set of Factors
Benefits	Accuracy and Quality of Technology	Technological evolutions	TE1. Integration of new network components for future availability TE2. Integration of old applications over new infrastructure
		Resource evolutions	RE1. Integration of new knowledge of latest technology RE2. Availability for future developments of new and emerging applications
		Organisational evolutions	OE1. Reconfiguration of network rollout OE2. Integration of new terminal developments
	Market Demand for Technology	Technological evolutions	TE1. Support to the emergency applications TE2. Drive demand for new services – early adopter syndrome
		Organisational evolutions	OE1. External industry partnerships OE2. Internal industry partnerships OE3. Capturing and expanding towards new market segments OE4. Retention of suppliers of technology OE5. Assistance to Government: police and ambulance services
	Cost of Technology	Technological evolutions	TE1. Replication of existed infrastructure TE2. Integration of different infrastructures whenever accurate is not available TE3. Consolidate and maximum use of assets
	Self and Governmen -tal Regulations	Technological evolutions	TE1. No push from OFCOM TE2. Influence of operators on technology co-evolution decision
		Organisational evolutions	OE1. Leveraging of code of ethical purchase OE2. Leveraging of code of best practice for passive LBS OE3. Leveraging of responsible network deployment policy

Opportu-nities	Accuracy and Quality of Technology	Resource evolutions	RE1. Expectation from Galileo for improved accuracy RE2. Developing easy to use application interfaces for future applications RE3. Availability of core capabilities within organisation
		Organisational evolutions	OE1. Keeping track of exogenous industry resources
	Market Demand for Technology	Technological evolutions	TE1. New applications for new customers TE2. Retention of customers through offering multiple applications TE3. Retention of successful applications
		Organisational evolutions	OE1. Variations in R&D for service and application developments OE2. Need of highly customer focused management for niche applications OE3. Learning from International market stories OE4. Learning from customers' experiences
	Cost of Technology	Technological evolutions	TE1. Expected reductions in handsets cost TE2. Expected reductions in mapping data, services and applications cost TE3. Expected revenue from new applications
Costs	Market Demand for Technology	Organisational evolutions	OE1. Price associated with marketing of new applications for customers' awareness OE2. Strategy focused towards future investments in LBS
	Cost of Technology	Technological evolutions	TE1. Price associated with LBS enabled handsets TE2. Price associated with Infrastructure TE3. Price associated with components TE4. Price associated with new licences from external technology developers
Risks	Market Demand for Technology	Technological evolutions	TE1. Less market growth of available applications TE2. No visible killer application
		Organisational evolutions	OE1. Low revenue growth from available applications OE2. Keeping track of competitor's applications OE3. New entrants changing market dynamics
	Self and Governmen-tal Regulations	Technological evolutions	TE1. Unavailability of GPS signals TE2. Monitoring integrity and upgrading of digital maps
		Organisational evolutions	OE1. OFCOM insistence for highly accurate technology OE2. Satisfying customers' doubts about their privacy OE3. Measuring quality of exogenous and third party technological resources OE4. Satisfying media doubts
All networks	Alternative		A1. Invest now in the technological co-evolutions A2. Wait until exogenous technology becomes commodity A3. Do not invest in technological co-evolutions

3.2.1.2 The BOCR merits

The values of BOCR merits can be examined by the mobile operators with the detailed analysis of a set of factors grouped with respect to their relative clusters. The clusters are categorized with respect to their relative drivers. As discussed in chapter two these four

main drivers are behind the adaptation of technology co-evolution. In order to observe the influence of technology co-evolution on the evolution of organisational capabilities, all individual clusters are discussed in detail in the following section.

3.2.1.2.1 Benefits

The goal of this section is to calculate merits of the ***benefit***s. This section is classified into: Accuracy and Quality of technology, Market Demand for technology, Cost of technology and Self and Governmental Regulations. This section is shown in figure 3.2.

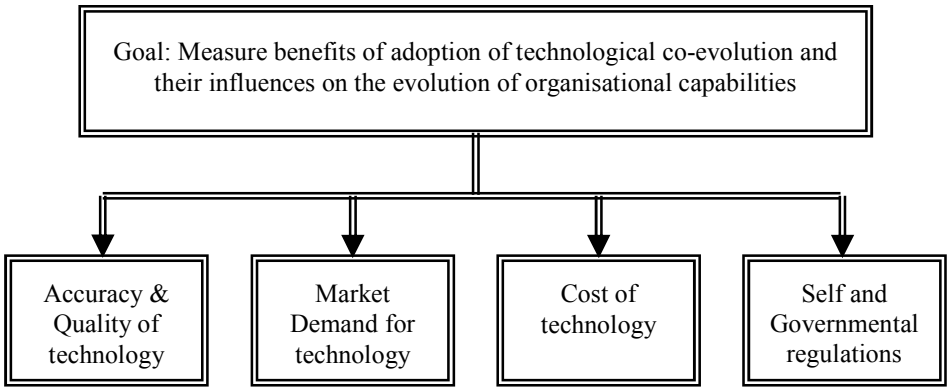


Figure 3-2: The Benefits segment

Under benefits of Accuracy and Quality of technology, there are three clusters: Technological evolutions, Resource evolutions and Organisational evolutions. Their factors are defined below.

1. The Technological evolutions cluster has two factors:

TE1. Integration of new network components for future availability

TE2. Integration of old applications over new infrastructure

- *TE1: Integration of new network components for future availability* - refers to the benefits of adding new and standard components with available infrastructure. In terms of LBS, the components are Location Servers and the GPS chips inside the mobile handsets. The integration of locations servers such as Ericsson's Mobile Positioning System (MPS): MPS-U for WCDMA (Wideband Code Division Multiple Access) based Cell-ID, MPS-G for GSM (Global System for Mobile communication) based Any Time Interrogation (ATI), Cell Global Identity (CGI), Timing Advance (CGI-TA), Enhanced CGI (E-CGI) and Assisted-Global Positioning system (A-GPS), with already available components like

Location Enabling Server (LES) in order to increase the accuracy of available technology. This factor relies on the availability of these components, ease of integration of these components into network and speed of this integration. Another component, the GPS chip, has its contribution towards this integration. One survey conducted by Berg Insights revealed that 75% of the mobile operators in Europe feel that the built in GPS chip in the mobile handsets is the most important factor to make the LBS market boom (Berg Insight, 2006).

- *TE2: Integration of old applications over new infrastructure* - refers to the possibility of integrating already available applications such as Yellow pages, Point of Interest, pedestrian navigation, public transport information, traffic information, Lone worker tracking, (Wilde et al., 2004) etc. over new infrastructure with the increased level of accuracy. It identifies the benefit of no need for further resource allocations for the development of new applications but increase of the end users' experience through quality applications.

2. The Resource evolutions cluster has two factors:

RE1. Integration of new knowledge of latest technology

RE2. Availability for future development of new and emerging applications

- *RE1: Integration of new knowledge of latest technology* - refers to the benefits of increased learning of the technologists due to the addition of new components and infrastructures. The research reveals a dynamic interplay between the firm's internal capabilities and the changing external conditions, recognizing that learning is the main way in which organisation interact with, and are changed by their environment (Davies and Brady, 2000). In environments where technologies are co-evolving continuously, the learning of technologies becomes the main resource for future evolutions. Technology in use is an amalgam of artifacts, knowledge and organisation (Fleck, 2000; pp.257). Therefore its knowledge and learning can further develop organisational capabilities (roles of organisation, knowledge, skills and experience) required to carry out particular functional activities (R&D, design, production, marketing, etc) (Davies and Brady, 2000). However, in terms of LBS, the hitherto largely untapped value of the mobile operators' knowledge base can also become an additional driver for the development of LBS (Gibson and Cory, 2005).

- *RE2: Availability for future development of new and emerging applications* - refers to the benefits of utilizing the enhanced infrastructure for the development of more advanced and accurate applications. In terms of LBS, the increased level of accuracy will make it possible in future to lend locations for virtual city guides, and enable virtual tagging to take users on real world treasure hunts and partake in more advanced gaming formats (McQuigg, 2006).

3. The Organisational evolutions cluster has two factors:

    OE1. Reconfiguration of network roll-out

    OE2. Integration of new terminal developments

- *OE1: Reconfiguration of network roll-out* - refers to the benefits of the addition of new assets due to the recombination of an increased number of components with the recent roll-out of network infrastructure such as 3G-WCDMA, 3.5G-HSDPA (High Speed Downlink Packet Access) and HSUPA (High Speed Uplink Packet Access). To offer LBS, mobile operators reconfigure their 2.5G network with the Cell-ID technology (Finney, 2002a). Since the launch of mobile networks there is a continuous evolution in the form of network roll-out in respect of technological generations from 1G through 2G, 2.5G, 3G and now 3.5G (Hart and Hannan, 2004). The evolutionary path of the mobile infrastructure is complemented with the evolution of related technologies which collectively provide benefits to organisation.
- *OE2: Integration of new terminal developments* - refers to the benefits of new assets due to the addition of fixed GPS receivers that are required to be placed at regular intervals, every 200 to 400 km to fetch the GPS data and complement the readings of the mobile handsets. The assistance data makes it possible for the receiver to make timing measurements from the satellite without having to decode the actual message. This assistance greatly reduces the time needed for a GPS receiver to calculate the location. Without the assistance information the TTFF (Time-To-First-Fix) could be in the range of 2045 seconds. With the assistance information the TTFF could be in the range of 18 seconds. This assistance is broadcast around one each 1 hour (Silva, 2002).

The factors of these clusters are shown in figure 3.3. The arrow heads in the figure are pointing to present the influence of one cluster on another. The investment decision of three alternatives is influenced by three clusters but at the same time, these alternatives are also

influencing evolutions of these clusters (This is applied to every following cluster). Therefore A1, A2, A3 are influencing and are influenced by TE1, TE2, RE1, RE2, OE1, OE2. The knowledge of advance technology and its availability for future development will only occur when new technological roles are integrated with already available technological roles. Therefore RE1 and RE2 are influenced by TE1 and TE2. Similarly, reconfiguration of network rollout and integration of new terminal development will only occur when new technologies are integrated with the old technologies. Therefore OE1 and OE2 are influenced by TE1 and TE2.

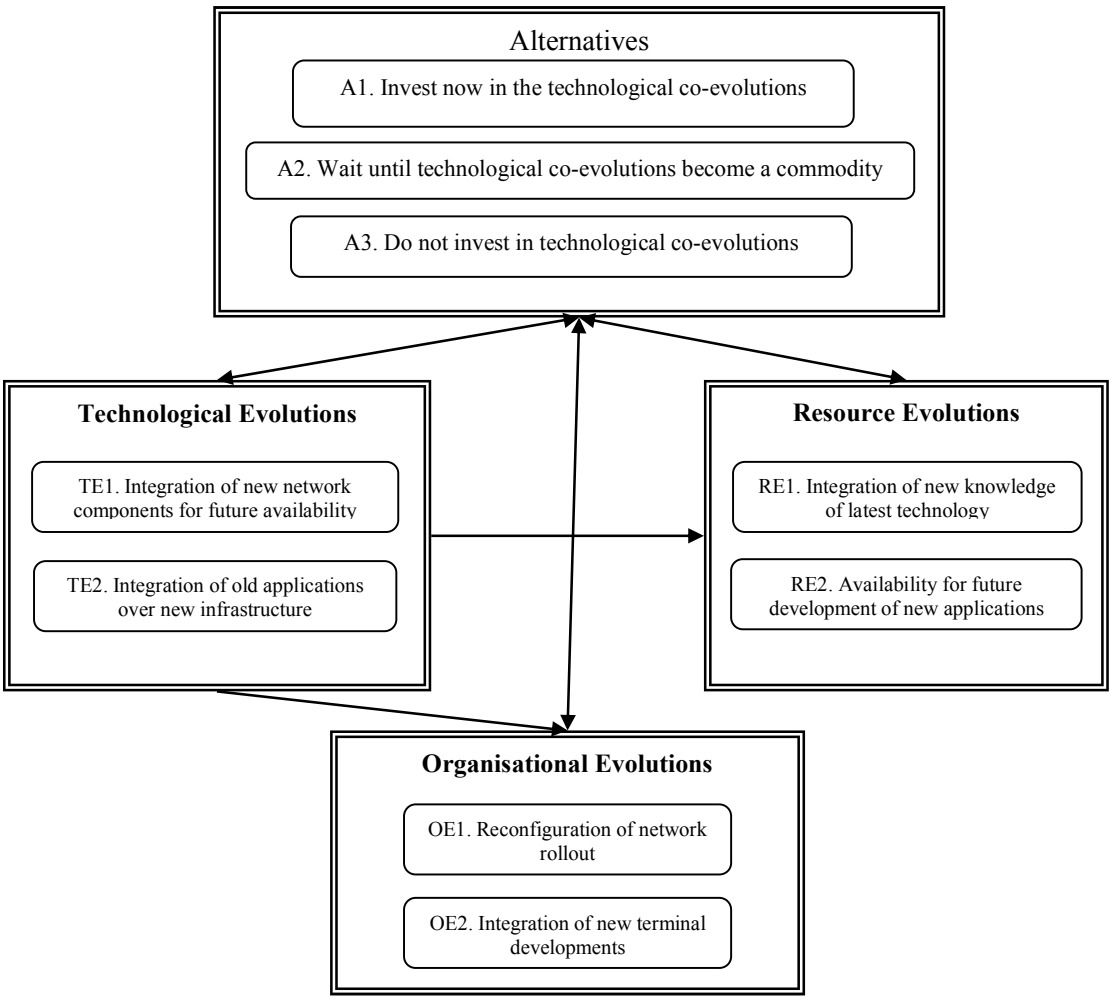


Figure 3-3: Clusters with factors under benefits of accuracy and quality of technology

Under benefits of Market Demand for technology, there are two clusters: Technological evolutions and Organisational evolutions. Their factors are defined below.

1. The Technological evolutions cluster has two factors:

TE1. Support to the emergency applications

TE2. Drive demand for new applications – early adopter syndrome

- *TE1: Support to the emergency applications* - refers to the possibility of increasing the accuracy level, to about 5m, in pinpointing the locations of the mobile callers. At present, the accuracy level practically achieved from the UK mobile operators ranges between 49 and 5031 m (Belcher, 2007). It is expected that the number of mobile users in Europe will grow to 779 million by 2011 (Portio Research, 2006). With the continuous increase in the number of mobile users the probability of receiving emergency calls from mobile devices also increases. LBS in such a scenario provide a convenient way to locate positions of the mobile callers. Because of the potential of LBS for saving lives, the EU should consider wireless e-112 a high priority (Wilde, 2002). The increased precision can enable the capturing of new markets by complementing the applications of emergency services with vehicle tracking provided by AA and RAC, through identifying locations of their customers. Along with this, it can offer greater accuracy for services developed by third party application developers like ChildLocate for the safety of children. Research identifies some appealing services in the tracking including child tracking and alert for tracking and emergency services for elderly (TruePosition, 2005).
- *TE2: Drive demand for new applications – early adopter syndrome* - refers to benefits of technology co-evolution in a way that sometimes early adopters take new technology for the sake of new technology. The co-evolution of LBS, and expected launch of Galileo, have created an emerging market in which if mobile operators do not invest in this advance technology they may miss the future opportunities related to the Galileo technology. The early adoption may not be cost effective for the mobile operators but can bring in benefits of utilizing the technology to develop and launch new applications before competitors and can further create demand for these new applications. First movers are generally thought to garner fairly robust advantages over later entrants. However, the degree to which these advantages prevail in emerging markets is not known (Cheryl and Sivakumar, 1997).

2. The Organisational evolutions cluster has five factors:

OE1. External industry partnerships

OE2. Internal industry partnerships

OE3. Capture and expanding towards new market segments

OE4. Retention of suppliers of technology

OE5. Assistance to the government – police and ambulance services

- *OE1: External industry partnerships* - refers to benefits of widening the scope of networking amongst the organisations of the satellite and mobile industries. The networking can blur industrial boundaries and can widen the possibilities of sharing the tangible and intangible resources. European Satellite Navigation Industries (ESNI, 2004) have already commented, '*Integration of communications with LBS promises to open the door to many interesting applications'*. These partnerships can enable mobile operators to further explore new technologies which can decrease the risk of losing out on new interesting technological opportunities and spread costs and risks among partners (Schoenmakers and Duysters, 2006).
- *OE2: Internal industry partnerships* - refers to benefits of networking of several players of LBS value chain. Such a network includes developers of digital maps (Ordinance Survey, Webraska, Navteq, Navman, Google, etc) and other contents like events of interest, traffic and weather information, developers of mobile handset (Nokia, Sony Ericsson, Motorola, etc), developers of infrastructure (Ericsson, Nokia, Nordic, Alcatel, etc) and the mobile operators (Vodafone, Orange, O2, etc). Their partnership and networking is due to the technology co-evolution related to LBS or in other words the evolutionary process drives the development of these networks (Kirman, 1997). These networks allow the resource sharing amongst these players along with the sharing of expensive resources between competitors. All the players of the value chain can benefit directly from partnerships to expand their offerings and become more competitive. The mobile operators in particular can gain the advantages of increased revenue, decreased churn, decreased time to market, and decreased overheads (McQueen et al., 2002).
- *OE3: Capturing and expanding towards new market segments* - refers to broadening the exposure of the mobile applications to the mass market LBS for value added services. The different market segments include corporate, personal & family safety, information and leisure & youth. The corporate segment includes fleet tracking, asset tracking,

management, navigation, mobile advertising. The personal safety segment includes child watching, emergency call routing, nearest hospital and paramedics support. The information segment includes traffic and weather info, where is the nearest?, maps and routes and navigation instruction. The leisure & youth segment includes mobile gaming, friend finder, match mapping and tourism information like hotel finders and city guides while on the move (Finney, 2002b). These value added services result due to the external and internal industry partnerships. Firms form partnerships in order to exploit their existing resources in new markets where each firm brings in its core competencies (Schoenmakers and Duysters, 2006). These partnerships will provide benefits to mobile operators to increase profits by differentiating their market offering and get new revenue streams.

- *OE4: Retention of suppliers of technology* - refers to benefits of utilizing the technology from the previous suppliers of technologies such as Ericsson, Nokia, Siemens, Redknee etc, which supply technologies for Cell-ID as well as for A-GPS and evading extra strategic partnerships. Because new partnerships, at one hand, bring the external knowledge but also increase the massive integration challenges (Schoenmakers and Duysters, 2006) for organisations. The retention of suppliers also relies on the pedigree of these suppliers which is already known to the mobile operators. The network infrastructure suppliers and location specialists like CellPoint supply integrated position-determining and gateway products from the start, providing the mobile operators with the capability to offer higher location accuracy than standard Cell-ID technology (Finney, 2002b).
- *OE5: Assistance to government – police and ambulance services* - refers to benefits of mobile users' surveillance through closest and most appropriate ambulances, fire and rescue resources and police services, in high emergency conditions (*In UK LBS applications are demanded by ambulances, as most of the calls are now done by the mobile phones the ambulance services providers need LBS to identify the exact location of the mobile callers – Pat Norris*, *Logica)*. Research shows that medical emergencies and road accidents are two of the leading causes of death throughout the industrial world (Wilde et al., 2004). Road accidents involving traumatic injury can be even more sensitive to timing. It typically takes 5 minutes or more to report such emergencies on the road. Delays due to the lack of information about the crash site can be crucial to the victim's chances, since 30% of deaths occur within minutes of the crash and 50% occur before the patients arrive in the hospital (Champion et al., 1999). This benefit saves lives as well as identifies the government as a potential customer of LBS applications. It is also expected that legislation

around e-112 can stimulate the development of LBS enabling technology as it is on track to become law by 2011 (Cory, 2007).

The external industry partnerships, capturing and expanding towards new market segments including government will only occur when technologically the mobile operators become capable of supporting the emergency applications due to the early adopter syndrome. Therefore OE1, OE3 and OE5 are influenced by TE1 and TE2. Similarly, new internal and external industry partnerships and motivation of capturing new market segments like government will make the mobile operators technologically capable of supporting emergency applications and evolve technologically due to the technology's sake. Therefore TE1 and TE2 are influenced by OE1, OE2, OE3 and OE5. At the same time, OE3 and OE5 are also influencing each other. The factors of these clusters are shown in figure 3.4.

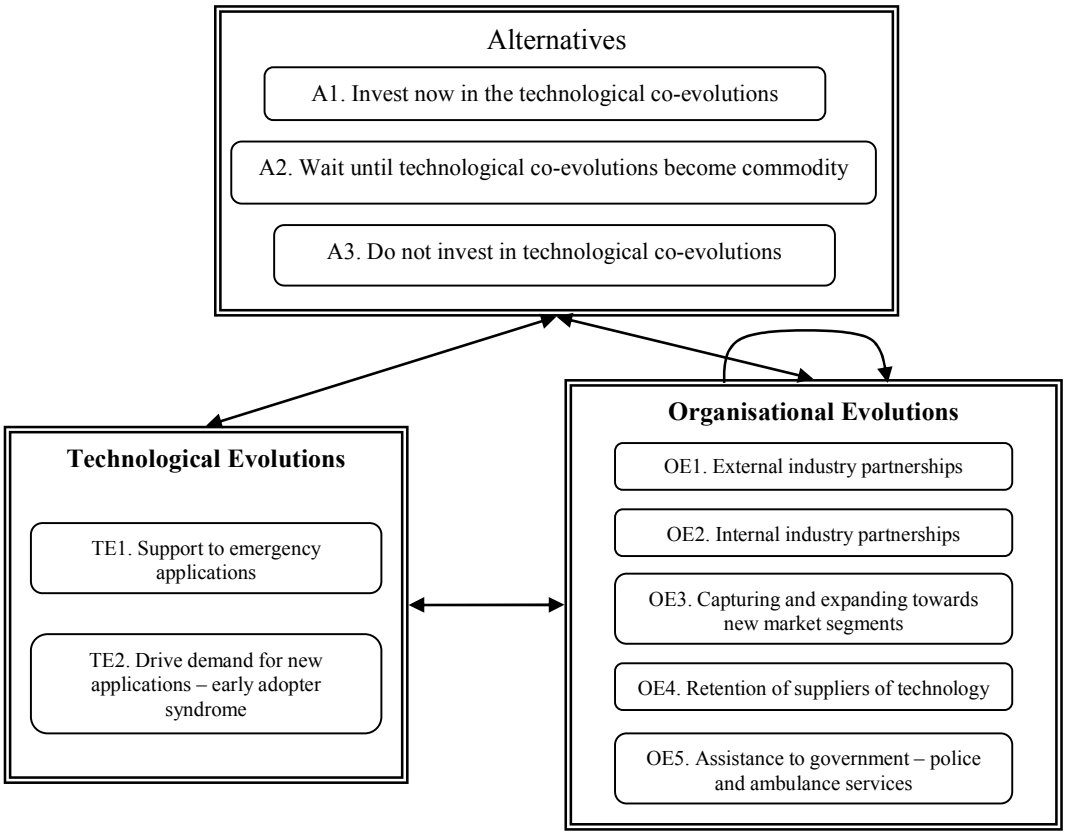


Figure 3-4: Clusters with factors under benefits of market demand for technology

Under benefits of Cost of technology, there is one cluster: Technological evolutions. Its factors are defined below.

1. The Technological evolutions cluster has three factors:

TE1. Replication of existed infrastructure

TE2. Integration of different infrastructure whenever accurate is not available

TE3. Consolidate and maximum use of assets

- *TE1: Replication of existed infrastructure* - refers to the benefits of utilizing existed network for advance applications. Hamel and Prahalad (1994) have emphasized the need for managers to generate competitive advantage by leveraging the resources of the firm. In terms of LBS, the existed infrastructure of the mobile operators such as 2G-GSM, 2.5G-GPRS (General Packet for Radio Services), EDGE (Enhanced Data rate for GSM Evolution) and 3G-WCDMA, 3.5G-HSDPA & HSUPA can be replicated for advanced location enable technologies. For the Cell-ID technology GSM and GPRS have been identified as the most feasible infrastructure and the regulatory body 3GPP (Third Generation Partnership Project) demonstrated 3G as the basic infrastructure of A-GPS based LBS. Replicating and leveraging this basic infrastructure for advance applications will create value for the mobile operators.
- *TE2: Integration of different infrastructure whenever accurate is not available* - refers to benefits of exploiting seamless communication by switching between Cell-ID and A-GPS. This integration is required in the serious fading environment where satellite signals are weak or not available such as urban canyon or inside buildings. The combination of GPS and cellular networks can obtain higher signal availability, better geometry, and a better location performance (Changlin, 2003). These various positioning techniques including triangulation based on measurements of the uplink and downlink channels and the satellite navigation are considered on the basis of their cost-effectiveness and feasible hybrid solutions for delivering a reliable location service. In a longer perspective the European framework have a plan to standardize positioning techniques, interfaces and platforms (Bohlin and Andersson, 2004).
- *Consolidate and maximum use of assets* refers towards benefits of combining a group of technological resources and assets to improve their collective output for the mobile operators. With rapid technological developments, the ability to imagine and combine

different, formally separated technological capabilities in order to facilitate new and valuable user experiences is possible now (Galli et al., 2005). In terms of LBS, consolidation of several technological assets possessing distinct technological roles can offer the cost benefits and if these assets are from external resources can share the cost risks.

The replication of infrastructure, integration of different infrastructure and consolidation of assets will only occur if all these assets will collectively be utilized and be evolved together. Therefore TE1, TE2 and TE3 are influencing each other. The factors of this cluster are shown in figure 3.5.

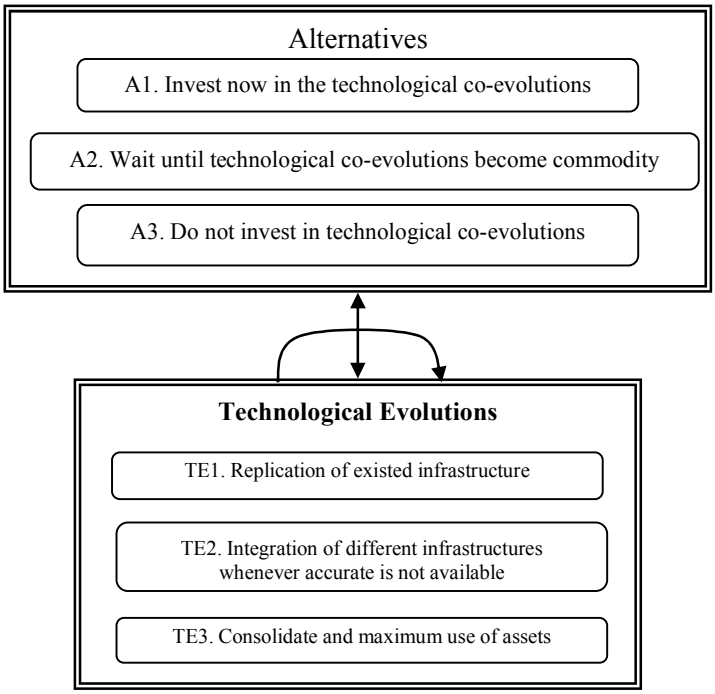


Figure 3-5: Clusters with factors under benefits of cost of technology

Under benefits of Self and Governmental regulation, there are two clusters: Technological evolutions and Organisational evolutions. Their factors are defined below.

1. The Technological evolutions cluster has two factors:

    TE1. No push from OFCOM

    TE2. Influence of mobile operators on technology co-evolution decision

- *TE1: No push from OFCOM* - refers to the benefit of relaxation offered by the regulatory body OFCOM (Office of Communication) in UK. At present, OFCOM does not ask for any specific level of accuracy from location technologies and therefore allows operators to choose any technology with their preferences. In the US, the FCC (Federal Communications Commission) has issued precise directives for how accurate emergency positioning the operators need to provide and when it has to be implemented, whilst regulatory bodies within the EU has chosen not to issue such detailed directives (TruePositions, 2005). (*The government laws and regulations are affective on Galileo, but as far as the mobile industry is concerned the government has not put any influence on operators and service providers. They develop their own policies and implement it. – Pat Norris*, *Logica)*.
- *TE2: Influence of mobile operators on technology co-evolution decision* - refers to the benefits of no regulation influence on certain technological roles in technology co-evolution. Location based services bring a new dimension of user interaction and personalization of mobile services, it is an enabler and enhancer of mobile services and, as such does not exist in isolation (McQueen et al., 2002). Shifting the focus from location service towards location enabler a wider range of services catch operators' interest (Finney, 2002b). As this technology integrates a large numbers of inter-related technologies, the mobile operators sometimes get some technologies free of cost within the expensive bundle of technologies, bringing in the benefits of their inter-relations and therefore showing no influence of mobile operators on this evolution.

2. The Organisational evolutions cluster has three factors:

    OE1. Leveraging of code of ethical purchase and supply chain policies

    OE2. Leveraging of code of best practice for passive LBS

    OE3. Leveraging of responsible network deployment policy

- *OE1: Leveraging of code of ethical purchase and supply chain policies* - refers to benefits of replicating already developed codes when purchasing new technologies from the technology developers such as Ericsson, Siemens, and Nokia etc. In the UK, the mobile operators work with suppliers to raise awareness about ethical sourcing. They publish annual Corporate Responsibility Reports (CSR) in which they mention their ethical purchasing and procurement policies based under industry codes. In term of LBS, where a

single technology is unable to operate in isolation, mobile operators need to handle their purchasing and supply chain standards. As these standards are already established they can be leveraged for LBS.

- *OE2: Leveraging of code of best practice for passive LBS* - refers to benefits offered by the 'Industry Code of Practice for the Use of Mobile Phone Technology to provide Passive Services in the UK'. This code was announced by the UK mobile industry in 2004 (Imcb, 2004) as the result of an issue raised by the mobile users who do not want to be located all the time. Based on this code a contract was established with all service providers to ensure that the consent of the person being tracked is obtained before initiating a tracking service. In terms of consumer applications the service provider obtains consent directly from the person being tracked. For business applications, employee consent must be obtained either by the LBS provider or by the employer. The focus of that code covers four key areas: child protection, consent, anti-surveillance and ease of use.
- *OE3: Leveraging of responsible network deployment policy* - refers to the benefits of replicating 'The Ten Commitments' code of practice for the network rollout and terminal developments. The Ten Commitment code was launched by the UK mobile operators in 2001. This initiative has three aims: improved transparency of the process of building mobile networks; providing more information to the public; and increasing the role of the public in the sitting of base stations. The commitments are being put into practice in consultation with key local government and community stakeholders to ensure they are fully workable. This code is now regularly monitored by the Mobile Operators Association (MOA), who are responsible for environmental friendly network deployment in the UK.

These codes are developed in isolation and therefore do not possess any relationship with each other. The factors of these clusters are shown in figure 3.6.

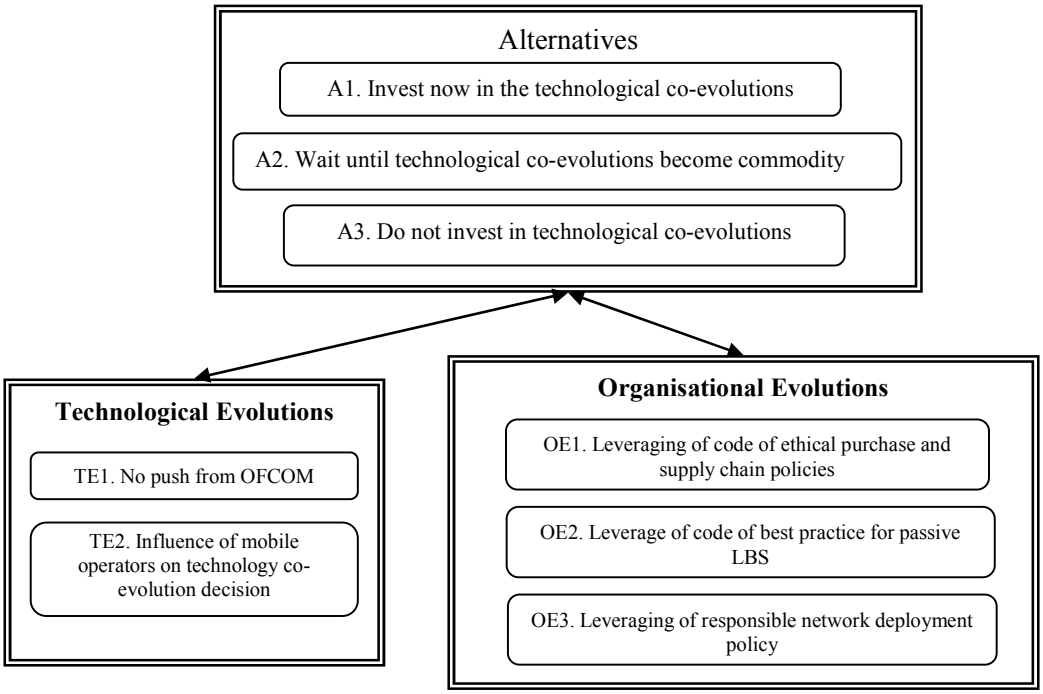


Figure 3-6: Clusters with factors under benefits of self and governmental regulations

3.2.1.2.2 Opportunities

The goal of this section is to calculate merits of the ***opportunities***. This section is classified into: Accuracy and Quality of technology, Market Demand for technology and Cost of technology. This section is shown in figure 3.7.

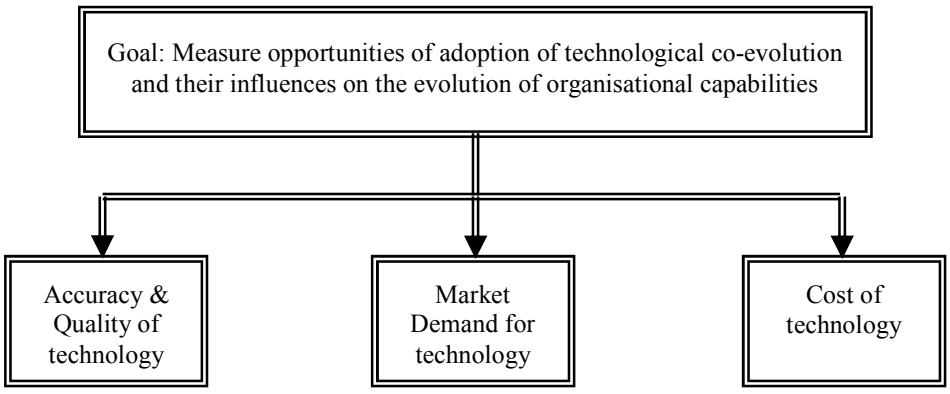


Figure 3-7: The Opportunities segment

Under benefits of Accuracy and Quality of technology, there are two clusters: Resource evolutions and Organisational evolutions. Their factors are defined below.

1. The Resource evolutions cluster has three factors:

RE1. Expectation from Galileo for improved accuracy

RE2. Developing easy to use application interfaces for future applications

RE3. Availability of core capabilities within organisation

- *RE1: Expectation from Galileo for improved accuracy* - refers to opportunities which can be achieved by offering more advance applications in corporate and consumers' markets after the uptake of Galileo. In this regard, the satellite industry is complementing the efforts of the mobile industry for LBS. In Europe, the EC identifies Global Navigation Satellite Services (GNSS) as a critical technology that could revolutionize European transport infrastructure (COM, 2001). Another good example is the Application of Galileo In the LBS Environment (AGILE) project, managed by LogicaCMG and Alcatel Alenia Space, which aims to foster the take-up of GNSS in the key sector of mass-market LBS, with special emphasis on the use of EGNOS (European Geostationary Navigation Overlay Service) and Galileo (Hanley et al., 2006). AGILE is supported by the Galileo Joint Undertaking (GJU) with funds from the EU's sixth framework programme. Once the Galileo is launched in a few years' time, a small Galileo chip will be integrated within mobile phones, giving users the ability to pinpoint restaurants, hotels, movie theatres, hospitals or car parks (Scottsdale, 2006). The overall expectations from Galileo are based on clear consensus from the studies which was that the user will greatly benefit, in all application areas, from the additional system in terms of availability, reliability and accuracy (Hanley et al., 2006).
- *RE2: Developing easy to use application interfaces for future applications* - refers to opportunities offered by the LIF (Location Interoperability Forum) in defining, developing and promoting common ubiquitous service solutions. Much effort is put in standardizing LBS, both on the network and application side. Main forces are LIF, formed by vendors and interested parties including Ericsson, Motorola and Nokia (NorthStream, 2001) and the 3GPP (3^{rd} Generation Partnership Program), defining mainly the addition of the LBS capabilities with releases of 3G networks. 3GPP has also initiated substantial effort to introduce Galileo positioning in location based standards. Its purpose is to use Galileo through the A-GNSS techniques already standardized (Swann et al., 2003). Defining standards makes it easier for application developers to provide application interfaces irrespective of endogenous or exogenous positioning technologies.

- *RE3: Availability of core capabilities within organisation* - refers to opportunities of enhancing organisational and technological capabilities by integrating advanced technologies and using them for future evolutions. The core capabilities enable an organisation to distinguish its capabilities to adapt, grow and achieve competitive advantage (Leonard, 1995). Before investing in technologies the mobile operators consider the unique selling proposition (USP) of technology versus its competitor. The A-GPS technology itself cannot be a core technology for the mobile operators because it can easily be bought from exogenous technology developers. But its presence inside the organisation can be considered as a resource which will be used to develop certain capabilities through the co-evolution of technological and organisational capabilities which will be value-creating and will utilize rare resources (Barney, 1991). Theories suggest that firms make technology internally if they possess related competences or buy externally if they do not possess related competencies (Prahalad and Hamel, 1990). Once a technological capability becomes part of an organisation, the development of rare resources seems possible inside an organisation.

2. The Organisational evolutions cluster has one factor:

OE1. Keeping track of exogenous industry resources

- *OE1: Keeping track of exogenous industry resources* - refers to the opportunities which can emerge by knowing and utilizing the technological progress of the satellite industry in order to push the LBS applications in corporate and customized markets. The satellite industry is developing resources for six market segments (Styles et al., 2005). Road: covering all corporate and consumer telematics applications for route finding, congestion avoidance, fleet management and distance based road user charging. This segment also includes advance future applications related to automated safety and a drive assistance system along with the Intelligent Transport System (ITS) (Firmin, 2006). Personal LBS: covering all navigation and LBS where the basic platform is a hand-held receiver. This includes the leisure market, location in mobile phones and the rapidly growing PDA navigation market. Aviation: covering all aviation navigation applications for civil and general aviation. Rail: covering both non safety-critical rather telematics applications (Fleet management and customer information) and safety critical train control. Maritime: covering regulated and un-regulated maritime navigation. Professional: covering both high value business critical applications such as oil and gas exploration, together with regulated

applications in support of specific policy objectives, such as control of fisheries and monitoring of hazardous goods in transit (Styles et al., 2005). Knowing these progresses can keep the mobile operators updated for their future application developments.

The expectations from Galileo will only increase when the mobile operators keep track of related resource evolutions. But at the same time, the mobile operators will only track these resources if they possess some expectation from exogenous technology. Therefore RE1 and OE1 are influencing each other. The factors of these clusters are shown in figure 3.8.

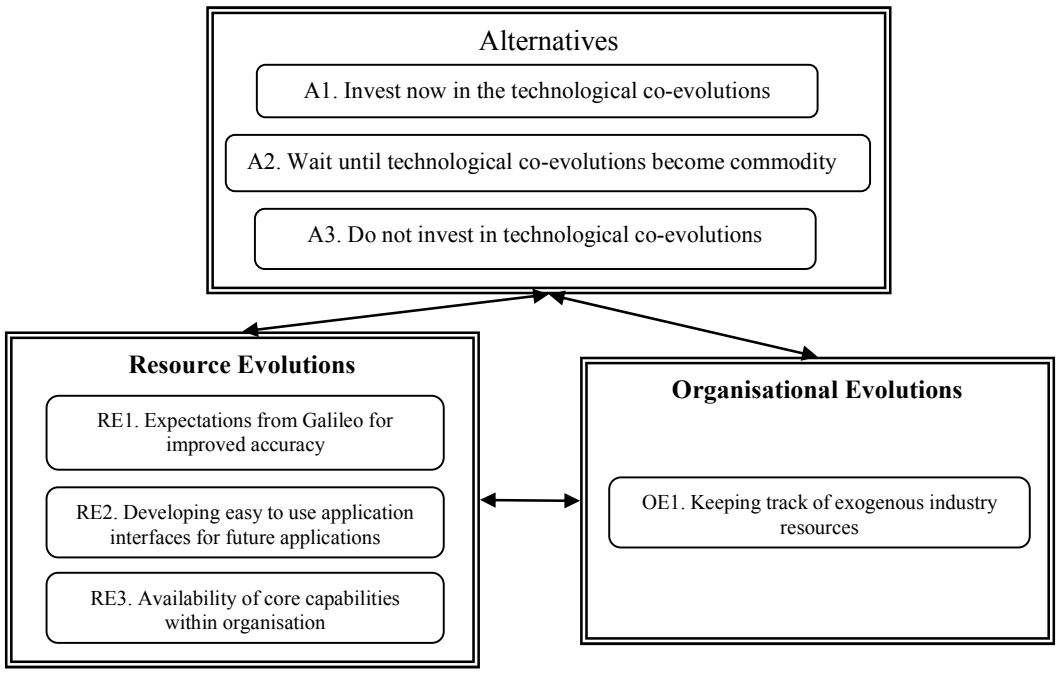


Figure 3-8: Clusters with factors under opportunities of accuracy and quality of technology

Under opportunities of Market Demand for technology, there are two clusters: Technological evolutions and Organisational evolutions. Their factors are defined below.

1. The Technological evolutions cluster has three factors:

    TE1. New applications for new customers

    TE2. Retention of customers through offering multiple applications

    TE3. Retention of successful applications

- *TE1: New applications for new customers* - refers to possible opportunities which will emerge by expanding towards new market segments and identifying new applications for

consumers and corporate customers. LBS appeal to four fundamental needs: Efficiency (primary driver for corporate application), Enjoyment and Convenience (primary divers for consumer applications), Safety (primay driver for both corporate and consumer applications) (Gibson and Cory, 2005). LBS are the enabler for existing services rather than compelling services. Therefore, Mobile advertising as a fast growing application that requires location knowledge (Cory, 2007) can be considered as a new application for new customers. The mobile advertising can rely on geo-marketing which can be specified as automated advertising or delivery of proximity coupons (Hanley et al., 2006).

- *TE2: Retention of customers through offering multiple applications* - refers to opportunities which will be created by multiple and striking applications and will attract new and retain old customers. Location data provides valuable context to other data therefore mobile operators see LBS as one element in the jigsaw of components for creating revenue opportunities, attracting new customers and retaining profitable, existing customers (Gibson and Cory, 2005).
- *TE3: Retention of successful applications* - refers to opportunities which will emerge by retaining already applied applications and improving their accuracy and quality with advanced technologies. Some LBS applications, such as finder-type applications and information services, are being slowly rolled out by mobile operators. This approach allows operators to target existing customers and current generation handsets, testing their business and revenue models, marketing strategies and segmentation models. This should help to ensure there is a reasonable return from each step (McQueen et al., 2002).

2. The Organisational evolutions cluster has four factors:

    OE1. Variations in R&D for service and application developments

    OE2. Need of highly customer focused management for niche applications

    OE3. Learning from International market stories

    OE4. Learning from customers' experiences

- *OE1: Variations in R&D for service and application developments* - refers to the opportunities which will emerge by developing new applications through R&D activities by keeping market demands a priority. In mass production, capabilities like R&D, production and sales carry out the repetitive tasks required to maintain a continuous throughput of products and services, but lack the flexibility and responsiveness necessary to cope with

usually complex, new or rapidly changing project requirements (Middleton, 1967, p. 74). In technology co-evolution where development of applications also relies on the evolution of other technological roles, certain variations in the R&D are required to create opportunities.

- *OE2: Need of highly customer focused management for niche applications* - refers to opportunity which can be achieved by focusing towards small but profitable market segments and designing custom-made niche applications. These niche applications can also be used as a test bed and learning place for new technological applications to achieve better integration between technological and social domains (Hegger et al., 2007). In terms of LBS, the identified niche markets include Maptuit's FleetNav services, for example, which target the long distance transport market. Trucking companies, faced with rising fuel costs, are eager to reduce the number of miles that a truck is driven. Using information about truck stops, fuel networks, weight scales, and the like, FleetNav provide routes and directions that optimize the driver's journey and minimize the number of 'out of route' mile – travel that does not contribute to getting to the destination (Guille, 2001). The foundation of any good LBS marketing strategy, and services for that matter, is niche product marketing. Taking mass product market approach results in messages that are too generic to be attractive to customers, or too easily replicated by competitors to command a premium price point (Williams, 2007).
- *OE3: Learning from International market stories* - refers to opportunities which can be obtained by inevitable stories of US and Japan. In the case of the US, A-GPS being implemented in CDMA networks uses the satellite based GPS in conjunction with an A-GPS chip in the handset, to pinpoint a location (Wilde et al., 2004). One application, Friend Finder, launched in the US by AT&T wireless, is being observed as the notable exception (Finney, 2002b). On 02 July 2008, a survey commissioned by Motorola revealed that enterprises using GPS technologies are saving 54 min/day, resultantly saving $53billion annually on industry-wide fuel consumption. In the Japan, even with millions of GPS enabled handsets sold, and a myriad of LBS rolled out, Japan is still faced with technological and commercial challenges to make LBS a commodity that consumers want and need to use on a regular basis (Fuente et al., 2004).
- *OE4: Learning from customers' experiences* - refers to opportunities which can be obtained by observing the customers' behaviour towards LBS. LBS have come to market more slowly than the industry predicted (Finney, 2002a). Since 2001, LBS are part of the

UK mobile industry with distinct applications for mass market and business customers. But due to certain missteps, referred to as 'LBS seven deadly sins', LBS remained unable to capture customers' interest. These sins include: poorly identified opportunities; inadequate value proposition; weak business care; inflexible business model; flawed design; inattention to intellectual property; deficient marketing (Williams, 2007). The unwillingness of the mobile operators to provide information about take up and usage of LBS suggests that the numbers are still not high. There appears to be consensus amongst the mobile operators that new location offers should be launched cautiously in order to test user reaction (Finney, 2002a). The primary rationale behind the launch of any LBS should be to meet consumer needs. Consequently an understanding of the psychological determinants behind end user attitudes is critical to satisfying customer demand (McQueen, 2002). Therefore, observing their interest towards LBS can be fruitful learning for future applications. It is expected that stronger customer loyalty can be achieved through more attractive services (McQueen, 2002) which need further technological evolutions.

The variation in the R&D for service and application developments will occur only when learning from customers and international markets identifies the need of new services and applications. Therefore OE1 is influenced by OE3 and OE4. Similarly, development of new applications and retention of old applications will occur only when learning from customers identifies the required application. Therefore TE1, TE2 and TE3 are influenced by OE4. Once these new applications are developed it will be required to mange these applications in distinct markets, particularly the niche ones. Therefore OE3 is influenced by TE1, TE2 and TE3. The factors of these clusters are shown in figure 3.9.

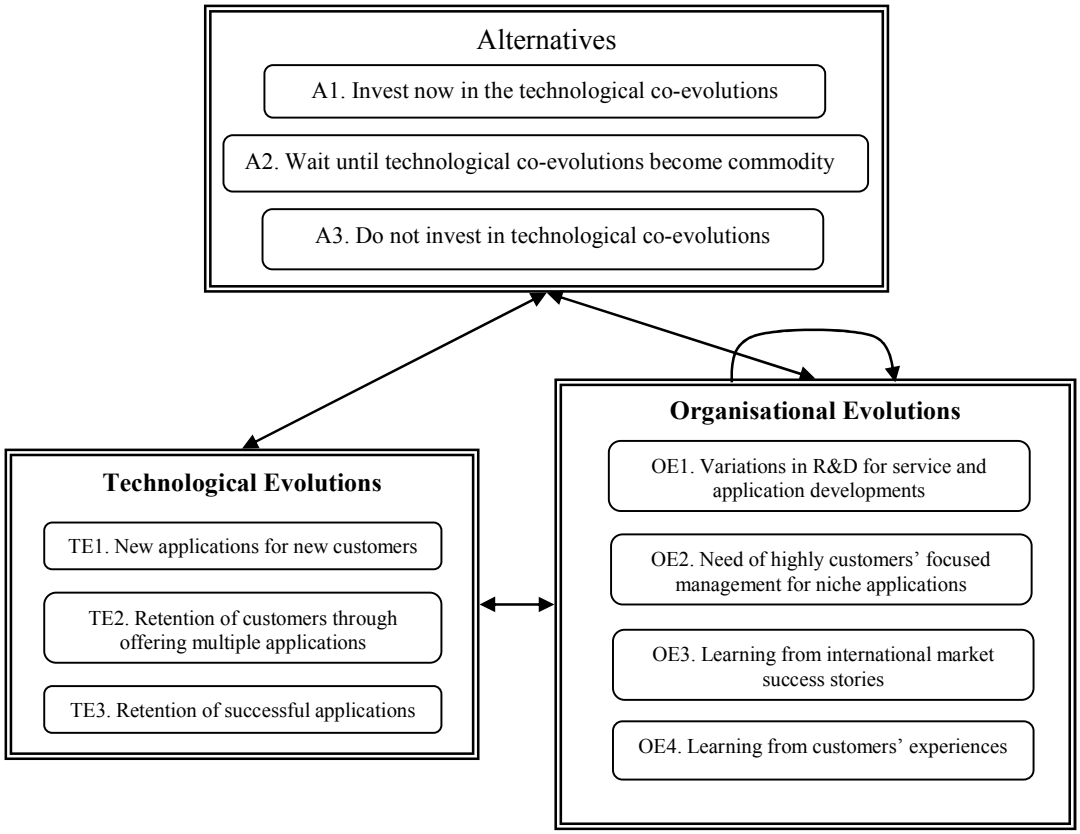


Figure 3-9: Clusters with factors under opportunities of market demand for technology

Under opportunities of Cost of technology, there is one cluster: Technological evolutions. Its factors are defined below.

1. The Technological evolutions cluster has three factors:

TE1. Expected reductions in handset costs

TE2. Expected reductions in mapping data and services and applications costs

TE3. Expected revenue from new applications

- *TE1: Expected reductions in handset costs* - refers to the opportunity of regular increase in technological efficiencies and the regular decrease in the cost of the technological products. The evidences of this opportunity are news from CSR, BlueSky Positioning and NXR Semiconductors which offer the possibility of a reduction in GPS chip cost. According to CSR (2007), it is possible to provide software based high performance GPS suitable for mass market mobile handsets for an incremental price that falls to less than $1 of the overall bill of materials when used with CSR Bluetooth technology. According to BlueSky Positioning, it has developed a complete GPS system, including the antenna,

which physically fits in, and works from within, a mobile phone SIM slot (Ray, 2007). This GPS SIM card is developed for deploying precise legally mandated positioning capability quickly, cost effectively and without any compromise of the privacy issue, and to reduce the mobile handset costs. According to NXP Semiconductors (2008), a new A-GPS chip for mobiles as well as PNDs with the smallest size, lowest power and lowest price is launched to reduce handsets' cost. According to Dominique Bonte, Principal Analyst, Telematics and Navigation at ABI Research, '*By 2013 we can expect to see more than 900 million GPS enabled devices in the market, each offering an array of new and innovative LBS beyond traditional navigation, such as automatic geo-tagging of pictures taken with digital camera, road toll system, and social networking applications*'. The launch of such a big number of GPS enabled handsets with reduced cost will provide convenience to mobile operators in offering A-GPS based LBS.

- *TE2: Expected reductions in mapping data and services and applications costs* - refers to the opportunity in reduction in the cost of these additional support technologies for the evolution of LBS. The mapping data is available in two solution forms. One is termed as on-board solution in which GPS chip is inside the mobile handset and the navigation software is added on a memory card. Another is termed as off-board solution in which the navigation software is accessed on a server via the mobile network infrastructure (Fagerberg and Malm, 2006a). The navigation software provides functionality such as map display, route calculation, and turn by turn directions to chosen destinations. The software is delivered separately for mobile handsets on CD, DVD or memory cards and needs to be updated regularly. The cost of the on-board solutions is a one-off price, whereas off-board solutions are usually priced according to some kind of subscription model. As the navigation services become commodity it is expected that navigation solution providers like ALK, TeleNav, Telemap, Webraska, etc, will offer this technology at less cost. The additional reduction in the huge amount of costs for services (Java clients etc) which are new and to be adapted to the device (screen size, memory etc) is also considered as an opportunity.
- *TE3: Expected revenue from new applications* - refers towards the opportunity which will result in terms of return on investment (ROI). The mobile operators are developing new and distinct applications and their expectations in terms of ROI vary (*we can foresee that users will adopt these applications but still what will be the frequency of these applications and how much will be demanded by users is still vague – Nicola Binucci*, *3*

UK). Individual meetings with the UK mobile operators revealed their forecast data of expected revenue till 2011. According to these mobile operators the expected revenue varies from £8.5 million to £11 million. According to a report from the research firm Berg Insight, revenue from LBS in the European market will grow by 34% annually and reach €622 million in 2010 with the expected 18 million mobile users' subscription. The factors of this cluster are shown in figure 3.10.

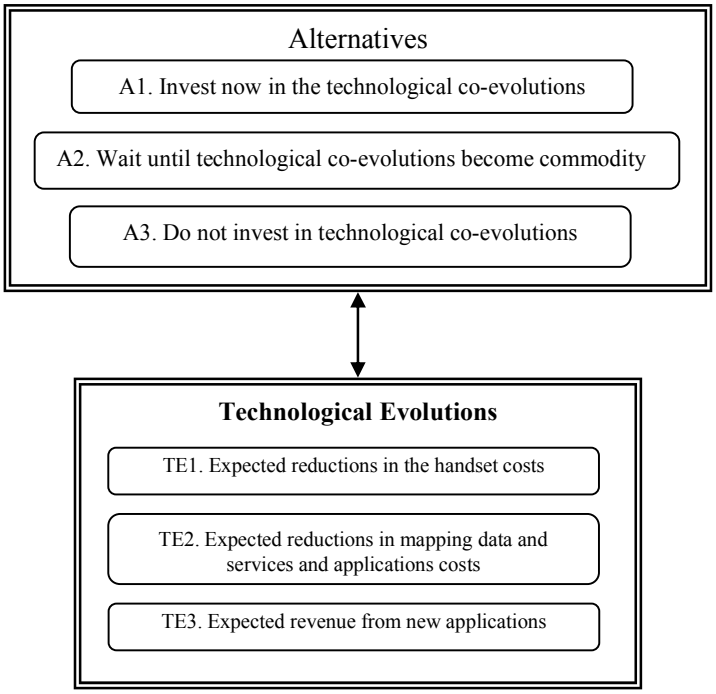


Figure 3-10: Clusters with factors under opportunities of cost of technology

3.2.1.2.3 Costs

The goal of this section is to calculate the merits of ***costs***. This section is classified into: Market Demand for technology and Cost of technology. This section is shown in figure 3.11.

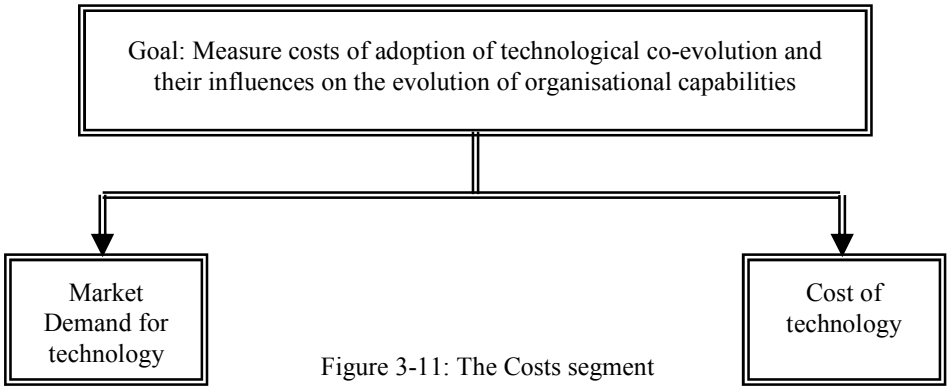


Figure 3-11: The Costs segment

Under costs of Market Demand for technology, there is one cluster: Organisational evolutions. These factors are defined below.

1. The Organisational evolutions cluster has two factors:

OE1. Price associated with marketing of new applications for customers' awareness

OE2. Strategy focused towards future investments in LBS

- *OE1: Price associated with marketing of new applications for customers' awareness* - refers to the investments to be carried out by the mobile operators in order to increase the awareness of customers through marketing, advertising, and users' interaction activities regarding LBS applications. So far, several problems identified with LBS also include lack of marketing efforts (O*ne reason behind the slow uptake of LBS could be our lack of initiative as we are not putting much efforts on these services and not promoting them a lot – Nicola Binucci*, *3 UK).*With the launch of LBS it was assumed that users were intimately familiar with LBS. The mobile operators assumed the customer knows as much as they do. The result was lack of marketing initiatives and fewer acceptances of LBS. Promotion is as necessary for location as it is for any new service to increase user awareness, but in addition the mobile operators must actively ensure subscribers understand what location information is collected and how it is used (Finney, 2002a). Therefore, investments in advertising and on-line portal based campaigns are highly required to support these services. Only shops that sell handsets are not good at marketing applications (Cory, 2007). According to Berg Insight (2006), 50% of the mobile operators around Europe identified the need for more visibility and marketing of LBS for end users' awareness and to make the LBS market boom.
- *OE2: Strategy focused towards future investments in LBS* - refers to the need for additional resource allocation for LBS identified by managers and technologists of organisations. Chandler (1990) defined strategic capabilities as the ability of an organisation to move into growing markets more quickly, and out of declining ones more rapidly and effectively, than its competitors. A-GPS based LBS creates a new market where strategic capabilities of the mobile operators play a vital role in dynamics of organisation and industry. In this scenario, the task of the top management is to create flexibility for action by effectively monitoring internal organisational operations and adjusting strategies to a changing technological and market environment (Davies and Brady, 2000). Lawrence and Lorsch (1967) also identified the importance of strategic choice in shaping these

environments. In this rapid technological co-evolution where investment is required for any evolution, the mobile operators need to exploit their strategic capabilities in identifying the feasible investment decisions and related costs. So far they have been busy deploying other services; the prioritization of LBS services has largely been put on hold (Fagerberg, and Malm, 2006b)

The price associated with marketing of new applications will only become possible when top managers find it feasible through their strategic decision. Therefore OE1 is influenced by OE2. The factors of this cluster are shown in figure 3.12.

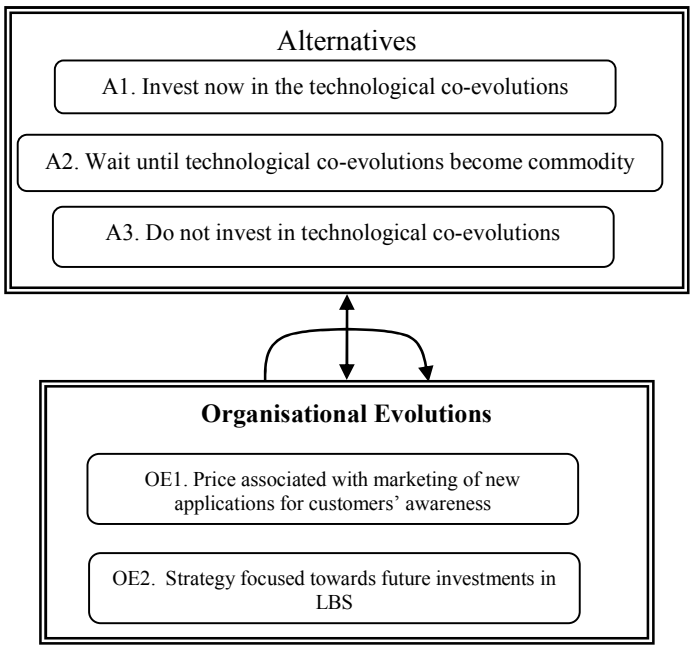


Figure 3-12: Clusters with factors under costs of market demand for technology

Under Cost of technology, there is one cluster: Technological evolutions. These factors are defined below.

1. The Technological evolutions cluster has four factors:
    TE1. Price associated with LBS enabled handsets
    TE2. Price associated with Infrastructure
    TE3. Price associate with components
    TE4. Price associated with new licences from external technology developers

- *TE1: Price associated with LBS enabled handsets* - refers to the investments which need to be carried out by the mobile operators in purchasing new handsets. In order to offer A-GPS based LBS applications, handsets need to be enabled with GPS chip and satellite navigation software. The recent launch of handsets by Nokia (e.g. Nokia N95, Nokia 6110, Nokia N81) and Sony Ericsson K530 shows the good example of an integral GPS and mapping functionality with pre-installed maps insides these handsets. Nokia intends to equip all of its devices that have built-in GPS with the mapping service in future. The UK mobile operators are offering these handsets in the market at a contract price from £35 per month. However, the cost of these handsets is slightly more than other devices which need to be handled by the UK mobile operators but with the increasing popularity of GPS devices, the cost of the full chipset is declining (Fuente, 2004).
- *TE2: Price associated with Infrastructure* - refers towards the investments which need to be carried out by the mobile operators in upgrading their networks from Cell-ID to A-GPS technology. The evolution needs software and hardware upgrade of the network infrastructure of the mobile operators. It is accepted that due to the competitive pressure and availability of attractive services the mobile operators might feel encouraged towards required evolution through the required investments (Wang, 2007).
- *TE3: Price associated with components* - refers towards the investments which need to be carried out by the mobile operators for several hardware and software components like chip-sets, location servers, location middleware, applications, billing systems, receivers, antennas, etc. However, tough economic conditions have contributed to operator's cautious approach to making decision about location architecture and services (McQueen, 2002). This caution has contributed to slowing down the LBS evolution.
- *TE4: Price associated with new licences from external technology developers* - refers towards the investments which need to be carried out by the mobile operators in order to buy and upgrade licences for the required software for the A-GPS technology and for other third party applications. While some application providers are prepared to accept revenue sharing agreements other are looking for guarantee in the form of licence fee agreements (Finney, 2002a).

The prices associated with infrastructure, components, handsets and licences are related to each other as all of them possess distinct technological roles and these roles will co-evolve

with respect to each other. Therefore TE1, TE2, TE3 and TE4 all are influencing each other. The factors of this cluster are shown in figure 3.13.

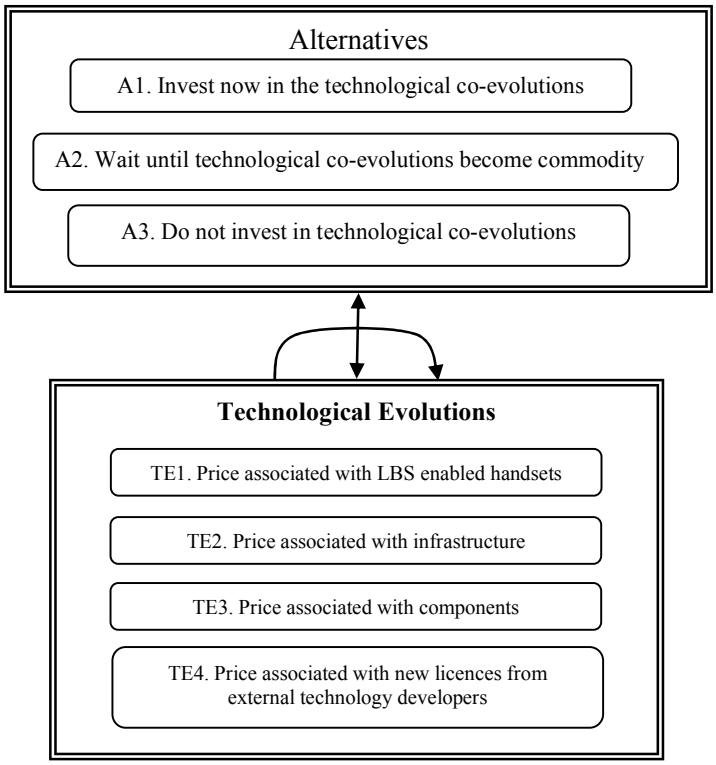


Figure 3-13: Clusters with factors under cost of technology

3.2.1.2.4 Risks

The goal of this section is to calculate merits of the ***risks***. This section is classified into: Market Demand for technology and Self and Governmental regulations. This section is shown in figure 3.14.

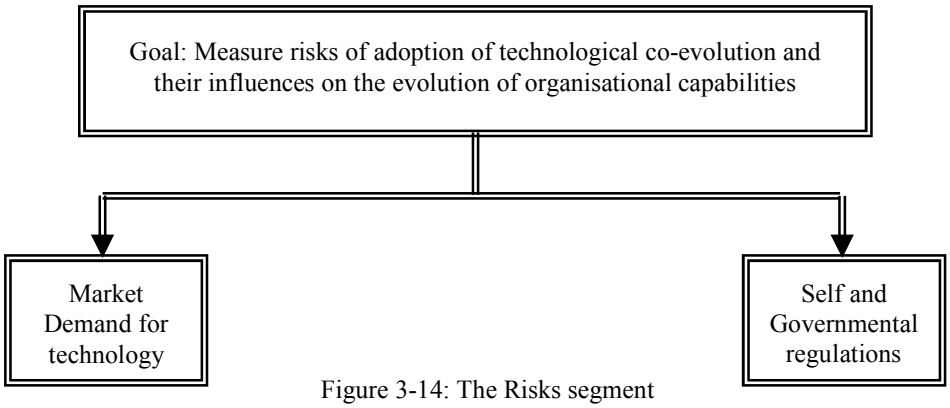


Figure 3-14: The Risks segment

Under risks of Market Demand for technology, there are two clusters: Technological evolutions and Organisational evolutions. Their factors are defined below.

1. The Technological evolutions cluster has two factors:
    TE1. Less market growth of available applications
    TE2. No visible killer applications

- *TE1: Less market growth of available applications* - refers to less usage of LBS in the market. In practice, low numbers of consumers are using these applications but in terms of business customers, the overall application acceptance is better than the mass market. However, it is evident that, so far, both LBS and telematics industries have failed to live up to the high expectations of some market forecasts (Jenkins et al., 2005). LBS have been around since the turn of the century, but the market has been slow to take off (Wilde et al., 2004). The past years have been characterized by much lamenting within the industry about the snail-like pace of mobile operators' investments in location technology and the launch of location services. There is no doubt that the number of location players, public and private, have suffered through these delays (Finney, 2002b). One of the reasons behind low market growth has been identified as the limitations of the GPS enabled handsets. However, ABI Research expected that beginning in 2007 and increasing in 2008, many handsets will contain GPS chipsets, allowing mobile operators to offer LBS applications (Juniper Research, 2006), which has been proved with the range of available Nokia handsets. (*We do mobile handsets from our side to user, we suppose to invest a lot in them. Apart from handsets, investment in infrastructure will also cost us a lot. We are ready to invest provided we can find enough market – Nicola Binnucci, 3 UK).*
- *TE2: No visible killer application* - refers to the need of such application which may capture a market with high penetration rate. One to one marketing (Peppers and Rogers, 1997), or knowledge based marketing, where information about individual customers is used to integrate services into customer preferences treating different customers differently, was cited as the killer application for the mobile communications (Rodriguez, 2003). So far available applications are good in number but none of them can be considered as the killer application. The market, especially in Europe and North America, is still searching for the perfect application (Hanley et al., 2006).

2. The Organisational evolutions cluster has three factors:

OE1: Low revenue growth from available applications

OE2: Keeping track of competitors' applications

OE3: New entrants changing market dynamics

- *OE1: Low revenue growth from available applications* - refers to risks of small revenue generated from LBS for mobile operators. Since 2000, the wireless industry has been talking about the exciting possibilities of LBS but despite the introduction of several different types of technology, revenues from commercial applications are less than expected and growth rates are not promising (Wlide, 2002). During interviews mobile operators revealed that their annual revenue from all mobile services is about £4000-5000 million from which LBS contain £10-20 million only. The business applications are showing better growth but still as revenue is shared amongst mobile operators and other players of value chain, this revenue is not sufficient for the mobile operators.
- *OE2: Keeping track of competitors' applications* - refers to the activity of a mobile operator to regularly monitor the progress of competitors. Due to the lack of market acceptance, every mobile operator is following defensive capability, in the case of LBS, by observing their competitors. None of them is trying to achieve the benefits of first mover. First movers are the leaders in exploiting the cost advantages of scale and scope economies (Davies and Brady, 2000). Monitoring the competitors' track is a feasible strategy for technology co-evolution. Some technologies might not create incentive for the mobile operators to achieve the first mover advantage but at the same time cannot allow them to lose the chance of being an early follower. Due to the type of technology co-evolution, the mobile operators in LBS do not face competition only from other mobile operators, but at the same time, they are facing competition from ISPs as well as retailers, hardware manufacturers, traditional media players, financial institutions and many other companies that have started online services as part of a multi-channel strategy (McQueen et al., 2002). Therefore mobile operators need to keep track of all these competitors along with other UK mobile operators.
- *OE3: New entrants changing market dynamics* - refers to an increase in the number of competitors due to blurring industrial boundaries where new entrants from satellite and internet industries (e.g Google offering Location based GMaps) are changing the dynamics of the mobile industry. These disruptive changes are providing ample opportunities for new

entrants to redefine competitive rules (Steinbock, 2002). In 2001, Nokia, Ericsson, SignalSoft and CellPoint might have claimed to have the established location technology market sewn up, but since then a number of new entrants have crept in and clinched major deals. What is more, a number of start ups are capitalizing on growing mobile operator investing in emerging middleware solutions that offer the capability to manage location specific aspect of services, including subscriber privacy, mapping and routing (Finney, 2002b).

Low revenue growth from available applications will only appear when there is less market growth of these applications and lack of killer application. Therefore, OE1 is influenced by TE1 and TE2. As new entrants are changing the market dynamics and causing huge competition for mobile operators, the mobile operators are required to track these competitors' applications. Therefore, OE2 and OE3 are influencing each other. The factors of these clusters are shown in figure 3.15.

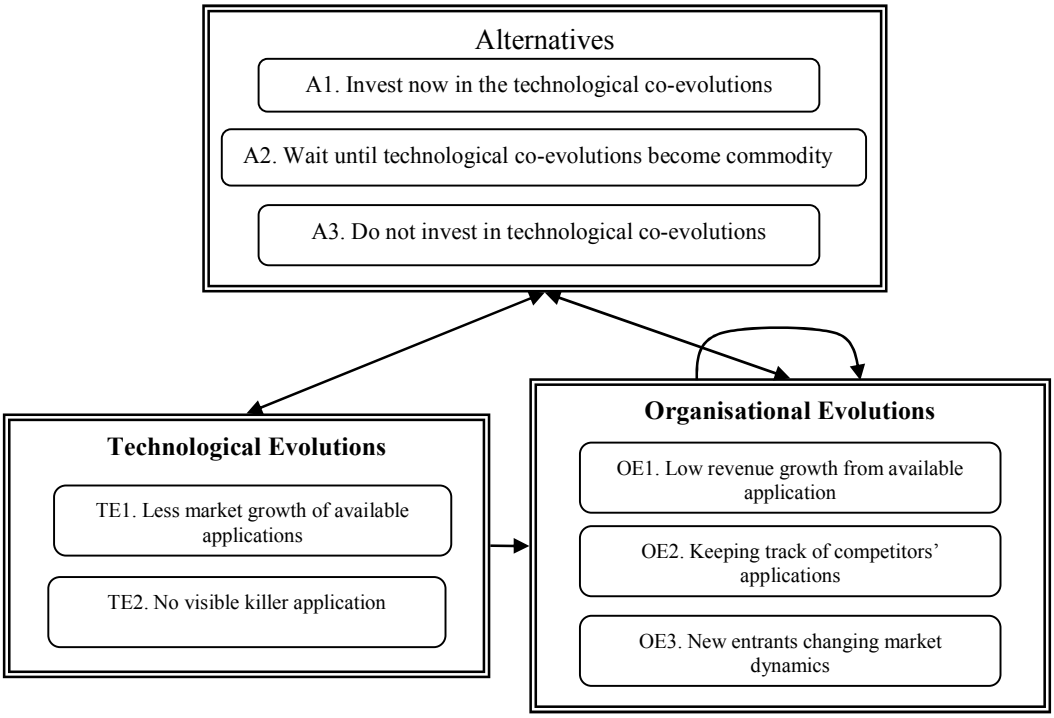


Figure 3-15: Clusters with factors under risks of market demand for technology

Under risks of Self and Governmental regulations, there are two clusters: Technological evolutions and Organisational evolutions. Their factors are defined below.

1. The Technological evolutions cluster has two factors:

TE1. Unavailability of GPS signals

TE2. Monitoring integrity and upgrading of digital maps

- *TE1: Unavailability of GPS signals* - refers to the risks of the US monopoly in providing the GPS signal. The GPS navigation system is owned by the US military with complete authority of either providing or not providing the signals for market applications. When GPS was set up, it represented a monopoly in the sense that it faced no competition in GNSS (Jenkins et al., 2005). The launch of the Galileo programme, however, raised US concern about its monopoly. The president of the USA authorized a new national policy on 08 Dec 2004 that established guidance and implementation actions for space based positioning, navigation and timing programs, augmentations, and activities for US national and homeland security, civil, scientific, and commercial purposes. One of the policy goals includes promoting US technological leadership in applications involving space based positioning, navigation and timing services (Jenkins et al., 2005).
- *TE2: Monitoring integrity and upgrading of digital maps* - refers to the risks of providing wrong directions to the customers if digital maps are not upgraded with changes in the physical locations. If the mobile operators offer off-board solutions to customers, where mapping data and basic navigation functionality reside on a network server (Fagerberg and Malm, 2006a), it is highly required that mobile operators need to be sure about the correctness of this data and other contents for the location applications. The map developers like Mapway, Navteq and others also monitor the quality of their end products but if an end application offered by mobile operators cannot satisfy customers then losing a potential customer can only affect the mobile operator. The online comments of customers about their discoveries of several map errors and routing mistakes need to be eliminated under proper monitoring activities as this wrong information might be very risky in certain conditions (*If blind people are given these navigation devices then one must have been assured about their validity. The government may pose an impact of providing some authority people to check the validity of output. For example in the airplane navigation system the civil aviation is authenticity provider – Pat Norris, Logica).*

2. The Organisational evolutions cluster has four factors:

OE1. OFCOM insistence for highly accurate technology

OE2. Satisfying customers' doubts about their privacy

OE3. Measuring quality of exogenous and third party technology resources

OE4. Satisfying media doubts

- *OE1: OFCOM insistence for highly accurate technology* - refers to the risks of government push which may cause mobile operators to develop more accurate technologies. In the USA, the mandatory accuracy offered by mobile operators is 125 meters which can be achieved by using more accurate technologies. In future, the risk of mandatory accuracy by the EU may push the mobile operators to invest in GPS technology. Fuente et al., (2004), clearly indicates regulations as a key driver to the adoption of A-GPS solutions. The government can play roles in stimulating market development through a range of measures, including procurement, standards setting and mitigation potential market failure arising from imperfect information (Jenkins et al., 2005). So OFCOM could certainly stimulate the adoption of A-GPS in mobile phones by mandating position accuracy requirements.
- *OE2: Satisfying customers' doubts about their privacy* - refers to the risks of fear amongst customers which hinders them to adopt LBS (*People might not like to be identified where they are all the time. The issue like tracking the teenagers by parents and wives by husbands may also become hindrance – Bob Cockshott*, *KTN, NPL).* The advent of the wireless location has prompted widespread concern that the privacy rights of individuals can be violated in a number of ways through the use of this technology. The initiative is required by the mobile operators to remove all these doubts from the minds of customers by the help of Code of Best Practice for Passive LBS. This code can protect the mobile phone user from invasions as intrusive, unwanted advertising, tracking of the user for marketing purposes, or covert investigations by private parties or employers (Wilde et al., 2004). At present, applications such as tagging personnel within buildings where high security is an issue, such as banks, are already raising concern with civil liberties groups. So far, service providers are designing their applications to compel staff to agree explicitly to be tracked (Gibson and Cory, 2005).
- *OE3: Measuring quality of exogenous and third party technology resources* - refers to the risks which may be generated if the quality of an application offered by the mobile

operators degrades due to the quality of the suppliers' products. As LBS depend upon integration of several components, low quality of one component may affect the quality of end product. Mobile operators need to measure the quality of suppliers' products through their self regulatory codes. The third party developers also take care of quality assurance of their products but certainly the mobile operators need this sort of reassurance that infrastructure and application are capable of coping with user demand before they launch new services (Finney, 2002b).

- *OE4: Satisfying media doubts* - refers to the risks of wrong advertisement by media which can harm the mobile operator's brand. The media have raised fears that customers will be bombarded with endless adverts due to LBS. This issue is gaining in influence in Europe more than in other regions (Swann et al., 2003). Other media news raises the issues such as child abuse or abduction due to the availability of location services on the mobile phones. Such type of privacy issues raised by the media could have potentially massive social consequences. The aftermath of criminals using stolen location data to commit abductions and other crimes could be crippling to the industry, and any invasion of privacy resulting from location data being inappropriately used could lead to widespread service abandonment by subscribers (McQueen, 2002). In terms of location based advertisement, the media pointed that they may be illegal according to the Data Protection Commission. The restriction regards third party advertising. Telecommunication companies were not forbidden to advertise their own services, but were restricted from carrying third party adverts.

The mobile operators can measure the quality of exogenous and third party technological resources only if they possess technology for monitoring integrity of these resources. Therefore OE3 is influenced by TE2. The media doubts can create more customers doubts. Therefore OE2 is influenced by OE4. The factors of these clusters are shown in figure 3.16.

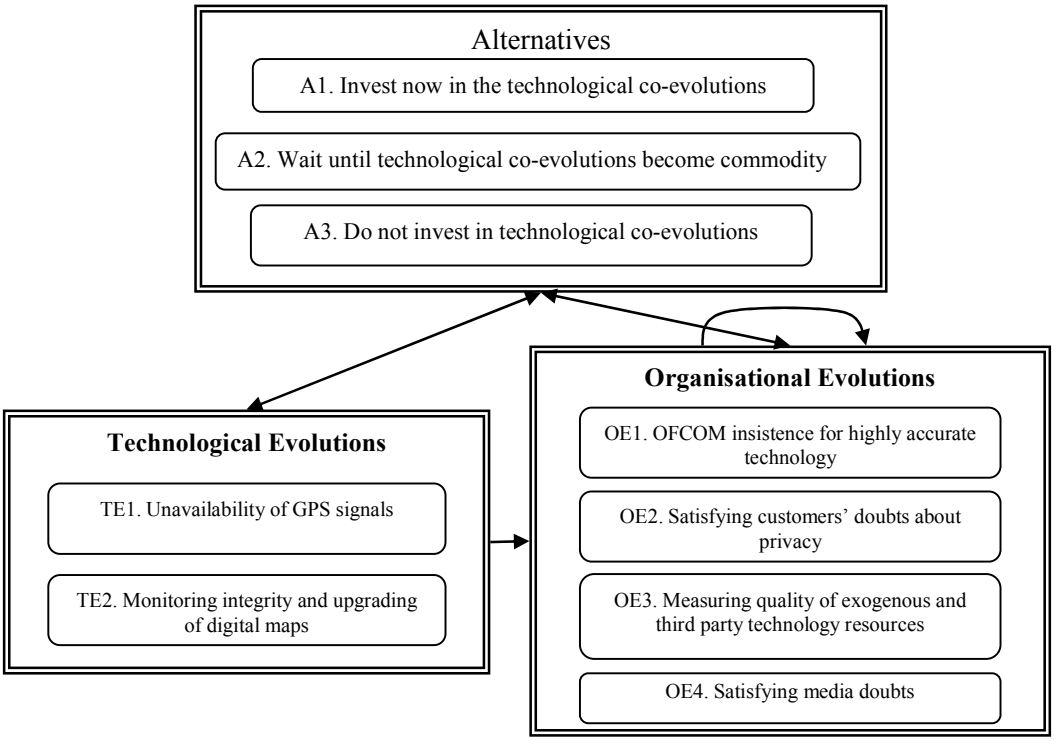


Figure 3-16: Clusters with factors under risks of self and governmental regulation

So far discussed factors rely on the empirical domain of the UK mobile industry and have been collectively observed in table 3.1. The definition of these factors and their classification with respect to their relative clusters makes it possible to visualize the influence of technology co-evolution on evolution of organisational capabilities and its resources. The launch of LBS in the UK market was based on the fact that technology can provide these applications (*LBS started when a bunch of engineers said, hey we can find where people are; we definitely started with the technology and then tried to develop applications around it - Tim Williams*, *Vodafone).* The LBS evolution started by knowing technological capabilities and then gradually evolving inter-related technologies and organisational capabilities. In other words, it is possible to say that for LBS, technological co-evolutions appear as a source of evolutions in organisational capabilities and resources. The factors which belong to the technological evolutions (TE) cluster have empirically presented their influences on the factors which belong to the organisational evolutions (OE) and resource evolutions (RE) clusters. At the same time, the influence of those factors which belong to the organisational evolutions cluster is also visible on factors of the technological evolutions cluster. The quantitative assessment of these factors will further prove the influences of factors and their clusters on each other.

These multicriteria factors will allow the mobile operators to make the investment decision in technology co-evolution by measuring priorities of their strategic alternatives. The alternative which will show maximum priority will be considered as the most feasible alternative. The priorities of strategic alternatives can be measured by assigning all factors with their relative weights through the pairwise comparisons. To support the decision making process Saaty (2000) developed an Analytic Network Process (ANP) model. This model is supported by the user friendly software Super Decisions. The feasibility of the ANP model for assigning these priorities to these factors is discussed in the following section.

3.2.1.3 Feasibility of Analytic Network Process (ANP)

Many decision problems cannot be structured hierarchically because they involve the interaction and dependence of higher level elements on lower level elements. Not only does the importance of the criteria determine the importance of the alternatives as in the hierarchy, but also the importance of the alternatives themselves determines the importance of the criteria (Saaty, 1996; pp. 75). In terms of LBS, the above defined set of factors shows the complete influence of these factors on each other which ultimately proves the influence of clusters on each other. Alongside, it shows that the alternative decisions of either investing or not investing in the A-GPS technology rely on these factors but also these factors influence the mobile operators to make an investment decision.

In order to calculate values of the BOCR merits in such inter-related scenario, hierarchy structure does not seem feasible. To solve such problems, Saaty (1996) developed an analytic tool named Analytic Network Process (ANP). It is a new tool for multicriteria decision making (MCDM) but can also be applied in academic research to prioritize the factors or criteria (Cheng and Li, 2007). It allows presentation of more complex interdependent relationships among factors and criteria. It is also known as the system-with-feedback approach (Meade and Sarkis, 1998). The ANP incorporates both qualitative and quantitative approaches to a decision problem (Cheng and Li, 2005). Saaty (1996) established the outline of ANP steps consisting of both the qualitative and quantitative approach. These steps are explored later for the DTC model. The development of the DTC model in the first stage relies on the qualitative data to establish an evolutionary framework. In the second stage, the factors identified during the first stage are organized

with respect to their BOCR merits, driving forces and clusters which will later be quantitatively measured to assess values of the BOCR merits to reach a feasible strategic decision for the mobile operators. The DTC model is designed to be used by the group of managers and technologists who, with their knowledge and analytical ability, can exercise their imagination to practice analysis. Therefore using ANP for the second stage of the DTC seems to be the most feasible.

3.2.1.3.1 Outline of ANP steps for the DTC model

These steps, proposed by Saaty (1996; pp. 153), compose both qualitative and quantitative analysis together. Here these steps present it in context of the DTC model.

1. The four control hierarchies are determined along with their criteria and sub-criteria for comparing the elements and the components of lower system according to influence. These four control hierarchies are *Benefits, Opportunities, Costs, Risks*. In table 3.1, under these control hierarchies, four drivers are chosen as control criteria which are further divided with respect to technological, organisational and resource evolutions clusters.
2. For each driver the clusters of technological, organisational and resource evolutions are further divided in a number of factors. These factors are represented as TEs, OEs, and REs respectively.
3. To better organize the development of the lower level, each factor is numbered as TE1, TE2 and so on in table 3.1.
4. All these clusters and their factors are with respect to their influences for the analysis. In figures 3.2 to 3.16, all clusters and their factors are representing their influences on each other.
5. To represent the organisation of factors and their relative influences with respect to their clusters, drivers and BOCR merits, they are given in table 3.1.

The results of the so far discussed five steps have decomposed the unstructured problem to a set of manageable and measurable levels (Cheng and Li, 2005). These steps use knowledge from an evolutionary framework and deliver the representation of the influence of technological co-evolutions on the evolution of organisational capabilities. Further steps will rely upon the contribution of the mobile operators to measure priorities of these factors in order to reach the most feasible strategic alternative for making the investment decision.

At this step it is required to determine who should be involved in the process of analysis. As discussed above, the DTC model is for the group of managers and technologists who are familiar with the technology and at the same time can identify relations of factors and possess analytical abilities. Once a group is identified, the next steps will be chosen to reach the investment decision. These steps will be practiced later in chapter four.

6. For every cluster identified in table 3.1, the mobile operators will perform paired comparisons on the clusters as they influence each cluster or are influenced by each other, with respect to their drivers. Saaty (1980) has developed a 9-point scale of measurement, with score of 1 representing equal importance and 9 being overwhelming dominance of one over another (Cheng and Li, 2007). Assign zero if there is no influence. This step will represent the influence of drivers on each other and the influence of technological, organisational and resource evolutions on each other.
7. For factors identified in table 3.1, the mobile operators will perform paired comparisons on the factors within the clusters. This step will show the network approach and represent the relative influence of factors on each other.
8. Once the paired comparison stage is complete, the supermatrix will be constructed for all clusters and their factors. The supermatrix presents priorities in the form of eigenvectors (Cheng and Li, 2005) which emerged after pairwise comparison and after measuring the consistency ratio. Saaty (1994) set three acceptable levels for the consistency ratio. It is 0.05 for a 3 x 3 matrix, 0.08 for a 4 x 4 matrix and 0.1 for other matrices.
9. The supermatrix will be accompanied by the computed limiting priorities. The limiting priorities can be achieved by raising the eigenvectors to high power until weights have been converged and remain stable (Sarkis, 1999). For the purpose of computation of matrices, a software tool, *SuperDecisions*, is used here. The software is developed by Williams J. Adams and Embry Riddle Aeronautical University and Rozann W. Saaty and is appropriate to solving a decision problem of a network model (Saaty, 2003).
10. The alternative A1, A2 and A3 will be included in the supermatrix as they influence other clusters.
11. The priorities of alternatives A1, A2 and A3 will be multiplied with the priorities of the governing control criteria.

12. The weights of the alternatives will be synthesized for all the control criteria for each of the four BOCR merits. This will yield four sets of weights for three alternatives.
13. The final priority of each alternative will be calculated by: (benefits x opportunities) / (costs x risks), and will help in choosing the one alternative with the largest value.

3.2.2 The DTC model

This section presents the full DTC model by combining both stages. These stages are elaborated in chapter two and three in detail. The aim is to design an investment decision model for organisations with a focus on technological and organisational evolutions. So far, the discussed concepts make it possible to use the ANP tool to compute the measures for the investment decision. The discussion presented two stages which are shown in figure 3.17. The two stages of the DTC model can be used for:

Stage 1: determining the sources of evolution and their representation in the form of an evolutionary framework.
Stage 2: determining the relationship of factors under the influence of drivers and their measures to reach to the BOCR merits and to the investment decision through the evaluation method.

These stages perform several judgments. During the first stage the decision makers will judge:

- What is their strategic objective about the investment decision in technology co-evolution?
- What are the sources of technology? Is it from a dependent or an independent innovative regime?
- What are the historical evolutions related to the technology?
- What were the historical influential factors that will determine the present influential factors?

The concern of this stage is ‘history matters’ in the way where we understand the trajectories for firms and the technological choices they are confronted with. This idea

defends the path dependence concept which provides a useful theoretical framework to understand the trajectories of firms, technologies and markets (Araujo and Harrison, 2002). Path dependence can facilitate technological development, when solutions that are historically built in industrial structures come to be confronted with new possibilities. Thus the path dependence can contribute to technological development through the reuse of existing knowledge (Araujo and Harrison, 2002). The research reveals how firms grow along paths set by their prior possession of capabilities and how these capabilities themselves slowly expand (Richardson, 1972, pp. 888). The new possibilities can emerge from dependent or independent innovative regimes and their integration may raise the technological possibilities for the organisations to create value for them.

During the second stage the decision makers will judge:

- What are the relationships of these factors in terms of technological, organisational and resource evolutions?
- What are their relative influences on each other?
- What are the priorities of these factors in relation to the investment decision?
- What are their influences in terms of benefits, opportunities, costs and risks?
- What should be the investment decision on the basis of the BOCR merits?

On the basis of calculated decision, which is transmitted back to the evolutionary framework, further evolutions occur within cycles of the evolutionary framework. The DTC model is developed from a theoretical review of the dynamic capabilities, resource based view, evolutionary cycle and eco-system of technology evolution and from the empirical studies of the mobile and satellite industrial practices. The DTC model on one hand extends the theory of dynamic capabilities and on the other hand helps the mobile operators in making the investment decision related to technological and organisational evolutions. Once developed, the next phase is to prove this conceptual model. How the DTC model is going to be validated is discussed in the following section of the research methodology.

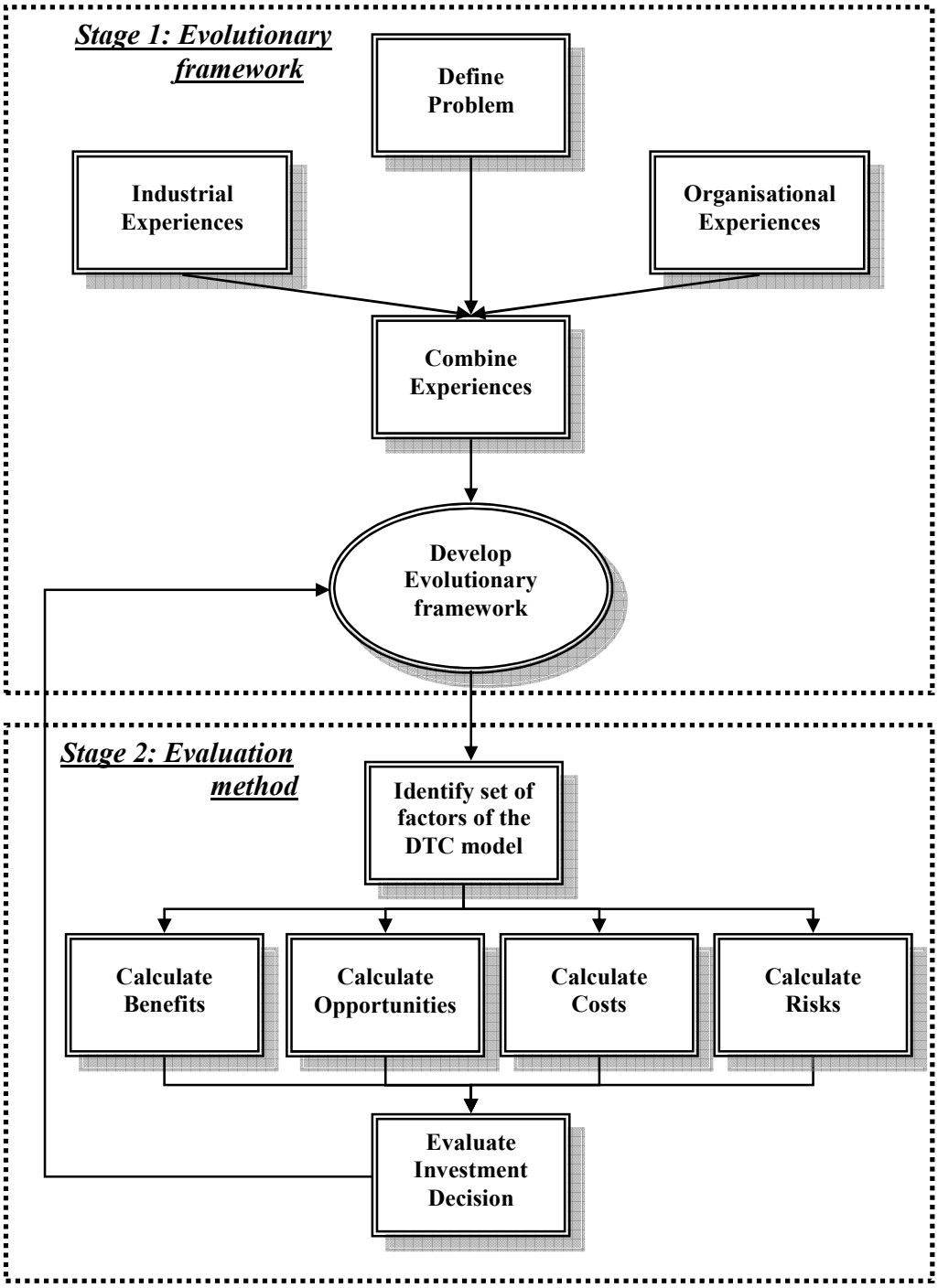


Figure: 3-17: The DTC model for the investment decision makers

3.3 The research methodology

This section discusses the methodology adopted for this research. The major groundwork of this research is based upon the case study approach. The case studies were chosen to get the holistic view on which the strategic investment decision relies. The study is limited to the three cases selected for a similar type of applications. The three case studies include the UK mobile operators: Vodafone, Orange and O2. Their organisations provide a fruitful source of information along with certain comparisons, as each has a quite distinct strategic view and each occupies a distinct position in the mobile market. The overall research methodology combines the qualitative and quantitative research methods to initially develop the DTC model and then to validate it and utilize it for making the investment decision by the mobile operators.

3.3.1 The case study methodology

Case study is an ideal methodology when a holistic, in-depth investigation is needed (Feagin et al., 1991). This research work is defined as basic research as it is based upon the holistic investigation of theory of the dynamic capabilities and extending it through the concept of the technology co-evolution. Once extended, this basic research is utilised for the problem-oriented research for the UK mobile operators. The detailed understanding of related theories results in the development of an evolutionary framework which is further utilised to develop a set of factors for the mobile operators to reach the less risky investment decision. The case study methodology in this research follows the five stage case research process (Stuart et al., 2002). These stages are discussed in detail:

3.3.1.1 Stage 1: Defining the research question

The first stage of the research process involves defining the research question. Invariably, this involves contributing towards building a body of knowledge (Stuart et al., 2002). The observational richness of the case study approach provides a means of extensions to the existing concepts (Stuart et al., 2002). The research which extends the existing concepts can be defined as a basic or a fundamental research. The basic research identifies some relations in developed concepts of theoretical and practical domains. This research work, on one hand, develops relations in the theories of dynamic capabilities and technology co-

evolution and on the other hand, develops relations between the conceptual evolutionary framework and the practical domain of the UK mobile operators.

Yin (1994) defines a case study as an empirical inquiry that investigates a contemporary phenomenon within its real life context. This approach is closer to the concept of deductive research method developed by Aristotle. The deductive research method refers to the structured approach utilising an accepted premise to move from the general to the specific knowledge gained about a particular relationship. According to Yin (1994), for this research design the theory development is essential. The developed theory must be tested through replication in the empirical case structures. An important step in all these replication procedures is the development of a rich, theoretical framework. In the earliest stages of the case study the past experiences are implicitly incorporated in the researcher's activities (Wallace, 1971). The theoretical framework can be developed through detailed understanding of previous theories. The framework needs to state the conditions under which a particular phenomenon is likely to be found (a literal replication). Applying the framework for more than one similar type of case satisfies the literal replication and conformation becomes stronger (Yin, 1989). The theoretical framework later becomes the vehicle for generalizing to new cases, again similar to the role played in cross experiment design (Yin, 1994).

The case study approach, in the context of this research work, is helpful in extending the concepts of dynamic capabilities. The research methodology first extends this concept by developing an evolutionary framework which is then tested through replication in the empirical domains of three UK mobile operators.

3.3.1.2 Stage 2: Instrument development and site selection

The second step in conducting the case research is the development of a research instrument and selection of the appropriate field sites (Stuart et al., 2002). Once the research question is defined, it needs to be tested through some data for the case analysis. The research based on extending the existing concepts should define initially, what is likely to be found. This becomes possible due to the detailed investigation of theoretical concepts and identification of a gap. Once the gap is identified, this stage finds instruments to fill this gap. Stake (1995), discussed an 'instrumental' type of case study to understand more

than what is obvious to the observer. This research fills the identified gap with the help of instrumental study of the mobile industrial practices particularly in the context of LBS. The case study of the mobile operators to provide LBS in the market will not only describe their organisational capabilities but will also help in understanding the causal relationship of technology co-evolution and the organisational capabilities.

The case study must demonstrate that its means of measuring are valid (Stuart et al., 2002). Yin (1989) discussed four criteria of case study research: construct validity, internal validity, external validity and reliability. The primary concerns for case studies are construct validity. It proves whether or not the measurements reflect the phenomena they are expected to reflect. The phenomenon which needs to be measured for this research is the influence of the technology co-evolution on the evolution of the dynamic capabilities of organisations. This phenomenon is measured in this research work with the help of LBS. These services heavily rely on the technology co-evolution due to their ability of involving several technological roles together. The case study of LBS identifies that co-evolution of related technologies are required to bring efficient LBS applications into the UK market. This co-evolution affects the decision of the UK mobile operators to evolve accordingly. Eventually, the technology co-evolution of LBS shows the evolution of organisational capabilities of the mobile operators in the time span of 2001-2007. The study of such time span proves the construct validity of the case studies for LBS.

Case based research depends on investigating observations which influence the choice and number of firms for field interviews (Stuart et al., 2002). The firms chosen here are the UK mobile operators and they are studied in terms of their evolving technologies and organisational capabilities as they exhibit the phenomenon of interest (Eisenhardt, 1989; Yin, 1994). The specification of firms provides the internal validity as on their basis theories are extended, data is collected, and analyzed to test theories (Tellis, 1997). This research investigates the phenomenon of technology co-evolution which might not necessarily rely on the resources from endogenous industry but may emerge from exogenous industries. This concept needs to be measured at the industry levels. Kaplan (1964) defines the paradox of sampling which refers to the usability of the sample to be truly representative of its population. This research selects three amongst five UK mobile

operators. The study of 60% of the UK mobile industry provides usable samples with sufficient evidence for the measurement and verification of phenomena.

3.3.1.3 Stage 3: Data gathering

In case-based study, the 'data' are the written and taped records of the interviews, documents that the company is willing to provide, and the researcher's observation (Stuart et al., 2002). Beyond the interviews, archival records, artifacts, internal company documents and multiple interviews provide a more complete picture of the environment being studied (Stuart et al., 2002). The combination of the variety of evidence and observations proves the distinctive strength of a case study method (Oshri and Weeber, 2006).

This research work initiated with the data collection from desk research and open-ended interviews with the experts of the mobile and satellite industries followed by semi-structure interviews with the UK mobile operators. The players in the mobile and satellite industries were experts in the LBS area and others included the university faculties. The selection of interviewees was based on four key areas given by Rubin and Rubin (1995). The first key area is to find the initial contact. The knowledgeable informant was found by attending the LBS related conferences (European Navigation Conference, 2006) which revealed related facts of LBS about its capability of integrating the satellite and mobile industries. This was followed by several other interviews whose contacts were given by the previous interviewees. The second key area is related to getting views. The initial interviews offered a range of views related to LBS. Emerging concepts of LBS headed towards the related theoretical literature and helped in developing an evolutionary framework. The third key area is to test emerging themes with new interviewees. The emerging concept of an evolutionary framework for the support of LBS helped in selecting the UK mobile operators as a source of future interviews. The final key area is to choose interviewees to extend the results. The managers and technologists of three UK mobile operators were chosen to extend the concept of an evolutionary framework and further use it for the development of the DTC model.

The semi-structured interviews with the managers and technologists of the mobile operators allowed interviewees to share their insight and views on industrial practices and identified

related evolution of technological and organisational capabilities and disclosed reasons behind the slow uptake of technology. These experts helped in clarifying the concepts such as which technology is integrating these two industries and why it has not succeeded to achieve its position. All participants were asked the similar questions to confirm observations and opinions for the reliability of the interview data (Eisenhardt, 1989; Yin 1984).

The detailed information about the LBS evolutions is obtained through a number of interviews with the experts of Vodafone, Orange and O2 who possessed detailed knowledge of previous evolutions and of required evolutions. The interviews included senior managers and technologists (Head of Strategy and Change, Head of Business Development, Head of Whole Sale, Head of Solution Products, Head of Product Management, Product Managers, Industry Initiatives, Director R&D, System Delivery Manager, Solution Products, Account Managers, Product and Delivery Strategy, Project Managers and Group Technology). Interviews ranged in length from 45 minutes to 2 hours. The interviews were recorded with the permission of the mobile operators. A few, however, did not assent to the voice recording. These interviews identified all related technological and organisational evolutions and helped in developing a set of factors for the second stage of the DTC model. The detailed information of all these interviewees is in appendix A.

In case studies, the data collection should be treated as a design issue that will enhance the construct and internal validity as well as external validity and reliability (Yin, 1994). Yin (1994) and Stake (1995), discussed the importance of multiple sources of data towards the reliability of the case study. To ensure construct validity, the multiple resources of evidence were looked for each of the important factor in the propositions, using the important technique of triangulation (Denzin, 1978; Jick, 1979; Fielding and Fielding, 1986; Yin 1994). These corroborated pieces of evidence helped in solving problems of subjectivity. The table 3.2 shows different sources of evidence to collect data for this research work.

Triangulation can occur with data, investigators, theories and even methodologies (Feagin, Orum and Sjoberg, 1991). Stake (1995) added that to ensure accuracy we use triangulation. To ensure the accuracy of interviews, data of LBS related activities were also obtained through the keyword search across on-line media archives of the mobile operators'

websites. This search covered the time period of 2001-2007. The media archives were downloaded and printed for content-analysis. The content analysis collected all evolutions related to LBS including development and launch of new applications, sharing of resources, establishment of new partnerships, suppliers of certain technologies, types of relationships with suppliers and partners, evolutions in regulations etc.

Table 3-2: Multiple sources of evidence for the research work

Source of Evidence	
Documentation	• Company Press Releases • Company's Case Studies • Company's published Reports • Future Vision Reports • News Letters • Magazines
Archival Records	• Annual Reports • Survey Data Results, e.g., 'Berg Insights' • Employees' Database
Interviews	• Open ended for theory extension • Semi Structured interviews for theory validation • Semi structured interviews for identifying a complete set of factors
Physical Artifact	• Availability of LBS applications in the market and results of their market acceptance surveys. • Managers' Presentations • Conferences CDs

Denzin (1978) identifies four types of triangulation. This research work adopts two of them, data source triangulation and methodological triangulation, looking for the same data in the different organisations supports data source triangulation. In order to improve confidence in interpretation (Tellis, 1997) the combination of the qualitative and quantitative research methods supports methodological triangulation. The qualitative approach was used for the validation of an extended theory in the form of an evolutionary framework, the first stage of the DTC model. Once this stage was developed, the quantitative approach was adopted for the validation of an evaluation method with the set of factors, the second stage of the DTC model. During this approach the data was gathered by arranging three separate workshops with three mobile operators. During workshops same experts, who were interviewed first, gathered to prioritize the 52 factors mentioned in table 3.1 and discussed in section 3.2.1. The workshops started with presentations of the author, followed by group discussions with assigning weights to factors where managers

and technologists were asked to perform the pairwise comparisons of all factors and their relative alternatives in order to reach the investment decision for these mobile operators.

The case study of Vodafone is considered as a pilot case study. Glaser (1978) offered a comparative method which allows parallel data collection and data analysis. The collection of data from 'Vodafone' and its analysis through the DTC model helped in developing ideas for the data collection of Orange and O2.

3.3.1.4 Stage 4: Analyzing data

The challenge of the case study research method is not just the observation, listening and recording of data in a systematic manner but also its analyses and interpretation. Much of the important data come from analyzing and interpreting what individuals are trying to say (Stuart et al., 2002). The analysis of the empirical data, on one hand, is for the purpose of validation of the theory extension. On the other hand, its complete relevance to the empirical domain makes it utilizable for the problem-oriented research. The problem-oriented research develops a solution method for a particular problem in a real and practical environment. The result of the data utility for both purposes can validate the basic and problem-oriented research. But in such scenarios questions about how data for the research can be analyzed, what knowledge is going to be achieved and how data can be presented, carry an integral portion of the research task and take a great deal of time and effort (Van Maanen, 1987).

This research work develops an evolutionary framework for the theory extension and its analysis is used for the development of an evaluation method through a set of factors which can help the mobile operators in making their strategic decision. The cautious measures of a set of these factors, on one hand, offer mobile operators a less risky strategic alternative and on the other hand, prove the relation and influence of technology co-evolution on the evolution of the organisational capabilities. For the evolutionary analysis of the history of technology the development of a set of factors and their judgment on the basis of their priority selections can be considered as a 'technique' (Ziman, 2000) which focuses on an important and historical entity while satisfying the basic characteristics of the evolutionary system (Ziman, 2000; pp. 55). Typically knowledge provides tools to solve problems, while techniques embody solutions (Ziman, 2000; pp. 55). The evolutionary framework provides

historical knowledge for the development of the evaluation method. The data collected is analyzed and presented through the analytic tool, the ANP, which is feasible to measure the BOCR merits of the alternative decisions.

3.3.1.5 Stage 5: Disseminating the research findings

The best possible way of achieving feedback on the case study process is to share the research findings with appropriate personnel. This research work is based upon the case studies of three UK mobile operators. Therefore, the most suitable personnel to get feedback from are these mobile operators. The dissemination of this research work is in the form of reports sent to individual mobile operators. These reports were accompanied by the feedback forms to test the validity of the DTC model. Testing was done by applying this model for the investment decision in the A-GPS technology by these mobile operators. The prime objective of the testing stage is to determine whether the DTC model provides a practical and procedural step for making the investment decision (Platts, 1993). This model was judged on the basis of three criteria: feasibility (can the model be followed); usability (how easily could the model be followed); and utility (does the model provide a useful step in making the investment decision) (Platts, 1993).

3.3.1.5.1 Feasibility

The feedback on feasibility testing was based upon the question asked from the mobile operators: 'how easily can the model be followed?'. The respondents replied to this question by selecting one box from four options (very easily; quite easily; not very easily; not easily). The overall feasibility of the DTC model can be demonstrated by completing the process for the mobile operators for making the investment decision. In this complete process, however, the author was responsible for the development of the DTC model therefore this activity was facilitated by the author.

3.3.1.5.2 Usability

The feedback on usability testing was based upon the question asked from the mobile operators: 'how easily can the model be used for other technologies?'. The respondents replied to this question by selecting one box from four options (very easily; quite easily; not very easily; not easily). Overall usability of the DTC model can be demonstrated by assessing a way of data acquisition. The mobile operators were provided with tables

showing 52 factors. Each factor was discussed with a group of decision makers and they were asked to prioritize these factors with numbers varying from 1 to 9. However, in this complete process the author was responsible for describing each factor and therefore this activity was also facilitated by the author.

3.3.1.5.3 Utility

The feedback on utility testing was based upon the questions asked from the mobile operators: 'Can the model provide a useful step in strategy formulation for investment decision?', 'Does the result appear useful?', 'Can the model be adopted for other technologies?'. The respondents replied to this question by selecting one box from two options (Yes; No). The results of feedbacks showing feasibility, usability and utility of the DTC model are given in appendix B.

The overall utility of the DTC model can be demonstrated by matching the results of the model with their already taken strategic decision. Three operators have their own reasons towards the investment decision in the A-GPS technology. The investment decision of Vodafone appears in favour of alternative A2 due to their strategic focus towards the cost reduction and revenue stimulation in Europe. At present, Vodafone is not ready to make a quick investment in the A-GPS technology. The investment decision of Orange appears in favour of alternative A1 due to their strategic focus towards offering more integrated applications to customers and achieving revenue from new applications. Orange has declared that evolution towards the A-GPS technologies has already been initiated. The investment decision of O2 appears in favour of alternative A1 due to their lack of control and influence on the investment decision of the technology co-evolution. O2 declared that their licence for offering basic LBS through the Cell-ID technology is about to expire. Therefore they have to buy this technology. The A-GPS technology is coming in a bundle with LBS, therefore they will get the A-GPS technology.

The discussed five stage research process adopted for the case study methodology will be applied to the three case studies in the following chapter. Chapter four will discuss the application of combined qualitative and quantitative research methods. The detailed studies of these cases will be useful in validating the DTC model. Amongst other validity criteria, external validity is achievable from theoretical relationships which can lead to

generalization. External validity refers to the domain to which a study's findings or presumed causal relationships may be generalised (Cook and Campbell, 1979; Kidder and Judd, 1986; Yin, 1989). These multiple case studies will help in generalizing the DTC model in the context of mobile operators where they can make the investment decision for multiple types of technologies. As case studies rely on analytical generalization (Yin, 1989, pp. 43), the analytical study of three mobile operators is the motivation behind the next chapter. These multiple case studies also fulfill the reliability requirements. Reliability is the extent to which a study's operations can be repeated, with the same results (Cook and Campbell, 1979; Kidder and Judd, 1986; Yin, 1989). Applying the same method in each case will lead towards finding comparisons (Steenhuis, and Bruijn, 2004) and as each case will be investigated in a similar way (Swanborn, 1996) their results will lead towards the theory extension.

3.4 Conclusion

As the technological roles co-evolve, the technological organisations must develop clearer concepts of the contributions of these technological roles towards the evolution of their organisational capabilities. Concepts such as: what are their contributions towards making an investment decision? with which driving forces? under what level of merits? should be considered by the decision makers of these organisations. In the context of this research work, a key question is for the development of a solution method which can facilitate the decision makers of the technological organisations in making the investment decision in the next generation of the technology by considering all of the mentioned concerns.

The initialization of the development of a solution method was discussed in chapter two. Under such discussion, this research identifies the influence of technology co-evolution which must be considered in the process of making an investment decision. But in order to reach an investment decision the solution method should be accompanied by a set of factors. In a situation of investing for evolution towards the next generation of technology these factors must be taken with respect to their clusters, drivers and merits. The processes of classifying these factors go through:

- Gathering information of these factors from evolutions in *technologies, organisational capabilities* and *resources*;

- Assigning these factors with respect to the driving influences of *accuracy and quality of technology, market demand for technology, cost of technology* and *self and governmental regulations*;
- Measuring these factors with respect to their *benefits, opportunities, costs* and *risks* merits;
- Calculating the *benefits, opportunities, costs, risks* merits to achieve the less risky investment decision.

As an example in the context of this research work, the above solution method is put into the empirical environment of the UK mobile industry which is involved in the process of making an investment decision in the next generation of the Location Based Services. In this regard, this chapter elaborated 52 factors which should be considered in the context of LBS.

The incorporation of the concept developed in chapter two, and a set of factors developed in chapter three, presents a solution method called a Dynamic Technological Capability (DTC) model, for the decision makers. The DTC model can be utilized by the group of managers and technologists for making the investment decision of evolution in the next generation of the technology within a fairly swift market. For the validity of the DTC model, the research work follows a case study approach which will utilize this model for the decision makers of the UK mobile industry. The following chapter will present their studies.

Chapter 4: Case Studies – Vodafone, Orange and O2 UK
An application of the DTC model

4.1 Introduction

This chapter illustrates how the Dynamic Technological Capability model developed in chapter two and three can be implemented in a real industrial scenario. The main concern is to prove the validity of the DTC model in the practical domain of Vodafone, Orange and O2, UK. These organisations need to identify the less risky strategic alternative of making an investment decision in the A-GPS technology. These three case studies represent 60% of the UK mobile industry, therefore their detailed study and calculations can also help in identifying the less risky strategic alternative for the two remaining mobile operators of the industry. The industrial study will thereby prove the concept of an evolutionary framework which identifies the influence of exogenous industrial resources on the endogenous industrial resources. This concept is described in terms of independent innovative regimes and dependent innovative regimes, which in these case studies are represented by the satellite and the mobile industries respectively.

All three cases are discussed in detail and are supported with two stages of the DTC model. The decision for all of them is for the similar technology, therefore similar technological and organisational evolutions are discussed. The first stage of the DTC model presents the historical knowledge of these companies in which they gradually evolved in terms of their technologies and organisational capabilities. The second stage presents their priorities for the discussed 52 factors of chapter three.

As a result of the analysis of these two stages, each of these companies recognizes the benefits, opportunities, costs and risks of the A-GPS investment. This exercise also shrinks the number of factors to 32 and helps them in calculating the results for their strategic alternatives. The results for all companies appear to complement their own strategic decisions regarding the A-GPS investment. The similarities between their strategic decision and the calculated results conclude that the DTC model works well in the practical domain

as well as in the theoretical domain as a solution method for reaching the investment decision for the next generation of the technology evolution within a fairly swift market.

4.2 The first stage of the DTC model

This section discusses the historical knowledge of technological and organisational evolutions of three companies, and views these evolutions for the Location Based Services through the lens of the DTC model. The study of Vodafone is termed as the pilot case study of this research. However, Orange and O2 will follow the same patterns of the first case.

4.2.1 Evolution of LBS in Vodafone, Orange and O2, UK[1]

Vodafone, Orange and O2 UK are three of the five UK mobile operators. Vodafone, UK is the subsidiary of Vodafone Group Plc which is the world's leading mobile telecommunications company. The headquarters of the Vodafone UK is in Newbury, Berkshire. Its name represents an abbreviation of **Vo**ice **da**ta **fone**, to reflect the provision of voice and data services over mobile phones with a slogan of "make the most of now". Vodafone follows the strategy 'to delight customers'. Vodafone possess their own organisational capabilities and perform their organisational processes separately. But there are certain decisions which Vodafone Group Plc takes and applies to all of its subsidiaries. These decisions initiate from distinct groups including Global Technology, Global Marketing, Group HR, Group Business Development, Group Strategy and New Business, Group Legal, Group Corporate Affairs and Group R&D. Vodafone launched LBS in April 2001 and announced evolutions in Oct 2002 under the mobile internet service portal, the Vodafone Live!.

Orange, UK is a member of the global communications group 'Orange'. The Orange group entered into the UK mobile market as a start-up in 1994. The group Orange is a subsidiary of the France Telecom (FT). In 2000, FT bought Orange from the British firm, Vodafone

[1] The sources of information for this section are companies archives and annual reports, web sites of companies, web based news of 3G Insights, 3G News, BBC news, Cellular Newsletters, CTIA Smart Brief, Direction Magazine, LBS Insight, ZDNet news, white papers, industry surveys by TruePosition, Berg Insight, MapInfo, ESRI, BWCS and Juniper Research and interviews conducted with the companies' employees.

Airtouch. Vodafone acquired Orange as a part of its takeover of the German telecom giant Mannesmann. Mannesmann bought Orange from Hutchinson Whampoa of Hong Kong in Feb 1999. The corporate offices of Orange are in London Hertford, Bristol and Leeds. Their slogan is "the future's bright, the future's Orange". Orange has built its success on the ability to deliver quality products and services that satisfy customers of both consumer and business markets. Keeping customers' demands as priority, Orange continuously evolves its products, services, technologies and methods and in return achieved very strong brand awareness in the consumer market and very strong partner recognition in the enterprise market. Orange has a vision for 2010 for significant growth of new revenue streams, driven by new and converged services and business transformation into a fully integrated operator including fixed-line, internet, mobile and content. Orange offered LBS in the market in 2001 and evolved its capabilities in 2003. Orange evolved from cell-id towards the triangulation technique to increase the accuracy level from the range of 100m-30km to 50m-100m (Adshead, 2002).

O2, UK is a member of the wider O2 group. The O2 group comprises mobile network operators in UK, Ireland, along with integrated fixed/mobile businesses in Germany, the Czech Republic (Telefónica O2 Czech Republic) and the Isle of Man (Manx Telecom). It also owns 50% of the Tesco Mobile and Tchibo Mobilfunk, joint venture businesses in UK and Germany respectively. The O2 group is the subsidiary of Spanish based Telefonica S.A. O2 became an independent wholly owned company in 2001 following the demerger from BT. In May 2002 a single customer brand 'O2' came into being with its headquarters in Slough (group and UK HQ), Bury, Glasgow, Leeds and Preston Brook. According to O2, customers are at the heart of everything O2 does. O2 wants to turn customers into fans by delivering the best customer experience. O2 keeps its 'Customer Promise' charter at the heart of strategy to keep customers happy and loyal. The mission of O2 is to build an inseparable relationship with customers by understanding their needs and delivering solutions that they truly value. In order to offer LBS, O2 initiated with the cell-id technology. O2 also experimented with other technologies like TOA (Time of Arrival), SIM based and E-OTD. According to Ian Curran, '*O2 possesses a patent for its E-OTD technology*'. At present O2 offers cell-id which provides latitude and longitude and distance of the cell to calculate the location of the user in the range of 50m-15km.

In terms of technology co-evolution, LBS play an application role and its emergence has caused these companies to alter some of their organisational capabilities. LBS caused technological co-evolution in handsets, network infrastructure and several supporting technologies. The major evolution in organisational capabilities was that these companies allowed third party developers to become a part of their LBS value chain. Alongside co-evolutions also occurred in capabilities like R&D, ethical purchasing, strategies, marketing, environmental policies, codes for privacy, brands, organisational structure and processes etc. These three cases validate the first stage of the DTC model by mapping LBS related technological and organisational co-evolutions and validate the second stage of the DTC model by evaluating their strategic decisions for the evolution towards the next generation of the LBS technology. The following section discusses and illustrates these LBS evolutions of these cases.

4.2.1.1 Vodafone LBS evolutions

Vodafone targeted the needs of consumers and business customers individually to offer its LBS. The very first LBS application for consumers was 'Find and Seek' with Vizzavi. Vizzavi Ltd, is the company which provides internet and mobile data services. This service was launched on 02 Apr 2001. This service was based on the WAP (Wireless Access Protocol) technology and was providing local information of consumers' whereabouts, with information of eating, drinking, sports, banks, museums, amusement parks, local taxi firms and other leisure activities. These applications became enabled after licensing the technology from AirFlash, Inc. and striking a deal with Google Inc. AirFlash, Inc. built location relevant wireless services for the Vodafone customers including business listings, driving and walking directions, a restaurant finder and community application. Google, Inc. integrated the company's advanced search engine, web directory and wireless technology into the Vodafone network.

In the UK, the main focus remains on large and better value bundles of applications. Following the bundling strategy, Vodafone Live! was launched on 24 Oct 2002 based upon 2.5G GPRS technology. It is an easy to use consumer service which integrates multimedia with communication. This service allowed customers to find and purchase a range of contents online. To provide these new contents Vodafone established relationships with content and services as the strategic partner, distributor, reseller or customer.

One of the recent content providers of Vodafone is m-spatial Ltd. m-spatial was established in 2001 in Cambridge. It provides geo-spatial data for Vodafone Live! applications. Vodafone bought the 'MapWay' application from m-spatial. On 05 May 2004, m-spatial announced the evolution of the MapWay application and broadened its service offerings on Vodafone Live!. With this evolution, a large number of POI like pubs, banks, and supermarkets were added under Vodafone Live!. This evolution made it easier to read icons and reduced the large number of clicks required before reaching the exact service. This new version deployed additional applications like 'Walk to/from nearest station', 'Nearest tube to...' and 'Where am I?'. On 13 Jan 2005, Vodafone announced the update of Vodafone Live! 'Find and Seek' service. For this update Vodafone became the distribution partner with Mobile Commerce. Mobile Commerce added 31 extra services to 'Find and seek' service. According to Al-Russell, Head of Contents and Advanced Messaging, Vodafone UK, "*Find and Seek has proved to be an exceptionally popular Vodafone Live! service. Our customers really value having access to a wide variety of information relating to social activities like comedy clubs and clubbing guides*".

On 17 Jan 2005, Vodafone announced that Vodafone Live! 'Find and Seek' is available for 3G customers also. With this evolution, customers are automatically presented with a colorful map of their current location, along with an additional five services in the vicinity. These services are not only based on current locations but also on timing of search, e.g., in the morning time the location of coffee bars appears on the map and at night time, a pub appears. This evolution was supported by Mobile Commerce. On 09 Feb 2005, m-spatial announced another evolutionary integration of its Spatial Platform which delivers a set of re-usable high level components to allow Vodafone live! content and application providers to quickly and easily 'spatially enable' their services with Vodafone Live! menus. For example, having identified a restaurant through 'Find & Seek', a user can immediately request a map or directions with Vodafone Live! 'look and feel', without having to visit another mapping service and re-enter the name of the restaurant.

On 13 Sep 2006, Vodafone signed a reseller agreement with @Road, Ltd. @Road, a business customer, resells Vodafone's wireless data service bundle with the integration of @Road GeoManager (SM) field force management service. Vodafone provided its GPRS network to @Road, Ltd., to launch their Mobile Resource Management (MRM) services

which can drop down fuel and other operating costs through location intelligence of mobile workers and vehicles. On 12 Feb 2007, Vodafone announced that Vodafone and Google intend to develop a location based version of Google maps for mobile?. Google and Vodafone are currently working together to ensure the service provides customers, on selected handsets, with an automatic user location capability. At present, Vodafone Live! provides several "Travel and Location" services to consumers. Table 4.1 describes a recent classification of consumer based LBS along with their costs. For its business customers Vodafone provides services like "Travel and Tourism" and "Transport and Distribution". Their classification is listed in table 4.2.

Table 4-1: Vodafone consumer based applications

Location Based Service	Description	Cost
Find and Seek	It locates essential services and entertainment activities including restaurants, clubs, cinemas etc with directions and maps of these locations.	It costs 35p/use or as much as £2.50 a month, with first month free.
Directions	It pinpoints where you are on an on-screen map. Also uses AA RoutePlanner and provides walking directions to destinations.	Just to find nearest car park will not cost anything. However AA Direction is £2.50/month.
Time-Out-City Guide	It provides pocket guide for more than 100 cities, all packed with information on things to see and do, places to stay, and where to eat, drink and shop. It can also be forwarded to a friend to plan a trip together.	Downloading is charged at standard browsing rate.
Travel and Journey	Either travelling by road, rail or air in order to avoid the chance of a delay, it checks the AA RoadWatch to find out about jams, makes sure when the last train home is, and checks when a plane is landing.	Just looking at timetable of local station will not cost anything. But AA RoadWatch is £2.50/month, rail is £2.50/month, and air is £1.50/month with 1 month free.
Holidays and Break	It provides information about fancy holidays and breaks through 'Travel Shop' and snaps up a deal from British Airways, Virgin Atlantic or lastminute.com	Booking is charged at standard browsing rate.

(Source: Information based on Vodafone UK website)

Table 4-2: Vodafone business customers' applications

Applications	Description	Technology	Cost
Fleet and Asset Management	It tracks the exact position of vehicle & transmits timing of reaching destination.	GPRS and LBS	GPRS is pay monthly
Security and Surveillance	It provides automatic service solution utilizing dual path transmission via a fixed & mobile connection and provides more efficient and cost effective means of transmitting notification of intrusion or CCTV images.	GPRS, Gateway services and Paknet	GPRS is pay monthly with single fixed bill
Retail	It provides remote payment via credit or debit cards.	GPRS, Gateway services and Paknet	GPRS is pay monthly with single fixed bill
Metering and Monitoring	It captures performance and usage data, such as energy use and cost and transmits to relevant utility	GPRS, Gateway services and Paknet	GPRS is pay monthly with single fixed bill

(Source: Information based on Vodafone UK website)

Table 4-3: Suppliers of consumers' applications

Application	Supplier	Description	Relation
MapWay	m-spatial	It provides map and directions on Vodafone Live!	Customer
• 3G Find & Seek • Travel & Journey • What's Nearby • Special Needs • Deep links • Overture • SMS Infotainment • What's On & • Infotainment • Naughty Places	Mobile Commerce	They provide content delivery platform and alliances with content supplier.	Distribution partner
• RoadWatch • RoutePlanner • Directions	AA	They plan journeys, help in avoiding traffic jams and provides updated traffic information.	Partner
MapXtreme for Vizzavi Find and Seek	MapInfo Corp	It is based on WAP technology, it provides StreetLine Mapping, distance to the nearest location.	Customer
Multimap Server	Multimap Company	It provides street level and road maps of UK proximity searching, routing, aerial images with map overlay, local information, weather; door-to-door travel directions; and local information. Through partners it provides hotel, holiday-cottage, restaurant-booking services, and ability to buy historic and aerial photographs.	Customer

(Source: Information based on Vodafone UK website)

Table 4-4: Suppliers of business customers' applications

Application	Content Provider/ Solution	Description	Vodafone relations
Flight and Asset Management	Cognito/ Activus™	It offers a complete end-to-end managed mobile data service, for deployment over the Vodafone GPRS/GSM network. It is designed for integration into back-end systems, enabling field workers to receive and return relevant job information whilst in the field through the integration with Service Management and Scheduling solution vendors.	Mobile Network Operator (MNO) Partner
	TBS/ TaskMaster	It is a mobility solution which enables organisations to communicate information wirelessly to their field workers by eradicating paperwork administration and driving consistent adherence to business processes. It is GPS enabled application.	Network Partner
	Aeromark/ Triplock	It provides portable security and tracking for containers and box trailers. It is suitable for real time tracking and provides data needed for efficient supply chain management, ensuring full visibility of inventory status, location and progress and also protects the load space and transmits an alarm in the event of unauthorized entry and can be quickly located via the internet to street level.	Network Partner
	Vettro/ RainMaker	It provides field sales services through automatic routine tasks and provides functionality unavailable on the desktop versions of the CRM tools. Features such as calendar integration and email capture work the way you think. Because the data is synchronized automatically whenever you're in a wireless coverage area, the timeliness of the data is guaranteed.	Carrier Partner
	Vodafone Locate You	It provides fleet management over internet, provides exact position of each vehicle, its speed, and where they have been. The information is available online 24/7. Also an additional report can be requested for historical vehicle movements. It combines both GPRS and GPS technology.	Owner

(Source: Information based on Vodafone UK website)

Since the day these applications were launched, they have been continuously evolving in terms of infrastructure and mobile handsets and evolutions offered by several other content providers. Content providers play an important supplier role in enriching the customer's experience of LBS. For example the numbers of content providers only for 'Find and Seek'

has now reached ten including Itchy, Toptable, Press Association, Ticketmaster, FilmNight, Active Hotels and Ents24. In addition to contents, some suppliers also provide solutions to support LBS in the form of components. Table 4.3 & 4.4 presents the solutions and contents provided by the suppliers for LBS of consumer's and business customer's segments respectively. These tables also show the relationship of Vodafone with these suppliers.

4.2.1.2 Vodafone technology co-evolution

Vodafone provides LBS based on the enhanced cell-id technology. Due to this technology the location of a mobile device is updated in the Vodafone network and can be sent to any application in the form of XY co-ordinates, time of last known location, start angle, stop angle, inner radius and outer radius. Apart from enhanced cell-id technology the network of Vodafone supports A-GPS devices but only for control signals. To offer new LBS applications other service providers take advantage of the location information from Vodafone's network and integrate it with data from content providers. Currently, infrastructure used for LBS is IP based GPRS and WCDMA. Fig 4.1 shows the main components which Vodafone uses to deliver LBS to its customers. These components are mainly supported by the basic mobile network infrastructure without which Vodafone cannot send and receive signals for applications.

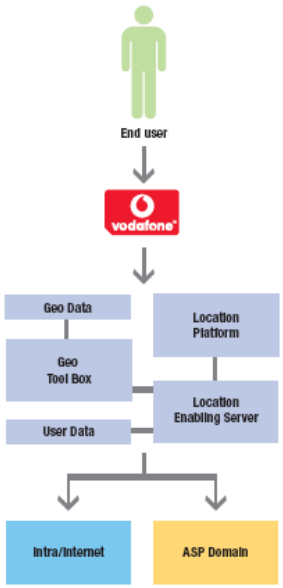


Figure 4-1: Major components to deliver LBS
(Source: Vodafone WholeSale Product Datasheet: Location Based Services)

4.2.1.2.1 Infrastructure technology

The mobile network infrastructure is fundamental for Vodafone to provide mobile services to customers. The network consists of a large number of antennas which are termed as base stations, covering the UK to manage transmission of voice and data signals. These base stations cover a particular area termed as 'cell'. The increase in the number of base stations increases the accuracy and quality of voice and data signals. Since 1985 when Vodafone provided the first mobile services the infrastructure has been continuously evolving. This evolution depends upon the deployment of a larger number of base stations along with the addition of software components to improve their efficiency. The evolution of infrastructure technology is given in table 4.5. This evolution increases the number of the base stations. In 2003, 20817 base stations supported the mobile traffic and provided 99% coverage for 2G infrastructure of the mobile population. This evolution allowed mobile users to send a large amount of data on a cost effective basis.

For the roll-out of the 3G infrastructure, Vodafone followed a depth strategy. Vodafone initially offered services to a limited number of the UK cities but with a deep level of penetration within buildings. This strategy helped Vodafone to deliver reliable services to customers and in return gained customers' confidence. To cope up in those areas where 3G services were not offered, Vodafone provided a seamless handover between 3G and 2G infrastructure. Since the launch of the 3G infrastructure, Vodafone has been continuously investing to increase the UK coverage by increasing the number of base stations. During the year from Mar 2005 to Mar 2006, the number of 3G base stations increased from 9837 to 11,352. Up until 2007, Vodafone provided 80% coverage for 3G infrastructure.

The infrastructure technology was provided to Vodafone from Ericsson and others alike. Ericsson has worked with Vodafone since Jan 1985, when the Vodafone Group Plc launched its first 2G infrastructure. Their strategic partnership has been continuously leveraged for more than two decades. In an inauguration of Vodafone 'Global Supplier Conference' in Mar 2006, Vodafone awarded Ericsson with the award of 'Network supplier of the Year' for achieving 'Best Engagement In Network' in Vodafone's Supplier Performance Management Program. The award was a result of Ericsson's success in delivering a range of efficiencies, being the first to deliver HSDPA and overall engagement with customers. Table 4.6 shows the list of technology providers to Vodafone.

Table 4-5: Evolution of the Vodafone infrastructure and product technologies

Infrastructure	Launched	Services
2G-GSM	June 1991	It offers digital services for voice, text and basic data. The evolution took place due to the increased market demand for value added services from 15% to 43% within one year.
2.5G-GPRS	June 2000	It sends and receives data over IP based networks, enabling wireless access to data network like internet. The evolution took place as previous technology was not sufficient to fulfill the needs of business customers.
Integration of GPRS & WAP	June 2001	It offers business customers to access their office LAN and mobile internet information, downloads, update records and email services on the move. This service also helped in tracking travel information. The evolution took place due to the increased market demand for integrated data.
3G-WCDMA	October 2004	It provides customers with mobile broadband data access allowing data download speeds of up to 384 kbps (kilobits per second), which is seven times faster than a dial up modem. The evolution took place due to the increased market demand for high data rate.
3G+-HSDPA	June 2006	It enables customers to download data with a high speed of 1.4 Mbps. It increased the capacity of previous 3G data rate by three times. The evolution took place to support multimedia services.
3G+-HSUPA	Autumn 2007	It enables customers to upload data with high speed. The evolution took place to support multimedia services.
Product	**Launched**	**Services**
Motorola T260	June 2001	The evolution took place to supports WAP and GPRS services.
Nokia 7650	October 2002	It carries capabilities of easy to use colour menu's to access Vodafone Live! services.
Sony Ericsson V800, Sharp 902SH, Motorola V980, Nokia 6630, Samsung Z107V, Motorola E1000	October 2004	It carries capabilities of easy to use color menu's and other technologies to access Vodafone Live! 3G services.
Nokia 6234 exclusively for Vodafone customers.	December 2005	It offers branded access to Vodafone's services, with an easy to use menu structure, complemented by Vodafone's signature colors, graphics, icons, menus, texts themes, Vodafone start-up and shut-down graphics and tones, customized wall papers, screen savers and ring tones.
Range of 54 HSDPA phones: LG, Motorola, Nokia, Sagem, Samsung, Sharp & SonyEricsson, Vodafone 710	October 2006	This range includes not only expensive handsets, to support Vodafone Live! with 3G, but at the same time Vodafone considered low price handsets to expand Vodafone's 3G consumer services to the mass market. Vodafone 710' was launched at low price to encourage further adoption of 3G services for prepay market.

Table 4-6: Suppliers of supporting infrastructure and component technology

Supplier	Infrastructure /Component	Technology	Description	Vodafone relation
Ericsson	2G and 3G	GSM, WCDMA, HSDPA HSUPA	They provide infrastructure for roll-out of network enabling mobile communication services	Strategic Partner
Cisco	IP converged, Packet network (CPN) 'IP Factory'	IP based 3G traffic	They transformed mobile service production and support using an IP factory which leverages e-Telecommunication operating map framework	Customer
Siemens	Location Enabling Server (LES)	WAP	It offers a platform which works as gateway for location enabling applications like mapping, routing and geo-coding functionality. Works in integration with MapInfo miAware^{TM} GeoToolBox.	Customer
Mobile Commerce	Location Gateway	Application-programming interface (API) based on XML standards	It delivers dynamic access to cross network handset location feed. Customer sends the mobile telephone number to the Location Gateway which responds with information of X,Y co-ordinates (in GB National Grid format or GPS / WGS84 format), area of accuracy and date/time	Distribution partner
m-spatial	Spatial Platform for 'spatially enabling' Vodafone Live!	URL based API	It is software based interactive spatial component which can be integrated with services of any content and application provider to deliver standard and simple user interface to customers of Vodafone Live!	Customer

(Source: Information based on various electronic NewsLetters)

4.2.1.2.2 Product technology

The evolution of infrastructure and components could enable Vodafone to provide value added services, but at the same time the mobile handsets need to be enabled to support these high data rate services. As the buyer of technology, Vodafone also remained closely associated with suppliers of handsets and followed the product evolution. For this purpose Vodafone had launched several handsets along with every new technology. The product evolution is given in table 4.5.

To provide the services of Vodafone Live! Vodafone worked very closely with Nokia and developed Vodafone Live! enabled mobile handsets. In order to offer GPS based LBS,

Nokia introduced Nokia N95, with integrated GPS and navigation functionalities. This launch appears as a positive sign for future progress towards A-GPS technology. Vodafone is offering Nokia N95 and Nokia 6110 to facilitate the GPS based navigation services along with BlackBerry Curve 8310 with added benefits of fully operational satellite navigation. With the introduction of new A-GPS enabled handsets in the market, Vodafone will be able to offer A-GPS enabled services to customers.

4.2.1.3 Vodafone organisational evolutions

Due to the complex structure of LBS, Vodafone cannot deliver these applications to customers alone and therefore established several relationships and alliances with suppliers of these technologies. These technologies can be defined as handsets (products), mobile network (infrastructure), mobile maps (contents) and location intelligent tools (components). The established relationships are not only valuable for Vodafone, but suppliers also achieve values from these relationships. Allowing third party application developers inside Vodafone and permitting them to share the Vodafone LBS value chain has been identified as the major evolution in the organisational capabilities. The value chain shows all processes in a product's creation including design, pricing, procurement, and fulfillment. Therefore any relationship established to offer LBS in the UK market caused Vodafone to develop individual teams to support commercial partnerships, contracts and finance issues. Fig 4.2 below shows the LBS value chain and fig 4.3 shows the Vodafone LBS value chain with a few of the Vodafone key suppliers.

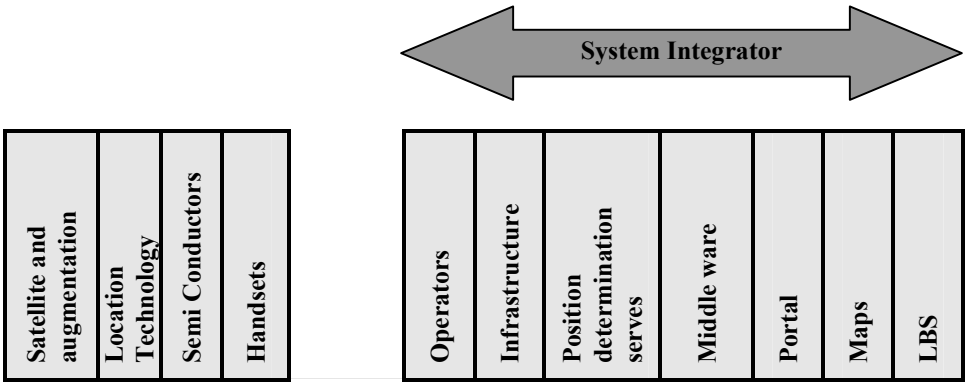


Figure 4-2: LBS value chain
(Source: Fuente, C.D. et al., 2004)

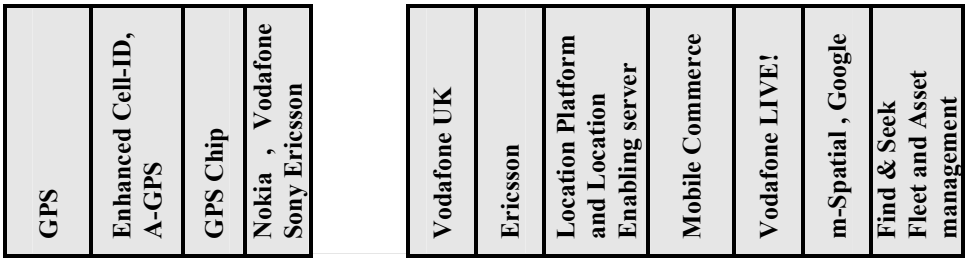


Figure 4-3: Vodafone LBS value chain

To establish new relationships and retain previous ones with suppliers, Vodafone has to follow some organisational capabilities. The capabilities rely on managing the supply chain, managing the standard of contents, managing further roll-out of network infrastructure keeping health, safety and environmental policies at priorities, along with very essential, managing R&D capabilities. These organisational capabilities are discussed below.

4.2.1.3.1 Supply chain management capabilities

Vodafone offers services to customers through established relationships with suppliers of technologies. These relationships are managed through supply chain capabilities. At present, Vodafone deals with 2000 suppliers. In 2006, Vodafone spent £1.9 billion on goods and services from suppliers, from which 38.1% was for the handsets and 20.1% for the infrastructure technologies. Because Vodafone relies on others' technologies, their end product's quality is highly dependent on the quality of the suppliers' products. Therefore to increase its quality Vodafone judges the quality of the suppliers' product through a Supplier Performance Management (SPM) program. SPM judges the quality on the basis of corporate responsibility, financial, technology, commercial, delivery, and quality criteria. Vodafone published the regulations of SPM as a Code of Ethical Purchasing (CEP) to specify the essential labour and environmental standards for the suppliers to follow. Any new supplier is assessed on the basis of CEP and regular suppliers are re-assessed regularly every six months. The clear specifications of CEP make it convenient for new and old suppliers to comply with standards of Vodafone and become or remain its suppliers.

4.2.1.3.2 Managing content standard capabilities

The growth in numbers of content providers and types of contents makes Vodafone establish a team to manage content standards. The team was established in Oct 2002 to

protect customers from inappropriate contents, contacts and commercialism. To make it conveniently manageable, Vodafone together with other UK mobile operators launched a joint 'Code of Practice for the self regulation of new forms of contents on mobile phones' in Jan 2004. Apart from this process, human moderators work in chat rooms hosted on Vodafone Live!. Taking advantages of component technology, Vodafone integrated 'Content Control', a network bar on the Vodafone Live!, to prevent access to 18-rated contents. In default it is placed on every mobile and allows customers to access these contents only when they prove their ages. For LBS, Vodafone established a contract with all service providers to ensure that the consent of the person being tracked is obtained before initiating a tracking service. In terms of consumer applications the service provider obtains consent directly from the person being tracked. For business applications, employee consent must be obtained either by the LBS provider or by the employer. These contracts with service providers are also regulated on the basis of compliance with the 'Industry Code of Practice For the Use of Mobile Phone Technology to Provide Passive Services in the UK'. This code was announced on 24 Sep 2004 and covers four key areas: child protection, consent, anti-surveillance and ease of use.

4.2.1.3.3 Managing mobile network roll-out capabilities

With the evolution of 3G infrastructure, Vodafone faces an enhancement in the number of base stations. The number of base stations was 9,837 in Mar 2005 but within one year, to Mar 2006, increased to 11,352. As evolution continues, the number of base stations also continues to increase. The installation of these base stations depends upon factors such as maximum utilization, impact on society, visibility, health and safety issues. Vodafone cannot directly deploy these base stations anywhere. To solve this problem, Vodafone along with other mobile operators developed 'Ten Commitments to Best Siting practice'. These ten commitments are incorporated in the 'Government's Code of Best Practice on Mobile Phone Network Development'. In response to these commitments, Vodafone revised its policies and procedures, including updating their planning manuals to incorporate the government recommendations.

In order to follow the regulations, Vodafone developed additional capabilities including collecting information and consultation. Before deploying any base station Vodafone consults with the local planning authorities, local ward councillor and parish or town

council. Vodafone provides plans to them to show the locations of their current base stations and envisage the location of new base stations. If the local authority accepts plans, Vodafone initiates network roll-out. So far 82% of the planning authorities felt the information in the Vodafone plans met or exceeded their expectations. Apart from feasible locations the visibility of base stations is also considered before their implementations. In some situations Vodafone used specialist designs like camouflaged equipment on historic buildings and churches. To fulfill these requirements Vodafone works with site acquisition agent companies who can find new sites for base stations and can complete the planning and acquisition process.

4.2.1.3.4 Managing health and safety standards

The base stations transmits radio frequency (RF) which could be harmful for humans if it exceeded certain limits. The RF field penetrates a few centimeters into the body and is absorbed as heat. It is measured through specific absorption rate (SAR). The International Commission on Non-Ionizing Radiation Protection (ICNIRP) provides the limit which seems un-harmful for human beings. Vodafone complies with these clearly stated ICNIRP guidelines before launching any base station.

4.2.1.3.5 Managing environmental policy capabilities

As the number of base stations is increasing, the consumption of energy also increases. Until 2006, 83% of the total energy of Vodafone was consumed by the infrastructure technology. These issues are handled under the capabilities for policy and management. The environment policy commits Vodafone to improve energy efficiency. To cope with this situation Vodafone is planning for some changes in the cooling systems of base stations and trying to accredit the ISO 14001, the international environmental management standards for the consumption of energy across base stations.

4.2.1.3.6 Managing research and development capabilities

Vodafone relies on its Group R&D programme which provides the long term technical policy, strategy and leadership, as well as technical underpinning for the Group's public policies and government relations. The group spent millions of pounds on these activities. Group R&D gets the benefit of concern from participants of Group R&D, Technology officers from four mobile operating subsidiaries (at present the UK is one of them), Future

products, Business Strategy and Technology Development. They perform their operations under three main clusters:

- Future vision and opportunities expand business boundaries through advances in technology, science and business practices providing input to group strategy.
- Technology research includes core radio network and services enabling technologies, business modelling technology, application of social science, analysis of disruptive technology.
- Application research develops new applications of radio base technology for commercial launch.

LBS can be a part of each of these clusters. Within 'further vision and opportunities' Vodafone can take A-GPS technology as an opportunity and can develop A-GPS related strategies. Within 'technology research' LBS business models can be developed which take advantage of already available network and service technologies. Within 'application research', huge numbers of LBS applications can be developed for commercial launch.

4.2.1.3.7 Managing organisational structure

Along with evolutions in the mentioned capabilities, Vodafone also took a major decision for change in the organisational structure on 01 Aug 2004. Fig 4.4 below shows the current organisational structure of Vodafone.

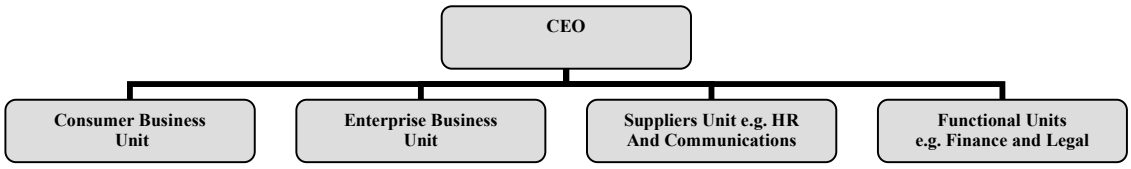


Figure 4-4: Organisational structure of Vodafone UK

This change helped in achieving better focus towards the segments of customers and made it easier to separately manage and support the above mentioned capabilities. One of the key principles of the new structure is to drive operational benefits and cost reduction. Vodafone UK as a mature market is influenced by the principle of cost reduction and therefore needs to focus on leveraging its capabilities. Another key principle is related to capturing new revenue streams through converged and IP services to provide innovative services to customers. Major groups of Vodafone like Group Business Development, Group Strategy

and New Business are dealing with these requirements. Group Strategy and New Business identifies new business opportunities and key partnerships. LBS under Vodafone Live! gets the benefits of IP services and the integration of GPS chips makes this service a source of convergence between the mobile and satellite industry.

4.2.1.3.8 Managing customer care capabilities

Vodafone develop strategies in favour of customers. Vodafone performs CRM (Customer Relationship Management) activities through its strategic agreement with Amdocs, the world's leading provider of billing and CRM products and services for integrated customer management. This strategic relationship has been followed up since 1995 on numerous voice and data billing, CRM and mediation projects. In Jul 2004, however, this relationship became a long term global framework agreement. The new agreement specifies service levels, pricing and a legal framework for all future projects between both companies worldwide. In the Vodafone stores, for convenience of customers, the new technology tool, Q-Management has been deployed since Jun 2007. This tool can identify a customer's enquiry and resolve it quickly.

For the management of LBS, CRM and billing services also get complemented with customers' privacy concerns. In Feb 2007, Vodafone organised a focus group of privacy experts from academia, industry, investors, NGOs, government and law enforcement authorities to discuss a wide range of safeguarding customer privacy. The issue related to a request for user data or assistance with surveillance from government, and law enforcement agencies also became the part of the discussion. The potential implications of targeted mobile advertising for customer privacy were also discussed. Vodafone performs targeting in the mobile advertisement by capturing the customers' information and sending them advertisements to their mobile phones but this information does not include their real location. According to the Markus Muenkler, '*So far Vodafone captures only age, gender and home locations of customers before sending any advertisement. This data does not include the actual location of the mobile user. In order to make these advertisement location specific Vodafone needs business which offers some applications based on 'being close to me"*.

4.2.1.3.9 Managing strategic capabilities

To respond positively to the changing market demands, Vodafone followed some strategic changes to leverage Vodafone's position and remain competitive within the market. The changing market demands caused the following evolutions in the Vodafone strategies:

- In Europe, to focus on both cost reduction and revenue stimulation;
- To deliver strong growth in emerging markets;
- To satisfy customer needs and extend the current mobile offerings by innovating and delivering total communications solutions;
- To actively manage portfolio to maximize returns; and
- To align the financial policies regarding capital structure and shareholder returns to support strategy.

To reduce the cost Vodafone leverages the regional scale and also reduces the cost structure in Europe. Vodafone also outsourced the IT development of billing and customer management system and continues to drive scale benefits in the network supply chain management area. The main strategic partners of global outsourcing deal for management of the application development and maintenance are EDS and IBM. For revenue stimulation Vodafone continues to deliver innovative bundles and tariffs.

To deliver customers' total communication Vodafone offers a number of innovative services within home and offices with the help of HSDPA, DSL, WiFi, and VOIP technologies. Vodafone also extends its business model to generate revenue from advertising in ways that customers find attractive. To manage its portfolio, Vodafone seeks to invest only where it can generate superior returns. The policy of strict investment is based on criteria to ensure that transactions yield a return above the cost of capital within three or five years. The investments in LBS are slow due to this restriction. As LBS are not considered as a commercial success the returns are not visible in coming three to five years.

4.2.1.3.10 Managing marketing and sales capabilities

Vodafone manages its marketing capabilities on the basis of responsible marketing guidelines. The guidelines help to ensure that marketing activities and external communication through any direct or indirect channel are fair, honest and accurate and are

consistent with Vodafone's vision, values, business principles and policies. The marketing activities must comply with all relevant laws, regulations and codes of practice.

Vodafone uses separate channels for consumers and business customers. According to Chris Huggett, Enterprise sales director, "*Vodafone currently have seven to eight routes to market but needs a more sophisticated and sustainable strategy for indirect channels to explain where the channel sits in the picture"*. In 2004, Vodafone built up the direct channel capability to manage 100% of its contract customers from a single point in the UK. These direct channels help in sales and retailing capabilities. With over 300 high street stores, Vodafone is a leading player in communications technology retailing, offering a wide range of products and services to customers looking for the latest mobile phones and accessories. Because of its clear retail position, Vodafone was awarded the 'National Retailer of the Year' award in 2005. The award identified highly motivated staff of Vodafone, its excellent standards in store operations, investment in systems and ongoing research and performance benchmarking.

On 07 Jun 2006, Vodafone announced rebuilding of its 100 stores in the UK on the basis of its customer centric strategy. The new stores incorporate new brand image and design based on convenience in directing customers to exactly where they need to go. The design includes different areas for different activities like express area at the front for phone covers, e-top-up cards, dedicated help area for customers to receive advice and a distinct area for business customers. At present, Vodafone is in the middle of this substantial expansion programme.

Vodafone also established a new strategic agreement with Phones 4U on 12 Oct 2006 for the acquisition and retention of contract customers. Under the terms of a deal, Phones 4U becomes the exclusive third party retailer for Vodafone contract customers. Both parties have worked closely together for several years. This deal appeared as a natural evolution of a close working partnership. As a result, both parties get benefits from supply chain efficiencies and are working together to market mobile products and services.

Mobile advertising is one of the new communication channels suitable for marketing capabilities. In Nov 2006, Vodafone formed the strategic alliance with Yahoo! to create an

innovative mobile advertising business and to enhance the customer experience on mobiles for services like Vodafone Live!, games, TV and pictures messaging services.

4.2.1.3.11 Managing partnership and alliances

Vodafone works closely with key suppliers, partners and third party developers for development of the quality applications. To manage strategic partnerships with suppliers of infrastructure such as Ericsson, a supply chain team works at Vodafone. This team manages the relationships globally and also puts some pressure on prices of technologies. Vodafone recognise the contributions of these suppliers annually and award them on the basis of their outstanding services. In 2007, the Vodafone's Global Supplier Performance 'Supplier of the Year' Award went to Giesecke & Devrient, a leading supplier of telecommunication systems and smart cards. The award of 'Outstanding Performance' went to Huawei, the telecommunications network specialist, for delivering highly competitive products and services to Vodafone across the group's network. The award of 'Corporate Responsibility Engagement' went to Sun Microsoft. In the same event Vodafone also recognised Alcatel-Lucent, Dell, Gemalto, KPMG, Nokia Siemens Networks, Incard, Starhome and Tektronix as short-listed candidates for awards. The suppliers of some of the Vodafone LBS are Google, Multimap, and AA.

Apart from strategic partnerships, the third party partnerships are managed through a new Channel Programme. This programme was launched on 01 Dec 2005. Through this programme Vodafone aims to deliver a cautious approach to working with third party channel partners based on meeting individual customer needs. For example, a customer with specialist requirements, such as a logistics company, now refers via Vodafone towards a specialist channel partner who can deliver solutions which meet their specific business custom needs. In order to do so, Vodafone developed a new online portal containing marketing collateral as well as products, service and sales information. Along with dedicated sales and marketing support from Vodafone in the form of a supportive team and structured training based on the individual needs of each channel partner. This new Channel Programme equips these channel partners with the tools and training they need to sell the diverse range of mobile products and services.

The capabilities discussed so far resulted in terms of resources generation for Vodafone. Some of these capabilities developed new resources, some leveraged older ones and some older ones were integrated with newer resources. These resources are discussed briefly in the following section.

4.2.1.4 Vodafone resources evolution

Vodafone classifies resources as Non-Current and Current assets. Non-current assets include all intangible assets like licences purchased for 2G and 3G technology, computer software, R&D expenditure and brand recognition. Other non-current tangible assets include property, plant, equipment, fixtures and fittings and network infrastructure. The current assets are mainly related to cash flow, liquidity and capital expenditures.

4.2.1.4.1 Non-current assets

I - Intangible assets

For a network operator a very important intangible asset is the licence of technology acquired to make its business operational. Vodafone has already acquired the licence for 2G and 3G technology. The licence for the 2G technology was acquired in Dec 1991 to support GSM and GPRS networks. This licence is for an indefinite period with a one-year notice of revocation. The licence for 3G technology was acquired in Feb 2004 to support the WCDMA network and will expire in Dec 2021. The computer software is also purchased with these licences. The economic lives of these software usually vary from 3 to 5 years. Economic life represents the useful life of the asset. The useful lives of distinct intangible assets vary in numbers of years.

For managing R&D capabilities the expenditures on research are calculated in the period in which the research is incurred. Currently Vodafone R&D Group is working on several themes; a few of them are related to LBS and its related technologies. The first related theme is ‘Service Development’ which investigates emerging service – enabling technologies to provide application developers and content providers with new capabilities for the development and delivery of new applications. Service development includes the investigation of these technologies and their potential applications in new service concepts, the development of the service architectures to exploit technologies, the examination of

business implications as well as pilots and demonstrations. Along with this 'Telematics' is the special research theme which covers technology, services and applications related to travel and transport, including GPS/GSM based road tolling, advanced location technologies and applications, and M2M communication. In relation to the infrastructure technology, the theme of 'Network Performance and Optimisation' covers the development of any technique designed to improve the quality or cost effectiveness of Vodafone's network operations. These aspects of network operation are critical to profitability in a competitive market. This includes techniques for radio coverage planning, optimization of air interface capacity and quality, and investigation of the relationship between network capacity, quality of service (QoS) and traffic demand. To achieve the benefits of this intangible asset, Vodafone Group Plc spent million of pounds. The gradual increase in the amount is illustrated in figure 4.5.

Another intangible asset is the brand. The economic life of the brand varies from 1 to 10 years. Vodafone established a global brand for Vodafone Live! and allowed all of its companies to launch this service quickly into the market by leveraging their existing organisational capabilities. Regular evolutions, however, are going on through the integration of several other technological capabilities.

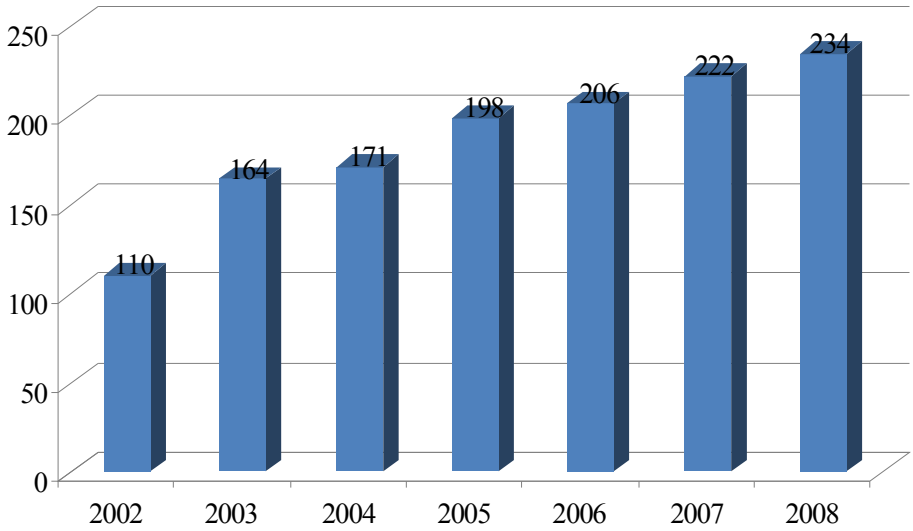


Figure 4-5: Research and Development expenditures (£millions)
(Source: Information based on Vodafone Group Plc Annual Reports)

II - Tangible assets

The tangible non-current assets are property, plant and equipment. The buildings, motor vehicles and computer equipment come under this category. A very integral asset of Vodafone is its mobile network infrastructure. To keep up the efficiency and integrity of this asset it is essential to evolve it regularly, but managing this evolution is very expensive. This evolution is influenced by certain factors like demand and regulations. On the basis of demand for high speed data transfer, Vodafone realised a need for evolution towards the 3G infrastructure. Jens Kurten, spokesperson for Vodafone, said, '*what we are sure of is that the growth potential in our business lies with data services and 3G, and if we want to remain a big player we have to invest in WCDMA. There is no alternative*'. Left with no choice Vodafone decided to evolve towards the 3G infrastructure. Along with the 3G infrastructure, Vodafone is continuously spending million of pounds over other fixed assets. During the year 2003, Vodafone invested in excess of £100 million in its 3G infrastructure only.

Because of the high cost analysis of network infrastructure, Vodafone and Orange decided to share their base stations. On 08 Feb 2007, Vodafone and Orange signed an agreement for their network sharing in the UK. According to Nick Read, Chief Executive at Vodafone UK, '*this proposal will enable the two companies to remain vigorously competitive against each other and the market, while realising the proven benefits of network sharing, notably faster roll out of high speed mobile services in the future and the earlier introduction of innovative products*'. This evolutionary step resulted from the estimation of Vodafone about the reduction in capital and operating expenditure costs of 20 to 30%, assuming full 2G and 3G consolidation. Apart from expenditures these assets are also generating some revenue for Vodafone. Fig 4.6 shows a turnover for Vodafone due to the equipment and other tangible assets.

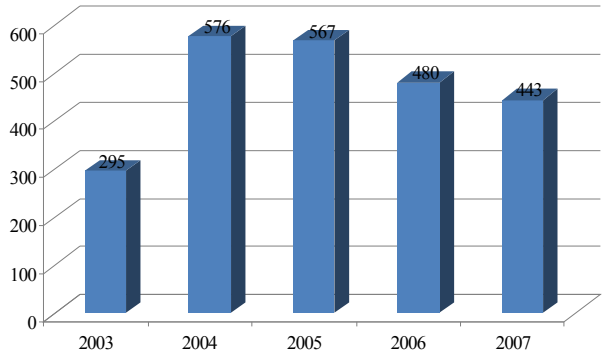


Figure 4-6: Turnover of equipments and other tangible assets (£millions)
(Source: Information based on Vodafone Group Plc Annual Reports)

Customers are also considered an asset to Vodafone. Customers are classified as prepaid or monthly contract tariff customers. The increase in the number of customers is beneficial for Vodafone. The table 4.7 shows growth in the number of Vodafone's customers.

Table 4-7: Annual customer's growth

Vodafone Customers	2003	2004	2005	2006	2007	2008
Closing customers (000)	13300	14095	15324	16304	17411	18573
Customer growth (%)	1%	6%	9%	6.4%	6.8%	8.9%
Prepaid customers (%)	59	60	61	61.1	-	-
Contract Customers (%)	41	40	39	38.9	-	-

(Source: Information based on Vodafone Group Plc Annual Reports)

4.2.1.4.2 Current assets

Current assets are related to the cash flow for liquidity and capital resources. These current assets are increasing and decreasing annually depending upon several factors. Some related factors which affect cash flow of liquidity and working capitals are; increased competition, regulatory ruling, delays in development of new services and networks, and inability to receive expected resources from the introduction of new services. Cash flow is highly affected by the capital expenditure on property, plant, equipment and special computer software for applications. The revenue can be classified according to different services offered to customers. Cash flow also results in the revenue generated from services offered by Vodafone. Table 4.8 shows the revenue generated for Vodafone. Whether these assets are non-current or current they always require expenditure for their evolution. Fig 4.7 provides a cost analysis of Vodafone expenditures on these assets.

Table 4-8: Turnover of voice and data services

Vodafone Revenue		2003	2004	2005	2006	2007	2008
Revenue/ Turnover (£m)		4055	4782	5065	5048	5124	5424
Voice services (£m)		3207	3487	3672	3642	3604	3601
Non-Voice services (£m)	Message	541	671	684	705	760	923
	Data			142	221	295	383
Total service revenue (£m)		3748	4158	4498	4568	4681	4952
Monthly ARPU (£)	Prepaid	10.4	10.8	10.3	9.4	-	-
	Contract	43.2	45.9	47.4	45.7	-	-
	Blended	23.8	25.8	25.5	24.0	-	-

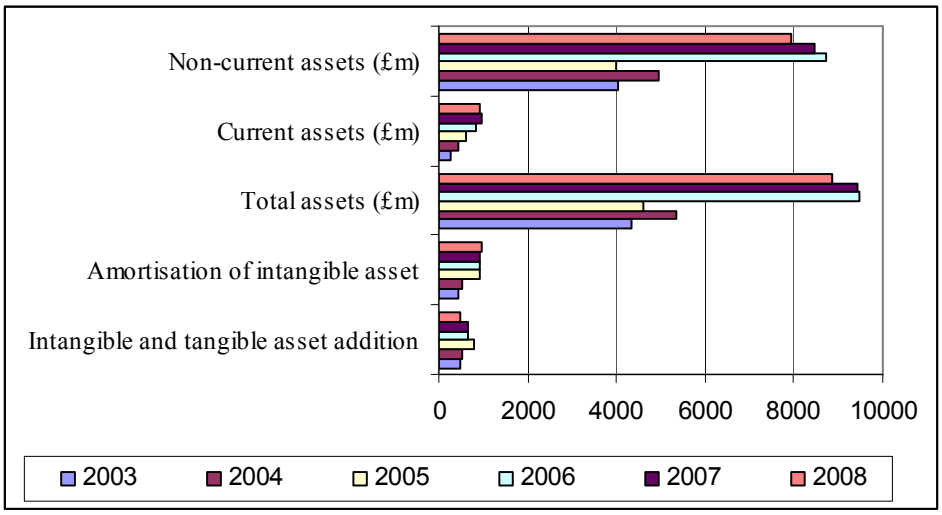


Figure 4-7: Cost analysis of Vodafone expenditures
(Source: Information based on Vodafone Group Plc Annual Reports)

The detailed discussion of the technology co-evolution and evolution of organisational capabilities of Vodafone has developed a ground study which shows a direct or indirect link to LBS. This discussion not only proves the evolutions in technologies and organisational capabilities but at the same time shows the linkages between them. These evolutions are mapped by using the first stage of the DTC model. The mapping on one hand presents the utility of the DTC model for the practical domain and on the other hand helps make all these evolutions transparent for the managers and technologists of Vodafone so they can identify those areas which will be evolved if Vodafone invests in A-GPS technology.

4.2.1.5 The presentation of the evolutionary framework of the Vodafone LBS

The evolutionary framework as the first stage of the DTC model is utilized to map evolutions of the technological and organisational capabilities. This graphical mapping can

offer a better way of conveying information to the decision makers and can also help in emphasizing particular aspects of this study which are related to prove the influence of technological co-evolution on the evolution of organisational capabilities and to measure the BOCR merits for the A-GPS investment.

4.2.1.5.1 Evolutionary cycle of the Vodafone LBS

At the first stage of this cycle the Group R&D initiated the idea of providing LBS to the consumer's market. In order to provide this service Vodafone identified the need for evolution in infrastructure as well as in the strategic relationships. Vodafone owned the infrastructure based on GSM and evolved towards GPRS. To provide LBS applications Vodafone decided to reconfigure its tangible assets and became capable of providing these applications. The reconfiguration process recombined the network infrastructure with the Location Enabling Server (LES) to get the benefits of the cell-id technology. The addition of the LES component made Vodafone able to capture the locations of the mobile devices within the cell area. To provide mapping services and location information like Point-of-Interest (POI) to consumers, Vodafone utilized the strategic relationship of Vizavvi Ltd. These evolutions delivered the new application 'Find and Seek' to the Vodafone customers. Due to nature of this evolution, which was slow and progressive, Vodafone added a few new assets along with the existing ones and reconfigured them to provide the required applications. LBS created additional resource in the form of new mobile data services. The recombination of WAP with GPRS technology also supported the *always on* connections to capture the location on mobile phones or on computers. Through the correct identification of current infrastructure and the need for future evolutions of resources, Vodafone deployed new assets in the continuation from the existing ones and this transformation allowed adoption and commercialization of LBS applications.

During the second stage, Vodafone identified the evolutions in LBS along with the development of new ones. The evolution took place through the addition of new applications after the first commercial launch. At this stage there was a need for selecting appropriate applications through the search process for identifying the needs of customers. To select appropriate applications there was the need for enhanced research which could identify and develop the killer application. This process was supported through the knowledge and the learning capabilities of those who were involved with R&D activities.

Their learning helped in the selection of additional applications like MapWay, RoadWatch, MapXtream, Travel & Journey and Flight & Asset management along with the bundle of applications in Vodafone Live!. In addition to this selection process of application, the decision of selecting appropriate partners and third party application developers to provide good quality applications also relied on the knowledge of selectors. For example, service operator Zingo has been chosen to offer the caller the possibility of directly connecting to the closest available London's black cab driver. This application matched the mobile phone location data to the GPS location data received from the taxi and was connected to the taxi drivers. Once an application such as 'Find and Seek' was launched by Vodafone the addition of new applications became easier, better and quicker because it was repetition and imitation of some capabilities.

During the third stage, newly launched applications took benefits from the already available infrastructure. Vodafone introduced these new applications under a newly established organisational structure. The consumer's related applications were launched by the Consumer Business Unit and applications for business customers were handled by the Enterprise Business Unit. By leveraging the network infrastructure and components, Vodafone launched a good number of LBS applications. Although these applications were categorized as LBS, their scope extended due to their adoption in different market segments. These market segments include road and toll taxes, location enabled games and booking holiday breaks through different airlines. The strategy of leveraging components and infrastructure for replicating LBS in different markets brought benefits to Vodafone in terms of cost saving. The leveraging did not only allow Vodafone to reutilize technology but at the same time relationships with suppliers were leveraged to further develop more evolving components and applications for LBS.

By the fourth stage, Vodafone had developed several applications for LBS by reutilizing tangible assets and offering them under Vodafone Live!. With the identification of demand for high speed applications, Vodafone decided to evolve towards 3G infrastructure. At this stage Vodafone retained the capabilities of the available infrastructure and already launched LBS applications. With this retention Vodafone also started the integration of 3G and 2G infrastructure. It also integrated the services of Vodafone Live! with the 3G infrastructure. The integration brought Vodafone closer to suppliers of infrastructure and

mobile handsets to further develop customized handsets and applications for Vodafone Live!. Vodafone worked very closely with suppliers for different types of products and applications, for example, customized handsets by Nokia and Sony Ericsson, and developing exclusive products for Vodafone Live! applications, developing Google maps for mobile phones etc. Vodafone worked with these suppliers under formally developed relationships. As a result Vodafone refined LBS applications of Vodafone Live! and also redefined the relationships with suppliers. The decision to create these new assets such as the 3G evolution resulted due to the huge research done before implementation with suppliers like Nokia. Fig 4.8 presents these evolutions in the form of an evolutionary cycle.

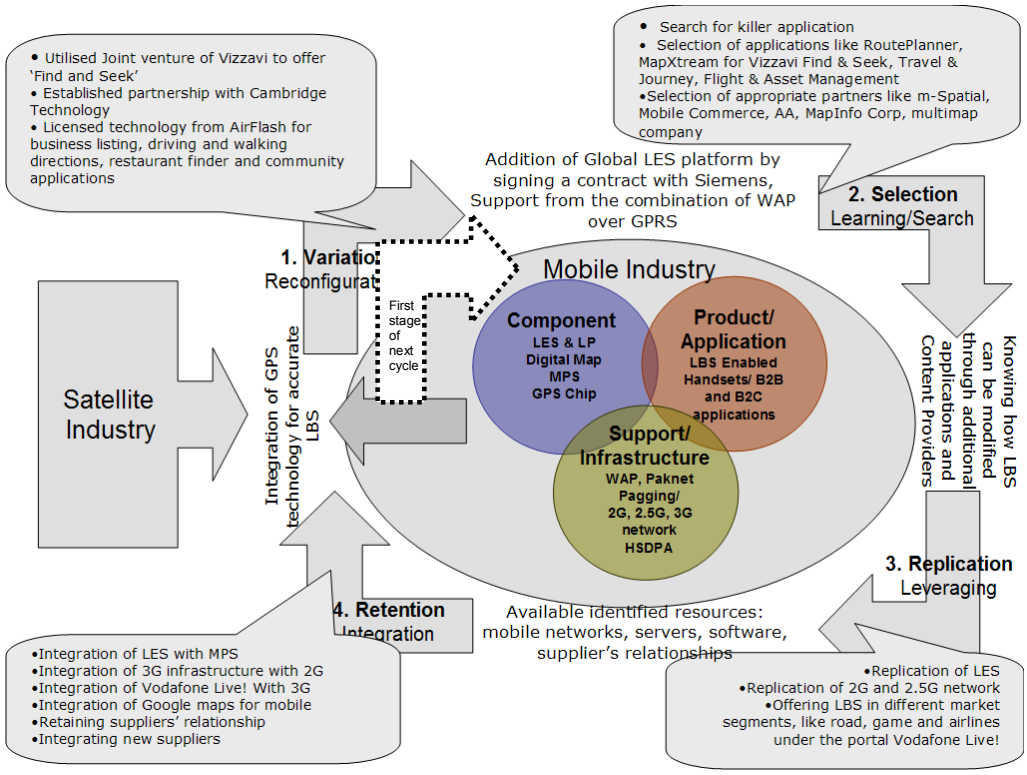


Figure 4-8: The evolutionary cycle of the Vodafone LBS

With the completion of the first evolutionary cycle, Vodafone has managed to develop new resources and technological assets. The developed technological assets are still inter-related to each other and evolving due to their inter-dependencies. A few of them were retained by Vodafone and therefore became the resources. A few were further required to be reconfigured and replicated for the next evolutionary cycle. At that moment, evolutionary technology for LBS emerged from an independent innovative regime, a satellite industry,

which pushed towards the integration of the GPS chip to enhance the accuracy of the LBS applications. Vodafone evolved towards this integration and adopted external industry resources and initiated the second evolutionary cycle. This integration caused some variations in infrastructure, application, products and components simultaneously with the evolution in organisational capabilities. The product evolution was supported with the launch of Nokia N95 and Nokia 6110. Nokia 6110 was launched exclusively for Vodafone.

At present, Vodafone is at the second stage of the second evolutionary cycle where the investment decision of selecting the A-GPS technology to offer more accurate LBS is like a question. The selection of the A-GPS technology needs further evolutions in infrastructure, enabled handsets and a few additional software components like A-GPS server. This selection needs investment on the mentioned technologies. The infrastructure of Vodafone possesses capabilities of A-GPS technology but only to support the control signals. This technology has not been deployed for the commercial applications. In this scenario, the second stage of the DTC model will be used as a tool in evaluating the benefits and risks of this investment decision. It seems that evaluating the benefits, opportunities, costs and risks (BOCR) merits of any decision can help in reaching the less risky decisions. If benefits and opportunities have more values than costs and risks, the decision of investment can be beneficial for Vodafone. In order to achieve these measurements a group of the Vodafone employees have participated in a workshop and performed an exercise of assigning weights to those 52 factors which are discussed in chapter three. These measurements will be discussed further in detail in section 4.3 under the heading of the second stage of the DTC model. In order to improve the validity of the first stage of the DTC model, the same is applied to the case studies of Orange and O2 which are discussed in the following section.

4.2.1.6 Orange LBS evolutions

Orange signed a deal with the US-based company AirFlash to test technology to remotely locate its customers in Jun 2000. Orange selected AirFlash's SmartZone technology to make LBS commercially available. Later Orange integrated the contents into AirFlash's Mobile Content and SmartZone technology (Kerridge, 2000). Orange launched its first mass market LBS in 2001 based on WAP technology. Since then, there is regular evolution in the services offered under the LBS banner.

Orange preferred a segmented approach towards consumer and business markets. For its business customers, Orange is offering multiple 'Business Services' including telemetry and tracking. The telemetic services are those services which offer management of mobile equipments and can therefore get the benefits of LBS. These services are offered to small, medium and large businesses individually. Through tracking services it is possible for these businesses to locate their valuables on the move and solve some identified problems in machines identified by telemetic services. For mass market applications, however, Orange provided all its mobile data offerings under the new umbrella concept of 'Everyday Life' Services (McQueen et al., 2002) including LBS and payment everywhere. These services are complemented by 'Personal Services' under which multiple LBS are offered including localised weather reports.

In early 2001, the Orange initial range of WAP based LBS featured location enabled contents include:

- Orange Directory: location relevant business directory (nearest pub, restaurant, cinema etc.);
- Cash Machine Finder: find the closest cash point;
- Hotel Finder: search for hotels by brand or type;
- Emergency Services: search for the closest hospital, police station, garage etc.;
- Driving Directions: get directions to your search result or other location.

On 06 Dec 2001, Orange upgraded its LBS by integrating the SmartZone application platform with its infrastructure which was provided by the Webraska Company. Webraska is the worldwide provider of LBS and telemetic software solutions. Because of this upgrade users could be located by network rather than typing in their addresses. Within a few weeks Orange also offered a set of custom WAP based LBS applications by Webraska on the same platform.

Orange identified the need of M2M applications for the UK market and defined three categories: alarms (including security and breakdown), resource managing (for stock control and navigation) and billing. The report by Frost & Sullivan (2001) forecasts that the European commercial vehicle telematics market will be worth 4.7bn euros by 2009 and this

market will increasingly rely on cellular communications. Orange took advantage of this market and is now offering a range of telemetic services to its business customers.

To increase the range of applications, Orange established an agreement with Mobile Commerce. On 26 Mar 2003, Orange offered extra wireless contents and third party applications to its customers. This agreement made it possible for the third party developers to directly establish technical and commercial agreements with Mobile Commerce instead of going to individual mobile operators in the UK. Mobile Commerce can receive the location data from the mobile operators in the form of map co-ordinates and can translate this into a position relative to a nearby landmark, thereby adding value to the location feed received through the API (Application Provider Interface).

To capture the mass market along with business services, Orange followed the bundling strategy and launched the 'Orange World' portal. In Nov 2003, Orange selected 'MapWay' services, offered by m-spatial, for Orange World portal in order to complement other LBS. TagandScan also established the innovative LBS which was launched on 01 Jan 2004 for the GPRS mobile phones and offered on all UK mobile operators. This service allowed subscribers to have access to public grids of information including history, explanations, events, reviews and opinions of anything located in the physical world available to users through tags and keywords and display on a map.

Because of the slow growth of LBS, Orange started treating LBS as a technology enabler which can create a platform for new applications. LBS began to be contextualized and enhanced SMS, WAP, voice, MMS and video services to make them relevant to users. This concept initiated the strategy of integrating multiple applications. As a result of this strategy Orange integrated LBS with the SMS services. On 24 May 2004, Orange announced that its customers could now use SMS message to locate businesses and services, with the launch of the Orange 'Find Nearest' service. This service has been developed by the Webraska Company, powered by Webraska's SmartZone Geospatial platform, as the 2 WAY SMS service. This service also complemented the existing WAP 'Find Nearest' service, but the SMS was priced at 20p per search.

Less mass market absorption of LBS caused Orange to focus towards business services. On 01 Dec 2004, Orange with the Mill Transport company announced the implementation of the 'Orange Fleet Link' solution. This solution uses telemetry technology to transmit information over Orange GPRS network. This solution allowed transport companies to monitor duration of the length of time drivers have been on the road along with the real time information on their locations, arrival and departure times and route history as the back-up information.

On 14 Feb 2005, at the 3GSM world congress, Orange announced a new partnership with Siemens for the development of the M2M solutions. Orange identified the demand of such solutions for the support of businesses which are offering fleet management and mobile health care applications. Through M2M solutions these businesses can improve their monitoring capabilities to drive efficiency and service delivery. Because of this partnership Orange reached 90% of the total M2M equipment market place and was the largest provider of M2M solutions.

Keeping business customers a priority, on 22 Mar 2005, Orange announced the launch of a new service, the 'Orange Cell-ID', for location solution providers. This service used the Orange GSM network and allowed the location service providers to use their own location applications to create accurate LBS. Orange initially offered this application to ETS (Electronic Tracking System) business, followed by the ADT. With the Orange Cell-ID the location service provider can offer applications like fleet vehicles, equipment asset location, personal location solution and lone worker tracking. On 19 Dec 2005, a new third party application to locate vehicle and other valuable assets was launched on the Orange network. The services were launched by the Cambridge firm HD Positions using CPS's Matrix technology. HD positions supplied the interface to Matrix, and facilitated the M2M services.

Orange also deployed Local Search and Discovery Engine (LSDE) for mobile local search from m-spatial on 07 Feb 2006. Orange created 'Orange Finder' the new local search engine based on LSDE on the Orange World portal. This service enabled customers to rapidly access detailed information rapidly for over 2 million businesses and amenities in the UK, along with other live and dynamic local information such as traffic and travel,

entertainment venues and gigs, reviews and listings. On 22 Mar 2006, m-spatial rolled-out new contents and functionality on 'Orange Finder' including new rich contents of business descriptions and photographs from third parties, increased personalization by creating favourite lists of saved locations and additional search options such as search by category and discovery based interfaces. On 08 Nov 2006, another evolution took place with the upgrading of the Orange World portal home page search function to include results of listing of locally relevant business and amenities. This action integrated 'Orange Local' (previously Orange Finder) into Orange's search functions and further extends Orange's strategy of offering a single 'search' point for consumers. It also highlighted the wealth of contents available, driving traffic and encouraged data usage and phrased it as 'Clustered Search'. This launched LBS benefit from the convergence approach adopted by Orange.

Table 4-9: Personal Services under Orange World based on GPRS

LBS	Description	Cost
Entertainment	**Online Maps:** find location online or plan a route	£5/month for pay monthly customers, £1/day for pay as you go customers.
Life Styles	**Motoring:** online maps and services for motorists, even online chat if you eat, drink and sleep in cars. **Food and Drinks**: Find restaurants and bars, and use the handy restaurant guide if you are after somewhere to eat.	£5/month for pay monthly customers, and £1/day for pay as you go customers.
Information	**Orange local:** a bit of local knowledge always comes in handy, and Orange local offers to look up any required businesses and services. **Travel Info:** with a mobile in pocket, one will never be lost for travel information again. **Travel Directions:** in a car or on foot, point towards right direction. **Train Times:** provides information of arrival, departures, full timetable of trains. **RAC Traffic News:** Live 'at a glance' real time Trafficmaster information on the phone. **Transport for London Info:** provides information of tube, bus, DLR, rail, also can pay congestion charges. **Flights:** find travel deals and flights to all over the world. **Cinema listings:** what's on, where, and what other people thought of it. **Ents 24 listings:** guide to a top night out, including music, clubbing, comedy, theatre.	£5/month for pay monthly customers, and £1/day for pay as you go customers. **or** Individual costs apply to individual services

(Source: Information based on Orange UK website)

Table 4-10: Business Services under telemetry and tracking

Applications	Description	Technology	Cost
Sat Nav from Orange	It locates address, improves efficiency for field staff as they get to their locations in the shortest possible time, improves driver safety through awareness of road safety cameras and spots.	GPRS and 3G to download journey route GPS to provide real time turn by turn navigation	Sat Nav box - £92.00, Real time road traffic information – annual charge of £27.59, or 60p/week for full UK mapping
Orange M2M Connect	It integrates the users' applications and infrastructures with service provider's networks and allows users to quickly measure efficiency, and identify, diagnose and resolve problems from internet access point.	2.5G/3G integrated	-
International M2M	It provides M2M communication across Europe with single contract and single connection point with Orange network.	2.5G/3G integrated	-
Orange Fleet Link	It offers vehicle tracking, key performance indicators reporting, job allocation and vehicle forms system, vehicle speed and driver behaviour reporting system including historical reporting, configuration, file formatting and delivery configuration options.	Uses technology and expertise of Aeromark, and Orange solution provider	Sold in two packages: * Fleet Link Trailer Pack (data only) * Fleet Link security and telematics pack (voice and data)
Orange Location API (Application Programming Interface)	Tracks valuable assets in transit, machinery or vehicles out in the field and field staff with mobile phones. Adopted by ADT and Toys R Us	GSM network	Pricing per individual request
Orange Cell ID	Tracks assets, vehicles, goods in transit and staff in the field with Orange SIM within 50 meters.	GSM based Cell-ID	Cost effective tracking solution
Lone worker solutions	Provides solutions to enable businesses to protect their people and comply with health and safety legislation with wide range of devices from handsets (PDA & smartphones) to specialist ID tags and ruggedised arm bands.	2.5G/3G integrated	-
240 Traffic information	Call from Orange phone to 240 provides live traffic information for motorways and A roads, along with live traffic and incident reports for other motorways and A roads.	GSM based Cell-ID	47p/minute (ex VAT)

(Source: Information based on Orange UK website)

Because of an agreement between Orange and Mobile Commerce all the content providers reach Mobile Commerce to launch a location enabled service for the Orange customers. The content providers include TDL Infomedia (Thomas directories), Yahoo, AA, ITIS holding, TicketMaster, PA, Active Hotels, Itchy, Visa, Top Table, CGA-Centro, Ents 24, OAG, Empics, Multimap, Que Pasa Media, Lastminute.com, Film Night and TEAMtalk.com. This agreement also made cross network location possible among other mobile operators. At present, Orange is offering multiple LBS 'Personal Services' under Orange World portal. Table 4.9 describes a recent classification of these services. For its business customers, Orange provides 'Business Services' as classified in table 4.10. Along with contents, third party developers also provide services to Orange. Table 4.11 and 4.12 shows these services and presents the relationship of Orange with these suppliers.

Table 4-11: Suppliers of Personal Services

Services	Supplier	Description	Orange relations
MapWay on Orange World	m-spatial	It provides suite of walking and driving directions and mapping services	Customer
Orange Local on Orange World through Local Search and Discovery Engine (LSDE) technology	m-spatial	It is a browser based service of Orange local mobile search and discovery service is downloadable onto phone from Orange world portal and integrated with Orange world search function and content services	Partner
Search - Travel deals Search – Free text input	Mobile Commerce	It provides content delivery platform and alliances with content supplier	Client
Orange Pocket	Mobile Commerce	It allows user to pocket information and access it later. Mobile commerce provides What's Nearby link from Orange Pocket.	Client
Live UK traffic and Travel information	RAC	Dialling 1740 provides instant access to traffic information on over 8000 miles of the UK motorways and major trunk roads	Partner

(Source: Information based on Orange UK and Suppliers' websites)

Table 4-12: Suppliers of Business Services

Service	Suppliers	Description	Orange relations
Sat Nav from Orange	Webraska	Provides pictogram to generate geometric representations of the roads. Sound quality of instructions optimises audio output. Webraska server uses Navteq maps to provide digital maps incorporating over 590000 POI in 23 countries	Customer
	Symbian	Provides operating system for mobile phones. It provides platform to run Sat Nav application.	Second Tier Customer
International M2M	Wavecom	Provides a straight forward, reliable service based on the latest technology	Technology Partner
	Alcatel	Able to explore even the most complex project, including the opportunities presented by the vending machine market	Technology Partner
Orange Fleet Link	Aeromark	Offers an innovative approach to ensuring that vehicles and mobile assets are easy to track, manage and communicate with. It provides vehicle reporting and management with more advanced systems that enable vehicle reporting, management with a safe and effective mobile communications tool for drivers.	Technology Partner
Lone Worker	Argyll Telecom	It allows employers to use mobile communication technology to help improve safety monitoring of its lone workers through real-time location tracking and is designed to suit the needs of customers whatever their risk profile.	Partner

(Source: Information based on Orange UK website)

4.2.1.7 Orange technology co-evolution

Orange provides LBS to its customers through the Cell-id and the GPS location technologies. Orange cell-id technology has evolved towards the triangulation technique. Because of this technique Orange can offer accuracy to 50m-100m by measuring time or angle from the base station. Along with Cell-id, Orange also launched GPS technology based applications 'SatNav' for business services in Nov 2006. These services provide GPS-triggered real-time, turn by turn voice instruction, clear maps with road names and pictograms of turns, which provide accurate directions. Orange is offering its LBS on its integrated 2G/3G technologies. The evolutions of all 2G and 3G technologies at Orange are discussed in the following section.

4.2.1.7.1 Infrastructure technology

As with all mobile operators, the network infrastructure is fundamental for Orange to provide mobile services to its customers. Since 1994 with the entrance of Orange in the UK market, its infrastructure is continuously evolving. At present, Orange is the only network operator in the UK which offers integration of multiple network technologies. For the evolution of 2G technologies, Orange initiated with the GSM technology and also supported it with the spare network capacity of HSCSD (High Speed Circuit Switched Data) for high speed data download, web surfing, email, multimedia and other basic data services at an additional cost of £5 a month.

Orange became one of the first mobile networks to unveil a fully operational range of WAP technology based services in 1999. The services including news, sports, listing, travel and entertainment were launched in the market with WAP enabled handsets after one month's launch of WAP technologies. Orange also achieved the lead position in providing high speed mobile data transfer services by filling the gap between GSM and the much-hyped GPRS. At present GPRS service coverage is about 88% of the UK landmass with 99.8% population coverage in the UK. The evolution of the infrastructure technology is shown in table 4.13.

At first, Orange offered the 3G network in over 20 cities, followed by regularly growing network roll-out. The 3G network roll-out was supported with integrated 2G/3G network, with over 40% population coverage. Orange has the largest integrated 2.5G/3G network in the UK, covering 99% of the UK population. Integrated means the customers will seamlessly switch over 2.5G/GPRS wherever 3G coverage is not available. To date there is a continuing expansion of 3G population coverage. At launch the coverage was 66% and reached 70% in Jan 2005 followed by 80% at the end of 2005. In order to support applications from third party developers, Orange also launched the '3G developer centres'. These centres are providing Orange resources such as Orange device labs, meeting spaces and interactive 3G demo environment, to the third parties for the development of innovative and exciting applications for customers. The 3G developer centre is located in Maidenhead, UK. Orange also offered EDGE (Enhanced Data Rate for GSM Evolution) with coverage from over 1,400 EDGE enabled network sites.

Orange also evolved towards HSDPA (High Speed Downlink Packet Access) and HSUPA (High Speed Uplink Packet Access) technologies. The target of Orange by the end of 2008 is to provide the 99% wide area coverage of 3G technology, complemented by HSDPA and HSUPA roll-out. It is also predicted that evolutions in mobile networks, with HSDPA and then HSUPA, will improve the development of M2M applications requiring high bit rate (such as CCTV). The evolution of network infrastructure has been complemented with the integration of computer software for enhancing the range of services and leveraging capabilities of the established network. Orange licensed Ulticom's Signalware platform to enable a wide variety of advanced mobility, messaging and location services by allowing the real-time exchange of customer information. This platform was used to create a real-time service broker to interwork the various network capabilities required to realize LBS, including positioning systems, WAP services, and location applications.

In order to develop LBS, along with the basic infrastructure, Orange also established relationships with suppliers of component and infrastructure technologies. For example Orange established a relationship with Kodiak Network Inc., the leading innovator in packet switched wireless voice systems, to deliver and advanced press-to-talk-style service. This service was launched as 'Talk Now' to allow customers to integrate instant voice, conferencing and messaging services with the added benefit of a real-time availability icon to create "buddy lists" that can be used to facilitate instant conference calling and know when contacts are available to talk and when they are busy. Table 4.14 shows the list of the developers of these technologies and their relationship with Orange.

Table 4-13: Evolution of the Orange infrastructure and product technologies

Infrastructure	Launched	Services
HSCSD	October 1999	It allows subscribers to access the high speed services via variety of technologies. Orange unlike its competitors believed HSCSD will co-exist alongside GPRS.
GPRS	February 2002	A range of business and leisure services were offered including intranet connection and secure business portals. It allowed access to WAP pages via handsets. Orange delayed this launch because it was identified that other operators have had some problems with the technology.
WCDMA	July 2004	The 3G infrastructure was launched to support mobile phones along with the broadband applications.
EDGE	February 2006	With EDGE, Orange can offer improved download and browsing speeds for high speed data services (three times faster than GPRS network) to both businesses and consumers. EDGE bridged the gap between GPRS and 3G technologies.
HSDPA	February 2007	Services were launched in top 5 cities in UK to further increase the data transfer.
HSUPA	Planned for 2008	
Product	**Launched**	**Services**
Nokia 7110e	1999	The product was launched to support full suite of WAP services including news, sports, lists, travel and entertainment. .
Motorola v66 Ericsson T68	December 2001	The products were launched to support GPRS and HSCSD services.
SPV E100 SPV E200	2002	These products were launched to support GPRS services. SPV E200 offered tri-band GSM/GPRS technologies with support to the WAP.
LGU8150, Sony EricssonZ1010, SanyoS750, Samsung Z107, Nokia 6630 Motorola C975.	December 2004	Orange announced the launch of next generation services for consumers through Orange World on integrated 2G/3G network supported by six handsets. Orange has developed a broad portfolio of contents accessible through the Orange World 3G portal including practical application such as Traffic TV, developed in conjunction with Trafficmaster and regional road transport agencies
Nokia 50/E60-E61 Nokia N70/N73 SonyEricssonP990i /M600i, Black Berry7130/8700f/8 100/8800, SPVM700 in with built-in Sat Nav.	With SatNav applications	These handsets supports SatNav application. These include built-in GPS with first dual-mode blackberry combining EDGE/GPRS/GSM cellular and WiFi connectivity for data access and voice support through UMA (Unlicenced Mobile Access) for fixed-mobile convergence (FMC) offerings, making it fully compatible with Unique, the converged service for business customers from Orange. The Blackberry 8820 was launched due to the collaboration of Orange with RIM (Research In Motion).

Table 4-14: Suppliers of supporting infrastructure and component technologies

Supplier	Infrastructure/ Component	Technology	Description	Orange relation
Ericsson	2.5G network	GPRS	Provides network roll-out	Supplier
Alcatel	3G network	UMTS	Provides network roll-out as well as the turnkey development and integration of innovative 3G end user services	Strategic Partner
Nokia	3G network	WCDMA & EDGE	Delivers and maintains WCDMA infrastructure and enhances end-to-end performance of WCDMA based applications & provides EGDE radio network	Strategic Partner
Nortel	3G network	Wireless Broadband	Develops network to deliver leading-edge, 3G wireless broadband services for Orange customers	Strategic Partner
MapInfo	Location Intelligence	Integrated 2.5G/3G	Orange uses 'MapInfo Professional' via a map, interfaced with network planning tools and infrastructure management tool to provide exact co-ordination and coverage of each mast with visual representation of links and gaps of the services between masts	Customer
MapInfo	Orange Coverage Management System (CoMS) embedded with MapInfo MapX mapping software	2G and 3G networks	Provides maps of thousands of staff across customer services, network management, engineering, sales and marketing as well as Orange shops and dealers. It accurately displays network coverage on detailed, interactive maps that show Orange base transmitter sites, road networks and other relevant site data.	Customer
Mobile Commerce	Location Gateway	Application-programming interface (API) based on XML standards	Delivers dynamic access to cross network handset location feed. Customer sends the mobile telephone number to the Location Gateway which responds with information of X,Y co-ordinates (in GB National Grid format or GPS / WGS84 format), area of accuracy and date/time	Distribution partner

(Source: Information based on various electronic NewsLetters)

4.2.1.7.2 Product technology

The evolutions of component and infrastructure technologies of Orange were also complemented with the co-evolution of products. Orange bought and launched multiple handsets with the launch of every infrastructure technology. The evolution in the product technology is given in table 4.13.

Orange became the exclusive reseller of the SPV series of mobile handsets. The SPV series was launched to support the GPRS technology with a loss-leader data service: all the data could be handled for £6/month. The SPV handsets worked as phones or PDAs. The SPV E200 was the first handset in the UK to run Windows Mobile 2003 for Smartphone software. On 17 Dec 2003, Orange also made an exclusive deal with Motorola to launch the MPx200 handset. This handset joined Orange's SPV E200. Later, Orange SPV E200 was replaced by Orange SPV C550 which is now discontinued. In order to complement EDGE technology, Orange announced the requirement of new handsets. The first model based on this technology was introduced in Q1 2004.

The handsets evolution at one side allowed mobile operators to deliver their signature enabled handsets to customers but on the other side increased the stress on handsets makers. Orange is continuously pushing handset makers to develop user interface on mobile phones which shows Orange wallpapers, ring tones and buttons. This situation affected interface developers who were entering for a big market share through their downloadable games and ring tones. Orange is not the only one who demands such interfaces but all other operators are routinely demanding specific way of manoeuvring through menus and buttons with certain functions.

Orange and Sony Ericsson have cemented a new partnership and launched W810i and W300i to offer mobile music contents via the Orange World portal. Orange also established a launch partnership with HTC to offer SPV M600 slim-line, ultra powerful compact PDA with Microsoft push email capability. The handset used Microsoft Windows Mobile 5.0 platform and supported quad-band EDGE/GPRS/GSM technologies to deliver instant high speed voice and data communications for mobile workforce and consumer segments.

In terms of future evolutions, Google has held talks with Orange to establish a new

partnership for the development of a Google phone. Google wants to develop a Google phone, manufactured by HTC with Orange's logo and built-in Google software which would dramatically improve the cumbersome experience of surfing the web from a mobile handset. Among the potential benefits are LBS: aware of handset's geographical position, Google can offer a tailored list of local cinemas, restaurants and other amenities, and maps and images from Google Earth. It is believed that the Google Phone would not go on sale before 2008 (Smith, 2006).

4.2.1.8 Orange organisational evolutions

As all required technologies for LBS cannot be developed by a single mobile operator, Orange has also established relationships and alliances and is still buying multiple technologies from multiple suppliers. Along with buying these technologies, Orange also provides its infrastructure to the third party LBS developers to design new services for its customers. All of these activities are managed through the Orange organisational capabilities. These capabilities have already been discussed in the Vodafone case. Here they are discussed in the context of Orange. The relationship with the suppliers of technology is one of the very important capabilities and is shown through the value chain of Orange LBS in fig 4.9.

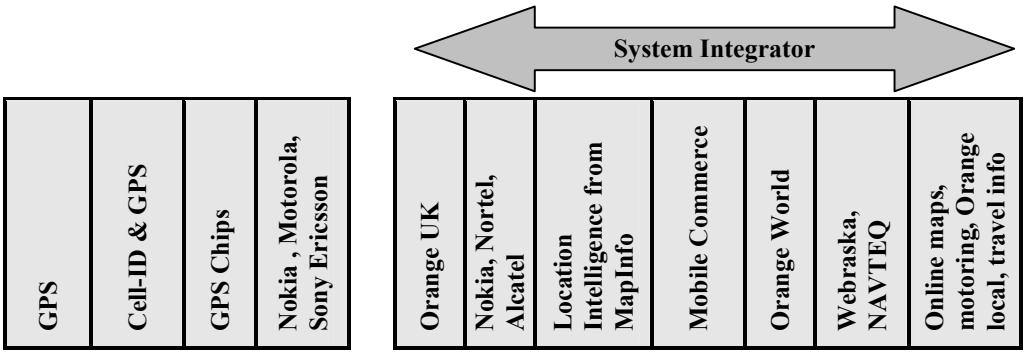


Figure 4-9: Orange LBS value chain

4.2.1.8.1 Supply chain management capabilities

Orange monitors the quality of the external technologies required by LBS through the tool, QREDIC. This tool includes environmental, ethical and social criteria to judge their quality. Through this tool Orange regularly analyze the overall performance of suppliers. In the end, these findings are presented to suppliers and are followed by joint improvement plans if required. During 2006, 527 suppliers were subjected to at least one QREDIC

evaluation, 58% of the suppliers questioned have made national or international commitments to agreements such as the Global compact, the Electronic Industry Code of Conduct (EICC) or codes defined by the World Business Council for Sustainable Development (WBCSD).

Orange also manages buying capabilities through a 'Responsible Purchasing Policy'. In 2002, Orange announced that it would follow the requirement of FT Policy on supplier relationship. According to this policy, Orange integrated social, environmental and ethical criteria into tendering procedures for corporate level suppliers. Orange wants to establish more than a contractual relationship by building up a total performance approach to its suppliers based on quality, innovation and respect for sustainable development.

4.2.1.8.2 Managing content standards capabilities

Contents have been identified as a major asset for the integrated operator. The new types of content based services on mobile phones require a high degree of monitoring capabilities. Orange has published a parent's guide to promote the good use of mobile by children. Through mobile phones children are open to harmful effects of text bullying and other safety issues related to their locations. According to the parent's guide, parents and guardians are reminded of the importance of supervising young children. Orange also provides interactive services such as chat rooms and bulletin boards to provide clear information about the services offered. Orange also published a 'UK Code of Practice for the self regulation of new forms of content on mobiles' to facilitate the responsible use of mobile phone services e.g. access to internet and guarding children from unsuitable contents. This code also helps Orange to manage its contents on the mobile phones.

For the safety related issues to the location services, Orange follows the same 'Mobile Industry Code of Practice for the use of mobile phone technology to provide passive location services in the UK'. All of these codes have been complemented with the 'Orange Safeguard' filter system. During mid 2006, Orange developed and implemented this filter system. This filter is applied for all the clients who are minors.

4.2.1.8.3 Managing network roll-out capabilities

With the evolution of 2.5G/3G infrastructure, Orange is continuously rolling-out its

network and increasing the number of base stations. In 2003 the number of these base stations was 11,310. This number increased to 11,657 and 12,288 in 2004 and 2005 respectively. The network roll-out is managed through preparation work prior to installation. The preparation work is conducted by Orange and is also supported with the industry based 'Ten Commitments to Best Siting Practice'. That work includes ongoing dialogues with local Councilors and Members of Parliament (MPs) about the location of base station siting. As a member of the Mobile Operator's Association (MOA), Orange conducted a joint survey with other operators, planning officers and the public. These issues not only consider feasibility of locations but also consider their visibility. Orange blends these stations with the environment to make them less visible. According to Paul Teague, Radio Solutions Engineer, '*We understand that these stations are not the prettiest piece of garden furniture, which is why we try to blend our equipment into the local environment to reduce the impact on those who live nearby'*. The results of dialogues help Orange to manage the network roll-out more efficiently and with the concerns of the public.

4.2.1.8.4 Managing environmental policy capabilities

The continuous network roll-out of integrated 2.5G/3G infrastructure is causing a continuous increase in the number of base stations. This increase also has electromagnetic impacts on the environment and human health. So far there is no conclusive evidence that exposure to these electromagnetic waves from the base stations could adversely affect human health but Orange regularly monitors any emerging scientific issue related to the research carried out on electromagnetic waves at national and international levels. Orange follows the International Commission on Non-Ionizing Radiation Protection (ICNIRP) guidelines for the protected use of electromagnetic waves. Also these base stations are randomly audited by OFCOM. So far none of them has emitted above the range mentioned by ICNIRP standards.

Orange also proved itself responsive to the comments regarding relocation of base stations. In 2005, Orange relocated its base station from a school in Hertfordshire due to the community group initiatives. The group is known as Mast Action UK (MAUK). Orange worked very closely with MAUK in order to identify the new location and visual integration of a new site. MAUK performed a survey and returned over 120 responses to

Orange with a range of comments. In 2007, Orange took down a base station from the top of 'The Tower of Doom' following a campaign by ill-informed, panic-stricken residents after seven people were struck with cancer. Later, Orange relocated it to a nearby shopping centre. As discussed, Orange and Vodafone have established a relationship to share their networks.

Today energy consumption and climate change are major focuses of public debate. Reducing energy consumption with growing business is a real challenge for Orange. New technologies offered by network infrastructure require more capacity. Network infrastructure as a major part of business consumes 80% of the total energy. The remaining 20% is consumed by offices and shops. In 2006, Orange started to set up an environmental management system (EMS) based on the international ISO 14001 standards. The standards make it possible to effectively manage the approach and provide regular reports. During 2006 the program was underway to set up an integrated HSE management based on the OHSAS 18001 and ISO 14001 standards.

4.2.1.8.5 Managing research and development capabilities

Orange performs highly customer centric innovations through its R&D capabilities. The innovation process links R&D and market together due to the capabilities established at the Orange Labs. These capabilities are enforced because of the partnership of 'Explocentre' based in Paris and 'Technocentre' based in the UK and Chatillon. The Explocentre develops new concept of services and Technocentre is responsible for strategic anticipation and development of integrated offers with multi-disciplinary teams. During 2006, Orange remained highly focused towards converging services. During spring 2007, GPS assistance was one of several other developing themes.

According to Dr Chris Sims, '*Technocentre works under 3P Program with multiple teams. The main sections of Technocentre include FT R&D, ROSI/DPS/MPS/DD and NSM. Collectively, 33 participants are working under Technocentre. All together it is 3P x 33 program. With several other themes LBS is also under research. Different teams are involved with the projects like 1 x LBS team, 1 x Local search, 1 x maps, 1 x M2M and 1 x SatNav*'. Figure 4.10 shows the structure of Technocentre.

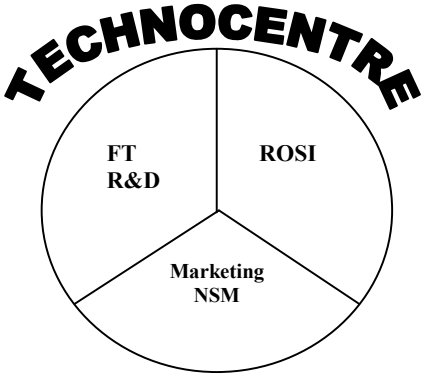


Figure 4-10: Organisational structure of Technocentre

As a result of these R&D capabilities, Orange established a portfolio of several patents amongst which 'localization' for LBS applications is one theme. In 2006, Orange spent €856 million on R&D capabilities. At present, 3900 researchers and engineers are working for its R&D capabilities. Apart from individual research Orange also performs cooperative research and has worked for the development of the 6th and 7th framework programmes in Europe.

At Orange, R&D performs two activities: Research and Development. Research activity explores new technologies, services and their usage. It also detects disruptive technologies and develops critical skills and generates IP revenue. Development activity, however, reduces time to bring any service to market, builds integrated services, industrialize products, services and network evolution, leverage partnership with manufacturers for more efficiency and contribute to standardization. The R&D activities are carried out with respect to 'service enabler' and 'infrastructure' areas.

Mainly there are three 'service enabler' research areas:

1. *My virtual and physical communities:* involves interpersonal communications, interactions with machines, dialogue, payment, social address book e.g., 'light' home infrastructure and devices for 'real meet' like services, telepresence and high quality audio conferencing (audio 3D).
2. *Immersion in a world of digital information:* involves access to information & contents, customer content management, profiling, audience & contents monetization e.g., image and sound pattern recognition for access to audiovisual contents (indexing, de-linearization

search and recomposition) and enrichment of web and local search, overlayed media search.

3. *Open service composition and delivery:* involves virtualization, frameworks for service composition, billing, administration and maintenance in all environments, QoS e.g., tools and technologies for fast composition of service for enterprise and consumer applications and secured payment through mobile NFC (Near Field Communications), contactless mobile transactions.

Mainly there are three 'infrastructure' research areas:

1. *Network and service set up:* involves IP, agility and optimisation, IMS and post IMS, 'alternative' architectures e.g., new network cost optimization and novel architectures and agile information systems.

2. *Seamless broadband access:* involves tools for next generations of fixed and mobile access networks (beyond 3G) e.g., very high broadband home network.

3. *Devices, communicating objects and local networks:* involves modular, extendable, customizable, disposable and invisible devices, interaction between devices and SIM e.g., sensor networks, M2M services, M2M gateway and connectivity (Panalver and Bonhomme, 2007).

LBS as the technology enabler can be a part of all these activities. In 'Virtual and Physical Communities', Orange can integrate dialogue services with location information. In the 'Immersion in a world of digital information' location contents play an important part. In 'Open services composition and delivery' location information based billing and maintenance can be performed. These services can also receive benefits with the launch of Orange Lab Networks. This network includes 15 R&D labs around the world (the UK is one of them) with Technocentre and Explocentre to leverage the technological advances. The integration of R&D into the organisations' core function is a key component of the NExT strategic plan. This strategic plan is discussed in detail in section 4.2.1.8.8.

4.2.1.8.6 Managing organisational structure

In 2001, Orange UK Technical, Orange UK IT and Engineering department were integrated to develop and rollout new services for customers. With the emerging trend of developing customer-focused services, to create new and retain old customers, Orange

identified the need to redesign strategy, organisational structure, processes and culture of Orange UK Technical. Orange established the transformation partnership with the Accenture company to drive this change. Accenture established a transformation program with focus on delivering tangible results with an emphasis on strengthening the relationship between the IT teams and the rest of the business. The transformation program fell into four phases: a strategic IT effectiveness review, mobilization, implementation and transition. The first phase was based on interviews with employees to understand the current state and to identify requirements for future changes. The second phase was based on the implementation of the new organisational structure with the appointments of personnel to key positions. The third phase was based on the implementation of new IT processes along with a behavioural change programme. The fourth phase was the shift of control from establishing the team to the Orange line organisation. The transformation allowed Orange to deliver new and innovative products and services faster and with less risk of disruption than before.

Before 2005, Orange was the sub-segment of Orange business segment along with other countries. Since 01 Jun 2005, France Telecom introduced four new business segments:

1. Personal Communication Services (PCS)
2. Home Communication Services (HCS)
3. Enterprise Communication Services (ECS)
4. Directories

The PCS business segment offers mobile telephone services in the UK with other courtiers. Now the PCS UK is the sub-segment with the Orange subsidiary in the UK to offer mobile services including LBS to customers.

4.2.1.8.7 Managing customer care capabilities

In 2004, Orange launched a ‘Code of Practice for Consumer Affairs’ to ensure commitment of Orange with customers to always deliver the best possible quality service. Orange follows this code but also resolve customer related problems through its customer care service helpline which is accessible on 150/451 for contract/prepaid customers. Due to highly customer focused intentions made it possible for Orange to become a winner in the contract category of the J.D. Power and Associates UK mobile telephone customer satisfaction survey. To understand what customers expect, Orange conducts approximately

180 customer satisfaction survey daily. In 2004, 78.3% of customers expressed satisfaction with customer services. This number was reduced to 73.1% in 2005 but again increased to 78% in 2006. Orange manages its customer care capabilities through a call centre operation that leverages Project ObjectStore technology. This technology provides customer information immediately so Orange can make intelligent business decisions about what type of service can be delivered to what class of customer.

To support LBS, Orange integrated Coverage Management System (CoMS) component with MapInfo MapX mapping software. This integration embedded a mapping facility into new applications and enabled CoMS to provide an accurate display of network coverage on detailed, interactive maps to show Orange base transmitter sites, road networks and other relevant site data. Later, Orange integrated this software with its engineering systems. With the help of this component, customer service representatives (CSRs) can answer queries from the public immediately and consistently. For instance, when a customer calls to report a signal problem, the CSR can determine whether the caller has entered an area of variable coverage or whether the local transmitter is under repair, and can provide this information to the customer. Feedback of subscriber hits on coverage problems can then be sent to engineering for analysis and input to network planning. The system's accurate and current maps provide information about planned new sites, date of their activation and details of how these sites will improve and expand coverage. All of this information is regularly updated; enabling CSRs to satisfy the customers' requirements for the latest information and CoMS now also holds detailed data about the 3G network.

Along with these internal activities Orange has teamed up with OFCOM and other UK network operators (Vodafone, T-Mobile and O2) to create an independent survey to allow customers to compare local call success performance across networks. TopNetUK.com uses mobile call success data, collected by the survey tests, conducted on selected roads, motorways and in selected town and cities, to supplement other drive and monitoring surveys and help Orange to optimize the network performance.

4.2.1.8.8 Managing strategic capabilities

The ever increasing growth of mobile applications and their convergence made it necessary for Orange to evolve strategies towards an integrated operator. The vision of an integrator

operator was based on the convergence of fixed, mobile and internet networks. The integrator operator strategy became reality at the end of 2003. The strategy was complemented with the launch of the NExT (New Experience in Telecom services) plan in June 2005. This plan was launched to move from network access logic to service access logic through the integration strategy. Through this plan the Orange Group will implement:

- Unified network management in each country;
- The adaptation of its information systems to further increase reactivity;
- Strategic marketing for the group based on new innovative centre and joint product;
- Development to shorten the time to place its new services on the market.

To further accelerate the NExT transformation, in 2006, groups focused on three priorities:

- Tighter control of the business with the creation of the nine members Executive Committee focused on generating organic cash flow and the achievement of twenty key objectives of the NExT program and with the implementation of integrated management of the business by country.
- Accelerated transformation of the enterprise with an in-depth transformation of the Group's structures and operating methods; with an adopted cost structure; and with the mobilization of skills in key areas for the Group with ACT program (Anticipation and Skills for the Transformation).
- Accelerated the marketing of convergent offers with an integrated management structure: the Group Strategic Marketing Unit; and with a powerful tool for the definition and launch of new offers like Technocenter with 1500 dedicated team members which has been operational since 01 Jan 2006.

4.2.1.8.9 Managing marketing and sales capabilities

The Orange marketing team is responsible for keeping the Orange brand healthy and effective. According to Orange, '*Nothing more than brand plays important part in the continuing success of Orange*'. Orange marketing team offers innovative services to consumer and business customers through straightforward, everyday language that highlights the benefits of products rather than technology behind them. For consumer services, the marketing and consumer sales teams sell a full range of Orange services through 5500 Orange outlets and retailers like The Carphone Warehouse and Phones 4U,

other high street stores and independent distributors and retailers. Consumer related LBS are offered to customers through these channels.

The business services are offered to the business customers through a sales support department that helps co-ordinate tender responses and improve the sales processes. This department consists of four teams:

- Direct sales team: responsible for winning, developing and retaining B2B accounts through corporate team, medium business team and small business team.
- Solution sales team: responsible for winning data and complex voice revenue in the medium and corporate business markets.
- Partnership team: responsible for delivering joint propositions with key strategic suppliers such as IBM, HP and Microsoft.
- Channel sales team: responsible for focusing on engagement and driving data and telemetry revenue with re-sellers and system integrators.

Through a corporate team Orange has offered LBS to the government and the logistic companies.

In order to make LBS a real success there is a need for a strong marketing campaign. So far Orange have not invested in marketing capabilities related to LBS. According to Dr. Chris Sims, 'O*ne reason behind no marketing campaign was that services were not accurate and sticky enough. These were based on WAP and therefore were very slow. But new services will be more eye catching, accurate and different from previous. The new services will combine many services like MAPme, What's near me?, Where my nearest?, MMTravel etc. These will be stickier and we know people will use them. And second reason, TV advertisements are very expensive. We will advertise our new LBS through portal advertisements like Online Advertisement shop* '.

The campaign on one hand can raise the public awareness regarding the LBS benefits and on the other hand can remove the doubts about privacy and children security issues. Orange also possesses the capability of advertising the third party products and services through Orange Online Media Pack. At present, many pages are available for advertisement including mobile downloads and travel channels. To be a responsible advertiser, in 2006,

Orange developed responsible marketing guides to ensure that future advertising campaigns are in line with international codes of conduct and are committed to corporate responsibility and do not target children. Therefore Orange has to be very sure that any advertisement related to LBS should not cause any harm to children in the form of bullying or abduction. Orange has initiated an anti-bullying program for secondary schools. It contains a 10 minutes film highlighting the issues of mobile bullying plus classroom activities designed to discuss the issues. The film also offers students practical advice on what they can do about mobile bullying (Lattimore, 2007).

4.2.1.8.10 Managing partnerships and alliances

Orange works closely with key suppliers and partners to achieve high quality services. These partnerships and collaborations are categorised with respect to the capabilities of technology suppliers. These collaborations cover areas such as infrastructure, products and applications. In order to establish network infrastructure, Orange has partnerships with manufactures such as Ericsson, Nokia, and Nordic. For the establishment of products and services to offer seamless mobility, Orange is related with Motorola, Nokia, Siemens, Sony Ericsson and Samsung. For the establishment of mobile applications such as mobile entertainment, Orange is working with Thomson. For mobile operating systems, Orange is related to ACCESS, Microsoft, Sun (Java), Symbian, UIQ. To make these applications versatile certain enablers are required. The enablers are: NAVTEQ, Sybase, Tele Atlas, Texas instruments and Wavecom.

Orange also offers a platform to third parties who develop and distribute their innovative mobile applications, contents and solutions to Orange customers. The third parties can develop applications for consumer and business markets. Orange manages these applications through the 'Orange Partner Programme'. Orange launched this program in June 2004 to encourage and inform third parties for innovation. For the business market applications, the Orange Partner Programme offers teams, enablers and networks and for the consumer market applications, offers direct and indirect distribution channels like 'Orange Application Shop' to these third parties. The Orange Application Shop was launched in June 2007 and it complements existing WAP and web based shops to allow consumers to buy mobile applications under the Orange World portal. The applications

along with others services include travel and LBS. For third party developers it is a rapid route towards the market.

4.2.1.9 Orange resources evolution

At Orange, resources are considered as the Current and Non-Current assets. Non-current assets can be further classified as tangible and intangible assets. The non-current tangible assets are property, plant and equipment (PPE) for example land and buildings, plant and equipment (2G-3G infrastructure), motor vehicles, fixture and fittings. The non-current intangible assets are software, GSM licence and UMTS licence. The currents assets are cash and cash equivalent.

4.2.1.9.1 Non-current assets

I - Intangible assets

Intangible assets are mainly licences, content rights, patents, development costs and software. These assets carry different useable lives and are tested for their impairments. Orange possesses separate licences for 2G and 3G technologies. Based on these licences Orange commercially launched services. A 2G-GSM licence was awarded to Orange for a term of 25 years from 25 July 1999, expiring in July 2020. Orange also won its 3G-UMTS licence on 27 Apr 2000 for approximately €6.3 billion (£4.1 billion) and accepted it on 11 June 2002. Orange was obliged to launch commercial UMTS services within 30 months from the moment of acquiring the control of frequencies. The UMTS licence is amortised on a straight line basis from the date on which the network is technically ready to market services. This licence is valid through 2022 when Orange has the option to request its prolongation. Acquisition of rights over content (sale, dissemination, broadcast) depends upon technically accepted contents with valid rights. Orange does not possess content rights related to the maps. Therefore users of LBS (e.g. Orange SatNav) have to download these contents at additional costs.

Patents usually possess useful lives not more than twenty years. By 31 June 2007, the number of patents had reached 8,536 including some related to LBS. The development of software and other R&D activities are also part of the intangible assets. The R&D projects are mainly related to upgrading the networks and their functionality and development of

service platforms to offer new services to customers. Orange spent millions of euros on R&D activities. In 2006, €856millions were spent on R&D capabilities. Orange not only invests in these patents but also derives financial benefits from research with telecom manufacturers, start-ups, software engineering and service companies or integrators. The dedicated licensing team and patent engineering team manages patents activities. In order to leverage the technological skills, R&D capabilities are also offered through expertise, consultancy services and technology transfers. Orange is able to provide such high calibre services due to the employee capabilities. Employees possess knowledge which is also considered as an intangible asset for Orange. The fig 4.11 shows the growing number of employees working for Orange.

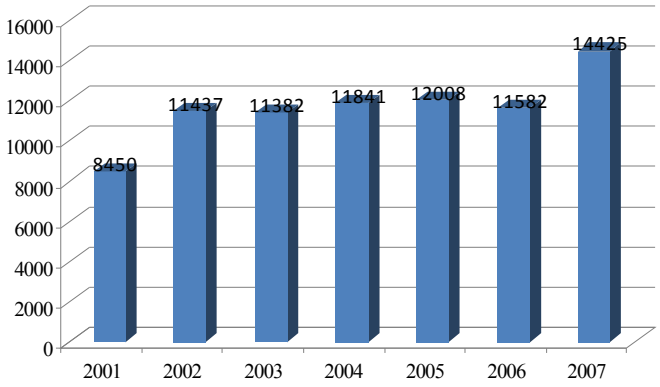


Figure 4-11: Number of employees
(Source: Information based on Orange Annual Reports)

II - Tangible assets

The non-current tangible assets are Property, Plant and Equipment (PPE). The PPE primarily represents costs incurred to construct the mobile network. The network infrastructure is a very integral asset of Orange. To strengthen services, Orange is continuously evolving its network. This evolution includes mobile switch centres, trans-coding units, base station controllers, and base transmitter stations. This evolution, however, is very expensive to manage but Orange is continuously investing to improve the service accuracy. Customers are the real asset for Orange. The continuous growth in number of customers made Orange competitive in the market of mobile communication in the UK. Customers are classified in prepaid and contract categories. The table 4.15 shows growth in the number of Orange customers. The number of customers also represents the market share of Orange. Fig 4.12 shows the change in the market share for the time period from 2001 to 2007. All these tangible and intangible assets shared the capital expenditure

of about €582 millions in 2005 and €481 millions in 2006, with the majority of investment relating to the 3G network deployment program carried out between 2002 and 2005.

Table 4-15: Annual customer growth

Orange Customers	2001	2002	2003	2004	2005	2006	2007
Customers (000)	12387	13312	13649	14221	14858	15333	15642
Customer growth (%)	26	7.5	2.5	4.2	4.5	3.2	2.1
Prepaid customers (000)	8626	9078	9192	9514	9880	10365	10027
Prepaid growth (%)	27.7	5.2	1.3	3.5	3.8	4.9	- 3.4
Contract Customers (000)	3761	4238	4457	4707	4978	4968	5615
Contract growth (%)	22.2	12.7	5.2	5.8	5.8	-0.2	13

(Source: Information based on France Telecom Annual Reports)

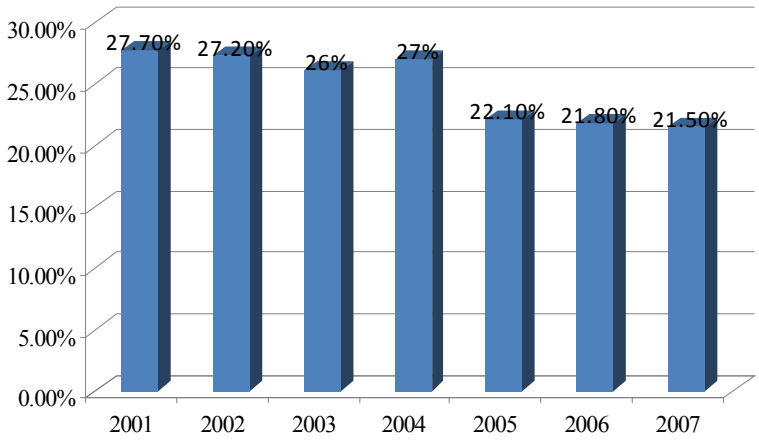


Figure 4-12: Market share of Orange
(Source: Information based on Vodafone Group Plc Annual Reports)

4.2.1.9.2 Current assets

Current assets are related to the cash flow and capital expenditure on non-current resources. The cash flow sometimes increases and sometimes decreases depending upon the investments on the technological requirements identified through the market demand or competition, or may be enforced by the governmental regulatory bodies like OFCOM. The cash flow appears in terms of revenue and ARPU. The revenue is classified in terms of equipment and services. The equipment revenues include the sale of mobile handsets and

accessories. The service revenues include voice and non-voice (data) services offered to customers. Table 4.16 shows annual revenue generated for Orange.

Table 4-16: Turnover of voice and data services

Orange UK Revenue	2001	2002	2003	2004	2005	2006	2007
Revenue (€m)	5227	5418	5819	5833	5832	5874	6217
Voice services (%)	13.2	1.4	4.3	-	-	2.1	8.9
Non-Voice services (%)	11.2	14.3	15.9	17.6	11.6	5.8	13.9
Network revenue (%)	-	16.4	7.5	4.3	19.4	20.2	7.3
ARPU (£)	245	259	271	274	263	257	298

(Source: Information based on France Telecom Annual Reports)

Since launching its services in UK in 1994, Orange is continuously making considerable investments in the development of the Orange brand (the main elements of which are the word mark "ORANGE", the "Orange" logo, the colour orange, and the slogan "the future's bright, the future's Orange"). These investments have resulted in an extensive portfolio of trademark applications and registrations which is complemented by a portfolio of domain names including orange.com, and orange.co.uk. Further, the investment has resulted in a high level of international and national brand awareness. The investment for the evolution of non-current or current assets and other cost analysis is given in fig 4.13.

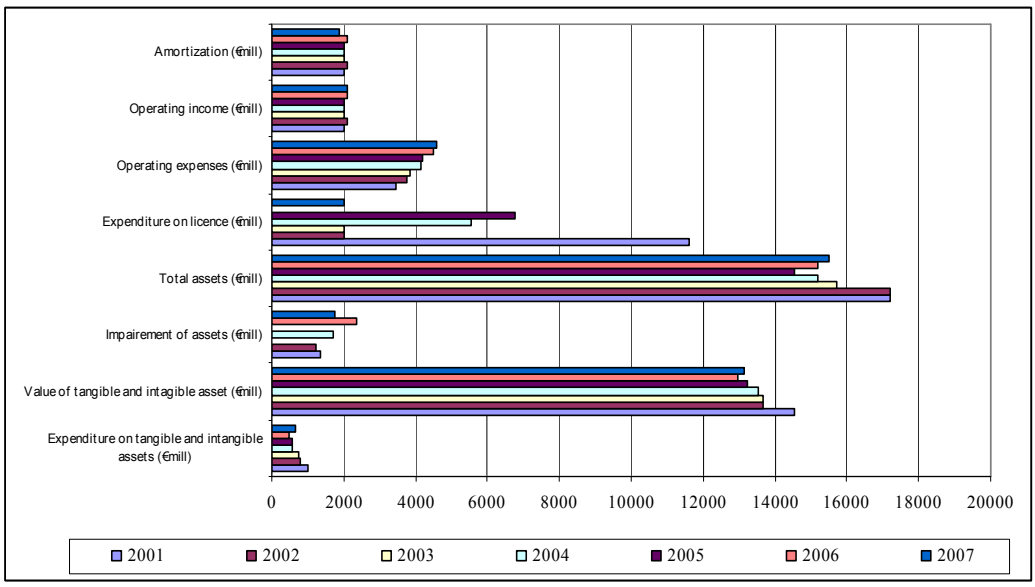


Figure 4-13: Cost analysis of Orange expenditures
(Source: Information based on France Telecom Annual Reports)

In order to adopt these resources for LBS the wise strategy identified by Orange is the leveraging of these assets. According to Charmaine Oak, '*Pragmatism is key to reusing existing infrastructure in generating revenue from the new streams including LBS'*.

4.2.1.10 The presentation of the evolutionary framework of the Orange LBS

This section will present the application of the first stage of the DTC model for the second time. This application can further enhance the validity of the first stage of the DTC model.

4.2.1.10.1 Evolutionary cycle of the Orange LBS

At the first stage, on the basis of market and regulatory demands, Orange decided to launch its first LBS to the mass market. This variation in services offered by Orange became possible due to the reconfiguration of LBS with WAP and configuration of contents with AirFlash technology. These technologies reached consumers through the tangible asset of Orange, the GSM network, which was recombined with the location technologies to offer cell-id based services. The reconfiguration of these technologies with contents made Orange capable of offering services to locate business directories, hotels, hospital, police stations etc. In order to quickly launch the group of these customer-focused services in market, Orange performed the redesigning of the organisational structure of the Orange UK Technical. This change helped in rapid commercialization and deployment of LBS, along with other data services, in the market. The result of this stage collectively identified the changes in infrastructure, applications and organisational structure which were required to develop new services for customers. It also identified the need to enhance the pool of partners through new alliances and collaborations to enrich the experience of customers with new offers.

During the second stage, just after the launch of LBS, Orange identified the need for an LBS upgrade. Orange decided to evolve towards a better application platform in order to avoid the lack of capabilities which emerged during previously launched services. Orange learned from the experience of customers and selected Webraska as the provider of upgraded component and application technologies. Along with this evolution, Orange focused on the search of a killer application which could really capture the mobile market and allow Orange to achieve the competitive advantage. The focus on the killer application enhanced the R&D capabilities and the knowledge of those who were involved in R&D

activities helped in reaching the strategy of segmented approach. Orange followed the segmented strategy to offer consumers and business customers distinct types of applications. Through the learning of customer demands Orange identified consumers' interests towards bundling applications and business customers' preference towards M2M and telemetry services. Orange developed new applications for both types of customers but at the same time allowed third party application developers, like TagandScan, to develop their own applications and offer these applications to the Orange customers. Orange selected Mobile Commerce in order to achieve these tasks. Mobile Commerce acts as an aggregator amongst third party developers and all other mobile operators in the UK. Orange also successfully managed the relationships with the third party developers through the Orange Partner Programme. In short, this stage helped in converging focus towards R&D capabilities through segmented strategy. At the same time it allowed external players to become part of the Orange LBS value chain by blurring some of the boundaries around applications.

During the third stage, Orange replicated the bundle strategy and offered consumers LBS under the Orange World portal. Orange also introduced the support of LBS for other data services like SMS, MMS and video. Orange leveraged the same infrastructure 2G/2.5G/WAP to offer other data services. This became possible by leveraging the strategic relationships with the suppliers of these infrastructures. Orange also leveraged the same application named the 'Find Nearest' and replicated it for consumers with additional capabilities of other data services. For business customers, Orange leveraged cell-id technology to offer advanced fleet tracking, telemetry and M2M services through the establishment of a new partnership with Siemens. Orange continued to allow third party developers, like Cambridge, to leverage Orange infrastructure for the launch of their services and also leveraged the Orange Partner Programme. The results of increased partnerships made it possible for Orange to leverage LBS in distinct market segments including roads. At the end of this stage Orange identified the feasible infrastructure, market segments, portal, partners, and partnership programs for LBS.

By the fourth stage, Orange had developed and commercialized several LBS, some under the Orange World portal and some individually. Because of the need for more accurate technologies Orange integrated the 3G infrastructure with the Orange World portal. This

integration has also been complemented with the integration of 2.5G/3G network infrastructure to offer LBS in the areas where 3G coverage was not available. The numbers of LBS also enhanced the numbers of suppliers and third party developers. Some of them were new and some were old. The relationship with old suppliers and developers was retained; however new suppliers and developers were integrated into the LBS value chain. Orange integrated new applications, the Orange Local, with the Orange World portal. This application was based on LSDE technology provided by mSpatial. Orange supported the launch of these new applications with integrated management structure and group strategic marketing unit.

By the end of the first evolutionary cycle Orange had managed to establish several new resources, based on old and new technological and organisational evolutions. The developed technological and organisational assets have strong linkages with each other and caused the evolution of one with respect to the other. The specific combination of these assets also created the resources for the second evolutionary cycle. For its second cycle Orange allowed the resources of an independent industry, the satellite industry, to be integrated with the resources of dependent industry, the mobile industry, to increase the efficiency of LBS. Orange offered Orange SatNav application which uses GPS technology to provide real time turn by turn navigation. This application caused evolution in the mobile handsets which must possess the GPS chip to support the GPS technology. The integration of GPS technology also caused a variation at the start of the second evolutionary cycle. At present, the satellite industry is pushing the mobile industry to invest in the A-GPS technology which further needs the evolution in infrastructure and handset technologies. Orange is at the stage where it needs to identify the benefits of the A-GPS technology. As the technology needs investment, evolutions towards this technology need high revenue returns from LBS. Up to the present time LBS had not shown any promising growth. In order to make LBS a real success Orange is supporting these services through R&D capabilities in Orange Labs and commercializing new applications through the online Orange Application Shop.

The evolutions performed by Orange related to LBS are shown in above figure 4.14 as the graphical representation of the first stage of the DTC model of Orange LBS. This graphical representation further contributes towards the validity of an evolutionary framework but, at

the same time, offers a specific model to Orange to map all technological and organisational evolutions.

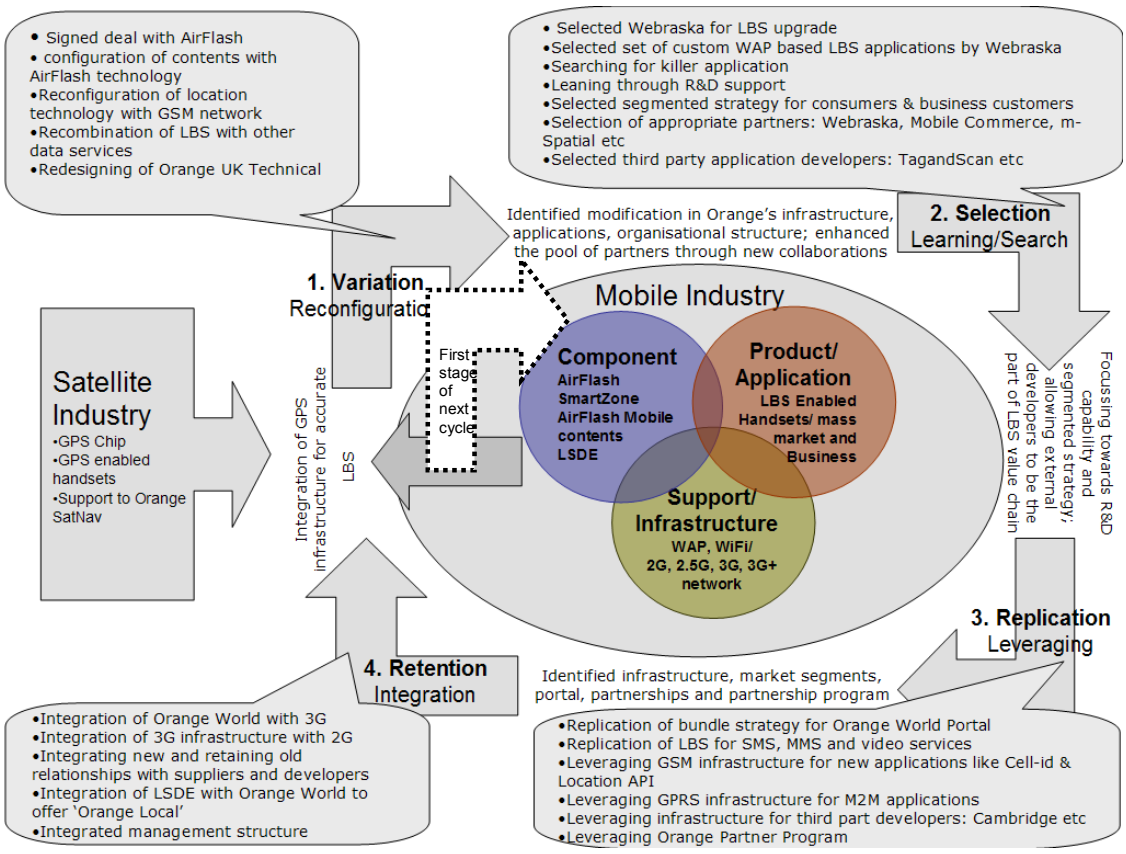


Figure 4-14: The evolutionary cycle of the Orange LBS

4.2.1.11 O2 LBS evolutions

O2 developed its first LBS with the launch of its GSM infrastructure in 1994. The first commercial launch of the LBS application by O2 was in 1997. The launch of these applications was based on identifying the technological capabilities and therefore the technological evolution became the driver behind the launch of LBS. In 1997, O2 offered an application, Traffic 1200, which is still available for the O2's users. In 2000, EC asked every mobile operator to launch LBS in order to offer a single European emergency number e-112. O2 responded to this regulation by initiating a series of multiple LBS from time to time.

On 22 Aug 2002, O2 announced the launch of a new deal with Webraska to offer location finding services for ATMs and cinemas. O2 announced that it is going to launch LBS

imminently which includes ‘BuddyFinder’ and allows users to locate public facilities, such as ATMs, cinemas, restaurants, pubs and to request directions to their destinations, whether they are travelling by car or on foot. O2 signed a conventional software licensing deal with French-based Webraska for its SmartZone Platform to manage user authentication services, geographical mapping and address finding services and user preference profiling. Along with software, Webraska also offered its consulting services to O2 to implement LBS. O2 also invested in the LBS hardware which was obtained from the Canadian hardware company RedKnee. To complement the simple LBS O2 also announced the future deals with niche application providers for commercial LBS applications on a revenue-sharing basis. This first step of O2 towards LBS was followed by several other evolutionary steps. In Sep 2003, O2 launched ‘O2 Home’, which used location based technology to allow customers to make cheaper mobile calls from their home for a fixed monthly premium.

O2 offered LBS for consumers and businesses. For consumers O2 offered LBS under portals, channels and services like ‘O2 Active’, ‘Revolution’ and ‘i-mode’. For its business customers O2 initiated the M2M services. O2 was the first mobile company to launch a dedicated M2M team in the UK in Jan 2004. At O2, M2M is defined as: Telemetry and Telematics. The telemetry services offer a flow of information from a fixed asset with already known location. The telematic services offer a flow of information from a moving asset with continuously changing locations. O2 provides M2M services to different categories of businesses like SMEs (<200 employees) and Corporate Businesses (>200 employees).

Due to the increase in the number of the content providers for various mobile applications, O2 launched its market place ‘Revolution’ channel in November 2002, where O2’s customers can access various mobile services. It created a new revenue stream for the developer community and for O2. The Revolution services encouraged developers to constantly come up with new services and initiatives since it provided a distribution channel for WAP, SMS and Java applications. This service allowed billing for applications and returned a significant portion of that revenue to developers. Revolution has created a solid partnership between developers and O2 and ensured the sustainability and growth of the mobile application developer market. O2 offered its LBS through the ‘Revolution’ channel. Since Aug 2004, the users of the Revolution started accessing the CITYNEO Maps

services. O2 selected Cityneo as a main supplier of maps and LBS through O2's Revolution channel. This application enabled users to view detailed maps of surroundings, to calculate itineraries in a town or between towns and to guide pedestrians through schematically created itinerary and symbolic arrows. Today, Revolution is no more active. According to Coles Adrian, '*The Revolution was a communication society where third party developers could launch their products and services but such type of model did not prove a success and therefore it is dead now*'.

O2 also launched its 'O2 Active' portal in June 2003 to provide users with access to comprehensive services like info, news, sports, instant messaging, and third-party contents from partners such as the BBC and Bloomberg, restaurant guides, downloadable games and ring tones. The 'O2 Active' portal was launched with support for 2G-GSM and 2.5G-GPRS technologies. The support for 3G-UMTS was under development at the time of its launch. The partners of O2 for the development of the 'O2 Active' portal were BEA and HP. The BEA provided its WebLogic Platform™ 8.1 for the showcase of the portal with the hardware platform from HP ProLiant servers built around Intel® Xeon™ processors, with the Linux operating system.

On 23 June 2003, O2 launched Fonetrack&trade, a third party application developed by Justfone. Many applications were offered by Fonetrack including vehicle tracking, fleet management, caller identification, lone worker monitoring and the work flow optimisation of field-based personnel such as sales teams and service engineers by incorporating Fonetrack's GSM mobile location capabilities. These applications were based on GSM technology. At the same time, O2 launched another third party application, ChildLocate. It was launched in Oct 2003. This service was developed by MobileLocate to enable parents to locate their children. At the time of launch the accuracy level of this application was 50-500 meters in urban areas. This application was available to users via the internet or with the use of SMS texts at the cost of £9.99/month. These third party applications were launched not only by O2 alone but also by Vodafone, Orange and T-Mobile in the UK.

On 03 June 2004, lastminute.com, Europe's leading independent travel and leisure website, launched an exciting new service 'DealFinder' through O2 mobile network. This application enabled leisure seekers to locate various deals in specific relevant areas through

the mobile location technologies. This service is still available via the ‘O2 Active’ portal. DealFinder gives real time access to the lastminute.com database. The database allows the user to select from options like ‘All Deals’, ‘Eating Out’, ‘Hotels’, and ‘Going Out’. Each of these options further provides a choice of locating these deals through ‘Where I am now’ or ‘Some Where Else’ services.

On 01 Feb 2005, O2 announced the launch of an enhanced ‘O2 Active’ portal for its 3G technology. This launch marked the arrival of a new and improved version of the innovative ‘O2 Active’ portal, which was redesigned to take advantage of richer, faster, more capable 3G based features. The contents launched for this portal included Emap with several others. Soon after the launch of the 3G based portal, on 11 Feb 2005, Mobile Commerce launched a ‘StoreFinder’ feature on 'O2 Active’, enabling users to locate their nearest high street store wherever they were. In this application location information is presented as a map, displaying details of stores. Alternatively, the user can search for the store by name by using ‘Business Finder’ service. This application works by using real-time data from O2, content sourced from Thomson Directories and Mobile Commerce’s Location application engine.

Another portal based on i-mode wireless technology was launched on 01 Oct 2005. At its launch, O2 announced a broad selection of high profile content partners. O2 announced explicitly that LBS will be added from Nov 2005. At the time of the launch O2 announced that it will retain just 14% of the total revenue it collects on behalf of the content providers. On 26 Jan 2006, m-spatial announced that its MapWay Local Search, Maps and Directions services are now live on O2 i-mode. These services enabled i-mode users to rapidly access information of about 2.2 million businesses and amenities in UK. The MapWay 'What's Nearby' local search service shows a map of the local area to users, and allows them to rapidly 'discover' the businesses they need via a location-sensitive menu. The MapWay Local Search is a standalone application and the content package is supported by m-spatial's powerful new Local Search and Discovery Engine (LSDE).

On 06 Mar 2006, O2 announced a new partnership with the AA (Automobile Association) to provide its routes and live traffic information along with other motoring content to i-mode consumers. The system for this application was developed by Mobile Commerce. The application is currently available via an i-mode based portal under the travel menu. In Aug

2007, O2 announced that it has extended its current strategic relationship with AA until 2011. The decision to extend the contract by another two years is part of the AA's continued commitment. O2 also offered a mobile version of the Streetmap.co.uk application in Sep 2006. It can triangulate a user's location and pinpoint them on a map.

In parallel to these consumers' services, O2 offered LBS and M2M services to the wide range of businesses. For businesses, LBS offered by O2, provides:

- Management and better workforce schedule;
- Information of resources' progress;
- Guarantees employees' safety;
- Provides customers with accurate ETA of service teams or deliveries;
- Web – View of workers' locations via map on the web;
- Reporting of historical activities for route histories and more;
- Alerts for any unusual movements of mobile;
- MMS to send location map to workers on call.

Among several businesses one name is e-Courier. e-Courier was established in 2004 and is currently situated in London. O2 offered e-courier its GPRS and GPS technologies for locating and tracking their courier packages. e-Courier developed a new courier management system which automatically assigns the jobs and provides end users with a constant online real-time view of locations of couriers through information from GPS satellite tracking, live weather and traffic feeds. In Mar 2006, e-courier announced the successful implementation of a fully automated mobile dispatch solution with the entire fleet of vehicles outfitted with O2 XDA IIs and GPS modules. Since then the e-courier business is growing effectively. Very recently O2 awarded e-courier with the 'O2 Inspiration Award' for being the most inspiring small business.

On 25 Jan 2007, O2 signed a 30,000 M2M SIM deal with telematics service provider Cybit. The Cybit company provides services for vehicle tracking and satellite navigation. Both companies signed an exclusive agreement for three years with an expected rise in the number of SIMs in future. The SIMs could be used for tracking vehicles for supermarket's home delivery, vending machines and CCTV cameras. Before signing this agreement O2

was already the strategic partner of Cybit and together both have supplied telematic solutions to a number of businesses including Danco, Aberdeenshire Council – Waste management, EIC, Marshalls, Sainsbury's To You and Scanfreight. On 05 Feb 2007, O2 and Real Business (the subscription based magazine for independent companies) awarded 'Mobile Commerce', 'e-Courier' and 'Trackaphone' companies with the positions in its 2007 '50 to watch in Mobile' list of applications. Mobile Commerce was awarded for the second time by O2. In 2006, the award was for an application Location Search Service and in 2007 the award was for an application Monetised Search API. These awards on the one hand recognised the efforts of these companies but on the other hand also proved usability of location based applications on the mobile phones by consumers and businesses. LBS provide a way of offering new services to users. LBS are classified as the digital contents and their integration with other types of digital contents can offer a wide range of future applications. At present, O2 offers a variety of these services to customers. Table 4.17 describes a recent classification of the consumer LBS which are offered under the 'O2 Active' portal and under the 'Alerts & Information' banner.

Table 4-17: Consumer services under O2 Active Portal and Alerts & Information

Location Based Service	Description	Cost
O2 Active Info/Travel	**Travel:** provides train times, maps, walking directions, flights from ebookers, Time Out City guides **Maps and Directions:** provide users with maps and walking direction of places and turns the mobile phone into a pedestrain navigation system. **Store Finder**: enables users to locate their nearest high street store such as Starbucks, HMV, Boots, Argos, Sainsburys, McDonalds and Dixon. **Lastminute.com - DealFinder:** allows users to take last minute holiday plans, gift purchases, dinner reservations and more using mobile phones. It enables leisure-seekers to locate various deals with the options of 'All Deals', 'Eating Out', 'Hotels' and 'Going Out'. **Thomas Local:** Cabs, fast food, restaurants and shops, find the phone numbers you need fast, while you are on the move.	Downloading & browsing with Active is only 1c per kilobyte. It charges only for what is downloaded, not for the length of the time. Additional 50p is for premium text message.
Traffic Line 1200	By dialling 1200 from mobile handset a user can have instant access to up to the minute traffic information on Britain's roads and motorways. Knowing that there is congestion ahead user can choose an alternative route and avoid frustration of sitting in a jam.	The service costs £0.45/minute for all O2 customers.
Streetmap	Allows users to download street maps. It is a complete replacement of A-Z. This service is available to users via O2 Active and i-mode®.	Subscription cost is £0.5/day, or £2/month plus standard browsing costs

(Source: Information based on O2 UK website)

O2 complemented GPRS technology with i-mode technology and offered LBS like Streetmap via its i-mode. At present, the LBS which are available via i-mode devices are given in table 4.18. Table 4.19 shows M2M services for corporate businesses and SMEs.

Table 4-18: Consumer services based on i-mode portal

Location Based Service	Description	Cost
Transport for London Journey Planner	Travelling by Tube or Train, Bus or Boat is covered by Transport for London's Journey Planner service on I-mode. This service plans a journey, provides live travel updates, timetables and information about the Congestion Charge. There is also a wealth of useful contact numbers and information on everything from lost property to dial-a-ride services and licensed minicab information.	Each page costs between 1p-5p, depending on the number of images it contains. Browsing and downloading is charged at £3/megabyte (a megabyte being equal to roughly 250 pages).
AA Routes and Traffic	With the AA on mobile it is possible to search for live traffic information, plan a route using the AA's route planner and search for nearest motoring related services.	£2.50/month
TrafficView	Trafficview provides access to high quality, live traffic information from Trafficmaster. The service provides a picture of traffic conditions across the UK with 5 levels of zoom, available so that users can view specific areas of interest and make informed decisions on journeys based on current traffic problems.	-
Streetmap	Streetmap provides a map and LBS directly to mobile. From the application with the search box it provides maps in one-click. The search is based on a variety of types; post-code, street name, place name, latitude/longitude and others. It also provides information of current whereabouts by using the automated "look up location" facility. It can also forward user's location/meeting point to friends.	Subscription cost is £0.50/day, or £2.00/month on O2 Active. Standard browsing costs is £3 per megabyte
Mapway	It provides a comprehensive business directory, zoomable maps and graphical/text walking and driving directions of pubs, bars, restaurants, shops, banks etc. Also provides 'Car Park Finder', 'Shop Finder', 'and Station Finder' services.	Subscription cost is £1.99/month
Via Michelin Route Planner	This is map and door-to-door route planning services, covering the UK and 25 countries within Europe. Search by address, Tube station or monuments. There's a Proximity search helping you to find nearby MICHELIN Guide hotels and restaurants, car parks, garages, tourist attractions from the Michelin Green Guide and petrol stations.	-

(Source: Information based on O2 UK website)

Table 4-19: Business services for Corporate/SME customers

Applications	Description	Technology
Safety and security	**Property Security:** It uses predefined 'pinging' communication to check the alarm status across business property and can send alarm to any location. It can also be used as a cable free back up if fixed line fails.	Wireless
	Vehicle security: It provides real control over companies' vehicles. It identifies the drivers' whereabouts by knowing when they enter in vehicle and also tracks vehicle's movements on the road. Silent alarms get trigger in emergency situations and send to the security firm or police for immediate action.	Bluetooth/ smartcard GPS-based tracking
	Employees safety by GPS phones and ID badges: People are most valuable asset for any business. For the safety of lone workers in remote and hazardous locations, O2 offers solutions range from mobile phones with GPS tracking capability to ID badges that use GSM/GPRS 'panic buttons' to send an immediate alert for assistance.	GPS-based tracking GSM & GPRS
Asset Management/ Machine Asset Management	**Fixed asset management:** Any fixed asset can be monitored using M2M. It provides routine checks and upgrades and changes can be done remotely of any remote or hazardous environment unsuited for fixed line systems.	SIM based technologies
	Moving asset management: It provides monitoring control of any vehicle on the road. It sends reports at pre-defined regular intervals or alarms when a defined threshold has been breached in the form of both real time and historic information. It also ensures that loads stay at the right temperature, aren't tampered with and reach the right destinations.	GSM and GPRS
Navigation/ Fleet Journey Management	It provides turn-by-turn information to drivers using both in-vehicle and portable devices. The service also gets supportive information from other vehicles and an extensive series of cameras along UK roads to give access to real time traffic information.	GPS tracking with GSM/GPRS SIM

(Source: Information based on O2 UK website)

The services shown in the above tables are mostly developed by third party players. O2 establish different types of partnerships with suppliers of these applications. Table 4.20 shows these applications, their suppliers and relationship of O2 with these suppliers.

Table 4-20: Suppliers of Location Based Services

Services	Supplier	Description	O2's relations
Traffic Line 1200	Traffic Master	O2 provides mobile phone connectivity for all traffic master services in the UK. Trafficmaster provides traffic news to O2's 1200 Traffic Line, to give up to the minute traffic information for roads you are on or nearby.	Technology Partner
WAP – What's Nearby Thomson Local WAP – What's On Storefinder 3G development Search - Travel Deals	Mobile Commerce	What's Nearby allows users to quickly access the most commonly POI. The service allows a free search through Thomson's local by either Business Name or Business Type. What's On is an extension to what's nearby. It allows finding which events are on along with times, prices etc. Storefinder finds local stores in UK.	Client
DealFinder	Lastminute.com	Provides real-time access to the lastminute.com database to choose from 'All Deals', 'Eating out', 'Hotels', and 'Going Out' and find their location by 'Where I am now' or 'Somewhere else'.	Mobile network partner
Streetmap	Streetmap.com	Streetmap is available to both Pay Monthly and Pay & Go customers with compatible video enabled mobile device with GPRS settings and i-mode devices. It delivers Ad-banners to O2 customers.	Customer
MapWay Local Search, Maps and Directions	m-spatial	Specifically optimised for mobile handsets and featuring a unique 'assisted browsing' capability that eliminates unnecessary keypad strokes, the MapWay services enable i-mode users to rapidly access information about almost 2.2 million businesses and amenities in the UK. The MapWay 'What's Nearby' local search service presents the user with a map of the local area, and allows them to rapidly 'discover' the business they need via a location-sensitive menu of relevant businesses and amenities.	Customer
AA Routes and Traffic	AA	The partnership forms part of i-mode advanced content ecosystem through which the AA was able to quickly deploy a secure commercial content to consumers. The system was developed by Mobile Commerce.	Strategic Partner

(Source: Information based on O2 UK and Suppliers' websites)

4.2.1.12 O2 technology co-evolution

O2 offers the wide range of LBS to customers through Cell-id and GPS technologies. The cell-id technology uses the triangulation technique. O2 supports the GPS technology through the range of its developed XDA Orbit GPS Smart Phones equipped with Sat Nav software. These location technologies are supported by the basic network infrastructure of

2G, 2.5G and 3G technologies which are evolving in parallel to LBS and are discussed below.

4.2.1.12.1 Infrastructure technology

From Jan 1985, O2 provided analogue mobile telephone services until October 2000. Later infrastructure evolved towards digital telecommunication services. In Apr 2000, O2 was awarded with the UMTS license for £4.03 billion. O2 was the first company in the world to launch and roll-out a commercial medium speed GPRS mobile data network. O2 was also the first operator to launch WAP in the UK market. A major drawback of this early launch, however, was the lack of exciting applications and enabled handsets. O2 admitted that *being aggressive in launching WAP and GPRS was a mistake*. However, this mistake changed the data strategy of O2 from being first in the market to being a leader in the provision of innovative data services. By Mar 2003, O2 managed to provide strings of data services including LBS.

O2 continued its evolution by following the trajectory towards 3G technologies. O2 expanded the role of Nortel Networks as an infrastructure supplier of 3G-UMTS technology. O2 already had the supply agreement with Nortel Networks. Nortel Networks was previously selected to provide GPRS and UMTS core networks. The contract was signed by both parties on 31 Oct 2002. The Nortel Network was selected as one of the two suppliers for the network infrastructure. According to the supply agreement Nortel Networks supplied BTS (Base Transceiver Station), Mobile Switching Center (MSC), Radio Network Controller (RNC), and Data Packet Core (GGSN, SGSN) technologies to O2. O2 chose the Nokia Siemens Networks as its second supplier. The Nokia Siemens not only supplied technology but at the same time offered the service management operations consulting services. O2 wanted to improve the performance of its rapidly expanding 3G networks but observed a disproportionately high number of problems when compared with the 2G networks. So during the rapid growth of 3G networks, Nokia Siemens Networks helped O2 and reduced the number of trouble tickets and increased the availability from 94% to 98.4%. Soon with the launch of UMTS, O2 announced the introduction of a range of new handsets and an enhanced O2 Active portal which was re-designed to take advantage of richer, faster more capable UMTS based features.

To provide LBS, on 29 June 2004, O2 announced the offer of a real-time location service for Microsoft® MapPoint® Location Server (MLS). It is a component of MapPoint Web Service that allows integration of real-time location into business applications. The MLS component enabled developers, independent software vendors (ISVs) and system integrators to create and deploy location aware business applications for their customers by combining the location data from the O2 networks with the rich mapping and location capabilities from the Microsoft MapPoint Web Service.

On 27 Sep 2005, O2 announced that it was to launch a new technology i-mode. The i-mode technology is the alternative to the WAP technology and developed by Japan's largest mobile operator, NTT DoCoMo. O2 complemented its infrastructure technologies with this supportive technology. According to O2, '*i-mode is a big step forward from WAP'*. The WAP technology became the international standard and adopted by all other operators in the UK. But for consumer experience, O2 found the ease of programming, speed, cost and much else is in the i-mode technology. O2 estimated that an i-mode site could be constructed for £8000 and, in contrast to WAP, programming would be compatible with all i-mode phones. O2 also announced a broad selection of high profile content partners for its i-mode technology which included LBS. Differing from O2 Active, which focuses more on entertainment and information services, i-mode offered services which were built to fit a customer's lifestyle.

O2 also showed its plan for a more extensive trail of HSDPA technology which is also termed as 3.5G+ at the start of 2006. So far, however, O2 did not demonstrate an aspiration for HSUPA technology. O2 also rolled-out support for the EDGE technology through offering its Iphone on the market. O2 did not clearly declare the launch of EDGE technology but commented that EDGE had been working in the UK for some time. EDGE is a half way house between regular GSM data, as provided by GPRS, and 3G, so it can offer a good speed for surfing the net on Iphone. O2 chose Nokia Siemens as supplier of the EDGE capabilities. Before offering these capabilities to O2, Nokia Siemens had the launch experience of 120 commercial networks. All these infrastructure evolutions are given in table 4.21.

Table 4-21: Evolution of the O2 infrastructure and product technologies

Infrastructure	**Launched**	**Services**
2G-GSM	July 1994	For digital services
2.5G-GPRS	June 2000	For always on connection
3G-UMTS	October 2004	High data rate services with 50% coverage
i-mode	October 2005	i-mode is a new platform for accessing web over mobile phones. It has an always-on functionality not dissimilar to broadband, with no need to 'dial up' to make a connection.
3G+-HSDPA	December 2006	For high speed data downloads
Product	**Launched**	**Services**
Motorola T260	June 2000	To support GPRS technology based services
Nokia 6630, Samsung Z107, Motorola V975 and the Sony Ericsson V800, O2 X4	January 2005	For 3G services
Ice 3G handset	August 2006	The handset was designed exclusively for O2 with easy access to 'O2 Active' and Streetmap applications.
NEC 411i, NEC 343i, Samsung S500i Samsung Z320i,	October 2005	For i-mode services
O2 XDA Orbit GPS	November 2006	To support personal navigation services and equipped with features to offer calculations for detailed routes, turn by turn directions, where am I?, 3D bird's eye view, London congestion charge avoidance, automatic day/night settings, avoid toll roads, fastest and shortest routing and walking mode.

O2 either purchase or license the discussed technologies from suppliers of technologies. O2 used technology of Nortel Networks and Nokia Siemens Networks for its infrastructure. In order to develop LBS, O2 also established different types of relationships with suppliers of the component technology. Table 4.22 shows the list of the developers of these technologies and their relationship with O2.

Table 4-22: Suppliers of supporting infrastructure and component technologies

Supplier	Infrastructure/ Component	Technology	Description	O2 relation
Nortel Networks	2.5G network	GPRS	Provided network roll-out	Supplier
Nortel Networks	3G network	UMTS	Provided network roll-out	Supplier
Nokia Siemens Networks	3G & 2.5G network	UMTS & EDGE	Provided network roll-out and offered service management operations consulting services for UMTS. Provided EDGE radio network.	Supplier and Consultant
NTT DoCoMo	2.5G and 3G	i-mode Wireless	It is most widely-used mobile Internet service. i-mode is an easy to use, fast and cost effective way for mobile users to enjoy a world of content from Internet sites.	Strategic Partner
Microsoft	MapPoint Location Server (MLS)	2G and 3G networks	It is a component of MapPoint Web Service that allows the integration of real-time location into business applications. It provides access to location providers such as mobile network operators and acts as a proxy between applications and the MapPoint Web Service	Customer
Mobile Commerce	Location Gateway	Application-programming interface (API) based on XML standards	Delivers dynamic access to cross network handset location feed. Customer sends the mobile telephone number to the Location Gateway which responds with information of X,Y co-ordinates (in GB National Grid format or GPS / WGS84 format), area of accuracy and date/time	Distribution partner

(Source: Information based on various electronic NewsLetters)

4.2.1.12.2 Product technology

The evolutions of component and infrastructure technologies of O2 were also complemented with the product co-evolution. O2 as a developer of the mobile handsets simultaneously developed and bought a number of mobile handsets at the launch of every infrastructure technology.

O2 offered LBS to several businesses through the range of its PDAs. A London black cab company, Xeta, used O2's wireless PDA, the Xda II, to support LBS. O2 developed a system based on custom software, XPert, which worked in conjunction with satellite navigation software from TomTom along with GPS receivers. Using those PDAs allowed drivers to leave their cabs for lunch and be able to respond to jobs. In order to boost its Windows based XDA line-up of wireless PDA, O2 launched its IIi model. This features a faster processor and more memory. The PDA was made by HTC and supported both Bluetooth and Wi-Fi technologies.

O2 launched an initial range of six 3G handsets for the 3G technology customers and later extended this range. To mark the introduction of O2's 3G service for consumers, O2 launched its own-branded 3G handset, the O2 X4, one of its existing X-range of handsets which includes the popular O2 Xda II® and the O2 X4™. In addition to this, O2 offered 3G customers a range of handsets from leading manufacturers. O2 launched 'Ice 3G handset', an own-branded 3G handset, with a number of features wrapped in a sophisticated design. The O2 Ice was launched through the O2 retail stores or online during Sep 2006. Later this device reached the UK market through other direct and indirect channels.

O2 sourced its i-mode handsets from just two suppliers initially, NEC and Samsung. At the end of 2006, O2 had the broadest range of exclusive ever – 44 post pay and 24 pre pay - handsets. At the launch of HSDPA technology, O2 did not offer any handsets. O2 offered the services by Sierra Wireless AirCard 850 PC cards. O2 declared that as soon as phones were available in the market, they would be comparable in size and shape to the technology. O2 has learnt with 3G, from its own experience and that of others, that customers value their choice. At the time of the HSDPA launch, the choice was not available for customers and therefore the timing of the handsets' launch would be influenced by the range of devices available in market and by the customers' demand.

To support personal navigation services, O2 launched its O2 XDA Orbit GPS equipped smart phone. This phone was the first O2 Xda to offer built-in GPS and seamless door to door navigation. The smart phone was equipped with the latest CoPilot Live sat-nav package from ALK technologies. The CoPilot Live7 navigation software is bundled with the new Xda Orbit 2. The software was supplied on an easy to install memory card with a

complete map of UK. The handset was developed for WiFi and GPRS technologies with its quad band capabilities. These evolutions are given in table 4.21.

According to Martin Butler, "*In terms of handsets the year 2007 showed a good progress. Several handsets have been developed by HTC integrated with the GPS technology. Particularly Nokia N95 is its classic case. It has also been observed that in 2007 applications have also shown a bit of improvement and shown the revenue generation*".

4.2.1.13 O2 organisational evolutions

To offer LBS, O2 has also initiated multiple partnerships and alliances for buying multiple technologies from multiple suppliers. The alliances and partnerships caused O2 to share its revenue with the suppliers of technologies. The share is visible in the value chain of the O2 LBS. Fig 4.15 presents the value chain of the O2 LBS showing a few of the key suppliers of technologies.

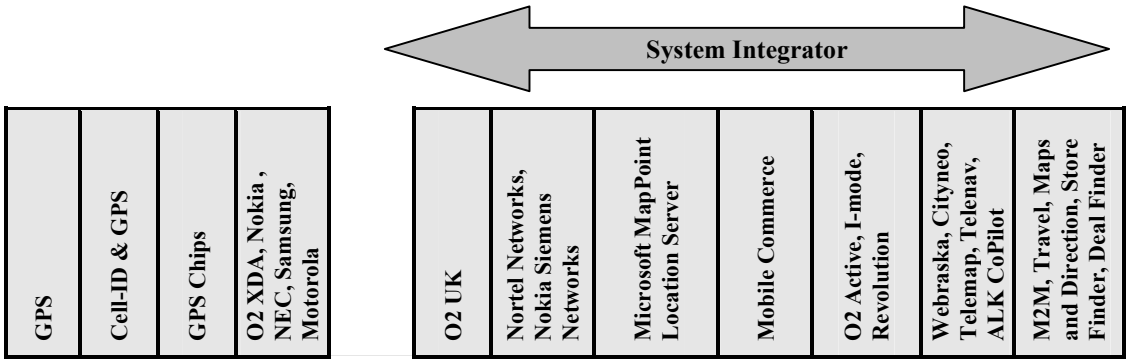


Figure 4-15: O2 LBS value chain

4.2.1.13.1 Supply chain management capabilities

O2 has a large number of local and international suppliers who provide products, components, infrastructure and services. LBS rely upon integrated technologies and therefore rely on the suppliers' technology. The nature of such applications and markets create a mutual dependency between O2 and its key suppliers. O2 believes in nurturing long term suppliers' relationships and therefore makes these relationships valuable to both parties. O2 manages this capability through its 'Supplier Relationship Management' programme. This programme is designed to:

- Maximise the value of supplier relationship to O2;
- Minimise supply and supplier problems;

- Minimise cost;
- Shrink time to market;
- Provide a framework to align and co-ordinate efforts;
- Get to know, understand and benefit from the power of the relationship;
- Understand key suppliers as customers as well as suppliers.

O2 also expect these suppliers to operate to the same standards as O2. To match the industry standards O2 adopted certain tools and processes for assessing and monitoring suppliers' technologies. These tools are mainly questionnaires which are developed in association with GeSI (Global e-Sustainability Initiative) and EICC (Electronic Industry Code of Conduct) Implementation Group. O2 uses a Risk Assessment Tool designed by EICC. These tools measure social, environmental and ethical impacts of suppliers. To ensure that supply chain meets all the criteria, O2 regularly carry out an audit of suppliers where O2 assess their capabilities, management systems, qualities of products and services, labour, environmental and business ethics practices. O2 benchmarks suppliers against the ISO 14001 standard and have developed a series of requirements for major suppliers. During 2006-2007, O2 sent eight questionnaires to major suppliers and conducted eight audits of suppliers. O2 also expect that suppliers agree to 'Purchasing Terms' which are available for all suppliers. It is O2's policy to make third party service provider agree to the O2 standard terms before allowing them to use O2's networks. These terms include the requirement that service providers ensure that their services are of a quality and kind which are not likely to bring O2 into disrepute.

Apart from dealing with suppliers, O2 also manages its own supply chain capabilities. On 15 Dec 2003, O2 selected Manugistics Supply Chain solutions to increase the availability of mobile handsets and mobile services. Manugistics is a leading global provider of demand and supply chain management solutions. Through this solution, O2 manages the supply of its handsets and services to its consumers, streamlines its internal demand forecasting process and prepares the company's purchasing plan for all retail locations and other channels. This acts as a fully integrated supply chain to enhance customer service levels while taking costs out of operations and reducing inventory levels. In 2005, O2 was awarded with the 'Best Supply Chain Integration and Excellence in Europe Award' by the Chartered institute of Logistics and Transport.

4.2.1.13.2 Managing content standards capabilities

As with any other mobile operator, O2 identified contents as a major asset to offer variety of applications for customers. O2 allowed third parties to offer different contents to the O2 customers through their commercial services. The content based commercial services reach the customer through a contractual relationship between O2 and the third parties. O2 provides delivery and access for these commercial services. To brief contract relationships to the third parties, O2 has published the UK Content Standards Policy. The policy covers all content services published by O2, policies for parents and other services on the open internet. The policy document complies with UK laws and regulations and 'Code of Practice for the self-regulation of new forms of contents on mobile'. Within O2 the responsible managers for this capability are product managers (content, data, portal and messaging services managers) and relationship managers (wholesale data support, interactive product sales). Outside O2, suppliers of content and data services, third parties and business partners are obliged to follow this policy.

To assure the need of meeting the standards of LBS, O2's passive LBS comply with the 'Industry Code of Practice for the use of mobile phone technology to provide passive location services in the UK'. This code defines traceability, registration, identification, and alerting features, required for passive services used by people under 16 years and needs clear instructions to be provided for turning such services off. Tracking a child via LBS seems like a useful idea but it has its risks. O2 allows parents to check the location based settings on the phone of their children by dialling 1300, an automated response number. This number provides four different levels of the privacy settings. In emergency situations the police or ambulances will always be able to request to switch on these settings. For the active type of LBS, O2 complies with the relevant data protection law and regulation.

Apart from policy, O2 with its new partner Childnet International, a leading organisation in child internet safety, has launched a website and produced a child protection film to advise parents about the risks of the mobile technologies and services. The policies at O2 also get reviewed for developing Best Practice in the area of child protection and get commended for assessing relevant best practice standards to protect its customers. O2 is also a member of the Home Office Task Force on Child Protection and is committed to adopting Home Office Guidelines in so far as they are relevant to mobile services. Along with this, O2

operates online public forums, or so-called chat rooms. These are ‘moderated’ by trained employees to identify inappropriate, threatening or bullying exchanges with children. O2 undertakes to alert relevant agencies to any complaints and works closely with the police when appropriate.

O2 also identified the possibilities of breaching these policies. If policies are breached within O2 and a service fails to meet the policy requirement, disciplinary action is taken. However, outside O2 if services offered by suppliers or business partners fail to meet the policy standards, this can lead to the termination of the business relationship and withdrawal of services. O2 from time to time conducts audits to ensure that policies are being adhere to inside and outside O2.

4.2.1.13.3 Managing mobile network roll-out capabilities

The mobile technology evolution has been supported with the evolution of the network infrastructure due to the increase in numbers of base stations through out the UK. O2 has done the same but under proper guidance through the full support of best practices in the development of mobile networks. This evolution followed the development of 2G and 2.5G networks and is currently related to development of the 3G networks. In 2005, the number of these base stations was 10523 and further increased to 10858 in 2006. This network roll-out is managed at O2 through wide dialogue and consultation with key stakeholders.

O2 also supports the GSM Europe Recommendations on network roll-out good practice. This recommendation was published by the group of GSM Association in November 2001. It contains nine key elements for the definition of good practice. These nine points encourage dialogue with local authorities, base station sharing with other operators, reduction in visual impacts, information sharing with regulators, following ICNIRP specifications, supporting research and providing clear and consistent documentation.

O2 also joined other network operators to develop the ‘Ten Commitments to base station siting in UK’. In addition to following these regulations, O2 established a team of community relations managers in each of its businesses to make sure that local communities are well informed about locations of present and future base stations. These managers attend public meetings, consult through drop-in sessions, distribute information leaflets and

operate a dedicated help line for queries. To reduce the number of the 3G base stations, O2 established network sharing agreement with T-Mobile. In addition, across every antenna, O2 provided clear safety signs to warn people not to get too close.

4.2.1.13.4 Managing environmental policy capabilities

With the ever increasing number of base stations, the concerns about environment and unknown health safety risks have also been raised. O2 responded this issue via the precautionary assurances that equipments do not exceed safety limits and remain within international exposure guidelines. The independent agencies which devise the network safety guidelines include: the UK Radiation Protection Division of the Health Protection Agency, the International Commission on Non-Ionization Radiation Protection (ICNIRP), the European Commission and the World Health Organisation (WHO).

O2 regularly monitors these networks and also allows regulators to do the same. The measurements by regulators showed that none of these base stations operation are at a harmful level. Rather they operate well below the guidelines. O2 also regularly reviews practices to ensure that it complies with all existing and new advice and regulations, and also makes sure that hazards associated with operations should remain identified, assessed, eliminated, reduced, or subject to controls.

Another main issue is related to energy efficiency and reduction. Most of the energy is consumed by the mobile network infrastructure. The 2006 statistics showed that from a total of 735.077 GWh, networks consumed 623,558, offices and call centers consumed 88.821 and retail stores consumed 22,698 GWh. In 2006, O2 sourced 72% of its electricity consumption from low-carbon or renewable sources. The operations of O2 are managed and audited by the international environmental standards ISO 14001 and OHSAS 18001.

4.2.1.13.5 Managing research and development capabilities

O2 have not engaged in any significant R&D activities since 2000 to date. According to Martin Butler, '*It can be seen that O2 is mainly involved in the Research side but not much in the development. At O2, R&D capabilities are managed by Product Managers and Marketing people. Marketing people do research and find out what customers want. They do focus groups, talk to consumers and corporate customers and also retain marketing*

research of companies. The development is mostly done by third party developers but O2 tells them what applications they are looking for'.

Before launching any application O2 tries to identify the real market demand of that application through the majority of surveys. O2 decided to launch an application named Streetmap under its 'O2 Active' portal, because of results achieved via a survey research. The 'Lost survey' was conducted amongst 1200 UK adults by Tickbox.net. The results were then calculated for the UK population. The research identified that 41.79 million of UK adults got lost when out and about. The research also identified Worst 'Lost' hotspots in the UK. The table 4.23 below shows their values. The results of this survey encouraged O2 to launch the Streetmap application which can help O2's customers to pinpoint exactly their current location.

Table 4-23: Worst Lost hotspots in the UK

Location	Percentage	Population
Manchester City Centre	67	2.7 million
Heathrow Airport	60	2.4 million
M6 (including Spaghetti Junction)	56	2.25 million
London's One Way Systems	45	1.8 million
Ikea Department Store	37	1.5 million
Meadowhall Shopping Centre	30	1.2 million
Alton Towers Theme Park	22	800,000
Kings Cross Railway Station	17	710,000
Devon Country Lanes	15	620,000
Lakeside Multistorey Car Par	12	500,000

(Source: Data based on O2 Media centre, 13 June 2006)

Another survey, conducted by O2 and Quocirca, identified the increase in demand of mobility for Corporate Businesses. The research showed for the span of Aug 2005 – 2006, the number of companies which deploy mobile and integrate it with wider IT infrastructure has risen from 20% to 65%. The survey was based on in-depth interviews with 520 senior IT and communication decision makers. The results clearly identified the competitive advantage and customer services as main drivers behind the adoption of the mobile technology by these corporate businesses. In response to these results, O2 re-focused its own corporate strategy to meet the challenge of UK corporates' changing mobile needs. The

new approach allowed O2 to increase its market share by taking a far more consultative approach to sales and give a better customer experience that is driven by customer insights.

Along with these surveys, O2 works very closely with Research In Motion (RIM) for the development of its branded handsets. O2 and RIM has launched a range of BlackBerry smartphones. The recent one is the BlackBerry Curve with the features of small size and light weight with several other technological capabilities. According to Martin Butler, '*O2 remains involved with third party developers like HTC and Time One for the development of handsets and reveals its demand of handset functionalities to these developers. O2 also provides roadmaps to other handset manufacturers like Samsung which integrated the chip inside the mobile phone once demanded by O2*'. These research capabilities help O2 to understand in a better way the market demands of technologies, and offer these technologies with the help of third party developers.

The research capabilities also measure the usability of multiple technologies. Particularly, for LBS O2 performed comparisons of multiple technologies. According to Ian Curran, '*O2 remained involved in bench marking of several LBS technologies by working with Motorola and Snapshot. O2 tested for the A-GPS first time in 1992*'.

4.2.1.13.6 Managing billing capabilities

Due to the integration of the third party developers in order to offer LBS, O2 had to adopt a system that can perform the revenue sharing capabilities. According to Ian Curran, *'Recently there was a change in the location server. O2 adopted Sage Gateway interface which gets connected to the Location Server and platform and through which the third party developers can access the location information from the O2 network'.*The Sage Gateway is the engine that fuels the communication and transmission of data between the functional components of the payment process. It allows companies with large product lines to integrate directly through the Application Programming Interface (API) which relays the request for payment to the appropriate entity then it relays the response or authorization that sets the funds transfer activity. This system allows the third party developers to access location information from the O2 networks and pays for this service to O2.

The billing capability also varies with onboard and off-board solutions. In an onboard solution, the handset stores maps and performs all the calculations and shows position on map and chosen route and progress in real time. By contrast, in an off-board solution, maps are not stored in the handset. The handset supplies the location data to a server, which then performs the calculations and downloads a map area covering the route to the device by GPRS.

4.2.1.13.7 Managing customer care capabilities

The aim of the O2 is to turn customers into fans by delivering them the best customer experience possible. O2 follows its 'Customer Promise' charter to make its customers happy and loyal. O2 listens to the customers' problems through the O2 customer care services which are available via 202 for pay monthly and 4445 for pay and go customers. According to O2, *'customers want great products and services, reliable coverage, useful and entertaining content, and simple but clear pricing. But they also want excellent customer services from well trained people they can actually talk to'*. At O2 employees get regular training to provide better services to customers. In 2006, O2 opened its fourth customer service centre in Glasgow, adding 1500 extra workers. To reach such high standards of customer care, O2 conducts focus groups; tests the market for new products; researches customer's needs and listen to the results of these activities.

The O2's customer care capabilities have been identified through the number of awards O2 received. In 2003, OFCOM recognised O2 as a 'Best Network Operator'. In July 2005, O2 was independently ranked first among all UK operators for customer satisfactions. The accolade was measured against all activities including network quality, customer service, billing, mobile services and value for money. O2 was also voted 'Operator of the Year for the Best Prepay Service' by mobile retailers at their annual awards dinner in 2005. In Dec 2005, O2 was ranked at top in satisfying customers with their mobile phone retails experience, according to the J.D. Power and Associates 2005 UK Mobile Phone Retailer StudySM. This award was based on three factors driving customer satisfaction including staff (39%), offerings and promotions (39%) and the store (22%). In 2006, O2 topped the JD Power and Associates Survey and also took first place in the UK's Customer Satisfaction Index for the second consecutive year. Along with these, O2 also received 'Best Mystery Caller for Customer Service Award' from Mobile News.

To manage its SME customers, O2 launched the SME starter pack on 07 Mar 2007. The capability was designed to help new businesses get started. This service offered SME customers two free months subscription to any of O2's bundled business voice tariffs along with a dedicated UK based customer service team available 24 hours a day via a freephone 0800 number and a call from an account manger every three months to discuss any issues and resolve any concerns. Soon after this, O2 announced the launch of the new and innovative 'Business Specialist' proposition designed to benefit SMEs. Through the launch the SME customers were offered personalized access to O2 Business Specialist by phone and in local O2 retail stores, for assistance and advice on leveraging the most value from their mobile phone contracts. O2 launched this service with a £2 million advertising campaign.

4.2.1.13.8 Managing strategic capabilities

The primary goal of O2 is to create value to its parent company Telefonica S.A by becoming the fastest growing major European mobile operator in revenue, profitability and delivering customer promises. According to O2, *'the growth opportunity in UK lies in improving customer experience and therefore the O2's aim is to become an integral part of customers' lives and improve its ability to attract and retain higher value customers'*. The O2's strategy puts the customer at the heart of every thing O2 does.

The O2's approach is:

- Maintain focus on performance and competitiveness by maximizing customer value, continue focus on loyalty and maintain growth;
- Drive best customer experience by keeping brand fresh, end to end customer experience, use customer insight to drive proposition and offer 'virtual' and 'real' experience;
- Broaden scope of business and build new capabilities by continuing to grow SMS and non-SMS data usage, continue targeted 3G rollout and exploit capabilities, extend scope into fixed broadband, expand revenue sources (e.g. mobile advertising);
- Align O2 and Telefonica businesses by delivering tangible customers benefits, sharing best practice and innovation and leveraging cost share, purchase and partnership benefits.

According to Martin Butler, '*due to the marketing conditions of LBS the strategic focus of O2 towards LBS is:*

- *To keep an eye on LBS and check where it is going;*
- *Do not invest much in this technology;*
- *Offer limited services;*
- *Measure how the market develops;*
- *Check where competitors are going'.*

4.2.1.13.9 Managing marketing and sales capabilities

O2 manages its marketing and sales capabilities through multiple channels.

- Online Shop – this channel is for consumers and SMEs to purchase products and services, manage their orders and perform accounts and billing online.
- Direct Sales – this channel is for business market only. Through this channel the direct sales forces interact with business customers.
- Corporate Sales Extranet – this channel is handled by O2 account managers only. Account managers can access to set up phones, provide quotations and create contracts for SME and business customers.
- Telesales Extranet – this channel allows call centre staff to place orders on behalf of customers.
- Retail store Extranet – this channel facilitates other retailers such as The Link to create their own branded website that communicates and sets up orders.
- Wholesale Extranet – this channel enables large corporate customers and partners to bulk buy minutes or network capacity on O2's network.
- White Label Extranet – through this channel O2 sponsors partners such as Arsenal foot ball club to create their own branded versions of the O2 online shop
- SMS Extranet – this channel provides a web interface that approved businesses can access to bulk buy SMS services in order to send out text campaigns to thousands of their own customers.

In order to manage sales capabilities through these wide number of channels, O2 signed a contract for five years with BroadVision in June 2004. According to this contract, BroadVision provided its Commerce application order management platform to O2 which

can carry out the sales process through the retail store extranet directly with the customer online. O2 has been awarded for managing these capabilities so effectively. O2 received the 'Best Large Retailer of the Year' award in 2006 from Mobile News. O2 continuously increased the number of its retail shops. Up to Dec 2006, O2 expanded its retail presence and accessibility on the high street with a major expansion programme, The Link Stores, form DSG (formerly Dixons) to add over 90 stores. By Sep 2007, O2 managed to have 400 outlets around the UK.

On 01 Feb 2006, O2 united with the mobile retailer Phone4U to sell O2's contract connections to customers but on 22 Feb 2007, O2 announced that it would stop selling new contract connections through Phone4U from 01 Apr 2007 and struck a better deal with Carphone Warehouse. According to O2, '*it would continue to use Phone4U for selling pre-paid connections and for upgrades to existing contract connection'*. In smaller towns where it seems difficult to generate sufficient returns, O2 adopted the franchise approach. From the O2's experience in operating stores in cities like London, it has been identified that operating the company owned outlets in small places like Marlow and St Albans could be an expensive strategy. O2 allowed franchisees to sell the O2's products and services by involving local expertise to develop and manage their store business. At O2 this model seems to be working well. On 12 Sep 2007, O2 declared the number of these stores had grown to 48 within one year and reached 70 by the end of year 2007.

For business customers in 2005, O2 enhanced its direct sales force and introduced new pricing and service propositions. These included the O2 Welcome service for larger corporate customers, designed to make switching from other networks trouble-free by giving dedicated support, advice and information at the customer's premises. The second service was the O2 Network Manager, which measured the service level given to corporate customers to an agreed standard to enable O2 to improve the network experiences. The marketing campaign, O2 for Business, also promoted the quality of O2's network.

On 12 July 2006, O2 re-launched its corporate strategy to meet the challenge of the UK corporates' changing mobile needs. This new approach allowed O2 to increase its market share by taking a far more consultative approach to sales and give a better customer experience that is driven by customer insights. The re-launch relied on three key elements.

First was the establishment of an O2 Sales Academy. The academy equipped the O2's staff with the advanced business skills, necessary to drive deep customer understanding crucial to this type of value added activity. This capability offered customers access to experts, people that really understand their business and a consistency of approach and experience. Second was a shift towards a more IT focused consultative approach to corporate sales. However, O2's aim was not to replace Value Added Retailers (VAR) in the mobile IT value chain. O2 worked with RIM, Microsoft and Westcoast to establish better ways for companies to understand, acquire and deploy mobile technologies. Third was about achieving recognition that partnership is a key and that O2 partners with the best in corporate businesses. O2 already has a long rich history with the mobile channel through the O2 Advance. The result of such capabilities helped O2 in acquiring many new corporate customers including DHL.

For the purpose of marketing and advertisements, O2 comply with several voluntary advertising codes and best practice in advertising. O2 seeks to withdraw any advertising that is found to be misleading and inaccurate. O2 follows the Advertising Standard Authority (ASA) website which offers rules to make sure all advertising meets the high standards laid down in the advertising codes. In 2004, O2 won the Institute of Practitioners in Advertising's (IPA) prestigious Grand Prix award. O2 spends a lot on advertising its products and services. For example, an £8.5m advertising campaign was rolled out by O2 behind its i-mode launch. No such investment, however, has ever been done for LBS.

4.2.1.13.10 Managing partnerships and alliances capabilities

O2 deals with a number of suppliers and partners to provide high quality applications to its customers. Depending upon the type of businesses and types of technologies offered by these suppliers and partners, O2 manages its partnership capabilities. For example, Nordic Networks and Nokia Siemens Networks are the infrastructure suppliers. NTTDoCoMo is the strategic partner to deliver the i-mode technology. Mobile Commerce is the distributor partner to offer LBS. AA is the strategic partner to offer route services. Traffic Master is the technology partner to offer Traffic Line 1200 application. Apart from being a partner of suppliers of technologies, O2 established a channel to offer technologies, services and expertise to other businesses in the UK. In 2006, in recognition of O2's ability to provide the highest levels of technical expertise, strategic thinking, and hands-on skills it was

accredited as a Microsoft Certified Partner Encompassing a broad range of expertise and vendor affiliations.

O2 invites different businesses to become O2's partner on the basis of certain selection criteria. The criteria include data connections, ARPU and retention performance of these businesses. In July 2004, O2 invited Azzuri, provider of converged voice, data and managed services in the UK, to join the O2 Data Centre of Excellence and O2 Advance. O2 launched the O2 Advance Partner in Feb 2004, a support programme, for Direct Independent (DI) partners. These DIs qualify to be the O2's partner on the basis of their excellent customer services and a true focus on delivering leading-edge mobile solutions within the business market. The programme offers a range of features including sales incentives and rewards, guaranteed market funding, bid management support, dedicated sales support helpdesk and jointly branded sales tools to help DIs further develop and increase their businesses.

O2 also launched the O2 Centre of Excellence particularly for Data and M2M services in Jan 2007 and announced its channel partners on 31 Jan 2007. O2 launched this centre to organise a group of UK business partners and bring together leading experts in mobile data to best meet needs of SMEs and corporate customers and to collaborate and grow the mobile data markets. The O2 Centre of Excellence is the first partner programme of its kind in the UK. It is sponsored and supported by RIM and Nokia. This launch followed a re-focus of the business strategy of O2 towards the adoption of a more IT-focused approach to corporate and SME sales. The M2M Centre of Excellence was launched with the aim to bring together experts of M2M and to offer integrated end-to-end offerings to customers. The centre offers member with the benefits of O2 endorsement and customer support, marketing support, training and accreditation, dedicated O2 pre-sales data consultants and access to events. M2M Centre of Excellence partners work collaboratively with O2 Direct Sales.

The integration of previously discussed technological and organisational capabilities creates resources for O2. These resources are considered as distinct assets and therefore possess different usable lives. Once their usable lives finish, O2 renews these assets. These assets are sometime leveraged to create new resources, and are sometimes integrated with other capabilities. The evolution of these resources is given in the following section.

4.2.1.14 O2 resource evolutions

At O2, resources are categorised as fixed and current assets. The fixed assets are further classified as tangible and intangible assets. The tangible fixed assets include land and buildings, plant and equipment and assets in the course of construction. The intangible fixed assets include values and technology licences. These assets are described in more detail below.

4.2.1.14.1 Fixed assets

I - Intangible fixed assets

Intangible assets consist of brand, licences, and know-how of employees. These assets depend upon their useful economic lives and are tested for their impairments. In May 2002, mmO2 introduced a single new customer brand 'O2'. Afterwards O2 became involved actively in protecting its brand, including the acquisition of core trademark registrations in the O2 brand and related brand materials.

The licence of technology, as an essential intangible asset, is required by every mobile operator to offer their services. O2 possesses licences for GSM and UMTS technologies. O2 was awarded with the GSM licence in May 1997 by the Federal Ministry of Post Telecommunication. The GSM license was awarded for the life of 19 years and is valid until Dec 2016. In Apr 2000, O2 was awarded with the UMTS licence for £4.03 billion. O2 paid this amount in May 2000. Under the licence conditions O2 is obliged to roll-out the 3G network so that it covers 80% of the UK population by 31 Dec 2007 which O2 has achieved to manage. This licence is valid until 31 Dec 2020.

O2 have not engaged in any significant R&D activities since 2000 to date but had worked closely with BT Exact and other suppliers and applications developers to create several products. O2 have a limited non-exclusive royalty free licence from BT, for the operation of businesses, to continue to use any and all patents, copyright, unregistered design rights, database rights and know-how. However, O2 spends a certain amount on R&D capabilities annually. In 2001, O2 invested £3 million in R&D. The amount rose to £10 million in 2004. In order to manage the discussed capabilities a large number of employees work under the

O2's umbrella. The employees' know-how is therefore considered as an intangible asset. Fig 4.16 shows the growing number of employees working for O2.

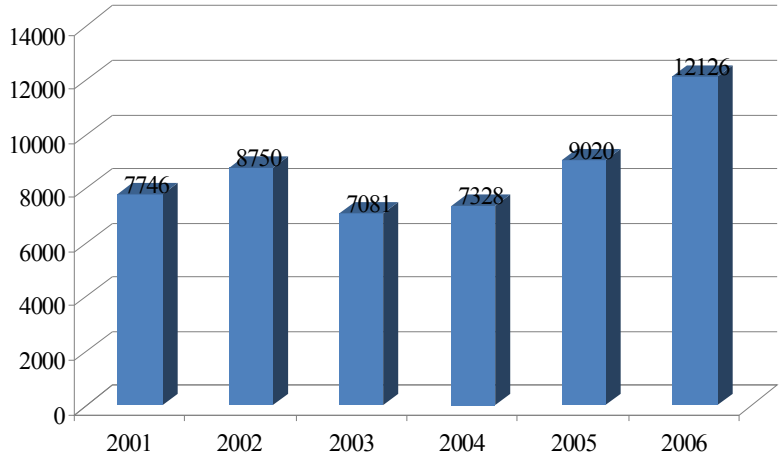


Figure 4-16: Number of employees
(Source: Information based on O2 Annual Reports)

I - Tangible fixed assets

The tangible fixed assets are land and buildings, plant and equipment and assets in the course of construction. The cost of these assets is related to their acquisition and installations. The main resources under this category are the mobile networks of 2G and 3G technologies. To enhance the value of services O2 is continuously investing in the mobile networks. The cost of these assets is depreciated from the date they are brought into use over their estimated lives. The lives assigned to tangible fixed assets vary between 2 and 40 years. Once the useful lives of these assets are over, O2 invests again in these assets to maintain their efficiency.

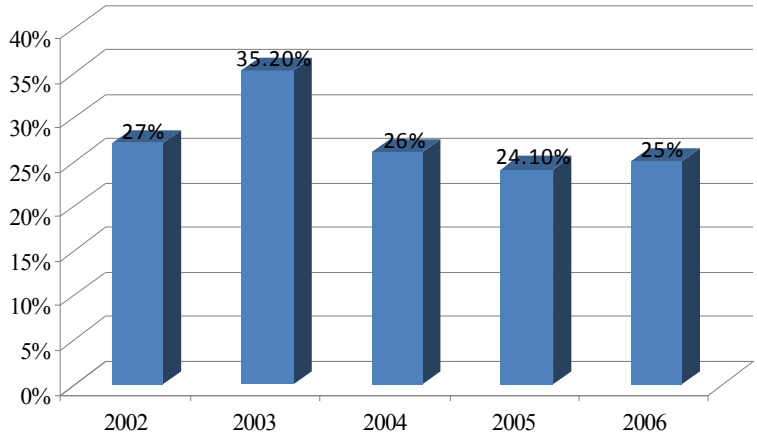


Figure 4-17: Market share of O2
(Source: Information based on O2 Annual Reports)

The continuous growth in the number of customers is considered as the real asset to O2. Customers are classified as pre-pay and post-pay customers. Table 4.24 shows growth in the number of O2 customers. The number of customers represents the market share in the UK market. Fig 4.17 shows the change in the market share for the time period from 2002 to 2006. The fixed tangible, fixed intangible and current assets possess certain values for O2.

Table 4-24: Annual customers' growth

O2 Customers	2001	2002	2003	2004	2005	2006	2007	2008
Customers (000)	10589	11084	12050	13264	14383	17633	17751	18403
Prepay customers (000)	7134	7542	7989	8687	9472	-	11453	11388
Postpay Customers (000)	3455	3542	4061	4577	4912	-	6298	7015

4.2.1.14.2 Current assets

Current assets are related to the cash, investments, stocks and debtors. The variation in cash value occurs due to several reasons. The reasons include investment in advance technologies due to the market demand or a competitor's investment decision or enforcement of a regulatory body such as OFCOM. The cash generated in the company can be represented in terms of revenue and ARPU. The revenue is classified in terms of service, data and equipment. Table 4.25 shows annual revenue generated for O2.

Table 4-25: Turnover of voice and data services

O2 Revenue	2001	2002	2003	2004	2005	2006	2007	2008
Revenue (£m)	2706	2756	3025	3451	4030	5124	5485	6221
Service Revenue (£m)	-	-	2738	3183	3627	3643	3654	3695
Data Revenue (%)	n/a	11.80	17.1	20.4	24.7	28	31.4	40.6
Equipment & Turnover (£m)	-	-	287	268	403	-	-	-
ARPU (£)	269	231	247	272	281	314	348	371
Prepay ARPU (£)	114	108	121	141	143	144	145	157
Postpay ARPU(£)	485	498	503	525	542	543	544	586

Source: Information based on O2 Annual Reports

O2 is also investing to protect its brand including the acquisition of core trade mark registrations for the O2 brand and related brand material. In order to protect its brand, O2 follows the litigation step path. At present, O2 are pursuing two significant trade mark infringement actions through the court: one in the UK for infringement of 'bubble' imagery and one in Europe for infringement of 'O2'. The aim of O2 is to keep the 'O2' brand fresh, with fewer, better services, all designed to enhance the customer experience. O2 is investing in platform and people to achieve this.

Whether these assets are fixed or current they always require expenditure towards their evolutions. Fig 4.18 provides a cost analysis of O2 expenditures on fixed and current assets.

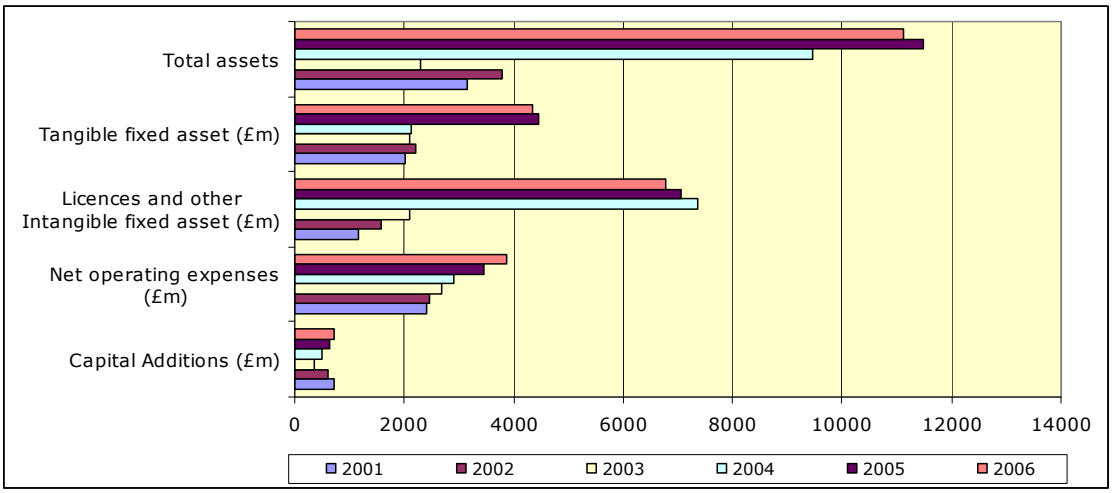


Figure 4-18: Cost analysis of O2 expenditures
(Source: Information based on O2 Annual Reports)

4.2.1.15 The presentation of the evolutionary framework of the O2 LBS

This section will present the application of the first stage of the DTC model for the third time. This application can further enhance the validity of the first stage of the DTC model.

4.2.1.15.1 Evolutionary cycle of the O2 LBS

At the first stage, on the basis of technological capability O2 decided to launch its first commercial application, Traffic 1200. In accordance with the EC regulatory demands, O2 offered a variety of LBS to the mass market. This variation in services offered by O2 became possible due to the reconfiguration of LBS with the tangible asset of O2, the GSM network, and configuration of authentication services, geographic mapping, address finding

services and user preference profiling. The reconfiguration of GSM network, cell-id and contents made O2 capable of offering services to locate ATMs and cinemas initially. O2 managed this evolution by signing a deal with Webraska for its Smartzone platform and consultancy services and by obtaining hardware from RedKnee. Soon after achieving these capabilities, O2 offered variations in its fixed monthly premium via its 'O2 Home' application. The result of this stage identified changes required in infrastructure, applications and partnership deals which were required to develop new LBS for customers. It also identified the need to enhance the pool of partners through new alliances and collaborations to enrich the experience of customers with new offers.

During the second stage, just after the launch of LBS, Orange identified the need of future deals with niche application providers. O2 selected a variety of these providers including Justfone and ChildLocate. Along with this selection, O2 focused on the search of killer application. O2 selected its strategy of segmented approach to offer consumers and business customers different types of applications. O2 performed a survey to identify the customers' demands. With this information, O2 offered bundling applications to consumers and M2M applications to business customers. O2 offered its own applications to customers but also selected appropriate partners and allowed them to offer their services through O2's network infrastructure. O2 worked with Mobile Commerce in order to achieve these tasks. This stage helped in converging focus towards segmented strategy. At the same time it allowed external players to become part of the O2 LBS value chain.

During the third stage, O2 leveraged its GPRS infrastructure to offer M2M applications more conveniently. O2 also leveraged its bundling strategy to offer consumers' LBS under the already developed 'Revolution' channel and 'O2 Active' portal. The 'Revolution' was leveraged to offer CITYNeo map services and 'O2 Active' was leveraged to offer DealFinder and BusinessFinder services. O2 replicated its Advance Partner programme, which was launched for Direct Investors (DI), to properly manage the LBS partners. O2 continued to allow third party developers to leverage O2 infrastructure for launching their services. The results of increased partnerships made it possible for O2 to leverage LBS in distinct market segments. At the end of this stage O2 identified the feasible infrastructure, market segments, portal, partners, and partnership programs for LBS.

Up to the fourth stage, O2 has managed to commercialize multiple LBS, some under the 'O2 Active' portal and some individually. Because of the need of more accurate technologies, O2 integrated the 3G infrastructure with 'O2 Active' portal. This integration has also been complemented with the integration of 2.5G/3G network infrastructure to offer services in the areas where 3G coverage was not available. O2 also integrated Emap contents. The numbers of LBS also enhanced the numbers of suppliers and third party developers. Some of them were new and some were old. The relationship with old suppliers and developers were retained however new suppliers and developers were integrated into the LBS value chain. Mobile Commerce as an old supplier, integrated its StoreFinder application with 'O2 Active'. O2 offered a new service i-mode which also integrated with m-spatial MapWay Local Search, maps and direction services. These applications were supported by LSDE technology provided by mSpatial. Along with this, O2 integrated mobile version of the old application, the Streetmap. O2 offered these services to customers through its different channels.

By the end of the first evolutionary cycle O2 has managed to establish several new resources based on old and new technological and organisational evolutions. The developed technological and organisational assets have strong linkages with each other and caused the evolution of one with respect to other. The specific combination of these assets also created the resources for the second evolutionary cycle. For its second cycle, O2 allowed the resources of the satellite industry to be integrated with the resources of the mobile industry, to increase the efficiency of LBS. O2 developed its new range of handsets which integrated GPS chip and offered SatNav applications. The integration of GPS technology also caused variation at the start of second evolutionary cycle. All the evolutions performed by O2 related to LBS are shown in figure 4.19.

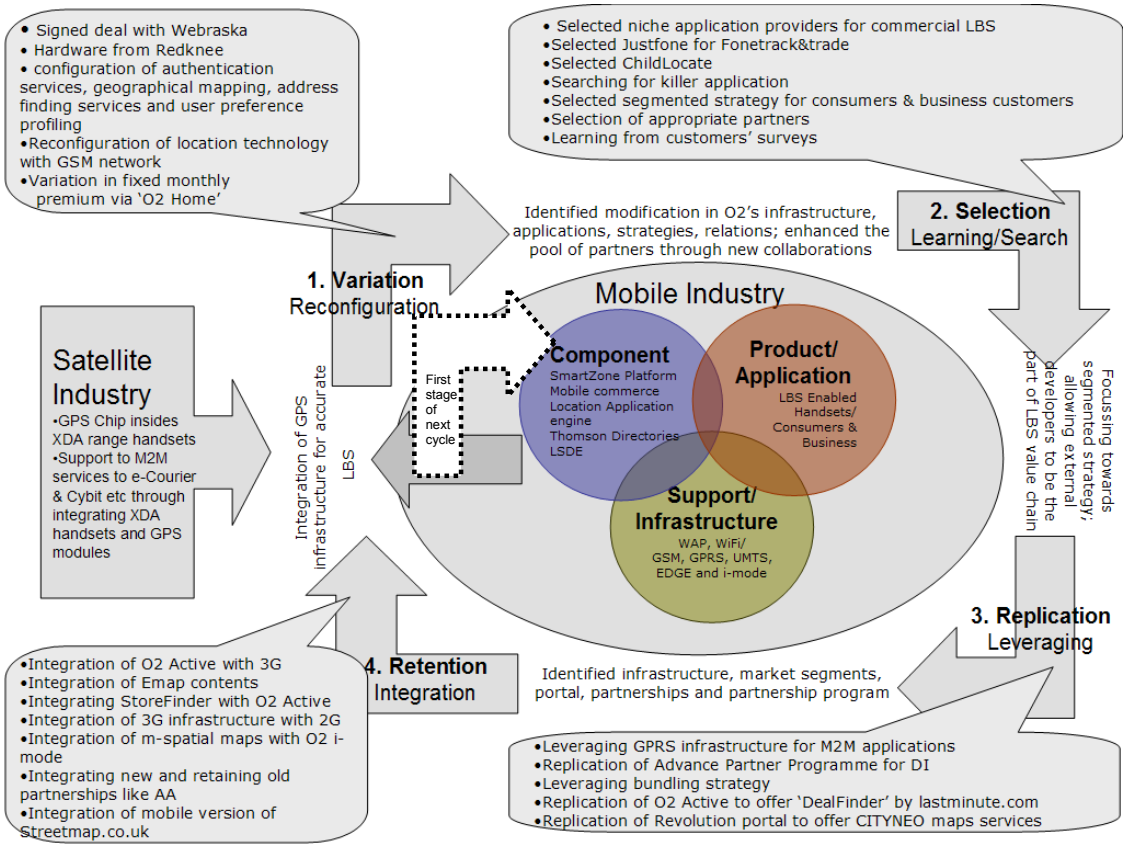


Figure 4-19: The evolutionary cycle of the O2 LBS

4.2.2 The influence of drivers on Vodafone, Orange and O2, UK

The detailed studies of three cases have identified the evolutions of all technological and organisational capabilities related to LBS. As mentioned earlier these cases represent 60% of the UK mobile industry. Therefore, discussed evolutions can be assumed valid for the entire UK mobile industry. These mobile operators are facing the dilemma regarding the A-GPS investment. They are facing influences from the satellite industry under the influence of four drivers. These drivers have been discussed in chapter two in detail. The following section discusses the influences of these drivers on all three cases. Fig 4.20 shows the influence of these drivers on the first stage of the DTC model of these mobile operators.

4.2.2.1 Cost of technology

During the first evolutionary cycle the mobile operators invested in components such as Location Server and platforms from different technology suppliers. In future, for A-GPS technology, they need to invest in the A-GPS server. Apart from component technology, the

handsets also require huge investments from these mobile operators. As far as investment in 3G mobile network infrastructure is concerned, which is already going on for other types of applications, can be replicated for LBS and can be considered in terms of cost benefits. To make any application successful in the market, it is essential to have a strong marketing campaign behind this application. At present, the mobile operators are less focused towards LBS. These services are part of their portals therefore they have launched these services without any marketing campaign or advertisement. In order to make the launch of A-GPS a success, the mobile operators need to face costs for marketing capabilities.

4.2.2.2 Accuracy and quality of technology

At present the mobile operators are offering Cell-ID and Enhanced Cell-ID based LBS to provide 50m to 50km accuracy. This accuracy level can reach 5m with evolution towards the A-GPS technology. But before selecting the A-GPS technology, these mobile operators are measuring the market demand for current LBS. So far the market had not shown any promising growth. This poor increase in growth is also the result of less accurate applications. It is assumed that selection of the A-GPS technology will increase the LBS accuracy and will also lead to increasing the satisfactory level of consumers and will increase the chances of returns on the A-GPS investments. Once the A-GPS technology is selected by the mobile operators, it will bring in more advanced components and knowledge of these technological resources. Having the core capability inside these organisations can increase the future prospect of offering more advanced and accurate applications.

4.2.2.3 Market demand for technology

According to the mobile operators, LBS was launched because of the technological capabilities and therefore appears to create the consumer demand. The capability of the Cell-ID technology to pinpoint the mobile users became a reason behind the emergence of LBS in the market. To make LBS a success, however, the consumers' demand needed to be created. The mobile operators identified the lack of initiatives in creating such demand. The segmented approach of the mobile operators offered individual applications for consumers and business customers but these applications could not reach the required threshold levels. In short, none of the applied applications proved to be the killer application and therefore showed very small revenue growth.

In order to create such demand, the mobile operators allowed third party application developers to develop their own applications and use their infrastructure. The third party developers are providing LBS by using the network of the mobile operators with their own products. The mobile operators need to monitor the third party developments in order to capture the market demand. As a part of the mobile industry, these mobile operators also keep track of their competitors. The initiative from anyone might help others in deciding to invest in the A-GPS technology.

The mobile operators need to offer more accurate and quality applications to capture consumers' interests. It is known that the A-GPS technology with increased level of accuracy will boost the performance of LBS and might increase the market demand. The increased level of accuracy will allow the mobile operators to capture new market segments like providing exact locations to police and ambulances in emergency conditions. The new market segments will also increase networking possibilities of internal and external industry partners.

4.2.2.4 Self and governmental regulations

Due to the convergence nature of LBS the standards are developed by Location Interoperability Forum (LIF) and 3G Partnership Program (3GPP). The LIF is a group of vendors and interested parties which are network and location determination technology independent. They develop and promote ubiquitous solutions for LBS. The 3GPP mainly defines the addition of LBS capabilities in releases of 3G networks. Apart from defining standards some technologies are being forced to be selected by organisations. As discussed one of the reasons behind the emergence of LBS in the mobile market is the governmental influence in the form of 'DIRECTIVE 2002/22/EC'. Because of this regulation, the mobile operators provided LBS through the cell-id technology. As the directive did not specify the accuracy level, the mobile operators are hesitating in investing in the A-GPS technology. If OFCOM defines a mandatory level of accuracy for the LBS applications, the decision of investment by the mobile operators will become easy to make. In terms of self regulation, the mobile operators follow the Code of best practices for passive LBS. This code helps avoids the customers' fear of being located without their consent.

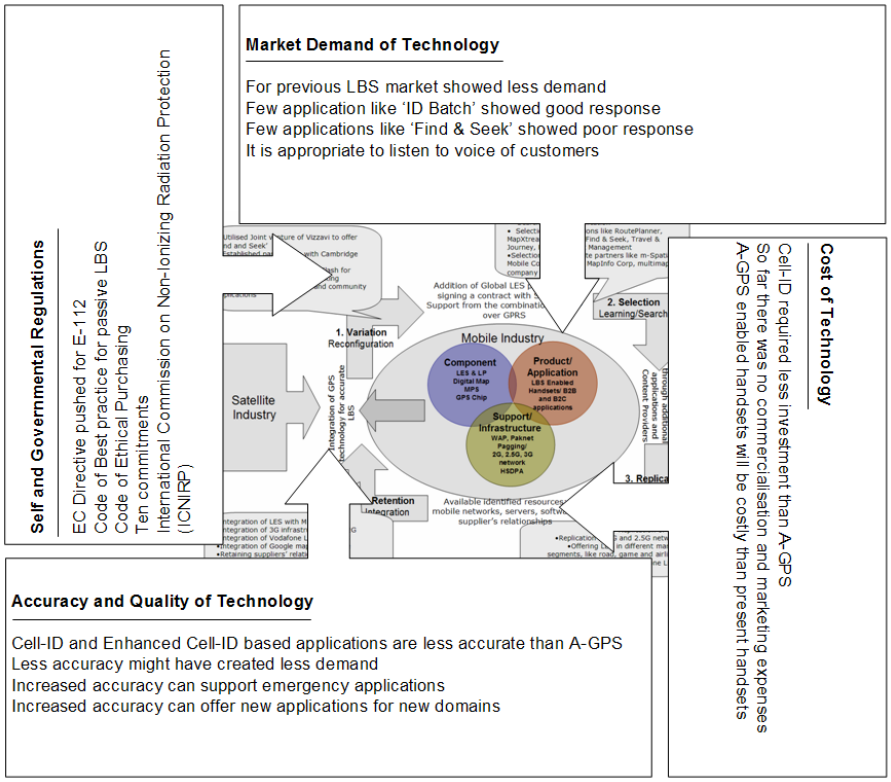


Figure 4-20: Influence of drivers

4.3 The second stage of the DTC model

The evolutions discussed so far, under the influences of drivers, will now need evaluation of the BOCR merits in order to select the less risky strategic alternative which helps these organisations in making the investment decision in the A-GPS technology.

4.3.1 Evaluation of the BOCR merits for Vodafone, Orange and O2, UK

The evaluation of the BOCR merits depends upon the 52 factors which are discussed already in chapter 3. The following section presents weights and priorities of these factors. Weights have been assigned by the managers and technologists of these three mobile operators during individually conducted workshops. The section will first provide the weights of factors assigned by Vodafone followed by Orange and O2 and their relative measured priorities. The priorities will then be calculated with the help of ANP to identify the most feasible alternative (A1, A2, A3) for these mobile operators.

The reason behind selecting the ANP tool is to utilise its loop capabilities to measure the influences of technological evolutions, organisational evolutions and resource evolutions clusters on each other. Their influences will identify the importance of individual factors for each other. At the same time, this will also prove the concept of this research work of the dynamic technological capabilities (DTC) which is defined as 'a capacity of technology to create, extend or modify the resource bases of organisations'. These weights are assigned to three alternatives by keeping in mind the importance of individual factors and their relative influence on each other. After assigning these weights, the calculations are performed with the help of Super Decision software.

4.3.1.1 Vodafone BOCR evaluations

For the Vodafone case study table 4.26 shows weights and table 4.27 shows priorities. The priorities are then analyzed to identify the most influential factor and the less risky investment decision.

Table 4-26: Weights assigned by the Vodafone managers and technologists

BOCR	Drivers	Clusters	Factors in clusters	A1/A2	A1/A3	A2/A3
Benefits	Accuracy and Quality of Technology	Technological evolutions	TE1. Integration of new network components for future availability	2	4	2
			TE2. Integration of old applications over new infrastructure	1	1/6	1/6
		Resource evolutions	RE1. Integration of new knowledge of latest technology	1/4	1	4
			RE2. Availability for future developments of new and emerging applications	1	2	2
		Organisational evolutions	OE1. Reconfiguration of network rollout	1/2	1/2	1
			OE2. Integration of new terminal developments	1	1	1
	Market Demand for Technology	Technological evolutions	TE1. Support to emergency applications	1/2	3	6
			TE2. Drive demand for new services – early adopter syndrome	2	2	1
		Organisational evolutions	OE1. External industry partnerships	1	3	3
			OE2. Internal industry partnerships	1/2	2	4
			OE3. Capturing and expanding towards new market segments	3	6	2
			OE4. Retention of suppliers of technology	1/3	1	3
			OE5. Assistance to Government: police and ambulance services	1/2	2	4

	Cost of Technology	Technological evolutions	TE1. Replication of existing infrastructure	1/2	2	4
			TE2. Integration of different infrastructures whenever accurate is not available	1/2	2	4
			TE3. Consolidate and maximum use of assets	1/4	2	8
	Self and Government Regulations	Technological evolutions	TE1. No push from OFCOM	1/6	1/2	3
			TE2. Influence of operators on technology co-evolution decision	1/4	1	4
		Organisational evolutions	OE1. Leveraging of code of ethical purchase	1/2	1	2
			OE2. Leveraging of code of best practice for passive LBS	1/2	1	2
			OE3. Leveraging of responsible network deployment policy	1/2	1	2
Opportunities	Accuracy and Quality of Technology	Resource evolutions	RE1. Expectation from Galileo for improved accuracy	1/2	3	6
			RE2. Developing easy to use application interfaces for future applications	1/4	1	4
			RE3. Availability of core capabilities within organisation	2	2	1
		Organisational evolutions	OE1. Keeping track of exogenous industry resources	1/2	4	8
	Market Demand for Technology	Technological evolutions	TE1. New applications for new customers	1/4	1	4
			TE2. Retention of customers through offering multiple applications	1/2	2	4
			TE3. Retention of successful applications	1/2	2	4
		Organisational evolutions	OE1. Variations in R&D for service and application developments	1	1/2	1/2
			OE2. Need of highly customer focused management for niche applications	1/4	1	4
			OE3. Learning from International market stories	1/2	2	4
			OE4. Learning from customers' experiences	1/3	2	6
	Cost of Technology	Technological evolutions	TE1. Expected reductions in handsets cost	1/4	2	8
			TE2. Expected reductions in mapping data, services and additional cost	1/2	2	4
			TE3. Expected revenue from new applications	1/2	2	4
Costs	Market Demand for Technology	Organisational evolutions	OE1. Price associated with marketing of new applications for customers' awareness	3	6	2
			OE2. Strategy focused towards future investments in LBS	1/8	1/2	4

	Cost of Technology	Technological evolutions	TE1. Price associated with LBS enabled handsets	1/3	1	3
			TE2. Price associated with Infrastructure	1/2	1/8	1/4
			TE3. Price associated with components	1/2	1/8	1/4
			TE4. Price associated with new licences from external technology developers	1	1/2	1/2
Risks	Market Demand for Technology	Technological evolutions	TE1. Less market growth of available applications	1/2	1/8	1/4
			TE2. No visible killer application	1/2	1/8	1/4
		Organisational evolutions	OE1. Low revenue growth from available applications	1	1/4	1/2
			OE2. Keeping track of competitor's applications	1/6	1/2	3
			OE3. New entrants changing market dynamics	1/6	1/2	3
	Self and Government Regulations	Technological evolutions	TE1. Unavailability of GPS signals	1/3	1/6	1/2
			TE2. Monitoring integrity and upgrading of digital maps	1/2	2	4
		Organisational evolutions	OE1. OFCOM insistence for highly accurate technology	1/3	2	6
			OE2. Satisfying customers' doubts about their privacy	1	1/3	1/3
			OE3. Measuring quality of exogenous and third party technological resources	1/2	2	4
			OE4. Satisfying media doubts	1/2	1/2	1

Table 4-27: Drivers, clusters and their factors with priorities by Vodafone

vodafone BOCR	Drivers	Clusters	Elements in clusters	Normalized Priorities	Limiting Priorities
Benefits (0.25)	Accuracy and Quality of Technology (0.15372)	Alternatives	Invest now in the technological co-evolutions	0.28995	0.130476
			Wait until exogenous technological co-evolutions become commodity	0.41848	0.188318
			Do not invest in technological co-evolutions	0.29157	0.31206
		Technological evolutions	Integration of new component technologies for future availability	0.47858	0.071787
			Integration of old applications over new infrastructure	0.52142	0.078213
		Resource evolutions	Integration of new knowledge of latest technology	0.49979	0.099959
			Availability for future developments of new and emerging applications	0.50021	0.100041
		Organisational evolutions	Reconfiguration of network rollout	0.36749	0.073498
			Integration of new terminal developments	0.63251	0.126502

	Market Demand for Technology (0.30445)	Alternatives	Invest now in the technological co-evolutions	0.41076	0.125926
			Wait until exogenous technological co-evolutions become commodity	0.45419	0.139240
			Do not invest in technological co-evolutions	0.13506	0.041405
		Technological evolutions	Support to emergency applications	0.30245	0.76643
			Drive demand for new services – early adopter syndrome	0.69755	0.176767
		Organisational evolutions	External industry partnerships	0.13589	0.059795
			Internal industry partnerships	0.136338	0.060011
			Capturing and expanding towards new market segments	0.40430	0.177899
			Retention of suppliers of technology	0.04509	0.019839
			Assistance to Government: police and ambulance services	0.27834	0.122474
	Cost of Technology (0.3881)	Alternatives	Invest now in the technological co-evolutions	0.26207	0.087355
			Wait until exogenous technological co-evolutions become commodity	0.60690	0.202301
			Do not invest in technological co-evolutions	0.13101	0.043677
		Technological evolutions	Replication of existing infrastructure	0.38914	0.259424
			Integration of different infrastructures whenever accurate is not available	0.38324	0.255490
			Consolidate and maximum use of assets	0.27763	0.151752
	Self and Government Regulations (0.15372)	Alternatives	Invest now in the technological co-evolutions	0.19444	0.097222
			Wait until exogenous technological co-evolutions become commodity	0.58333	0.291667
			Do not invest in technological co-evolutions	0.2222	0.11111
		Technological evolutions	No push from OFCOM	0.5	0.125
			Influence of operators on technology co-evolution decision	0.5	0.125
		Organisational evolutions	Leveraging of code of ethical purchase	0.3333	0.08333
			Leveraging of code of best practice	0.3333	0.08333
			Leveraging of responsible network deployment policy	0.3333	0.08333
Opportu-nities (0.25)	Accuracy and Quality of Technology (0.19973)	Alternatives	Invest now in the technological co-evolutions	0.31035	0.111291
			Wait until exogenous technological co-evolutions become commodity	0.57667	0.206791
			Do not invest in technological co-evolutions	0.11298	0.040516
		Resource evolutions	Expectation from Galileo for improved accuracy	0.77262	0.257540

			Developing easy to use application interfaces for future applications	0.11369	0.037897
			Availability of core capabilities within organisation	0.11369	0.037897
		Organisational evolutions	Keeping track of exogenous industry resources	1	0.308069
	Market Demand for Technology (0.29763)	Alternatives	Invest now in the technological co-evolutions	0.23227	0.080147
			Wait until exogenous technological co-evolutions become commodity	0.58040	0.200278
			Do not invest in technological co-evolutions	0.18733	0.064641
		Technological evolutions	New applications for new customers	0.44018	0.135546
			Retention of customers through offering multiple applications	0.31383	0.096639
			Retention of successful applications	0.24598	0.075745
		Organisational evolutions	Variations in R&D for service and application developments	0.25308	0.084359
			Need of highly customer focused management for niche applications	0.22214	0.074047
			Learning from International market stories	0.10559	0.035198
			Learning from customers' experiences	0.41919	0.139729
	Cost of Technology (0.50264)	Alternatives	Invest now in the technological co-evolutions	0.23339	0.116694
			Wait until exogenous technological co-evolutions become commodity	0.64992	0.324959
			Do not invest in technological co-evolutions	0.11669	0.058347
		Technological evolutions	Expected reductions in handsets cost	0.50363	0.251817
			Expected reductions in mapping data, services and additional cost	0.17842	0.089211
			Expected revenue from new applications	0.31794	0.158972
Costs (0.25)	Market Demand for Technology (0.25)	Alternatives	Invest now in the technological co-evolutions	0.37879	0.126263
			Wait until exogenous technological co-evolutions become commodity	0.47475	0.158249
			Do not invest in technological co-evolutions	0.14647	0.048822
		Organisational evolutions	Price associated with marketing of new applications for customers' awareness	0.5	0.3333
			Strategy focused towards future investments in LBS	0.5	0.3333
	Cost of Technology (0.75)	Alternatives	Invest now in the technological co-evolutions	0.15064	0.066652
			Wait until exogenous technological co-evolutions become commodity	0.26655	0.117934

			Do not invest in technological co-evolutions	0.58281	0.257866
		Technological evolutions	Price associated with LBS enabled handsets	0.24817	0.138366
			Price associated with infrastructure	0.42245	0.235535
			Price associated with components	0.16469	0.091823
			Price associated with new licences from external technology developers	0.16469	0.091823
Risks (0.25)	Market Demand for Technology (0.333)	Alternatives	Invest now in the technological co-evolutions	0.11655	0.047989
			Wait until exogenous technological co-evolutions become commodity	0.33464	0.137783
			Do not invest in technological co-evolutions	0.54880	0.225961
		Technological evolutions	Less market growth of available applications	0.60960	0.178658
			No visible killer application	0.39040	0.114415
		Organisational evolutions	Low revenue growth from available applications	0.59084	0.174413
			Keeping track of competitor's applications	0.25150	0.074241
			New entrants changing market dynamics	0.15766	0.046541
	Self and Government Regulations (0.667)	Alternatives	Invest now in the technological co-evolutions	0.21905	0.00977
			Wait until exogenous technological co-evolutions become commodity	0.47429	0.196984
			Do not invest in technological co-evolutions	0.30666	0.127366
		Technological evolutions	Unavailability of GPS signals	0.28723	0.079835
			Monitoring integrity and upgrading of digital maps	0.712777	0.198117
		Organisational evolutions	OFCOM insistence for highly accurate technology	0.29215	0.089608
			Satisfying customers' doubts about privacy	0.12476	0.038268
			Measuring quality of exogenous and third party technological resources	0.45832	0.140577
			Satisfying media doubts	0.12476	0.198117

4.3.1.2 Vodafone BOCR analysis

The following section shows an analysis of priorities achieved through the exercise of assigning weight by the managers and technologists of Vodafone. These priorities help in identifying those factors which have adequate influences on strategic alternatives. These influential factors are presented here with their priorities:

- Availability for future developments of new and emerging applications (0.100041)
- Integration of new terminal developments (0.126502)
- Drive demand for new services – early adopter syndrome (0.176767)
- Capturing and expanding towards new market segments (0.177899)
- Assistance to government: Police and ambulance services (0.122474)
- Replication of existing infrastructure (0.259424)
- Integration of different infrastructures whenever accurate is not available (0.255490)
- Consolidate and maximum use of assets (0.151752)
- No push from OFCOM (0.125)
- Influence of mobile operators on technology co-evolution decision (0.125)
- Expectation from Galileo for improved accuracy (0.257540)
- Keeping track of exogenous industry resources (0.308069)
- New applications for new customers (0.135958)
- Learning from customers' experiences (0.139729)
- Expected reduction in handset costs (0.251817)
- Expected revenue from new applications (0.158972)
- Price associated with marketing of new applications for customers' awareness (0.3333)
- Strategy focused towards future investments in LBS (0.3333)
- Price associated with LBS enabled handsets (0.138366)
- Price associated with infrastructure (0.235535)
- Less market growth of available applications (0.178658)
- No killer application (0.114415)
- Low revenue growth from available application (0.174413)
- Monitoring integrity and upgrading of digital maps (0.198117)
- Measuring quality of exogenous and third party technological resources (0.140577)

From all the discussed 52 factors, 25 factors are showing a constructive influence on the Vodafone decision. In order to analyse the investment decision, tables 4.28a and 4.28b are showing the limiting priorities and ranks of the strategic alternatives. The synthesized priorities for the BOCR merits are shown graphically in table 4.29.

Table 4-28a: Limiting priorities for the strategic alternatives with respect to drivers

Alternatives	Benefits (0.25)				Opportunities (0.25)			Costs (0.25)		Risks (0.25)	
	Accur (0.15)	Mark (0.29)	Costs (0.41)	Reg (0.15)	Accur (0.167)	Mark (0.333)	Cost (0.50)	Cost (0.80)	Mark (0.20)	Mark (0.25)	Reg (0.75)
A1	0.1305	0.1259	0.0871	0.0972	0.1113	0.0801	0.1167	0.0667	0.1263	0.0480	0.0910
A2	0.1883	0.1392	0.2023	0.2917	0.2068	0.2003	0.3250	0.1179	0.1582	0.1378	0.1970
A3	0.1312	0.0414	0.0437	0.1111	0.0405	0.0646	0.0583	0.2579	0.0488	0.2260	0.1274

Table 4-28b: Ranking of priorities for the strategic alternatives with respect to drivers

Alternatives	Benefits (0.25)				Opportunities (0.25)			Costs (0.25)		Risks (0.25)	
	Accur (0.15)	Mark (0.29)	Costs (0.41)	Reg (0.15)	Accur (0.167)	Mark (0.333)	Cost (0.50)	Cost (0.80)	Mark (0.20)	Mark (0.25)	Reg (0.75)
A1	3	2	2	3	2	2	2	3	2	3	3
A2	1	1	1	1	1	1	1	2	1	2	1
A3	2	3	3	2	3	3	3	1	3	1	2

The calculations for three alternatives are performed in table 4.30. In order to validate the answer two different calculations are performed. The first calculation multiplies benefits with opportunities and divides them by costs and risks (BO/CR). This operation is performed by the software. The second calculation multiplies the cluster values to each merit (b = 0.25; o = 0.25; c = 0.25; r = 0.25) and than add benefits and opportunities together and subtracts costs and risks (bB+oO-cC-rR) from them. This operation is performed by the author. The calculation presents the most wanted decision of Vodafone which supports A2. The results identified that A2 (0.1329) should be taken under consideration first, followed by A1 (0.0567) and A3 (-0.2588). In general, the higher the priority of alternative, the lower the risk that investment will cause harmful impacts for Vodafone. The results say that it is feasible to wait until the A-GPS technology becomes commodity, and Galileo is to be launched. This decision also favours a factor ‘strategies focused towards future investment in LBS’ which has been identified as a major concern of Vodafone with the highest priority (0.333), followed by ‘Price associated with marketing of new applications for customers’ awareness (0.3333)’ and ‘Expected reduction in handset costs (0.251817)’. This result is also consistent with the Vodafone strategic objective. The strategy of Vodafone “Reduce costs and stimulate revenue in Europe” causes Vodafone to wait until the cost of handsets reduces and the market starts showing some recognition. Another strategy “Actively manage our portfolio to maximise return” also caused Vodafone

to make LBS a part of Vodafone Live! so bundle of services may effectively produce good returns on investments.

Table 4-29: Graphical representation of the strategic alternatives

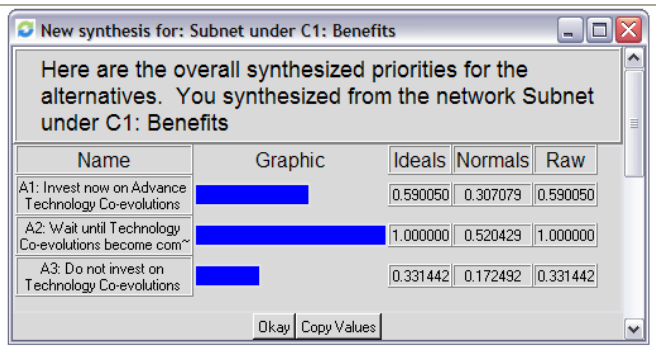
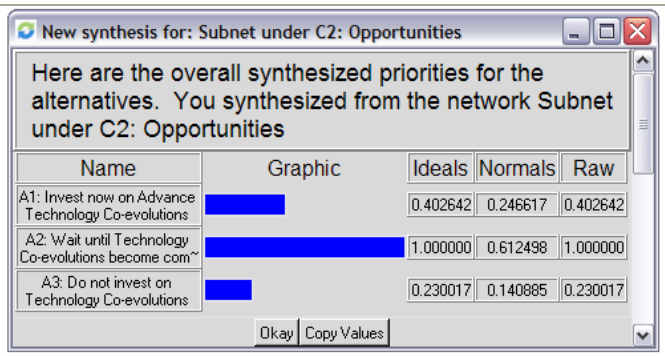
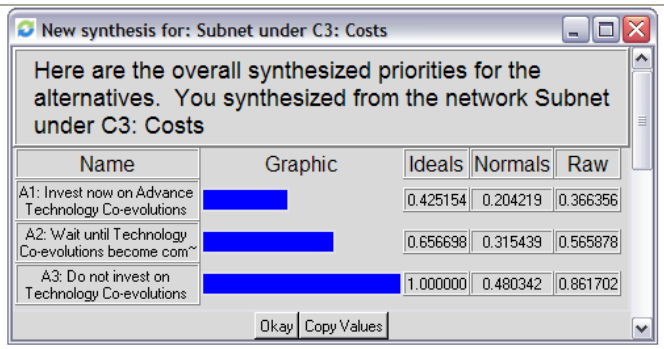
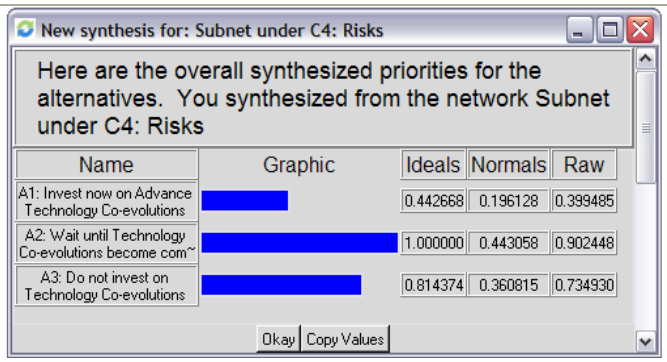
Benefits A2 is the best option with respect to benefits.	
Opportunities A2 is the best option with respect to opportunities	
Costs A3 is the best options with respect to costs	
Risks A2 is the best option with respect to risks	

Table 4-30: Limiting priorities for the strategic alternatives under the BOCR merits

Alternatives	Benefits	Opport-unities	Costs	Risks	BO/CR	bB+oO-cC-rR	Ranks
A1: Invest now in technological co-evolutions	0.59	0.4026	0.3664	0.3995	1.6228	0.0567	2
A2: Wait until technological co-evolutions become commodity	1	1	0.5659	0.9024	1.9582	0.1329	1
A3: Do not invest in technological co-evolutions	0.3314	0.23	0.8617	0.7349	0.1204	-0.2588	3

This result is also consistent with the fact that once the technological co-evolutions become commodity and Galileo is commercially launched, there will be a single investment required in terms of component and infrastructure technology. As Vodafone is 'keeping track of exogenous industry resources (0.308069)' and possesses some 'expectations from Galileo for improved accuracy (0.257540)', its reason for wait strategy fits well within its strategic objectives. As Vodafone is to wait for the launch of Galileo, it will not invest separately in the A-GPS and then in the A-GNSS technology. In order to remain competitive, however, Vodafone needs to monitor continuously the growth of its competitors and new entrants related to LBS. The graphical representation of results for all alternatives is given in figure 4.21 and 4.22 below.

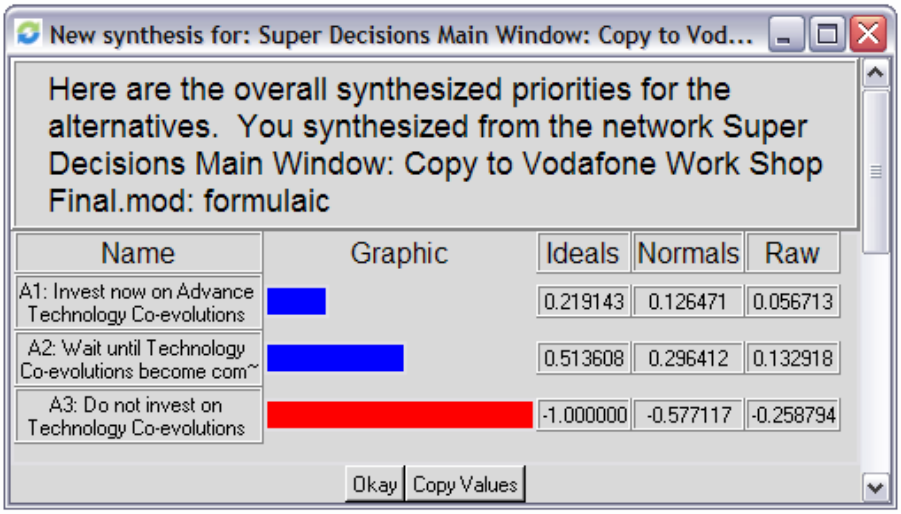


Figure 4-21: Synthesised priorities for alternatives decisions by Vodafone

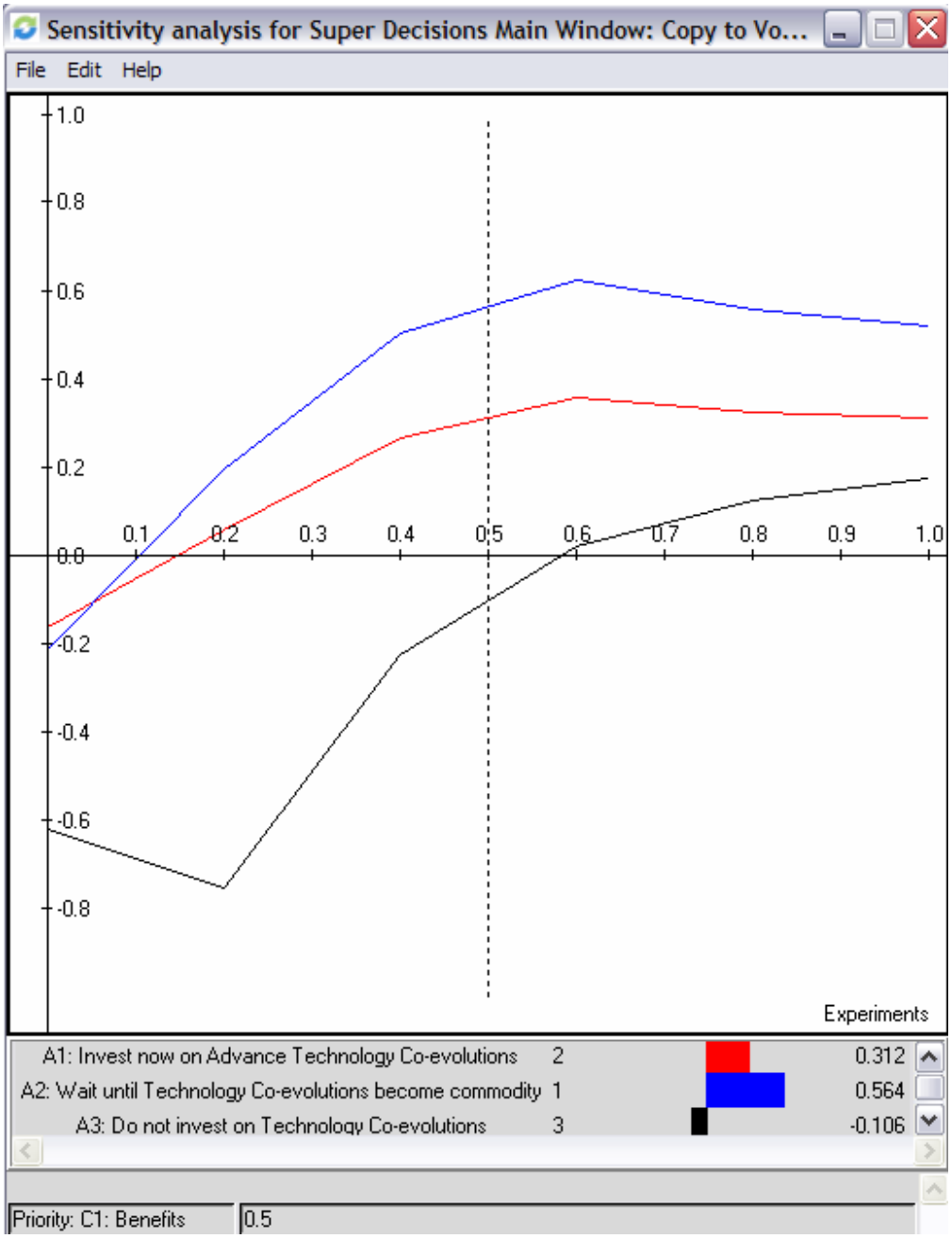


Figure 4-22: Sensitivity analysis for alternative decisions by Vodafone

4.3.1.3 Orange BOCR evaluations

For the Orange case study table 4.31 shows weights and table 4.32 shows priorities. The priorities are then analyzed to identify the most influential factor and the less risky investment decision.

Table 4-31: Weights assigned by the Orange managers and technologists

BOCR	Drivers	Clusters	Factors in clusters	A1/A2	A1/A3	A2/A3
Benefits	Accuracy and Quality of Technology	Technological evolutions	TE1. Integration of new network components for future availability	4	8	2
			TE2. Integration of old applications over new infrastructure	3	6	2
		Resource evolutions	RE1. Integration of new knowledge of latest technology	4	8	2
			RE2. Availability for future developments of new and emerging applications	2	4	2
		Organisational evolutions	OE1. Reconfiguration of network rollout	1	1	1
			OE2. Integration of new terminal developments	1	1	1
	Market Demand for Technology	Technological evolutions	TE1. Support to emergency applications	1/3	2	6
			TE2. Drive demand for new services – early adopter syndrome	4	8	2
		Organisational evolutions	OE1. External industry partnerships	4	8	2
			OE2. Internal industry partnerships	2	4	2
			OE3. Capturing and expanding towards new market segments	3	6	2
			OE4. Retention of suppliers of technology	1	1	1
			OE5. Assistance to Government: police and ambulance services	1/4	1/2	2
	Cost of Technology	Technological evolutions	TE1. Replication of existing infrastructure	3	6	2
			TE2. Integration of different infrastructures whenever accurate is not available	4	8	2
			TE3. Consolidate and maximum use of assets	4	8	2
	Self and Government Regulations	Technological evolutions	TE1. No push from OFCOM	1/4	1/2	2
			TE2. Influence of operators on technology co-evolution decision	4	4	1
		Organisational evolutions	OE1. Leveraging of code of ethical purchase	1	1	1
			OE2. Leveraging of code of best practice for passive LBS	1	1	1
			OE3. Leveraging of responsible network deployment policy	1	1	1

Opportunities	Accuracy and Quality of Technology	Resource evolutions	RE1. Expectation from Galileo for improved accuracy	1/3	2	6
			RE2. Developing easy to use application interfaces for future applications	2	4	2
			RE3. Availability of core capabilities within organisation	4	8	2
		Organisational evolutions	OE1. Keeping track of exogenous industry resources	2	4	2
	Market Demand for Technology	Technological evolutions	TE1. New applications for new customers	4	8	2
			TE2. Retention of customers through offering multiple applications	3	6	2
			TE3. Retention of successful applications	4	8	2
		Organisational evolutions	OE1. Variations in R&D for service and application developments	3	6	2
			OE2. Need of highly customer focused management for niche applications	4	8	2
			OE3. Learning from International market stories	3	6	2
			OE4. Learning from customers' experiences	4	8	2
	Cost of Technology	Technological evolutions	TE1. Expected reductions in handsets cost	1/4	1	4
			TE2. Expected reductions in mapping data, services and additional cost	1/4	1	4
			TE3. Expected revenue from new applications	6	9	1.5
Costs	Market Demand for Technology	Organisational evolutions	OE1. Price associated with marketing of new applications for customers' awareness	1/2	1	2
			OE2. Strategy focused towards future investments in LBS	4	8	2
	Cost of Technology	Technological evolutions	TE1. Price associated with LBS enabled handsets	1/6	1/6	1
			TE2. Price associated with Infrastructure	3	6	2
			TE3. Price associated with components	3	6	2
			TE4. Price associated with new licences from external technology developers	2	3	2
Risks	Market Demand for Technology	Technological evolutions	TE1. Less market growth of available applications	1/4	1	4
			TE2. No visible killer application	1/4	2	8
		Organisational evolutions	OE1. Low revenue growth from available applications	1/3	3	9
			OE2. Keeping track of competitor's applications	6	12	2
			OE3. New entrants changing market dynamics	6	12	2

	Self and Government Regulations	Technological evolutions	TE1. Unavailability of GPS signals	1/4	1/8	1/2
			TE2. Monitoring integrity and upgrading of digital maps	1/2	2	4
		Organisational evolutions	OE1. OFCOM insistence for highly accurate technology	2	6	3
			OE2. Satisfying customers' doubts about their privacy	1/4	2	8
			OE3. Measuring quality of exogenous and third party technological resources	4	8	2
			OE4. Satisfying media doubts	1/4	2	8

Table 4-32: Drivers, clusters and their factors with priorities by Orange

BOCR	Drivers	Clusters	Elements in clusters	Normalized Priorities	Limiting Priorities
Benefits (0.25)	Accuracy and Quality of Technology (0.25)	Alternatives	Invest now in the technological co-evolutions	0.51419	0.231385
			Wait until exogenous technological co-evolutions become commodity	0.27449	0.123521
			Do not invest in technological co-evolutions	0.21132	0.095094
		Technological evolutions	Integration of new component technologies for future availability	0.5	0.075
			Integration of old applications over new infrastructure	0.5	0.075
		Resource evolutions	Integration of new knowledge of latest technology	0.5	0.1
			Availability for future developments of new and emerging applications	0.5	0.1
		Organisational evolutions	Reconfiguration of network rollout	0.43750	0.0875
			Integration of new terminal developments	0.56250	0.1125
	Market Demand for Technology (0.25)	Alternatives	Invest now in the technological co-evolutions	0.54718	0.167391
			Wait until exogenous technological co-evolutions become commodity	0.31403	0.096066
			Do not invest in technological co-evolutions	0.13879	0.042458
		Technological evolutions	Support to emergency applications	0.30259	0.76479
			Drive demand for new services – early adopter syndrome	0.69741	0.176267
		Organisational evolutions	External industry partnerships	0.16060	0.070878
			Internal industry partnerships	0.12136	0.053562
			Capturing and expanding towards new market segments	0.43627	0.192543
			Retention of suppliers of technology	0.03973	0.017533
			Assistance to Government: police and ambulance services	0.24204	0.106823

	Cost of Technology (0.25)	Alternatives	Invest now in the technological co-evolutions	0.70445	0.234818
			Wait until exogenous technological co-evolutions become commodity	0.19703	0.065677
			Do not invest in technological co-evolutions	0.09852	0.032839
		Technological evolutions	Replication of existing infrastructure	0.37652	0.251012
			Integration of different infrastructures whenever accurate is not available	0.43005	0.286700
			Consolidate and maximum use of assets	0.19343	0.128955
	Self and Government Regulations (0.25)	Alternatives	Invest now in the technological co-evolutions	0.36905	0.184524
			Wait until exogenous technological co-evolutions become commodity	0.35119	0.175595
			Do not invest in technological co-evolutions	0.27976	0.139881
		Technological evolutions	No push from OFCOM	0.5	0.125
			Influence of operators on technology co-evolution decision	0.5	0.125
		Organisational evolutions	Leveraging of code of ethical purchase	0.3333	0.08333
			Leveraging of code of best practice	0.3333	0.08333
			Leveraging of responsible network deployment policy	0.3333	0.08333
Opportu-nities (0.25)	Accuracy and Quality of Technology (0.333)	Alternatives	Invest now in the technological co-evolutions	0.50140	0.186990
			Wait until exogenous technological co-evolutions become commodity	0.37501	0.139855
			Do not invest in technological co-evolutions	0.12359	0.046092
		Resource evolutions	Expectation from Galileo for improved accuracy	0.64357	0.214521
			Developing easy to use application interfaces for future applications	0.13815	0.046049
			Availability of core capabilities within organisation	0.21829	0.072762
		Organisational evolutions	Keeping track of exogenous industry resources	1	0.293729
	Market Demand for Technology (0.333)	Alternatives	Invest now in the technological co-evolutions	0.70831	0.243866
			Wait until exogenous technological co-evolutions become commodity	0.19446	0.066950
			Do not invest in technological co-evolutions	0.09723	0.033475
		Technological evolutions	New applications for new customers	0.44365	0.143021
			Retention of customers through offering multiple applications	0.27174	0.087601
			Retention of successful applications	0.28462	0.091754

		Organisational evolutions	Variations in R&D for service and application developments	0.18620	0.062067
			Need of highly customer focused management for niche applications	0.24280	0.080933
			Learning from International market stories	0.09863	0.032875
			Learning from customers' experiences	0.47237	0.157458
	Cost of Technology (0.333)	Alternatives	Invest now in the technological co-evolutions	0.39960	0.199801
			Wait until exogenous technological co-evolutions become commodity	0.46388	0.231938
			Do not invest in technological co-evolutions	0.13652	0.068261
		Technological evolutions	Expected reductions in handsets cost	0.31091	0.155456
			Expected reductions in mapping data, services and additional cost	0.31091	0.155456
			Expected revenue from new applications	0.37818	0.189088
Costs (0.25)	Market Demand for Technology (0.5)	Alternatives	Invest now in the technological co-evolutions	0.49918	0.166394
			Wait until exogenous technological co-evolutions become commodity	0.33388	0.111293
			Do not invest in technological co-evolutions	0.16694	0.055646
		Organisational evolutions	Price associated with marketing of new applications for customers' awareness	0.47790	0.318603
			Strategy focused towards future investments in LBS	0.52210	0.348063
	Cost of Technology (0.5)	Alternatives	Invest now in the technological co-evolutions	0.55459	0.242942
			Wait until exogenous technological co-evolutions become commodity	0.27361	0.119858
			Do not invest in technological co-evolutions	0.17180	0.075260
		Technological evolutions	Price associated with LBS enabled handsets	0.23646	0.132874
			Price associated with infrastructure	0.37379	0.210045
			Price associated with components	0.20445	0.114886
			Price associated with new licences from external technology developers	0.18531	0.104135
Risks (0.25)	Market Demand for Technology (0.5)	Alternatives	Invest now in the technological co-evolutions	0.36095	0.150668
			Wait until exogenous technological co-evolutions become commodity	0.52691	0.219947
			Do not invest in technological co-evolutions	0.11214	0.046811
		Technological evolutions	Less market growth of available applications	0.57715	0.167452
			No visible killer application	0.42285	0.122685

		Organisational evolutions	Low revenue growth from available applications	0.55686	0.162848
			Keeping track of competitor's applications	0.21585	0.063123
			New entrants changing market dynamics	0.22729	0.066467
	Self and Government Regulations (0.5)	Alternatives	Invest now in the technological co-evolutions	0.31583	0.133847
			Wait until exogenous technological co-evolutions become commodity	0.45041	0.190882
			Do not invest in technological co-evolutions	0.23375	0.099063
		Technological evolutions	Unavailability of GPS signals	0.38085	0.105948
			Monitoring integrity and upgrading of digital maps	0.61915	0.1772242
		Organisational evolutions	OFCOM insistence for highly accurate technology	0.18295	0.054521
			Satisfying customers' doubts about privacy	0.18608	0.055454
			Measuring quality of exogenous and third party technological resources	0.44490	0.132588
			Satisfying media doubts	0.18608	0.055454

4.3.1.4 Orange BOCR analysis

The following section shows an analysis of priorities achieved through the exercise of assigning weight by managers and technologists of Orange. These priorities help in identifying those factors which have adequate influences on their strategic alternatives. These influential factors are presented here with their priorities:

- Integration of new knowledge of latest technology (0.1)
- Availability for future developments of new and emerging applications (0.1)
- Integration of new terminal developments (0.11250)
- Drive demand for new services – early adopter syndrome (0.176267)
- Capturing and expanding towards new market segments (0.192543)
- Assistance to government: Police and ambulance services (0.106823)
- Replication of existing infrastructure (0.251012)
- Integration of different infrastructures whenever accurate is not available (0.2867)
- Consolidate and maximum use of assets (0.128955)
- No push from OFCOM (0.125)
- Influence of mobile operators on technology co-evolution decision (0.125)
- Expectation from Galileo for improved accuracy (0.214521)

- Keeping track of exogenous industry resources (0.293729)
- New applications for new customers (0.143021)
- Learning from customers' experiences (0.157458)
- Expected reduction in handset costs (0.155456)
- Expected reductions in mapping data, services and additional cost (0.155456)
- Expected revenue from new applications (0.189088)
- Price associated with marketing of new applications for customers' awareness (0.318603)
- Strategy focused towards future investments in LBS (0.348063)
- Price associated with LBS enabled handsets (0.132874)
- Price associated with infrastructure (0.210045)
- Price associated with components (0.114886)
- Price associated with new licences from external technology developers (0.104135)
- Less market growth of available applications (0.167452)
- No visible killer application (0.122685)
- Low revenue growth from available applications (0.162848)
- Unavailability of GPS signals (0.105948)
- Monitoring integrity and upgrading of digital maps (0.1772242)
- Measuring quality of exogenous and third party technological resources (0.132588)

From all the discussed 52 factors, 30 factors are showing a constructive influence on the Orange decision. In order to analyse the investment decision, tables 4.33a and 4.33b are showing the limiting priorities and ranks of the strategic alternatives. The synthesized priorities for the BOCR merits are shown graphically in table 4.34.

Table 4-33a: Limiting priorities for the strategic alternatives with respect to drivers

Alternatives	Benefits (0.25)				Opportunities (0.25)			Costs (0.25)		Risks (0.25)	
	Accur (0.25)	Mark (0.25)	Costs (0.25)	Reg (0.25)	Accur (0.333)	Mark (0.333)	Cost (0.333)	Cost (0.50)	Mark (0.50)	Mark (0.25)	Reg (0.75)
A1	0.2314	0.1674	0.2348	0.1845	0.1870	0.2439	0.1998	0.2429	0.1664	0.1507	0.1338
A2	0.1235	0.0961	0.0657	0.1756	0.1399	0.067	0.2319	0.1199	0.1113	0.2199	0.1909
A3	0.0951	0.0425	0.0328	0.1399	0.0461	0.0335	0.0683	0.0753	0.0556	0.0468	0.0991

Table 4-33b: Ranking of priorities for the strategic alternatives with respect to drivers

Alternatives	Benefits (0.25)				Opportunities (0.25)			Costs (0.25)		Risks (0.25)	
	Accur (0.15)	Mark (0.29)	Costs (0.41)	Reg (0.15)	Accur (0.167)	Mark (0.333)	Cost (0.50)	Cost (0.80)	Mark (0.20)	Mark (0.25)	Reg (0.75)
A1	1	1	1	1	1	1	2	1	1	2	2
A2	2	2	2	2	2	2	1	2	2	1	1
A3	3	3	3	3	3	3	3	3	3	3	3

The calculations for three alternatives are performed in table 4.35. Similarly, as with Vodafone, two different calculations are performed: BO/CR and bB+oO-cC-rR. The calculation presents the most wanted decision of Orange which supports A1. The results identified that A1 (0.0652) should be taken under consideration first, followed by A3 (-0.0178) and A2 (-0.0805). The alternative A1 with the higher priority of alternative shows a lower risk of investment for Orange. The results say that it is feasible to invest now in the A-GPS technology. This decision also favours a factor 'strategies focused towards future investment in LBS' which has been identified as a major concern of Orange with the highest priority (0.348063), followed by 'Price associated with marketing of new applications for customers' awareness (0.318603)' and 'Keeping track of exogenous industry resources (0.293729)'. This result is also consistent with the Orange strategic objective. The Orange strategy is founded on a pioneering model of an integrated operator offering its customers a new generation of telecommunication services based upon their NExT program. Being an integrated operator, Orange is willing to allow the technology of exogenous industry to become its technological part so Orange can evolve towards the next generation of technology for its customers.

Table 4-34: Graphical representation of the strategic alternatives

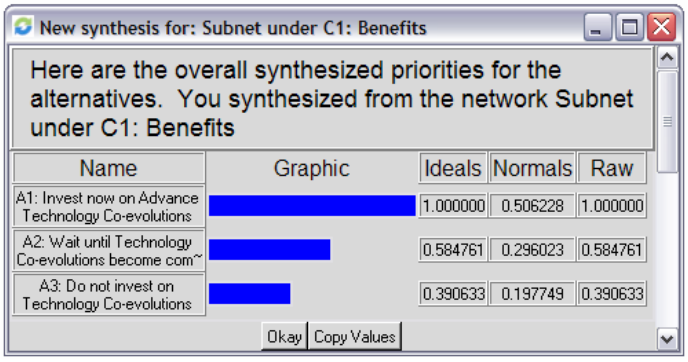
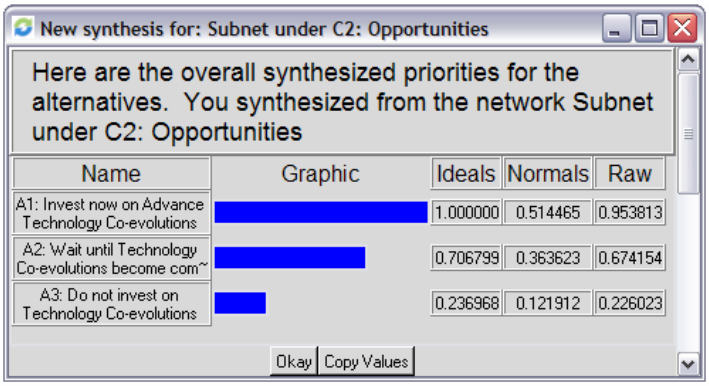
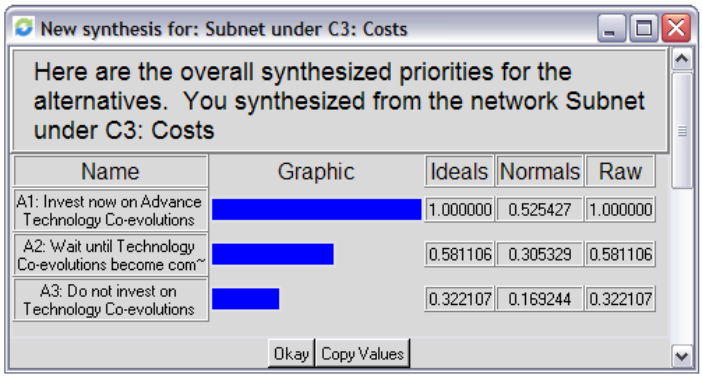
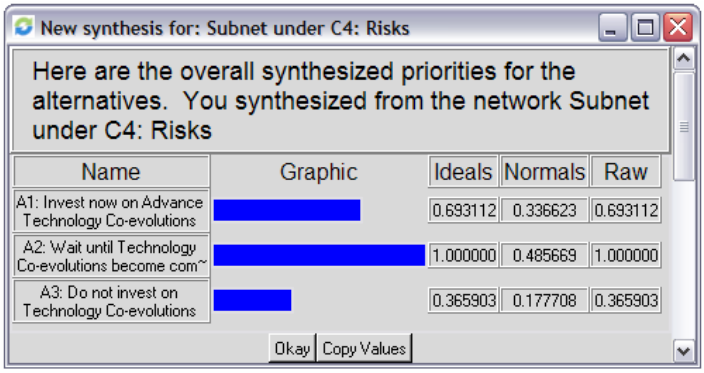
Benefits A1 is the best option with respect to benefits.	
Opportunities A1 is the best option with respect to opportunities	
Costs A1 is the best options with respect to costs	
Risks A2 is the best option with respect to risks	

Table 4-35: Limiting priorities for the strategic alternatives under the BOCR merits

Alternatives	Benefits	Opport-unities	Costs	Risks	BO/CR	bB+oO-cC-rR	Ranks
A1: Invest now in technological co-evolutions	1	0.9538	1	0.6931	1.3761	0.0652	1
A2: Wait until technological co-evolutions become commodity	0.5848	0.6742	0.5811	1	0.6785	-0.0805	3
A3: Do not invest in technological co-evolutions	0.3906	0.2260	0.3221	0.3659	0.74901	-0.0178	2

This result is also consistent with the fact that the A-GPS technology is emerging and apart from 'less market growth of available applications (0.167452)' there are certain 'expectations of revenue from new applications (0.189088)'. As these applications will be integrated and will take benefits of 'integration of different infrastructure whenever accurate is not available (0.2867)' and 'replication of existed infrastructure (0.251012)', will become more attractive to customers. Orange also has some 'expectations from Galileo for improved accuracy (0.214521)', and as an emerging market Orange cannot miss this future opportunity. This opportunity is seen by Orange as a 'driving demand for new services – early adopter syndrome (0.176267)' which might not be very beneficial now but with time will definitely bring up benefits of a new technology with new applications for old and new customers. By investing now in this technology, Orange can achieve the benefits of first mover advantage before its competitors. The graphical representation of results for all alternatives is given in figure 4.23 and 4.24 below.

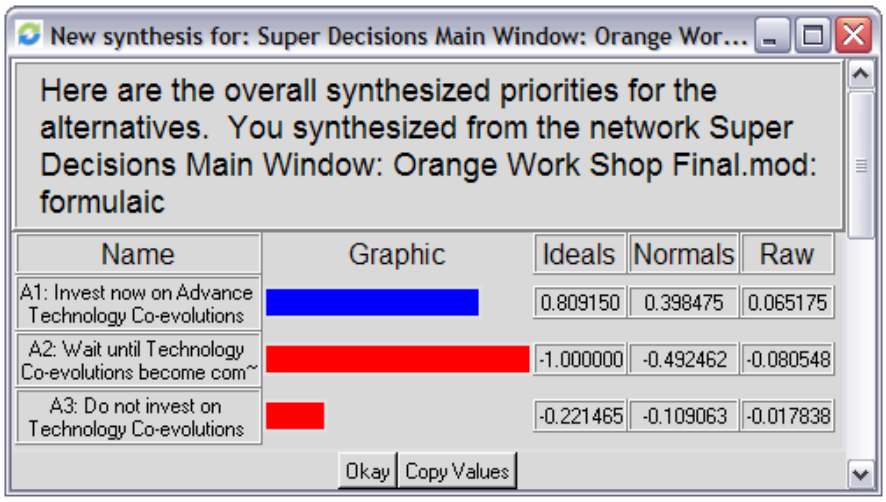


Figure 4-23: Synthesised priorities for alternatives decisions by Orange

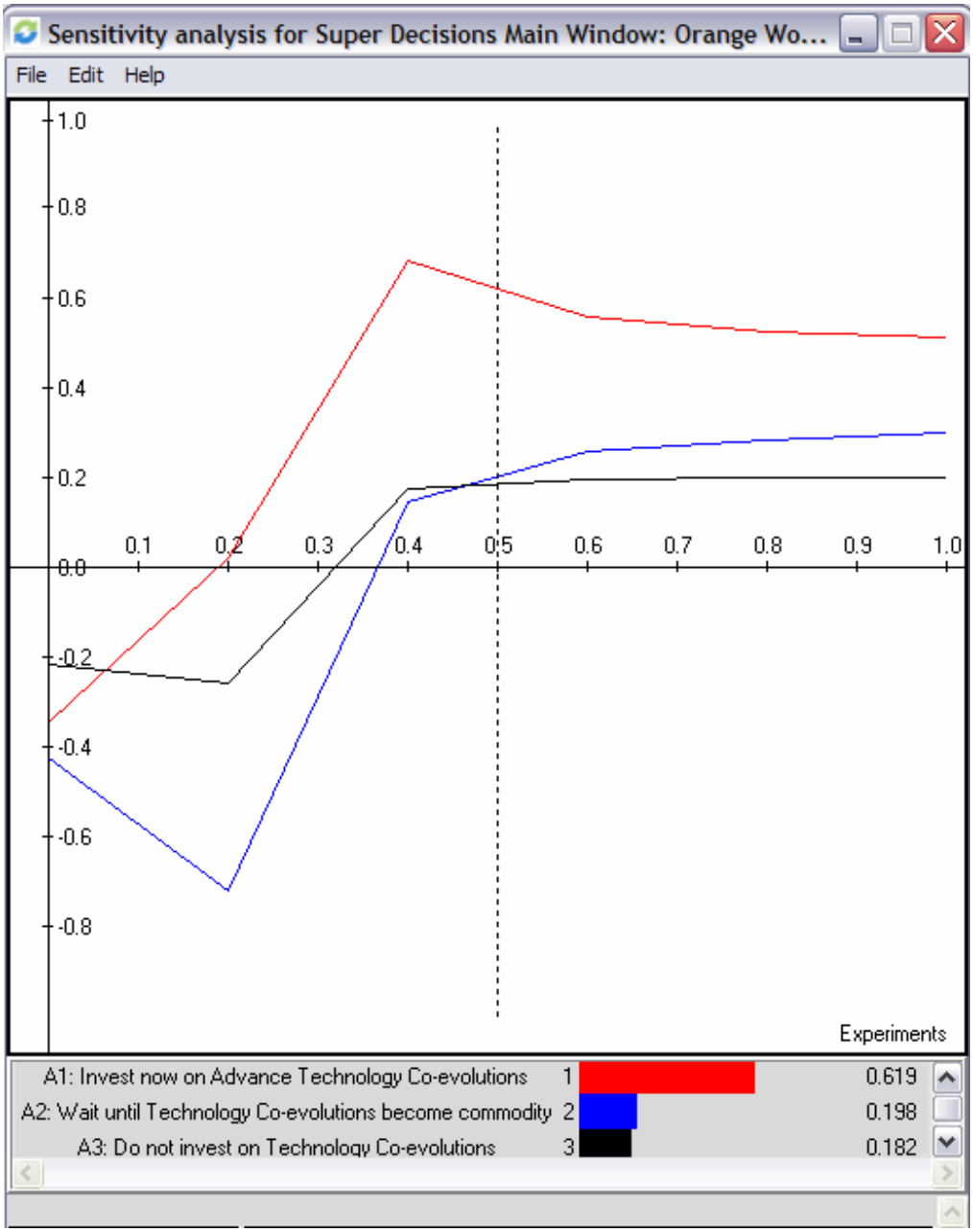


Figure 4-24: Sensitivity analysis for alternative decisions by Orange

4.3.1.5 O2 BOCR evaluations

For the O2 case study table 4.36 shows weights and table 4.37 shows priorities. The priorities are then analyzed to identify the most influential factor and the less risky investment decision.

Table 4-36: Weights assigned by the O2 managers and technologists

BOCR	Drivers	Clusters	Factors in clusters	A1/A2	A1/A3	A2/A3
Benefits	Accuracy and Quality of Technology	Technological evolutions	TE1. Integration of new network components for future availability	3	6	2
			TE2. Integration of old applications over new infrastructure	1	1/6	1/6
		Resource evolutions	RE1. Integration of new knowledge of latest technology	1	1	1
			RE2. Availability for future developments of new and emerging applications	3	6	2
		Organisational evolutions	OE1. Reconfiguration of network rollout	1	1	1
			OE2. Integration of new terminal developments	1	1	1
	Market Demand for Technology	Technological evolutions	TE1. Support to emergency applications	1/3	1	3
			TE2. Drive demand for new services – early adopter syndrome	3	6	2
		Organisational evolutions	OE1. External industry partnerships	1	1	1
			OE2. Internal industry partnerships	2	4	2
			OE3. Capturing and expanding towards new market segments	1	3	3
			OE4. Retention of suppliers of technology	1	1	1
			OE5. Assistance to Government: police and ambulance services	1	3	3
	Cost of Technology	Technological evolutions	TE1. Replication of existing infrastructure	1/2	1	2
			TE2. Integration of different infrastructures whenever accurate is not available	1	1	1
			TE3. Consolidate and maximum use of assets	4	8	2
	Self and Government Regulations	Technological evolutions	TE1. No push from OFCOM	1	1	1
			TE2. Influence of operators on technology co-evolution decision	9	9	1
		Organisational evolutions	OE1. Leveraging of code of ethical purchase	1	1	1
			OE2. Leveraging of code of best practice for passive LBS	1	1	1
			OE3. Leveraging of responsible network deployment policy	1	1	1

Opportunities	Accuracy and Quality of Technology	Resource evolutions	RE1. Expectation from Galileo for improved accuracy	1	1	1
			RE2. Developing easy to use application interfaces for future applications	3	9	3
			RE3. Availability of core capabilities within organisation	1	1	1
		Organisational evolutions	OE1. Keeping track of exogenous industry resources	2	2	1
	Market Demand for Technology	Technological evolutions	TE1. New applications for new customers	1/2	2	4
			TE2. Retention of customers through offering multiple applications	5	10	2
			TE3. Retention of successful applications	3	6	2
		Organisational evolutions	OE1. Variations in R&D for service and application developments	2	2	1
			OE2. Need of highly customer focused management for niche applications	1	1	1
			OE3. Learning from International market stories	1/4	1	4
			OE4. Learning from customers' experiences	5	10	2
	Cost of Technology	Technological evolutions	TE1. Expected reductions in handsets cost	1/2	2	4
			TE2. Expected reductions in mapping data, services and additional cost	1/2	2	4
			TE3. Expected revenue from new applications	4	8	2
Costs	Market Demand for Technology	Organisational evolutions	OE1. Price associated with marketing of new applications for customers' awareness	1	1	1
			OE2. Strategy focused towards future investments in LBS	1/3	2	6
	Cost of Technology	Technological evolutions	TE1. Price associated with LBS enabled handsets	1/2	2	4
			TE2. Price associated with Infrastructure	1/3	1	3
			TE3. Price associated with components	1/2	1	2
			TE4. Price associated with new licences from external technology developers	1/3	1	3
Risks	Market Demand for Technology	Technological evolutions	TE1. Less market growth of available applications	1/3	1	3
			TE2. No visible killer application	1/3	1/3	1
		Organisational evolutions	OE1. Low revenue growth from available applications	1/3	1/3	1
			OE2. Keeping track of competitor's applications	1/4	1	4
			OE3. New entrants changing market dynamics	3	3	1

	Self and Government Regulations	Technological evolutions	TE1. Unavailability of GPS signals	1	1	1
			TE2. Monitoring integrity and upgrading of digital maps	1	1	1
		Organisational evolutions	OE1. OFCOM insistence for highly accurate technology	1/3	3	9
			OE2. Satisfying customers' doubts about their privacy	1/3	1	3
			OE3. Measuring quality of exogenous and third party technological resources	1/2	1	2
			OE4. Satisfying media doubts	1/3	1	3

Table 4-37: Drivers, clusters and their factors with priorities by O2

O2 BOCR	Drivers	Clusters	Elements in clusters	Normalized Priorities	Limiting Priorities
Benefits (0.25)	Accuracy and Quality of Technology (0.15372)	Alternatives	Invest now in the technological co-evolutions	0.44646	0.200908
			Wait until exogenous technological co-evolutions become commodity	0.28210	0.126943
			Do not invest in technological co-evolutions	0.27144	0.122148
		Technological evolutions	Integration of new component technologies for future availability	0.56169	0.084254
			Integration of old applications over new infrastructure	0.43831	0.065746
		Resource evolutions	Integration of new knowledge of latest technology	0.30832	0.061664
			Availability for future developments of new and emerging applications	0.69168	0.138336
		Organisational evolutions	Reconfiguration of network rollout	0.42979	0.085958
			Integration of new terminal developments	0.57021	0.114042
	Market Demand for Technology (0.30445)	Alternatives	Invest now in the technological co-evolutions	0.47270	0.144544
			Wait until exogenous technological co-evolutions become commodity	0.36084	0.110340
			Do not invest in technological co-evolutions	0.16646	0.050902
		Technological evolutions	Support to emergency applications	0.29903	0.076446
			Drive demand for new services – early adopter syndrome	0.70097	0.179197
		Organisational evolutions	External industry partnerships	0.09692	0.042507
			Internal industry partnerships	0.15438	0.067705
			Capturing and expanding towards new market segments	0.44629	0.195728
			Retention of suppliers of technology	0.04585	0.020107
			Assistance to Government: police and ambulance services	0.25657	0.112524

	Cost of Technology (0.3881)	Alternatives	Invest now in the technological co-evolutions	0.40766	0.135885
			Wait until exogenous technological co-evolutions become commodity	0.35439	0.118130
			Do not invest in technological co-evolutions	0.23795	0.079318
		Technological evolutions	Replication of existing infrastructure	0.36877	0.245848
			Integration of different infrastructures whenever accurate is not available	0.36456	0.243039
			Consolidate and maximum use of assets	0.26667	0.17779
	Self and Government Regulations (0.15372)	Alternatives	Invest now in the technological co-evolutions	0.50336	0.251678
			Wait until exogenous technological co-evolutions become commodity	0.24832	0.124161
			Do not invest in technological co-evolutions	0.24832	0.124161
		Technological evolutions	No push from OFCOM	0.29865	0.074663
			Influence of operators on technology co-evolution decision	0.76135	0.175337
		Organisational evolutions	Leveraging of code of ethical purchase	0.3333	0.08333
			Leveraging of code of best practice	0.3333	0.08333
			Leveraging of responsible network deployment policy	0.3333	0.08333
Opportu-nities (0.25)	Accuracy and Quality of Technology (0.19973)	Alternatives	Invest now in the technological co-evolutions	0.50765	0.195875
			Wait until exogenous technological co-evolutions become commodity	0.27053	0.104385
			Do not invest in technological co-evolutions	0.22182	0.085589
		Resource evolutions	Expectation from Galileo for improved accuracy	0.52735	0.175784
			Developing easy to use application interfaces for future applications	0.36652	0.122174
			Availability of core capabilities within organisation	0.10613	0.035375
		Organisational evolutions	Keeping track of exogenous industry resources	1	0.280817
	Market Demand for Technology (0.29763)	Alternatives	Invest now in the technological co-evolutions	0.54292	0.189540
			Wait until exogenous technological co-evolutions become commodity	0.32069	0.11956
			Do not invest in technological co-evolutions	0.13639	0.047615
		Technological evolutions	New applications for new customers	0.36226	0.115037
			Retention of customers through offering multiple applications	0.39277	0.124725
			Retention of successful applications	0.24497	0.077793
		Organisational evolutions	Variations in R&D for service and application developments	0.16282	0.054273

			Need of highly customer focused management for niche applications	0.15663	0.052211
			Learning from International market stories	0.142	0.047332
			Learning from customers' experiences	0.53855	0.179517
	Cost of Technology (0.50264)	Alternatives	Invest now in the technological co-evolutions	0.42542	0.212709
			Wait until exogenous technological co-evolutions become commodity	0.44816	0.224080
			Do not invest in technological co-evolutions	0.12642	0.063211
		Technological evolutions	Expected reductions in handsets cost	0.34181	0.170903
			Expected reductions in mapping data, services and additional cost	0.34181	0.170903
			Expected revenue from new applications	0.31639	0.158194
Costs (0.375)	Market Demand for Technology (0.25)	Alternatives	Invest now in the technological co-evolutions	0.27523	0.091743
			Wait until exogenous technological co-evolutions become commodity	0.50765	0.169215
			Do not invest in technological co-evolutions	0.21713	0.072375
		Organisational evolutions	Price associated with marketing of new applications for customers' awareness	0.47706	0.318042
			Strategy focused towards future investments in LBS	0.52294	0.348625
	Cost of Technology (0.75)	Alternatives	Invest now in the technological co-evolutions	0.21964	0.096282
			Wait until exogenous technological co-evolutions become commodity	0.58304	0.255577
			Do not invest in technological co-evolutions	0.19732	0.086497
		Technological evolutions	Price associated with LBS enabled handsets	0.24390	0.136986
			Price associated with Infrastructure	0.36585	0.205479
			Price associated with components	0.19512	0.109589
			Price associated with new licences from external technology developers	0.19512	0.109589
Risks (0.125)	Market Demand for Technology (0.333)	Alternatives	Invest now in the technological co-evolutions	0.27122	0.12525
			Wait until exogenous technological co-evolutions become commodity	0.48505	0.201237
			Do not invest in technological co-evolutions	0.24373	0.101117
		Technological evolutions	Less market growth of available applications	0.58729	0.171461
			No visible killer application	0.41271	0.120490
		Organisational evolutions	Low revenue growth from available applications	0.57653	0.169021

			Keeping track of competitor's applications	0.12029	0.035265
			New entrants changing market dynamics	0.30318	0.088884
	Self and Government Regulations (0.667)	Alternatives	Invest now in the technological co-evolutions	0.27373	0.116742
			Wait until exogenous technological co-evolutions become commodity	0.48574	0.207160
			Do not invest in technological co-evolutions	0.24053	0.102584
		Technological evolutions	Unavailability of GPS signals	0.38670	0.106622
			Monitoring integrity and upgrading of digital maps	0.61330	0.169099
		Organisational evolutions	OFCOM insistence for highly accurate technology	0.30904	0.092029
			Satisfying customers' doubts about privacy	0.13568	0.040405
			Measuring quality of exogenous and third party technological resources	0.41960	0.124954
			Satisfying media doubts	0.13568	0.040405

4.3.1.6 O2 BOCR analysis

The following section shows an analysis of priorities achieved through the exercise of assigning weight by the managers and technologists of O2. These priorities help in identifying those factors which have adequate influences on their strategic alternatives. These influential factors are presented here with their priorities:

- Integration of knowledge of new technology (0.138336)
- Integration of new terminal developments (0.114042)
- Drive demand for new services – early adopter syndrome (0.17917)
- Capturing and expanding towards new market segments (0.195728)
- Assistance to government: Police and ambulance services (0.112524)
- Replication of existing infrastructure (0.245848)
- Integration of different infrastructures whenever accurate is not available (0.243039)
- Consolidate and maximum use of assets (0.177779)
- Influence of mobile operators on technology co-evolution decision (0.175337)
- Expectation from Galileo for improved accuracy (0.175784)
- Developing easy to use application interfaces for future applications (0.122174)
- Keeping track of exogenous industry resources (0.280817)
- New applications for new customers (0.115037)

- Retention of customers through offering multiple applications (0.124725)
- Learning from customers' experiences (0.179517)
- Expected reduction in handset costs (0.170903)
- Expected reductions in mapping data, services and additional cost (0.170903)
- Expected revenue from new applications (0.158194)
- Price associated with marketing of new applications for customers' awareness (0.318042)
- Strategy focused towards future investments in LBS (0.348625)
- Price associated with LBS enabled handsets (0.136986)
- Price associated with infrastructure (0.205479)
- Price associated with components (0.109589)
- Price associated with new licences from external technology developers (0.109589)
- Less market growth of available applications (0.171461)
- No visible killer application (0.120490)
- Low revenue growth from available application (0.169021)
- Unavailability of GPS signals (0.106622)
- Monitoring integrity and upgrading of digital maps (0.169099)
- Measuring quality of exogenous and third party technological resources (0.124954)

From all the discussed 52 factors, 30 factors are showing a constructive influence on the O2 decision. In order to analyse the investment decision tables 4.38a and 4.38b are showing the limiting priorities and ranks of the strategic alternatives. The synthesized priorities for the BOCR merits are shown graphically in table 4.39.

Table 4-38a: Limiting priorities for the strategic alternatives with respect to drivers

Alternatives	Benefits (0.25)				Opportunities (0.25)			Costs (0.25)		Risks (0.25)	
	Accur (0.25)	Mark (0.25)	Costs (0.25)	Reg (0.25)	Accur (0.333)	Mark (0.333)	Cost (0.333)	Cost (0.50)	Mark (0.50)	Mark (0.25)	Reg (0.75)
A1	0.2009	0.1445	0.1359	0.2517	0.1959	0.1895	0.2127	0.0963	0.0917	0.1125	0.1167
A2	0.1269	0.1103	0.1181	0.1242	0.1044	0.112	0.2241	0.2556	0.1692	0.2012	0.2072
A3	0.1221	0.0509	0.0793	0.1242	0.0856	0.0476	0.0632	0.0865	0.0724	0.1011	0.1026

Table 4-38b: Ranking of priorities for the strategic alternatives with respect to drivers

Alternatives	Benefits (0.25)				Opportunities (0.25)			Costs (0.25)		Risks (0.25)	
	Accur (0.15)	Mark (0.29)	Costs (0.41)	Reg (0.15)	Accur (0.167)	Mark (0.333)	Cost (0.50)	Cost (0.80)	Mark (0.20)	Mark (0.25)	Reg (0.75)
A1	1	1	1	1	1	1	2	2	2	2	2
A2	2	2	2	2	2	2	1	1	1	1	1
A3	3	3	3	3	3	3	3	3	3	3	3

The calculations for three alternatives are performed in table 4.40. Similarly, as with Vodafone and Orange, two different calculations are performed: BO/CR and bB+oO-cC-rR. The calculation presents the most wanted decision of O2 which supports A1. The results identified that A1 (0.2406) should be taken under consideration first, followed by A3 (-0.0123) and A2 (-0.1507). The alternative A1 with the highest priority shows a lower risk in investment for O2. The results say that it is feasible to invest now in the A-GPS technology. This decision also favours a factor 'strategies focused towards future investment in LBS' which has been identified as a major concern of O2 with the highest priority (0.348625), followed by 'Price associated with marketing of new applications for customers' awareness (0.318042)' and 'Keeping track of exogenous industry resources (0.280817)'. This result is also consistent with the O2 strategic objective. The strategy of O2 is to maintain focus on performance and competitiveness by maximising customer value. The performance needs integration of highly accurate technology which is only A-GPS and competitiveness needs availability of technology for improved applications. Another strategy include building new capabilities around LBS by continuing to grow different types of data usage which in future might include location based advertisement, and expanding revenue of £7 to 8 million by 2011 from LBS.

Table 4-39: Graphical representation of strategic alternatives

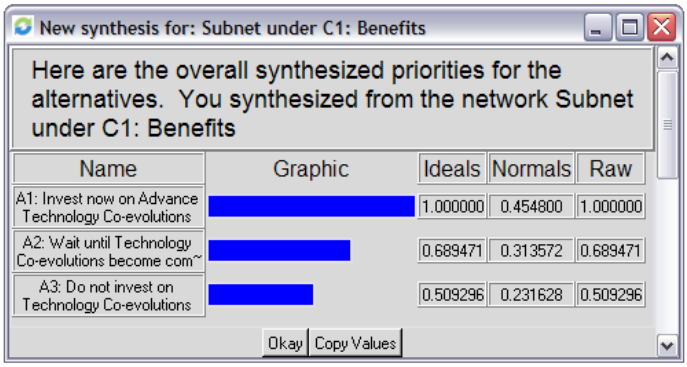
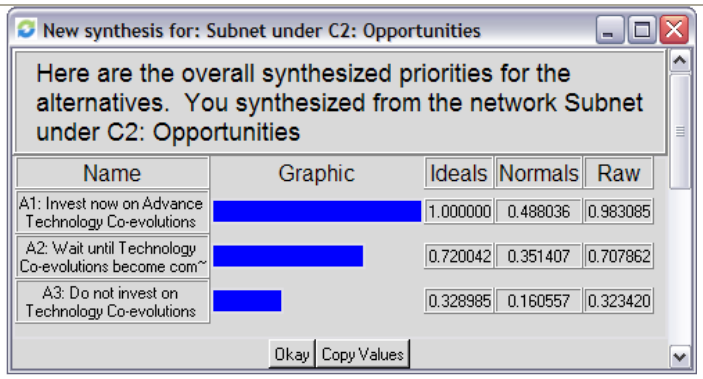
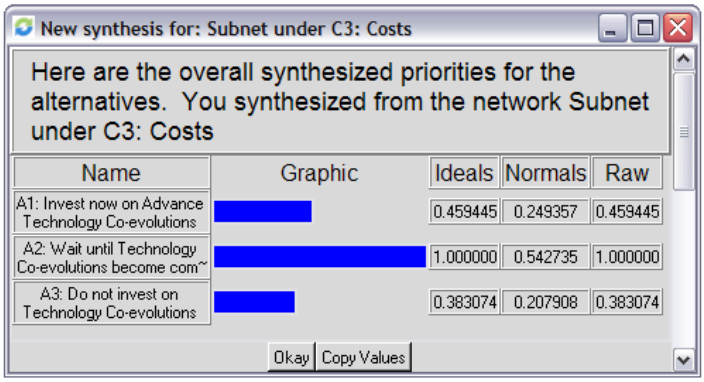
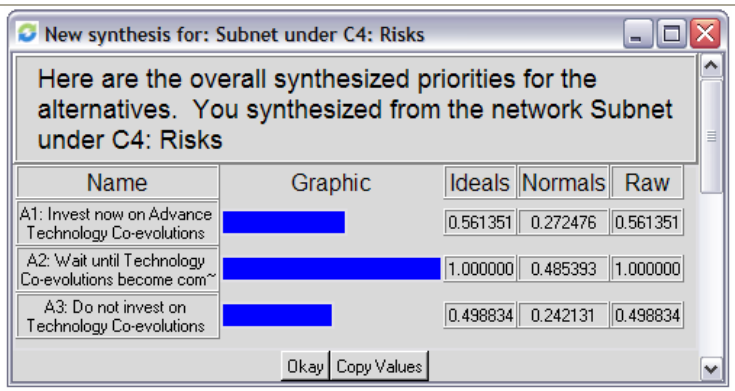
Benefits A1 is the best option with respect to benefits.	
Opportunities A1 is the best option with respect to opportunities	
Costs A2 is the best options with respect to costs	
Risks A2 is the best option with respect to risks	

Table 4-40: Limiting priorities for strategic alternatives under the BOCR merits

Alternatives	Benefits	Opport-unities	Costs	Risks	BO/CR	bB+oO-cC-rR	Ranks
A1: Invest now in technological co-evolutions	1	0.9837	0.4594	0.5614	3.8142	0.2406	1
A2: Wait until technological co-evolutions become commodity	0.6895	0.7079	1	1	0.4881	-0.1507	3
A3: Do not invest in technological co-evolutions	0.5093	0.3234	0.3831	0.4988	0.86134	-0.0123	2

At O2, the reason behind the investment in the A-GPS technology is not a direct investment in the A-GPS technology but is supported with the investment in the new location platform. In order to continuously offer LBS to customers, O2 have to invest in its location platform without which even the least accurate LBS will not remain accessible. The technology co-evolution is bringing in the A-GPS server free for O2 with the investment in the location platform. This result is also consistent in identifying the 'influence of operators on technology co-evolution (0.175337) investment'. As O2 is 'learning from its customers' experiences (0.179517) along with keeping track of exogenous industry resources, it can drive best customer experience by using their insights for LBS. The graphical representation of results for all alternatives is given in figure 4.25 and 4.26 below.

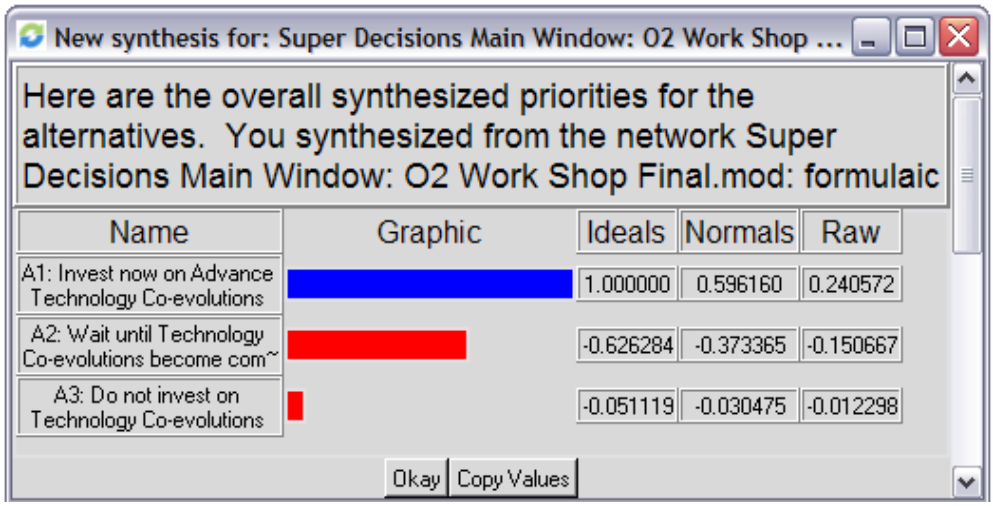


Figure 4-25: Synthesised priorities for alternatives decisions by O2

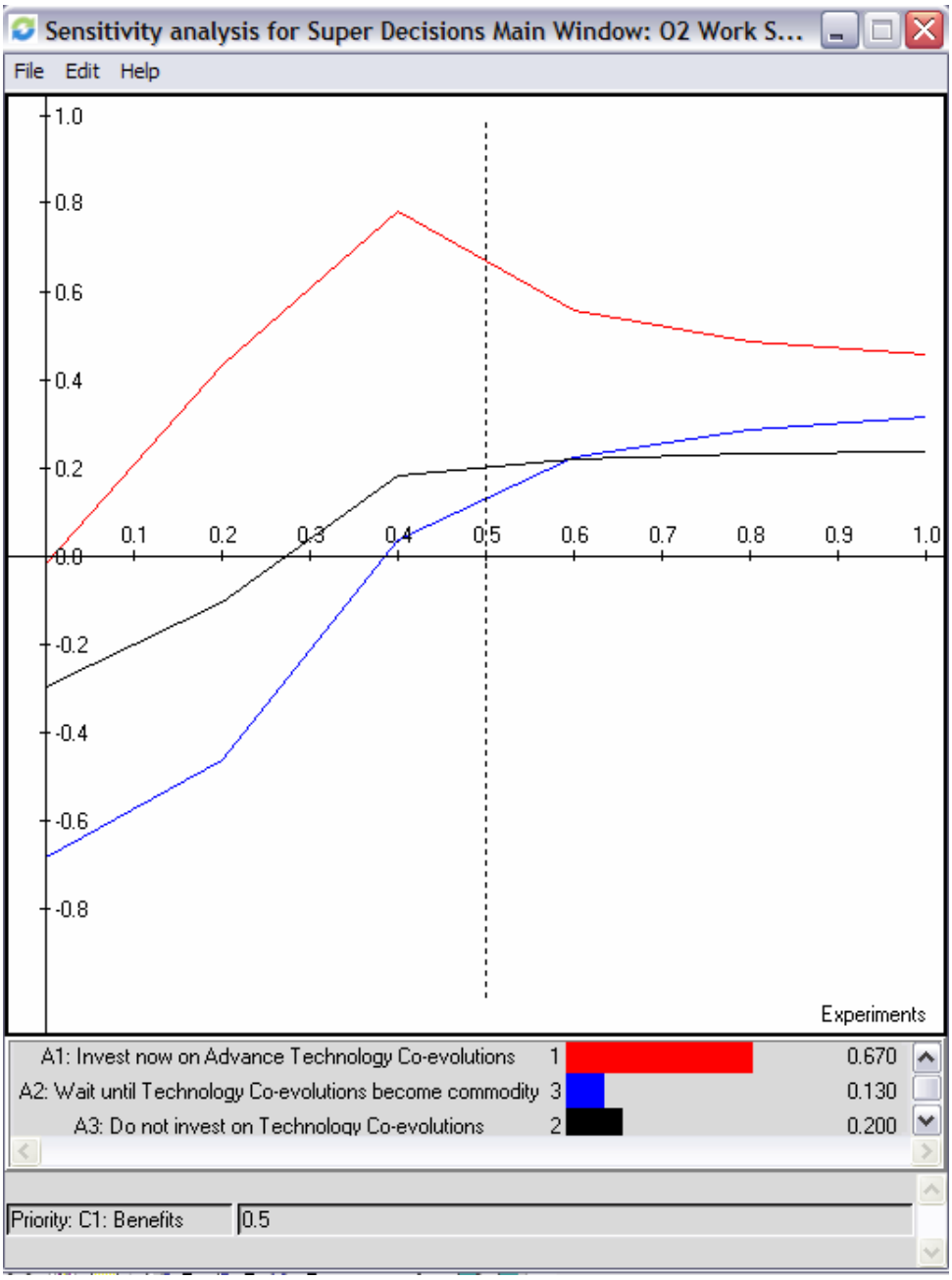


Figure 4-26: Sensitivity analysis for alternative decisions by O2

4.4 Conclusion

The central aim of these cases focuses on examining the utility of the research work in the practical environment of the UK mobile industry.

In this regard, the study shows that the concept of the Dynamic Technological Capability model works well to measure the benefits, opportunities, costs and risks for making an investment decision in the next generation of technology within a fairly swift market. The DTC model appears to provide a sequential way for dealing with the strategic decision which is inherently done by the strategic intelligence of the decision makers in organisations.

The calculated strategic alternatives, as a result of adopting the DTC model, are not just simple answers of investing or not investing in a particular technology; these are strategic plans, which include the details of those factors which allow or hinder the technology evolution; and are roadmaps in identifying those factors which will face future evolutions. Therefore the DTC model provides an optimum result and required details of an investment strategy for adopting the next generation of technologies for the technological organisations.

The cases discussed so far have answered the problem-oriented research. Each case has shown its results and priorities. In order to answer the basic research the influence of mostly identified factors will be analysed in the next chapter. Their influences will be discussed to validate the concept of dynamic technological capabilities by analysing relationships of clusters: technological evolutions (TE), organisational evolutions (OE) and resource evolutions (RE). The high influence of the TE clusters will help in providing evidence to the concept of a dynamic technological capability.

Chapter 5: Analysis of the Second stage of the DTC Model

5.1 Introduction

The extensions in the theoretical concepts are evident with the help of the case studies. The case studies provide the holistic view of phenomena which with replication offers verification required for the theory extension. In this research work, an extension in the theory of dynamic capabilities therefore takes advantages of the case studies of the UK mobile industry. Three cases of the UK mobile industry offer the sample size of 60% and an opportunity to achieve the required validity and reliability for the research work.

This chapter is intended to perform the cross case study to gather all the most influencing factors identified by the decision makers of three organisations. This study identifies the similar and different factors and combines them to achieve a group of the most influential factors. The detailed analysis and evaluation of that group proves the influence of technology co-evolution on the evolution of organisational capabilities. The group shows that all identified factors either belong to the technological evolution (TE) cluster or are influenced by those factors which belong to the technological evolution (TE) cluster.

The chapter begins by collecting all the most influential factors and then evaluating them with respect to their preferences for the decision makers. Their preference is discussed according to the range specified by the decision makers during the process of measuring priorities. The emergence of factors from technological evolution (TE) clusters proves the concept of theory extension.

In the second part, the chapter presents the graphical representation of the DTC model showing all three cases together. The section discusses the results of the overall approach including qualitative and quantitative, taken by three mobile operators and answers to both the problem-oriented and the basic research questions.

5.2 Evaluation of a group of most influential factors identified by the mobile operators

The individual cases discussed in chapter four have identified a number of factors which are influential on the decision makers in making the investment decision. From the 52 factors of table 3.1, the decision makers of three organisations have identified 32 important factors which influence their investment decision. The selection of these 32 factors relies on setting a limit for values which should be equal or greater than 0.03, so it possess at least 3% influence on the decisions of the decision makers.

These factors belong to three different clusters: TEs, OEs, and REs, which are defined in this research. The selected 32 factors are discussed here in terms of their relevance to these clusters. Along with this, their calculated percentage values are also considered in the form of range given by these organisations. The range offers percentage of the influential factors by which the decision makers are influenced before making the investment decision. These percentages are those limiting priorities which are calculated in tables 4.27, 4.32, and 4.37 with the consents of the UK mobile operators. The range offers the minimum and maximum percentage values of all three cases.

The decision makers of these organisations have identified the following important factors:

1. *RE1. The integration of new knowledge of latest technology* - This factor belongs to the RE cluster and is influenced by both factors which belong to the TE cluster. Whenever technology becomes a part of an organisation: only then it brings up its new knowledge which later becomes beneficial for the organisation. This factor influences the decision makers in the range of 9 – 13%.
2. *RE2. Availability for future development of new and emerging applications* - This factor belongs to the RE cluster and is influenced by both factors which belong to the TE cluster. Once technology enters into an organisation and becomes part of it, it can be used any time in future for new applications. This factor influences the decision makers in the range of 10 – 13%.
3. *OE2. Integration of new terminal developments* - This factor belongs to the OE cluster and is influenced by both factors which belong to the TE cluster. In order to develop a

new application which utilizes the benefits of new technology, the old technologies need to be integrated with the new technologies. Their integration will rely on their compatibilities and ability to work together. This factor influences the decision makers in the range of 11 – 12%.

4. *TE4. Drive demand for new services – early adopter syndrome* - This factor belongs to the TE cluster. It clearly states that some technologies are adopted for the sake of new technologies and therefore identifies the influence of the technological evolution on this factor. This factor influences the decision makers around 17%.
5. *OE3. Capturing and expanding towards new market segments* - This factor belongs to the OE cluster and is influenced by both factors of the TE cluster. Before capturing and expanding towards a new market segment, organisations must have the technology inside around which it becomes possible to develop new services for new markets. This factor influences the decision makers of organisations in the range of 17 – 19%.
6. *OE5. Assistance to government – police and ambulance services* - This factor belongs to the OE cluster and is influenced by both factors of the TE cluster. The government can be seen as a potential customer for organisations. In order to offer the value services to government, an organisation needs to become technologically capable. This factor influences the decision makers in the range of 10 – 12%.
7. *TE1. Replication of existing infrastructure* - This factor belongs to the TE cluster and is influenced by both factors of the TE cluster. The technological compatibility allows new technologies to be integrated with old technologies and therefore old technologies can be replicated and can be utilized alongside the new technologies. This factor influences the decision makers in the range of 24 – 26%.
8. *TE2. Integration of different infrastructures whenever accurate is not available* - This factor belongs to the TE cluster and is influenced by both factors of the TE cluster. As stated technological compatibilities allow them to be integrated and work in combination. This factor influences the decision makers in the range of 24 – 28%.
9. *TE3. Consolidate and maximum use of assets* - This factor belongs to the TE cluster and is influenced by both factors of the TE cluster. The consolidation of the technological roles is seen as cost beneficial through the organisational perspectives. As stated, technological compatibilities allow them to be integrated and work in combination. This factor influences the decision makers in the range of 12 – 17%.

10. *TE1. No push from OFCOM* – This factor belongs to the TE cluster. It shows benefits of no external influence except of technology on itself. This factor influences the decision makers in the range of 7 – 12%.
11. *TE2. Influence of mobile operators on technology co-evolution decision* – This factor belongs to the TE cluster. It shows the technological capability which does not allow any influence from the decision makers on the technology co-evolution. This factor influences the decision makers of 7 – 12%.
12. *RE1. Expectation from Galileo for improved accuracy* – This factor belongs to the RE cluster and identifies the future technological opportunities which will emerge with the launch of a new technological system. This factor relies on the technological opportunities and influences the decision makers in the range of 17 – 25%.
13. *RE2. Developing easy to use application interfaces for future applications* - This factor belongs to the RE cluster and identifies the technological opportunities which will allow development of ubiquitous platforms for developers of new technologies. This factor influences the decision makers in the range of 3 – 12%.
14. *OE1. Keeping track of exogenous industry resources* – This factor belongs to the OE cluster and identifies opportunities which will emerge by following tracks of the technological developments. These tracks are not internal to those industries in which organisations reside and therefore appear from the independent innovative regimes. This factor influences the decision makers in the range of 28 – 30%. The high influence of this factor also supports the concept of dependent and independent innovative regimes discussed in chapter two.
15. *TE1. New applications for new customers* – This factor belongs to the TE cluster and identifies opportunities which will emerge when technology evolves towards its next generation and as a result will create more technological opportunities for organisations. This factor influences the decision makers in the range of 11 – 14%.
16. *TE2. Retention of customers through offering multiple applications* - This factor belongs to the TE cluster and provides the possibility of keeping a very important asset (customers) within the organisation by allowing technological evolutions. This factor influences the decision makers in the range of 8 – 12%.
17. *OE4. Learning from customers' experiences* - This factor belongs to the OE cluster and offers possibilities of evolving further by being aware of the choices of customers and their priorities which will further help towards technological evolutions. This factor is

therefore influencing all factors in the TE cluster. This factor influences the decision makers in the range of 13 – 17%.

18. *TE1. Expected reduction in handset costs* - This factor belongs to the TE cluster and identifies opportunities which will improve the quality and reduce the cost of technology with time. As a part of the TE cluster, the factor is only influenced by technological evolutions. This factor influences the decision makers in the range of 15 – 25%.
19. *TE2. Expected reduction in mapping data, services and additional costs* - This factor belongs to the TE cluster and identifies opportunities which will improve the quality and reduce the cost of distinct technological roles with time. As a part of the TE cluster, the factor is only influenced by technological evolutions. This factor influences the decision makers in the range of 8 – 17%.
20. *TE3. Expected revenue from new applications* - This factor belongs to the TE cluster and identifies opportunities which will provide cost benefits to an organisation once the technology evolution occurs. As a part of the TE cluster, the factor is only influenced by technological evolutions. This factor influences the decision makers in the range of 15 – 17%.
21. *OE1. Price associated with marketing of new applications for customers' awareness* – This factor belongs to the OE cluster and enhances worries of cost which organisations have to face, if the decision makers agree on the technology evolution. As a part of the OE cluster, this factor is influenced by other factors of the OE cluster which will only be effective after the technology evolution takes place. This factor influences the decision makers in the range of 31 – 33%.
22. *OE2. Strategy focused towards future investments in LBS* – This factor belongs to the OE cluster and is identified as the most important factor of all. The factor itself decides whether the mobile operators invest in LBS or not. The factor is for decision of the technological evolution. In precise, this factor is influencing every factor in the DTC model. This factor influences the decision makers in the range of 33 – 35%.
23. *TE1. Price associated with LBS enabled handsets* – This factor belongs to the TE cluster and is concerned with the cost of the product technology which organisations need to face with the decision of investing in the TE. As a part of the technology evolution cluster, this factor is influenced by the technology evolution. This factor influences the decision makers of organisations around 13%.

24. *TE2. Price associated with infrastructure* - This factor belongs to the TE cluster and is concerned with the cost of the most expensive technological role which organisations need to face with the decision of investing in the next generation of the technology. As a part of the TE cluster, this factor is influenced by the technology evolution. This factor influences the decision makers in the range of 20 - 23%.
25. *TE3. Price associated with components* - This factor belongs to the TE cluster and is concerned with the cost of least expensive technological role which organisations need to face with the investment decision. As a part of the TE cluster, this factor is influenced by the technology evolution. This factor influences the decision makers in the range of 9 - 11%.
26. *TE4. Price associated with new licences from external technology developers* - This factor belongs to the TE cluster and is concerned with the cost of those technological roles which are not a part of industry to which organisation belongs. The organisations need to face this cost with the investment decision. As a part of the TE cluster, this factor is influenced by the technology evolution. This factor influences the decision makers in the range of 9 - 10%.
27. *TE1. Less market growth of available applications* - This factor belongs to the TE cluster and is concerned with a threat which organisations are facing nowadays. The threat is also identified as one of the reasons which hinder the technology evolution. This factor is influenced by other factors of the TE cluster. This factor influences the decision makers in the range of 16 - 17%.
28. *TE2. No visible killer application* – This factor belongs to the TE cluster and is concerned with recent threats of technological conditions in the market. This factor is influenced by other factors of the TE cluster. This factor influences the decision makers in the range of 11 - 12%.
29. *OE1. Low revenue growth from available applications* – This factor belongs to the OE cluster and is concerned with the current flaws of the technological developments. This factor is also identified as one of the reasons which hinder technology evolution. This factor is influenced by a factor of the TE cluster. This factor influences the decision makers in the range of 16 - 17%.
30. *TE1. Unavailability of GPS signals* – This factor belongs to the TE cluster and is concerned with the future threats which may appear if technology from the independent

innovative regime stops supporting technology of the dependent innovative regime. This factor influences the decision makers in the range of 7 – 10%.

31. *TE2. Monitoring integrity and upgrading of digital maps* – This factor belongs to the TE cluster and is concerned with errors which can be created because of the convergence of different technological roles. A lower quality of one technological role can affect the quality of other technological roles and this may ultimately affects the overall technology evolution. This factor influences the decision makers in the range of 16 -19%.
32. *OE3. Measuring quality of exogenous and third party technology resources* – This factor belongs to the OE cluster and requires an addition of organisational resources to avoid the risk of errors which may occur because of the combination of several technologies from several technology developers. This factor is influenced by a factor of the TE cluster. This factor influences the decision makers in the range of 12 – 14%.

The analysis of all of these factors which appeared with high priorities revealed the influence of technological co-evolution on the evolution of organisational capabilities. The frequent occurrence of those factors which are influenced by the technological evolution (TE) cluster is proving the validity of the concept of Dynamic Technological Capability. This concept identifies '*the capacity of technology which creates, modifies and extends the resource bases of the organisation*'. The validity of this concept also extends the current theory of the dynamic capabilities which can now go beyond the managerial capabilities towards technological capabilities.

All the discussed factors either belong to the technological evolution (TE) cluster or are influenced by those factors which belong to the technological evolution (TE) clusters. The concept of Dynamic Technological Capability appears convincing from the three case studies. Therefore an analysis of the second stage of the DTC model proves the concept behind the first stage of the DTC model. Fig 5.1 presents a graph which shows the comparative study of all these three cases.

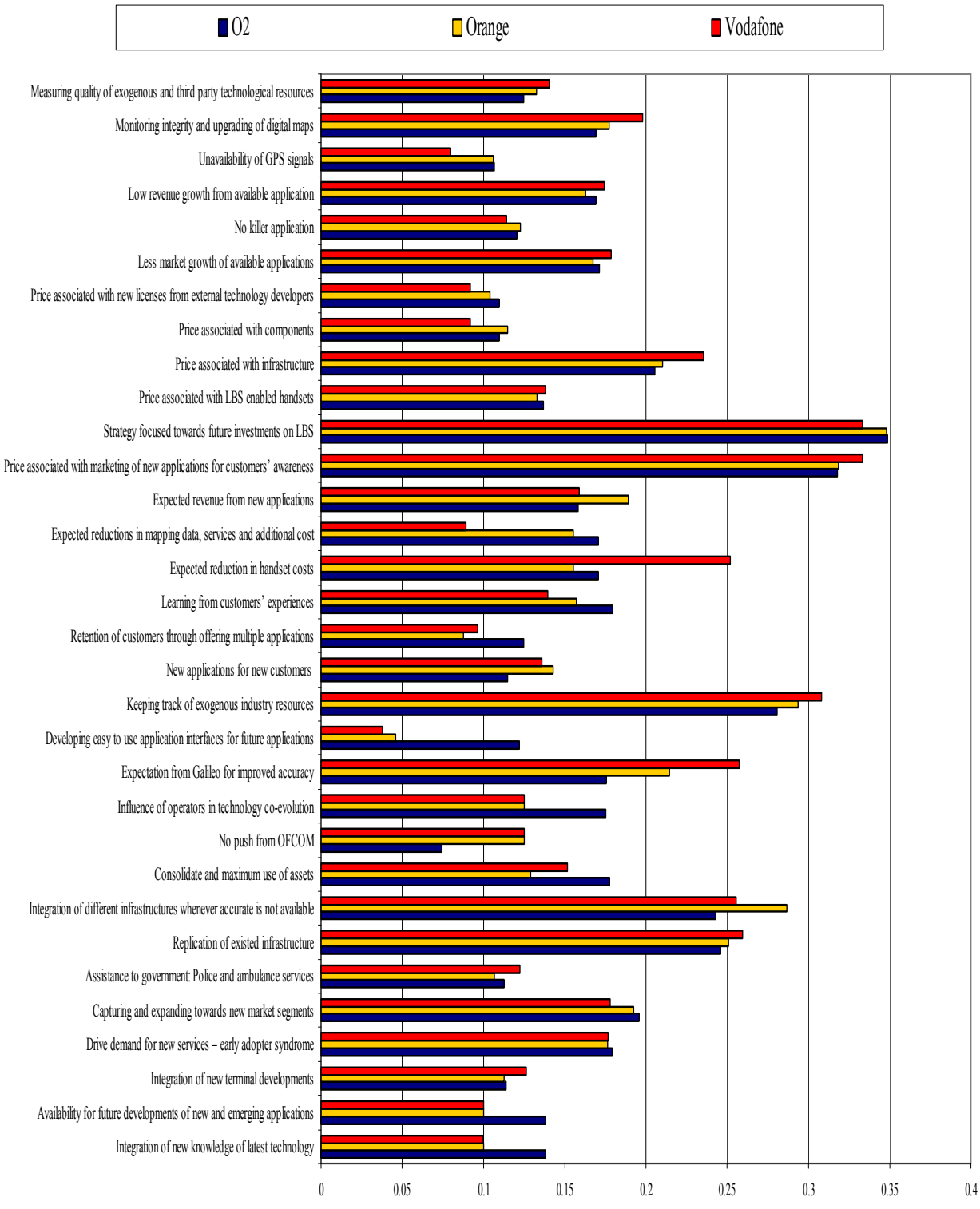


Figure 5-1: Comparative analysis of three cases showing influence of factor on the decision makers

5.3 The Dynamic Technological Capability (DTC) model for the A-GPS technology

This section illustrates the entire Dynamic Technological Capability model for all three cases. Both stages for these cases have been elaborated separately in chapter four. These elaborations have successfully demonstrated the validity of the DTC model in the practical domain. Now the graphical representation and its briefing are given here to draw some conclusions for the practical environment of the UK mobile industry. This entire model will offer answers to the mobile operators which they need in order to solve the dilemma of the investment decision in the next generation of the LBS technology which is identified as the A-GPS technology.

The investment decision in the A-GPS technology to improve the accuracy and quality of LBS has made the mobile operators think and perform quickly according to their strategic objectives. The strategic objectives force the mobile operators to leverage their technological capabilities and reduce their unwanted expenses in the mature markets like the UK. At the same time these objectives force them to remain competitive by achieving the first mover advantage in the advanced technologies and stimulate as much revenue as possible.

The A-GPS technology in this scenario makes them think more promptly as it is an advanced technology and also brings the technological capabilities from the external industry. The external industry does not depend on the evolutions of the mobile industry but the applications offered by the mobile operators will completely rely on the technological resources of this industry. Bringing this technology within the mobile industry will change the industrial boundaries and will also allow the competitors to enter inside the mobile industry from several other industries.

Since 2000 to date the technological capabilities which are offering LBS in the UK market have not been able to establish a good reputation. The major concerns remained about a lower level of accuracy, a lower level of attraction for customers, and less demand for personal and business markets. Since the launch of LBS the mobile operators have evolved in terms of technological and organisational capabilities to create or buy the required resources. These evolutions have occurred in all technological roles including component,

product, application, support and infrastructure. Along with technology, these evolutions have occurred in several organisational capabilities including management of supply chain, partnerships and alliances, content standards, network rollout, research and development, strategies, organisational structure and processes for customer care, marketing, sales and billing capabilities.

The investments in all these capabilities were influenced partially by the OFCOM regulations and partially by the interest of the mobile operators in exploiting the new technological capabilities. The future investments can still face the regulatory influences but might also face the competition amongst mobile operators and other third party technology developers. At the same time, a pull from independent industry can also influence the investment decisions.

The knowledge of these historical evolutions identifies the technological and organisational initiatives as well as obstructions for the future investments. The retained knowledge of technologies can help technologists to learn quickly about the next generation of technology and experiences of the market conditions. This knowledge can help managers to identify the opportunities and risks of the next generation of this technology. In short, their historical knowledge can help the mobile operators to move further for more technological advancements. The knowledge helped in identifying the 52 factors and their classification with respect to the technological, organisational and resource evolution clusters.

The detailed analysis of these factors identified their relationships with each other and their relative importance towards the investment decision in the next generation of the LBS technology. The ANP tool assisted in measuring the values for the benefits, opportunities, costs and risks. Taking into account the average values of these merits helped in identifying the decision of ‘making an investment now’ in the next generation of technology within a fairly swift market of LBS. Though the average values combine three distinct opinions from three distinct organisations but are seen as significant as they present values of highly practiced activities. Utilization of these average values for the BO/CR calculation selected alternative A1 as the most favourable strategy for the entire UK mobile industry. This result contributes towards the fact that if two organisations will invest in a particular technology and third will not then it will be lagging behind the others in exploiting the benefits of a

particular technology. All these developments along with the BOCR merits and the investment decision are shown in fig 5.2.

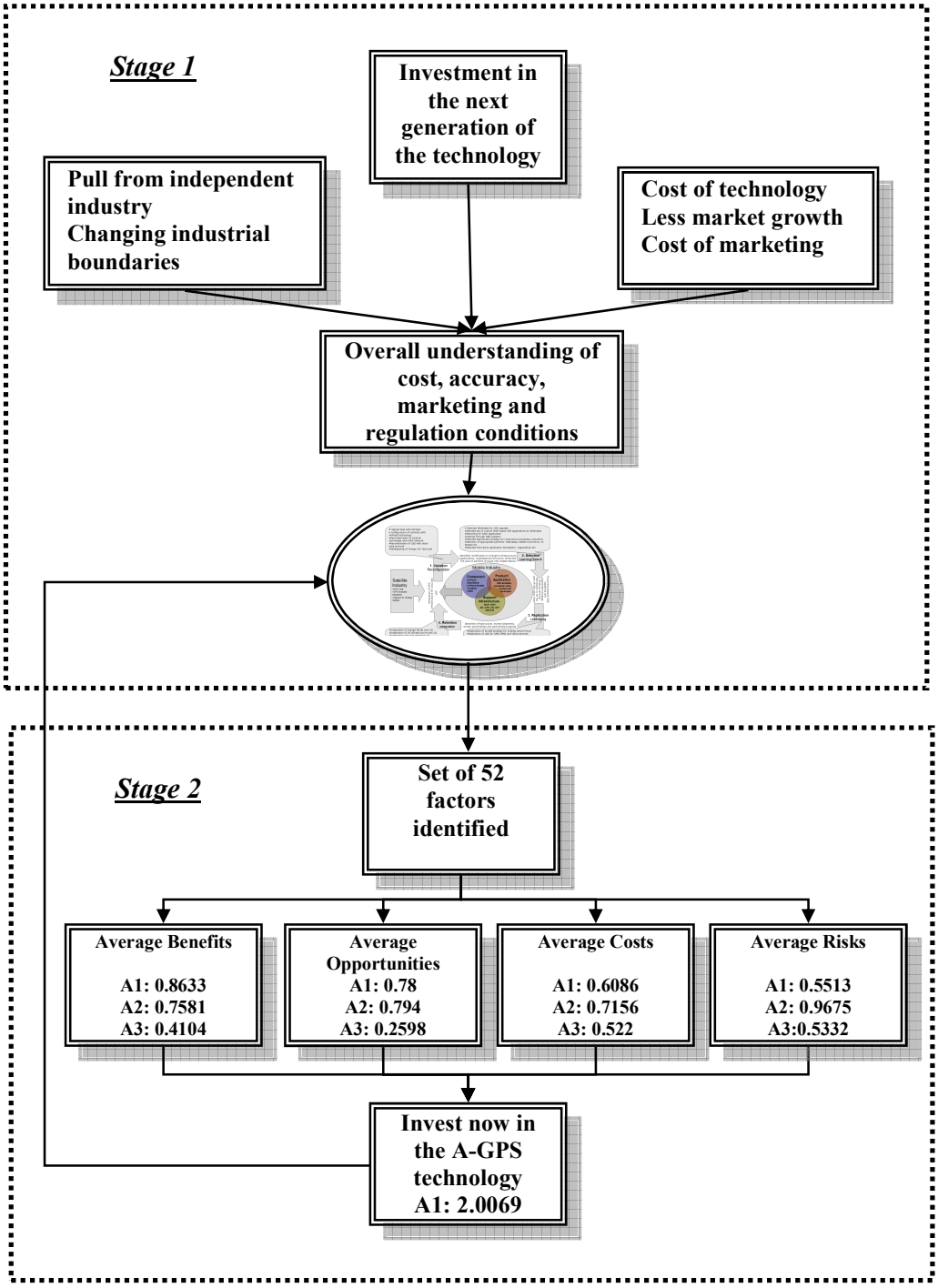


Figure: 5-2: The DTC model for making an investment decision in the A-GPS technology

So far, it has been identified that for the next generation of the LBS technology, which is based upon the A-GPS technology, the mobile operators require evolution in the infrastructure (A-GPS server), product (A-GPS enabled handsets), component (some software licences along with hardware such as antenna) and application (integration of several applications like What's Nearby with location based advertisement) technologies. At the same time, in order to make this technology a success they need to invest in the marketing capabilities to enhance the customers' awareness about this new technology.

5.4 Conclusion

The central aim of the chapter is to compile the stages of the DTC model and offer its implications to the mobile operators. In this regard, the study proves the usability of the DTC model for industrial practices. In short, the DTC model offers a managed and calculated way of thinking to the decision makers of the technological organisations.

For making an investment decision, the DTC model helps the decision makers to combine all the evolutions of the technological and organisational capabilities and then leads them towards the calculated measures on the basis of which they can reduce the obvious risks of the wrong decisions. The DTC model is developed for a group of managers and technologists. Being in a group they can raise several issues and can cover more areas of discussion than a single decision maker can do. The group not only discusses several important issues but at the same time shares the responsibility of every taken decision.

Chapter 6: Conclusion and contributions of the research work

This chapter offers some conclusions from the research work along with its summary and contributions. The chapter is divided into the following eight sections. Section one presents a summary of the thesis; section two presents an overview and a focus of the research; section three identifies the research gaps and ways of closing these gaps; section four presents the research methodology; section five offers a summary of the research findings; sections six presents the research contribution towards literature and industrial practices; section seven presents some limitations of the research and section eight presents a path forward for future research opportunities.

6.1 Summary of the thesis

The research provides a new model for the decision makers of the technological organisations, with a particular focus on creating value by measuring the benefits, opportunities, costs and risks of an investment decision. The decision makers belong to the technological organisations within a fairly swift market where they need to make the investment decision for the evolution towards the next generation of a technology. The basic notion of the next generation of technology within a fairly swift market is developed through the integration of theories of technology eco-system, dynamic capabilities and resource based view along with the industrial practices of the UK mobile and satellite industries.

The main characteristics of this notion comprise:

- *Value creation for the technological organisation*, which requires development of such a distinct resource by organisations of an industry which make them incomparable within industry.
- *Dynamic capability development*, which requires identification and exploitation of organisational, strategical and industrial competencies in the changing environment where time-to-market and timing are critical, the rate of technological change is rapid, and the nature of the future competition and markets difficult to determine.

- *Technology convergence and evolution*, which requires distinct roles played by technology to combine and out-perform in markets and co-evolve to remain responsive to the changing demands of markets and regulations.
- *Exogenous technological evolutions*, which require organisations to regularly monitor the technologies of other industries, identify their potential roles and adopt them by knowing their own industrial requirements.
- *Historical technological evolutions,* which require organisations to observe and measure their market conditions and customers' behaviours towards the previous generation of the technology.
- *Drivers behind technological evolution*, which require organisations to break out the dilemma of the technological quality and its market demand and to be responsive to its cost and the related regulations.
- *Competition and co-operation,* which requires competitors of an industry to co-operate alongside competing, in situations when exogenous technological evolutions occur or competitors of exogenous industries blur as well as create new industrial boundaries.

From the notion of the next generation of technologies within a fairly swift market, a set of operations are drawn out which is required to be considered by the decision makers of the technological organisations.

Receptiveness for Customer Awareness – The customer either of mass product or of customized product is the end user of any technology. Before adopting the next generation of technology organisations must focus on a way of attracting these customers and making them aware of the benefits of its next generation. With the pace of rapid technological evolutions where generations change quickly, customers of previous generations appear as an asset to the technological organisations. Through the proper marketing techniques these technological organisations will concentrate on retaining this asset and integrating new ones.

Receptiveness for Exogenous Industry Resources – The technological organisations must focus on a way of developing a means of monitoring the evolutions in the

technological generations of the relative industries. These organisations will develop new applications in response to the exogenous technological evolutions, with endogenous technological evolutions adapted to customers' requirements. This will bring up new markets and new customers from exogenous industries for technological organisations.

Receptiveness for Endogenous Industry Resources – The technological organisations must focus on a way of replicating, leveraging and integrating their own industrial and organisational evolutions of technologies for the next generation of technologies. The adoption of such resources will be cost-effective and will spare some financial resources for the development of the next generation of technologies.

In connection to the above operations some other criteria which must be considered by the decision makers of the technological organisations are discussed below:

- Investment decision making will be shared amongst the group of managers and technologists who will also share responsibilities of all pros and cons.
- Consolidation and maximum use of every asset will reduce cost associated with the new component, product and application, support and infrastructure technologies.
- Inter-relatedness of technological roles and their co-evolutions will reduce the influence of the decision makers in making an investment decision in some situations.
- Knowledge of exogenous technology will be beneficial for the development of new applications which will bring in the new customers along with revenue.
- Knowledge of customers' experiences will be beneficial for retaining old applications which will retain the old customers along with revenue.
- Knowledge of market conditions will be beneficial in keeping an eye on uptakes and falls of technological developments which will identify the killer application to enhance revenue.
- Early adopter syndrome of the next generation of technologies will derive demand of new applications and services.

In this regard, the notion of an investment in the next generation of technologies by the technological organisations within a fairly swift market is defined more elaborately than those which are discussed in the theories mentioned. There is a shift from the endogenous

technological capabilities towards the exogenous technological capabilities, which are defined as the independent and dependent innovative regimes, in order to create value for the technological organisations. This includes contribution of distinct technological roles and their co-evolutions towards creating new organisational capabilities and their later evolutions. In association to this definition, a new model for the decision makers is developed. The new model embodies the following stages to achieve a less risky and more calculated investment decision.

1. A new way of looking towards the evolutions of historical technological and organisational capabilities to identify an influence of the technology co-evolution on the evolution of the organisational capabilities and resources. These evolutions follow an evolutionary cycle of four stages, including reconfiguration, learning, leveraging and integration. In this research this cycle is termed as an ***evolutionary framework***. The evolutionary cycle is then observed under the influences of drivers: accuracy and quality of technology, market demand for technology, cost of technology and self and governmental regulations.

2. A new method of developing a set of factors which utilize an evolutionary framework and grouping them under the benefits, opportunities, costs and risks criteria. The 52 factors are developed by using the multi-criteria decision logic and by organising them in a network system. In order to achieve the merits of benefits, opportunities, costs and risks this research uses the Analytics Network Process (ANP), which will help in reaching the less risky investment decision. The investment decision comprises of three strategic alternatives: A1 – Invest now in the technological co-evolution; A2 – Wait until exogenous technological co-evolutions become commodity; A3 – Do not invest in the technological co-evolutions. In this research this stage is termed as an ***evaluation method***.

The fusion of the above concept and method places a new model, called the Dynamic Technological Capability (DTC) model within the context of the technological organisations for making an investment decision in the next generation of technologies within a fairly swift market.

6.2 Research overview, Scope and issue

This research work is focused on developing a new model for making an investment decision for the next generation of technologies in order to increase the value for the technological organisations within a fairly swift market. The identified drivers are:

1. Variations in the accuracy and quality of the alternative technologies;
2. Changing market and instability in technological demand;
3. Huge cost with less revenue from the technology;
4. Increasing influences of regulations.

The research presents a solution method using the sequential stages that would be followed in context of the technological organisations within a fairly swift market. At first it identifies the characteristics of the next generation of the technology and its organisational and industrial environments. From these characteristics the new evolutionary framework under the influences of four drivers is developed. The limitation of theoretical concepts (such as defining the technology co-evolution as the source of evolving dynamic capabilities) and (less momentum towards the issue of 'how' side of dynamic capabilities) are then identified that must be considered to achieve a reliable solution method of making an investment decision for the next generation of the technology. The perceptions to overcome these limitations are then utilized as essentials for the development of the Dynamic Technological Capability (DTC) model, which can be applied to make an investment decision in the next generation of technologies.

The argument behind the DTC model is that the exogenous industry is forcing the technology evolution and the previous generation of technology remained unsuccessful in the dynamic market. To overcome the problems of these uncertainties the decision makers must have a model through which they can take measures of decisions in a form of the benefits, opportunities, costs and risks values before making any investment decision.

The context of the DTC model comprises two major stages with their respective steps:

<u>Stage 1:</u>

I. Gathering information of the historical evolutions of technologies, organisational capabilities and resource;

II. Identifying sources of evolutions in terms of the dependent and independent innovative regime;
III. Organising the information according to an evolutionary framework;

Stage 2:

I. Identifying and assigning factors according to their relative clusters;
II. Measuring factors according to the BOCR merits and the strategic alternatives.

The DTC model has been evaluated using the industrial data of the UK mobile operators.

6.3 The Research gap

As the combination of both the basic research and the problem-oriented research, this research work focuses on extending a conceptual view of developed theory and on developing a solution method for the decision makers of the technological organisations within a fairly swift market. The research work incorporates the following concepts and industrial practices, and utilizes them for the technological organisations consistent with the characteristics of the next generation of technologies within a fairly swift market. These are:

1. The concepts of resource based view and dynamic capabilities;
2. The concepts of technology ecosystem;
3. The techniques of multicriteria decision analysis;
4. The recent industrial practices of the UK mobile and satellite industries and concerns of their experts in the context of location based services.

The current concepts of the resource based view and the dynamic capabilities for creating values for organisations are lacking in considering the characteristics defined for the next generation of technologies within a fairly swift market, which will be faced with increasing technological convergence and influences from accuracy, market demand, cost and regulations. The current industrial practices are lacking in visualizing these practices through the concepts of the dynamic capabilities and the technology co-evolution. Therefore, the related gap elements are described in table 6.1 and their detailed discussions are in chapters one and two.

Table 6-1: The elements of the research gap in the research context

The gap elements		
Contexts	**Current concepts**	**Next generation concepts**
Theory of dynamic capabilities	- Identified endogenous role of industrial structure	- Dependence on both the dependent and independent innovative regimes
	- Identified managerial capability as a source of dynamic capabilities	- Dependence on technological capabilities and viewing them as a source of dynamic capabilities
	- Identified separable moderately dynamic and high velocity markets	- Dependence on a fairly swift market which combines attributes of the moderately dynamic and high velocity markets
Technology eco-system	- Identified influences of technological roles (component, product and application, support and infrastructure) on the technology co-evolution	- Dependence of organisational evolutions on the technology convergence and technology co-evolution
Industrial practices of the UK mobile industry	- Dependence on the strategic intelligence of the investment decision makers (mostly managers)	- Dependence on the calculated way of reaching an investment decision with a group of managers and technologists for the next generation of technologies within a fairly swift market

6.4 The Research methodology

In order to answer the basic and problem-oriented research in making the investment decision for the next generation of technologies within a fairly swift market, the methodology of this research works relies upon the case study approach. A case study approach is adopted to achieve evidence for the basic research, then utilizing this evidence for the solution of the problem-oriented research. The case study approach follows the sequential steps:

For basic research;

- Define research question by observing the limitations in the developed theoretical concepts of dynamic capabilities and resource based view;

- Develop a new theoretical concept, an evolutionary framework, to finish those limitations with the integration of the concept of technology co-evolution;
- Identify industrial situations (UK mobile industry) within which a new theoretical concept can be implemented;
- Observe the industrial situations which have occurred within last few years (2001 - 2007) to achieve evidence for the validity of a new theoretical concept;
- Adopt the qualitative information gathering method based on interviews and other parallel resources for observing the industrial situations with more details;
- Delineate the characteristics of a new theoretical concept which defines contribution of technology co-evolution towards the dynamic capabilities;
- Identify influence of drivers on a new concept of an evolutionary framework;
- Adopt the new evolutionary framework to solve the problem-oriented research by developing a solution method for the investment decision makers of the technological organisations within a fairly swift market;

For problem-oriented research;

- Use multi-criteria analysis technique to delineate a set of factors which are recognized through the process of the basic research to solve the problem-oriented research;
- Define explicitly all factors of the problem-oriented research in the context of the mobile industry;
- Adopt the quantitative data gathering method for identifying the relative influence of identified factors
- Utilize these influences to identify the calculated values of the BOCR merits and for the strategic alternatives to reach the investment decision and answer the problem-oriented research;

For basic research;

- Analyze the results of the problem-oriented research to prove the new concept of an evolutionary framework and answer the basic research.

6.5 Summary of the main findings

As the research work evolves, the main finding appears in the form of a solution method for the investment decision makers of the technological organisations within a fairly swift market. Building of the new solution method combines details from several theoretical and practical foundations to develop a new model, called the Dynamic Technological Capability (DTC) model. A summary of the body of the DTC model and its elemental concepts, contexts and method is discussed below:

6.5.1 The body of the Dynamic Technological Capability model

The DTC model is a solution method within the context of technological organisations within a fairly swift market to give a less risky investment decision for the next generation of technologies. Apart from obtaining the merits of the investment decision, it recognizes;

- The influential relationship of the dynamic capabilities with the technology co-evolution;
- The contributions of the dynamic capabilities and the technology co-evolutions towards making an investment decision;
- The contribution of exogenous technologies of independent innovative regimes towards making an investment decision;
- The paradigm of a fairly swift market which is under the influences of accuracy, market demand, cost and regulatory forces of the next generation of technologies.

It defends the above described concepts as it is:

- Dynamic in nature and favours the strategy of continuous evolution in the environment where industrial boundaries are blurring and evolution appears as the only way of achieving value for those organisations which reside inside the dependent innovative regime. The dynamic nature of these environments extends competition from the independent innovative regimes but allows these organisations to identify the future potentials of the endogenous and exogenous resources.
- Technological in characteristics and identifies the strength of technology of proving itself capable of persuading the decision makers to consider its evolution before

making an investment decision. The investment decision must encompass its accuracy and quality, its market demand, its cost and its related regulations and taking into account its opportunities and risks.

- Capability is considered in terms of a vision of the decision makers which can identify the competences of the technological evolutions and can adapt to its variations, searching for and selecting its advance options, replicating it and retaining it for further creating value for their technological organisations.
- Model as it represents a way of adopting a solution method that allows the decision makers to perform a calculated way of making an investment decision for the next generation of technologies within a fairly swift market. The investment decision must comprise the benefits, opportunities, costs and risks merits and on the basis of which calculates the strategic alternatives.
- Next generation of technologies within a fairly swift market which defines an environment in which a previous generation of technology is not outperforming and its next generation is occurring not only because of technology convergence but also because of technology co-evolution, where industrial boundaries are becoming thin and sometimes invisible and where historical knowledge contributes towards making an investment decision.

In short the Dynamic Technological Capability (DTC) model is defined as a solution method for making an investment decision where decision makers identify the capacity of technology to create, extend or modify the resource bases of their organisations.

6.5.2 The elemental concepts: the drivers of research defining reasons for which the DTC model appears for the next generation of technology within a fairly swift market

The four following drivers will interpret the basic reasons for which the appearance of the DTC model occur and which will always be considered before the adoption of the DTC model in the practical environment. These drivers will serve as foundation criteria for:

I. Segregating the environment from others within which the DTC model would be applicable;
II. Developing the basis for the second stage of the DTC model that can identify the features that are needed for the investment decision in the context of the next generation of technology within a fairly swift market.

III. Defining a set of factors which allow the DTC model to allocate them according to these drivers and identify their relative importance.

These drivers are:

1. **Accuracy and quality of technology**, which indicate availability of multiple technologies from which the decision makers have to select the most feasible. The choice of multiple technologies is available from dependent and independent innovative regimes and the decision makers have to be very specific about their needs.
2. **Market demand for technology**, which indicate a shift from the application technology towards the enabler technology which the decision makers have to consider as it can help in capturing new market segments and as a result can increase the worth of the technology.
3. **Cost of technology**, which indicates an identification of the technological potential in making the value for organisations. The choice of investing in technology depends on its return which the decision makers consider before making any technological investment.
4. **Self and governmental regulations of technology**, which indicate conditions which the decision makers have to fulfill in response to regulations offered by the governmental bodies. The decision makers can respond to these conditions by fulfilling the regulatory requirements. They can also develop self regulations under which they can make the investment decisions.

6.5.3 The perspective: a framework of the DTC model for the next generation of technology within a fairly swift market

The context of the DTC model follows two stages

- Gathering and organising information of the previous evolutions of technological, organisational capabilities and resources according to an evolutionary framework;
- Assigning factors with respect to their clusters and measuring their BOCR merits to reach the alternative decision according to the evaluation method.

Each of these stages performs a new operation to building a basis for the investment decision for the next generation of technologies within a fairly swift market consistent with the dynamic nature of the technological capabilities.

6.5.4 The method: the implementation of the DTC model within the next generation of technologies within a fairly swift market

To use the DTC model in the practical environment of the next generation of technologies within a fairly swift market that allows the elemental concepts and drivers to be considered in detail. These details are developed through the following two stages:

Stage 1 - The evolutionary framework

This is a theoretically developed framework which allows evolution to take place inside multiple cycles. The framework integrates the following concepts:

1. ***Technology ecosystem***, that allows co-evolution of different technological roles, components, product and applications, support and infrastructure. The co-evolution allows one technological role to evolve in accordance with other technological roles.
2. ***Dynamic capabilities***, that allow value creation through managerial and organisational processes, position and path where managers can decide about reconfiguring, leveraging, learning and integrating the organisational resources.
3. ***Evolutionary cycle***, that allows evolution to follow the trajectory of variation, selection, retention and replication.

The multiple cycles of an evolutionary framework follow four stages. These stages are discussed below:

- ***Variation/Reconfiguration***, that allows the decision makers to create a new idea on the basis of technological capabilities and adopt the technological role and reconfigure it according to their organisational capabilities;
- ***Selection/Search/Learning***, that allows the decision makers to search for and then select from available technological alternatives by using their learning of the previous technological capabilities;

- ***Replication/Leveraging***, that allows the decision makers to replicate and leverage the previous technological capabilities for other technological roles thereby complementing a process of creating value by saving some created value;
- ***Retention/Integration***, that allows the decision makers to retain those technological capabilities which have been identified as a source of creating values and integrate them with other technological capabilities to create ideas to be reconfigured at the first stage of the second cycle. This stage allows integration from both the dependent and independent innovative regimes.

Stage 2 - The evaluation method

This is a group of 52 factors which appeared after the analysis of the first stage and their relative categorization according to the drivers and under their benefits, opportunities, costs and risks merits which performs the mathematical evaluation to reach the strategic decision.

The evaluation method includes the following steps:

- Defining the groups of 52 factors;
- Organising these factors according to technological evolution (TE), organisational evolution (OE) and resource evolution (RE) clusters;
- Arranging these clusters according to accuracy and quality, market demand, cost and self and governmental regulations;
- Measuring their benefits, opportunities, costs and risks with Analytic Network Process (ANP);
- Reaching the investment decision on the basis of the BOCR merits.

6.6 Contributions

The contribution of this research work can be seen in terms of two aspects:

6.6.1 Contribution to the literature

The contribution of the research work to the literature in the related fields could be classified as follow:

1. A critical review of the theory of the dynamic capabilities and looking at it through the lens of technology evolution, demonstrating the influence of technology co-evolution on the evolution of dynamic capabilities.

2. A conceptualization of a vision of the next generation of technologies within a fairly swift market.

3. An academic analysis of the industrial practices of technological organisations – Vodafone, Orange and O2 UK related to the evolutions which have been taking place within the context of technological capabilities of location based services.

4. Building a basis for an investment decision model in the context of technological organisations by integrating the theoretical concepts within the context of an investment decision model.

5. Delineation of factors which makes the basis for an investment decision model under the characteristics of the next generation of technologies within a fairly swift market.

6. Addition of empirical evidence in the context of the ANP method for making the investment decision on the basis of multi-criteria decision analysis.

7. Identification of the essentials which have to be considered within the above discussed theoretical concepts which will be required in the new environment of the next generation of technologies.

6.6.2 Contribution to the industrial practices

The contribution of the research work to the industrial practices could be classified as follows:

1. A detailed review of all the technological and organisational capabilities of the UK mobile operators in the context of LBS.

2. The development of a historical map, showing all evolutions, for the decision makers of the UK mobile industry which will act as a roadmap in identifying the required evolutions for the next generation of technology.

3. The calculated influence of factors on the investment decision of the decision makers of the UK mobile industry which identifies those areas which require the maximum concentration.

4. The measured values of the benefits, opportunities, costs and risks of the investment decision which identifies the most important strategic alternative for the decision makers in making the investment in the A-GPS technology.

5. The identified important operations which need to be performed in order to create the value from the next generation of the technology.

6.7 Limitations of the research work

The assumptions under which the theoretical concept and a solution method within the context of the DTC model are developed serve as significant limitations on its applications:

1. The DTC model is developed to reach the less risky investment decision for the next generation of technologies within a fairly swift market in the environment where life of the previous generation of technologies is limited and which is completely under the influence of four drivers. In an environment where any one of these drivers is not present the DTC model should be undertaken with caution.

2. During the first stage of the DTC model, in the process of developing a map of historical evolutions, a huge number of directly related and indirectly related factors have been identified. Their detailed analysis is a positive contribution towards the identification of factors for the second stage but it may consume time and effort of the decision makers which they might not appreciate for the process of decision making.

3. During the second stage of the DTC model, in the process of assigning weights to factors, intensive care is required as these factors are relatively prioritized with respect

to each other as well as with respect to three strategic alternatives. The large number of factors and their continuous affiliation with each other and with the strategic alternatives require continuous concentration from the decision makers which if broken, might lead to the selection of the wrong strategic alternative.

6.8 Path forward

The developments within the context of the DTC model indicate the following possibilities of future extensions of the research work:

1. In appreciation of the application of the DTC model in the practical environment, further research is required. In order to answer the practical-oriented research the DTC model is applied to the single industry where development of a set of factors for the identification of a particular decision of the A-GPS investment provides the operational definition of LBS variables with some variations for other technologies. This much detail can offer theory extension but for theory development the DTC model can further be tested to achieve the stipulative definition of constructs. It needs further details about other technological industries which can achieve the benefits of the DTC model. In this regard, the quantitative study of other industries will add more evidence towards the basic research.

2. The DTC model is very specific in selecting the strategic alternative which allows selecting one option from either investing or not investing in a particular technology. It does not offer technological choices from which the decision makers can select one technology. The model can further be extended towards offering these choices to the decision makers.

6.9 Conclusion drawn from the research work

As a result of technological convergence, a way of making an investment decision for the next generation of technologies within a fairly swift market has changed and further changes are certain to continue in order to create value for the technological organisations. The present technology co-evolution proposes that the next generation of technology will rely upon the integration of endogenous and exogenous industrial resources, their inter-

related evolutions and knowledge of their historical evolutions. These underpin the idea that theories which allow the value creation for the technological organisations need to be extended for the next generation of technologies within a fairly swift market. These theories should be accompanied with the solution methods in order to assist the decision makers in making the less risky investment decision.

As technologies start crossing industrial boundaries, a new way of mapping these technological evolutions is required in order to develop the appropriate solution method consistent with the dynamic influences of the driving forces. In this regard, this research develops a new model for the decision makers of the technological organisations, with the particular focus on making the investment decision for the next generation of technologies within a fairly swift market. The fundamental concept of the DTC model is that, the technology co-evolution offers multiple alternatives which vary in respect of their accuracy and quality, market demand, cost and regulations. Furthermore all of them possess their own benefits, opportunities, costs and risks issues. Therefore an appropriate solution method is required which can measure their outcomes and can utilize them in making the investment decision for the next generation of technologies within a fairly swift market.

The DTC model combines two novel operational stages together – the evolutionary framework and the evaluation method – to develop an appropriate basis for making an investment decision under the rapid pace of technological co-evolution, with emphasis on theoretical concepts of the dynamic capabilities; technology eco-system; resource based view; multicriteria decision analysis and analytic network process. The introduction of this model is seen as a shift for the decision makers in making the investment decision from the basis of the strategic intelligence towards a sequential method developed with the help of theoretical concepts. With regard to the undergoing changes in the theory of the dynamic capabilities which co-evolved with respect to organisational knowledge, organisational products, organisational forms, and organisational functions and identified the importance of managerial capability towards evolution, it is possible to extend this concept by saying that ***dynamic capabilities co-evolve with technology co-evolution, due to the importance of dynamic technological capabilities which purposefully create, extend, or modify the organisational resources.***

References

Adner, R. and Helfat, C., 2003. Corporate effects of dynamic managerial capabilities. *Strategic Management Journal*, Vol. 24, pp. 1011-1126.

Adomovicius, G. et al., 2005. Technology roles in an ecosystem model of technology evolution. (Working paper 05-04*)*, MIS Research Centre, University of Minnesota, Minneapolis, MN.

Amit, R. and Schoemaker, P.J.H., 1993. Strategic assets and organisational rents. *Strategic Management journal*, Vol. 14, pp. 33-46.

Antoniou, P.H. and Ansoff, H.I., 2004. Strategic Management of Technology. *Technology Analysis and Strategic Management*, Vol. 16, No. 2, June 2004, pp. 275-291.

Argyris, C. and Schon, D., 1978. *Organisational learning: A theory of action perspective*. Reading, MA: Addison-Wesley.

Araujo, L. and Harrison, D., 2002. Evolutionary process and path dependence in industrial networks. *Technology and Strategic Management*, Vol. 11, pp. 5-19.

Bailey, E.E. and Friedlander, A.F., 1982. Market structure and multiproduct industries. *The Journal of Economic Literature*, Vol. 20, No.3, pp.1024-1048.

Ballon, P. 2004. Scenario and business models for 4G in Europe. *Info*, Vol. 6, No. 6, pp. 363-382.

Barney, J.B., 1991. Firm resources and sustained competitive advantage. *Journal of Management*, Vol. 17, No. 1, pp. 99-120.

Belcher, D., 2007. Mobile and GPS/GNSS - Marriage on the rocks? *Mobile Commerce*, Location and Timing Seminar. 18th January 2007 at NPL.

Belton, V. and Stewart, T., 2002. *Multiple Criteria Decision Analysis: An integrated approach,* Kluwer: Dordrecht.

Berg Insight, 2006. LBS 2006 Temperature meter. *LBS Insight Industry Survey*.

Bresnahan, T.F. and Greenstein, S., 1996. Technical progress and co-invention in computing and in the uses of computers. *Brookings Papers on Economic Activity*, pp. 1-77.

Brown, J.S. and Duguid, P. 1991. Organisational learning and communities of practice: Towards a unified view of working, learning and innovation. *Organisational Science*, Vol. 2, Issue. Feb, pp. 40-57.

Bohlin, E. and Andersson, E., 2004. Wireless R&D in the EU: A review. *Info*, Vol. 6, No. 6, pp. 388-398.

Bowman, C. and Ambrosini, V., 2003. How the resource based and the dynamic capability views of the firm inform corporate-level strategy. *British Journal of Management*, Vol. 14, pp. 289-303.

Casal, C.R., 2004. Impact of location aware services on the privacy/security balance. *Emerald*, Vol. 6, No. 2, pp. 105-111.

Champion, H.R. et al., 1999. Reducing highway deaths and disabilities with automatic wireless transmission of serious injury probability ratings from crash recorders to emergency medical service providers. *International Symposium on Transportation Recorders*.

Chandler, A.D., 1990. *Scale and scope: The dynamics of industrial capitalism*. Belknap Press of Harvard University, Cambridge, MA.

Changlin, M. 2003. Integration of GPS and cellular networks to improve wireless location performance. *ION GPS/GNSS 2003*, 9-12 September, Portland OR, pp. 1585-1596.

Cheng, E.W. and Li, H., 2005. Analytic Network Process applied to project selection. *Journal of Construction Engineering and Management*, Vol. 131, No. 4, pp. 459-466.

Cheng, E.W. and Li, H., 2007. Application of ANP in process models: An example of strategic partnering. *Building and Environment*, Vol. 42, pp. 278-287.

Cheryl, N. and Sivakumar, K. 1997. Emerging market conditions and their impact on first mover advantages: An integrative review. *International Marketing Review*, Vol. 14, No. 6, pp. 461-485.

Coates, T.T. and McDermott, C.M. 2002. An exploratory analysis of new competencies: a resource based view perspective. *Journal of Operations Management*, Vol. 20, pp. 435-450.

Cook, T.D. and Campbell, D.T., 1979. *Quasi experimentation: Design and analysis for field setting.* Houghton Mifflin Company, Boston.

Cohen, W.M. and Levinthal, D.A., 1990. Absorptive capacity: A new perspective on learning and innovation. *Administrative Science Quarterly*, Vol. 35, pp. 128-152.

COM, 2001. European transport policy for 2010: time to decide. *Commission of the European Communities* (White Paper), Brussels 12 Sep 2001, pp. 101.

Conlisk, J., 1989. An aggregate model of technical change. *Quarterly Journal of Economics*, Vol. 104, pp. 787-821.

Cory, T. 2007. *Location Based Services (LBS) 2006 conference report*. Juniper research.

CSR, 2007. CSR Plc to deliver sub $1 GPS, acquires NordNav Technologies AB and Cambridge Positioning Systems Ltd. LPS media.

Davenport, T. Jarvenpaa, S. and Beers. M., 1996. Improving knowledge work process. *Sloan Management Review*, Vol. 37, pp. 53-66.

Davies, A. and Brady, T., 2000. Organisational capabilities and learning in complex product systems: towards repeatable solutions. *Research Policy*, Vol. 29, pp. 931-953.

Denzin, N.K., 1978. *The research act*, (2nd Ed). McGraw-Hill, New York.

Dierickx, I. and Cool, K., 1989. Asset stock accumulation and sustainability of competitive advantage. *Management Science*, Vol. 35, pp. 1504-1511.

Drucker, P.F., 1991. The new productivity challenge. *Harvard Business Review*, Vol. 69, Issue. Nov, pp. 69-76.

Dodourova, M., 2003. Industry dynamics and strategic positioning in the wireless telecommunications industry: the case of Vodafone Group plc. *Management Decision*, Vol. 41, No. 9, pp. 859-870.

Eisenhardt, K., 1989. Building theories from case study research. *Academy of Management Review*, Vol. 14, No. 4, pp. 532-550.

Eisenhardt, K. M., 1989. Making fast strategic decisions in high velocity environment, *Academy of Management Journal*. Vol. 32, No. 3, pp. 543-576.

Eisenhardt, K. M. and Martin, J. A., 2000. Dynamic capabilities: what are they? *Strategic Management journal*, Vol. 21, pp. 1105-1121.

ENSI, 2004. European Satellite Navigation Industries, Location Based Service.Available: http://www.medis-sat.de/galileo/galileo.nsf/pages/CONT-627HWA?openDocument&e

Fagerberg, J. and Malm, A., 2006a. Personal navigation market snapshot. *Berg Insight* (White paper), April, 2006.

Fagerberg, J. and Malm, A., 2006b. Strategic analysis of the European mobile LBS market. LBS Research Series, *Berg Insight*, September, 2006.

Feagin, J., Orum, A., and Sjoberg, G., 1991. *A case for case study*. Chapel Hill, NC: University of North Carolina Press.

Fleck, J., 2000. Artefact ↔ activity: the coevolution of artifacts, knowledge and organisation in technological innovation, in Ziman, J., (Ed.). *Technological innovations as evolutionary process*. Cambridge University Press, London.

Fleming, L., 2001. Recombinant uncertainty in technological search. *Management Science,* Vol. 47, pp. 117-132.

Fielding, N.G. and Fielding, J.L., 1986. *Linking data*. Sage, Newbury Park, CA.

Finney, V., 2002a. *Mobile location case studies*. Baskerville Executive Briefing, London.

Finney, V., 2002b. *Mobile location update: Technology is good, but where are the services*. Baskerville Executive Briefing, London.

Firmin, P.E., 2006. Satellite navigation technology applications for Intelligent Transport System: A European perspective. *European Navigation Conference*, Manchester, 8 – 10 May 2006.

Frost and Sullivan, 2001. *European automotive telematics system and service market*. Market Research.com Report, May 2001.

Fuente, C.D. et al., 2004. *Location based services and enabling technologies in Japan*. DTI Global Watch Mission Report, Nov/Dec 2004.

Galli, L. et al., 2005. *Initial market place dynamic (Including Business Model) analysis*, IST-2004-511607, MobiLife.

Gibson, B. and Cory, T. 2005. *Location: Mobile*. Juniper research (White paper).

Glaser, B.G., 1978. *Theoretical Sensitivity,* Sociology Press: Mill Valley.

Gold, B., 1988. Charting a course to superior technology evaluation. *Sloan Management Review*, Fall, pp. 19-26.

Goodwin, P. and Wright, G., 2004. *Decision analysis for management judgement*, (3rd Ed.). Wiley: Chichester.

Guille, M., 2001. The evolving location based services opportunity. *Business and Technology*, Vol. 1, No. 4.

Hamel, G. and Prahalad, C.K., 1994. *Competing for the Future,* Boston, Mass.: Harvard Business School Press.

Hanley, J., Scarda, S. and Wasle, E., 2006. Application for Galileo in the LBS environment (AGILE). *European Navigation Conference 2006*, Paper reference 104.

Hansen, M.T., 1999. The search-transfer problem: The role of weak ties in sharing knowledge across organisational subunits. *Administrative Science Quarterly*, Vol. 44, No. 1, pp. 82-111.

Hart, J. and Hannan, M., 2004. The future of mobile technology and mobile wireless computing. *Info*, Vol. 21, No. 5. pp. 201-204.

Hegger, D.L.T. et al., 2007. Niche management and its contribution to regime change: The case of innovation in sanitation. *Technology Analysis and Strategic Management*, Vol. 19, No. 6, November 2007, pp. 729-746.

Helfat, C.E. and Raubitschek, R.S., 2000. Product sequencing: Co-evolution of knowledge, capabilities and product. *Strategic Management Journal*, Vol. 21, pp. 961-979.

Helfat, C.E. et al., 2007. *Dynamic Capabilities: Understanding strategic change in organisations*, Blackwell Publishing.

Henderson, R. and Cockburn, I., 1994. Measuring competence? Exploring firm effects in pharmaceutical research. *Strategic Management journal*, Vol. 15, pp. 63-84.

Henderson R.M. and Clark, K.B., 1990. Architectural innovation: The reconfiguration of emerging product technologies and the failure of established firms. *Administrative Science Quarterly*, Vol. 35, pp. 9-30.

Imcb, 2004. Setting a framework for commercial contents. Classified framework for mobile operators in UK. 24 Sept, 2004.

Jenkins, B. et al., 2005. *Galileo awareness and justification study final report*, ESYS consulting report, ESYS-2005484-RPT-02.

Jick, T.D., 1979. Mixing qualitative and quantitative methods: Triangulation in action. *Administrative Science Quarterly*, Vol. 24, pp. 602-611.

Juniper Research, 2006. *Location Based Services 2006*. Conference Report.

Kaasinen, E., 2003. User needs for location aware mobile services. *Personal and Ubiquitous Computing*, Vol. 7, No. 1, pp. 70-79.

Kaplan, A., 1964. *The conduct of inquiry*. Chandler, San Francisco, CA.

Kerridge, S., 2000. Orange is going on location with information service. *CNET Network*, 21st June 2000.

Kidder, L.H. and Judd, C.M., 1986. *Research methods in social relations*, (5th Ed). CBS College Publishing, New York.

Kirman, A., 1997. The economy as an evolving network. *Evolutionary Economics*, Vol. 7, pp. 339-353.

Kodama, F., 1992. Technology fusion and new R&D. *Harvard Business Review,* July-August, pp. 70-78.

Kogut, B. and Zander, U., 1992. Knowledge of the firm, combinative capabilities, and the replication of technology. *Organisation Science*, Vol. 3, Issue, Aug, pp. 383-397.

Langlois, R., 1992. Transaction cost economics in real time. *Industrial and Corporate Change*, Vol. 1, No. 1, pp. 99-127.

Lawrence, P.R. and Lorsch, J.W., 1967. *Organisation and environment: Managing differentiation and integration*, revised edition (1986) Harvard Business School Press, Boston, MA.

Leonard, D., 1995. *Wellsprings of knowledge: Building and sustaining the sources of innovation*. Harvard Business School Press, Boston, MA.

Li, F. and Whalley, J., 2002. The destruction of the telecommunications industry: from value chain to value networks. *Telecommunications Policy*, Vol. 26, No. 9/10, pp. 451-472.

McCutcheon, D.M and Merideth, J.R., 1993. Conducting case study research in operations management. *Journal of Operations Management*, Vol. 11, pp. 239-256.

McIvor, R., 2000. A practical framework for understanding the out-sourcing process. *Supply Chain Management: An International Journal*, Vol. 5, No. 1, pp. 22-36.

McIvor, R., 2005. *The outsourcing process: Strategies for evaluation and management*. Cambridge University Press, New York.

McQueen, D. et al., 2002. *Location Based Services: Worldwide market analysis and strategic outlook 2002-2007*. Strategic Report by ARC Group.

McQuigg, R., 2006. Mobile technology for GenNext. *iMedia Connection*: Connecting marketing community.

Meade, L. and Sarkis, J., 1998. Strategic analysis of logistics and supply chain management systems using the analytic network process. *Transportation Research Part E: Logistics and Transportation Review*, Vol. 34, No. 3, pp. 201-215.

Meade, L. and Sarkis, J., 1999. Analysing organisational project alternatives for agile manufacturing process: an analytic network approach. *International Journal of Production Research*, Vol. 37, No. 2, pp. 241-261.

Middleton, C.J., 1967. How to set up a project organisation. *Harvard Business Review*, March-April, pp. 73-82

Molenaar, K.R. and Songer, A.D., 1998. Model for public sector design build project selection. *Journal of Construction Engineering Management*, Vol. 124, No. 6, pp. 467-479.

Montibeller, G. et al., 2006. Combining scenario planning and multi-criteria decision analysis in practice. *Journal of Multi-criteria decision analysis*, Vol. 14, pp. 2-20.

Nelson, R., 2000. Selection criteria and selection process in cultural evolution theories, in Ziman, J. (Ed.). *Technological innovations as evolutionary process.* Cambridge University Press, London.

Nelson, R.R. and Winter, S.G., 1982. *An evolutionary theory of economic change.* Cambridge, MA: The Belknap Press.

Nonaka, I.A., 1994. Dynamic theory of organisational knowledge creation. *Organisation Science,* Vol. 5, Issue, Feb, pp. 14-37.

NorthStream AB., 2001. Location Based Services: Consideration and challenges. NorthStream (White Paper).

NXP Semiconductor, 2008. Ultra low power, single chip GPS solution. *3G News*, 6th Feb 2008. Available: http://www.3g.co.uk/PR/Feb2008/5721.htm

Oftel quarterly market information, April to June, 2003.

Oshri, I. and Weeber, C., 2006. Cooperation and competition standards-setting activities in the digitization era: The case of wireless information devices. *Technology Analysis and Strategic Management*, Vol. 18, No. 2, May 2006, pp. 265-283.

Panalver, G. and Bonhomme, T. (2007), 'Research @ Orange Labs: building competitive advantage through innovation', Presentation given at Orange Partner camp.

Parmigiani, A., 2007. Why do firms both make and buy? An investigation of concurrent sourcing. *Strategic Management Journal*, Vol. 28, pp. 285-311.

Penrose, E., 1959. *The Theory of the Growth of the Firm.* (Third Ed.). Oxford, UK: Oxford University Press.

Peppers, D. and Rogers, M., 1997. *Enterprise one to one: Tools for competing in the interactive age*. Biddles TTD, London.

Pisano, G., 1994. Knowledge, integration and locus of learning: an empirical analysis of process development. *Strategic Management Journal*, Winter Special Issue, Vol. 15, pp. 85-100.

Platts, K.W., 1993. A process approach to researching manufacturing strategy. *International Journal of Operations and Production Management*, Vol. 13, No. 8, pp. 4-17.

Polyani, M., 1966. *The tacit dimension*. Garden City, New York: Doubleday.

Portio Research., 2006. *Mobile fact book*. http://www.portioresearch.com/resources.html

Prahalad, C.K. and Hamel, G., 1990. The core competence of the corporation. *Harvard Business Review*, Vol. 68, No. 3, pp. 79-91.

Priem, R.L. and Butler, J.E., 2001a. Tautology in the Resource Based View and the implication of externally determined resource value: Further comments. *Academy of Management Review*, Vol. 26, No. 1, pp. 57-66.

Priem, R.L. and Butler, J.E., 2001b. Is the Resource Based View a useful perspective of strategic management research? *Academy of Management Review*, Vol. 26, No. 1, pp. 22-41.

Quinn, J.B. and Hilmer, F.G., 1994. Strategic outsourcing. *Sloan Management Review,* Vol. 35, No. 4, pp. 43-55.

Ray. B., 2007. Blue Sky squeezes GPS onto a SIM. *Register Hardware*, News, 26th April 2007.

Richardson, G.B., 1972. The organisation of industry. *The Economic Journal*, September, pp. 883-896

Rindova, V.P. and Kotha, S., 2001. Continuous 'Morphing': Competing through dynamic capabilities, form and function, *Academy of Management Journal*, Vol. 44, No. 6, pp. 1263-1280.

Rodriguez, C., 2003. Location and personal information for direct marketing: third generation killer application, *Info*, Vol. 5, No. 2, pp. 45-50.

Romer, P., 1995. Beyond the knowledge worker, *World Link,* Vol. 28, Issue, Jan-Feb, pp.56-60.

Rosenberg, N., 1982. *Inside the Blackbox: Technology and Economics*. Cambridge, UK: Cambridge University Press.

Rosenkopf, L. and Nerker, A., 1999. On the complexity of technological evolution: Exploring co-evolution within and across hierarchical levels in optical disc technology, in Baum, J.A.C. and McKelvey, B. (Eds), *Variations in Organisation Science: In honour of Donald T. Campbell*, Sage Publications, Thousands Oaks, pp. 169-183.

Rubin, H.J. and Rubin, I.S., 1995. *Qualitative Interviewing: The Art of Hearing Data*, Thousands Oaks, CA: Sage.

Saaty, R.W., 2003. *Decision making in complex environments,* Creative decision foundation, Pittsburgh.

Saaty, T.L., 1980. *The analytic network process*, New York, NY: McGraw-Hill.

Saaty, T.L., 1994. How to make a decision: The analytic hierarchy process. *Interfaces,* Vol. 24, No. 6, pp. 19-43.

Saaty, T.L., 1996. *Decision making with dependence and feedback: The Analytic Network Process*, RWS publications.

Saaty, T.L., 2000. *Fundamentals of the Analytic Hierarchy Process*, RWS Publications.

Sarkis, J., 1999. A methodological framework for evaluating environmentally conscious manufacturing programs. *Computing Industrial Engineering*, Vol. 36, pp. 793-810.

Saviotti, P.P., 1996. *Technology Evolution, Variety and the Economy*, Edward Elgar Publication, Cheltenham.

Schoenmakers, W. and Duysters, G., 2006. Learning and strategic technology alliances. *Technology Analysis and Strategic Management*, Vol. 18, No.2, May 2006, pp. 245-264.

Schumpeter, P. J. H., 1934. *Theory of Economic Development*. Cambridge, MA: Harvard University Press.

Schumpeter, J., 1942. *Capitalism, socialism and democracy.* New York, NY: Harper Row.

Scottsdale, A., 2006. *Wireless Location Services for Businesses Could Top 1 Million Subscribers by 2010*. In-Stat Report.

Silva, A.P., 2002. *Location based taxi service in wireless based environment*. Dissertation, MSc Computer Science, Federal University of Minas Gerais.

Special issue on GPS, *Proceedings of IEEE*, January 1999.

Stake, R., 1995. *The art of case research,* Newbury Park, CA: Sage Publication.

Steenhuis, H. J. and Bruijn, E. J., 2004. Building Theories from Case Study Research: The Progressive Case Study. (Working Paper).

Steinbock, D., 2002. What happened to Europe's wireless advantage?. *Info*, Vol. 4, No. 5, pp. 4-11.

Stuart, I. et al., 2002. Effective case research in operations management: A process perspective. *Journal of Operations Management*, Vol. 20, pp. 419-433.

Styles, J., Jenkins, B. and Sage, A., 2005. An update of the market context for Galileo. *GNSS 2005 Conference*. 13-16 September, Long Beach, California.

Swanborn, P.G., 1996. *Case study's, Wat, Wanner en hoe?*, Boom: Amsterdam.

Swann, J. et al., 2003. Galileo: Benefits for location based services. *ION GPS/GNSS*, 9-12 September 2003, Portland, OR.

Szulanki, G., 1996. Exploring internal stickiness: Impediments to the transfer of best practice within the firm. *Strategic Management Journal*, Vol. 17, Winter Special Issue, pp. 27-43.

Tavana, M. and Banerjee, S., 1995. Strategic assessment model (SAM): A multiple criteria decision support system for evaluation of strategic alternatives. *Decision Sciences*, Vol. 26, No. 1, pp. 119-143.

Tayles, M. and Drury, C., 2001. Moving from make/buy to strategic sourcing: the outsource decision process. *Long Range Planning*, Vol. 34, No. 5, pp. 605-622.

Teece, D.J., 1980. The diffusion of an administrative innovation. *Management Science*, Vol. 26, No. 5, pp. 464-470.

Teece, D. J., 1986. Profiting from technological innovation: Implications for integration, collaboration, licensing and public policy. *Research policy*, pp. 285-305.

Teece, D. J., Pisano, G. and Shuen, A., 1997. Dynamic Capabilities and Strategic Management. *Strategic Management Journal,* Vol. 18, No. 7, pp. 509-533.

Teece, D.J., Pierce, J.L. and Boerner, C.S., 2002. Dynamic capabilities, competence, and the behavioural theory of the firm. *in Augier, M. and March, J.G.* (*Ed*.)*, The Economics of change, choice, and structure: Essays in the memory of Richard M. Cybert*. Cheltenham: Edward Elgar.

Tellis, W., 1997. Application of a Case Study Methodology. *The Qualitative Report*, Vol. 3, No. 3.

TruePosition, 2005. People tracking – a potential break through LBS application. *NorthStream*, (White Paper), March 2005, pp. 1.

Tushman, M. and Rosenkopf, L., 1992. On the organisational determinants of technological change: Towards a sociology of technological evolution. In Staw. B. and Cummings. L. (Eds.), *Research in organisational behaviour*. JAI Press, Greenwich, CT. pp. 311-347.

Van Maanen, J., 1987. Tales of the field. University of Chicago Press, Chicago.

Wallance, W., 1971. *The logic of science in sociology*. Aldine Atherton, Chicago, IL.

Wang, L. et al., 2007. Selection of optimum maintenance strategy based on a fuzzy analytic hierarchy process. *International Journal of Production Economics*, Vol. 107, pp. 151-163.

Wernerfelt, B., 1984. A Resource Based View of the firm. *Strategic Management Journal*, Vol. 5, pp. 171-180.

Wilde, G., 2002. Why are LB$ a long time coming? BWCS Report.

Wilde, G. et al., 2004. E-112 Issues and Answers: Recommendations and Insight for the Optimal Planning and Implementation of E-112: Emergency Wireless Location for the European Union. (White Paper). Location Resource Centre.

Williams, D.H., 2007. Why LBS applications fail, LBS360.NET Article, 31 January, 2007.

Williamson, O.E., 1975. *Market and hierarchies: Analysis of antitrust implications*. Free Press: New York.

Williamson, O.E., 1981. The economics of organisation: the transaction cost approach. *American Journal of Sociology*, Vol. 87, No. 3, pp. 548-577.

Williamson, O.E., 1999. Strategy research: governance and competence perspectives. *Strategic Management*, Vol. 20, No. 12, pp. 1087-1108.

Winter, S.G., 1984. Schumpeterian competition in alternative technological regimes, *Journal of Economic Behavior and Organisation*, Vol. 5, No. 3, pp. 287-320.

Yin, R., 1984. *Case study research: Design and methods* (1st Ed.). Beverly Hills, CA: Sage Publishing.

Yin, R., 1989. *Case study research: Design and methods*, (2nd Ed). Sage, Newbury Park, AC.

Yin, R., 1993. *Applications of Case Study Research*, Newbury Park, CA: Sage Publishing.

Yin, R.K., 1994. *Case study research, Design and methods*, (2nd Ed). Sage Publication: Thousand Oaks.

Ziman, J., 2000. Evolutionary models for technical change, in Ziman, J. (Ed.). *Technological innovations as evolutionary process.* Cambridge University Press, London.

Ziman, J., 2000. Selectionism and complexity, in Ziman, J. (Ed.). *Technological innovations as evolutionary process.* Cambridge University Press, London.

Zollo, M. and Winter, S.G., 2002. Deliberate learning and the evolution of dynamic capabilities. *Organisation Science*, Vol. 13, No. 3, pp. 339-351.

Zott, C., 2003. Dynamic capabilities and the emergence of intra-industry differential firm performance: Insight from a simulation study. *Strategic Management Journal*, Vol. 24, pp. 97-125.

Appendix A: List of interviewees and their contact details

Vodafone, Orange and O2, UK

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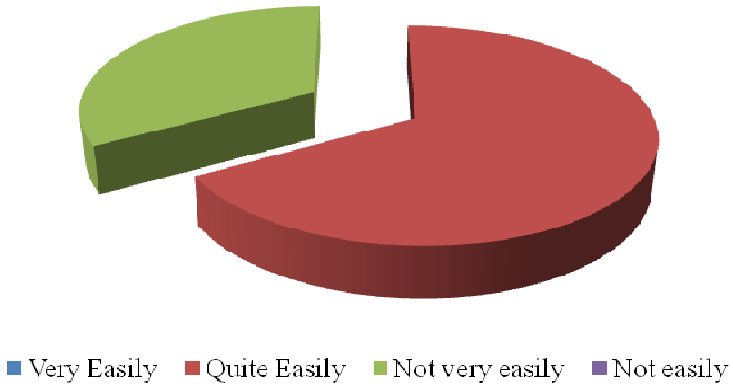
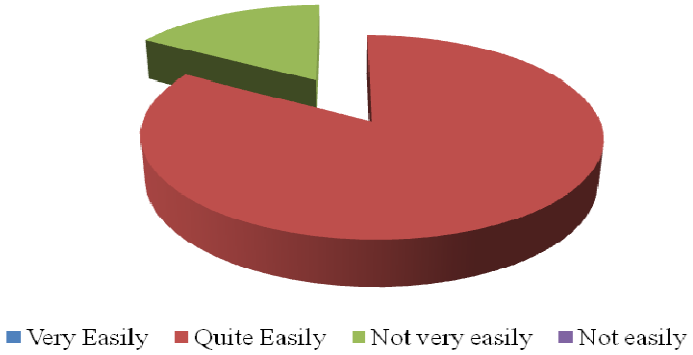
Appendix B: Feedback received from the mobile operators for the feasibility, usability and utility of the DTC model

Feasibility



Usability



Utility