New Technology Adoption in Field Service Operations: An Exploratory Study

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Abstract

For products that require maintenance and repair during the lifetime, field service plays an indispensable role in fulfilling customers' needs, maintaining customer relationships, and creating revenue streams. As such, companies increasingly seek to improve service quality and efficiency by applying new technologies in field service operations. Clearly, the actual contribution gained from the application depends on the process through which the technology is chosen, implemented and integrated into the service organisation. Therefore, it is important for both suppliers and acquirers to understand the process of new technology adoption. Despite the importance, however, there remains little knowledge on this topic.

In recognising the knowledge gap, this paper refers to studies in broader areas such as innovation assimilation and implementation, and proposes a conceptual framework of new technology adoption. This is followed by in-depth case studies of 11 companies – three suppliers of mobile technology and eight acquirers in equipment, utility, and property sectors – in which we examine the drivers of technology adoption, the nature of the adoption process, the major barriers involved, and the roles of suppliers and acquirer. The results support and add details to the conceptual framework, and the resulting process model illustrates the phases a field service organisation should go through for smooth implementation. The findings also highlight the gap between what is needed by the service organisation and what is offered by the suppliers during the adoption process.

In presenting the paper, we make both theoretical and practical contributions. For service operations literature, the paper adds an organisational dimension into the relationship between technology and service. Meanwhile, it provides well-grounded guidance for suppliers and acquirers to manage new technology adoption in field service operations.

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1 Introduction

1.1 Background

Companies are becoming increasingly aware of the value customers place on service, from the initial contact to after-sales. Field service is an integral part of the value-adding process and there is greater recognition of its strategic importance and that of investment into its infrastructure (Downton, 2007). This is because, in addition to being a potential revenue stream, field service is an important point of contact between service organisations and customers. Field engineers often visit clients to repair breakdowns, and these breakdowns lead to hostile feelings towards the company in the customer. The image a company presents in the field can greatly affect how it is perceived by customers, affecting its reputation and its market placement relative to the competition. As a result, there is much investment into improving field service management and becoming customer oriented.

Technologies in general have vastly improved over the past few decades, and those applied in field service management have benefited greatly, with many different hardware and software solutions. There is great scope for increasing productivity, efficiency and quality through the utilisation of new technologies (Yen and Chou, 2000) and through better practices. However, as with any innovation, the actual contribution a company can gain from its employment depends upon how the technology is chosen, introduced into the company culture and implemented into existing operations (Agnihothri *et al.*, 2002; Leseure *et al.*, 2004). It is therefore of great importance that technology suppliers and acquirers understand the processes involved in adoption. Nonetheless, there remains little knowledge as to how new technologies are adopted in field service operations.

1.2 The Study

The research outlined in this paper aimed to investigate new technology adoption as a process. Specifically, the purpose was to explore the stages involved and the major barriers to the adoption process. A further objective was to study how the ecosystem surrounding the technology affects the adoption process and the role of the supplier and the acquirer in the adoption process. After a practice review of field service management, new technologies, and their associated technology services, it was decided that mobile technology is the most appropriate as the main focus of the research. Through case studies, the research sought to produce an inductive process model of mobile technology adoption in field service companies. This model and the other findings provide a basis for future research into the process and the roles of the organisations involved.

The results support and add detail to the conceptual framework, producing a stage model illustrating the phases a service organisation should go through for smooth implementation. Finally, by examining the process from both sides, the research highlighted areas for further investigation, including the gap between what is needed by the service organisation during technology adoption and what is offered by the suppliers.

2 Practice and Literature Review

2.1 Practice Review

Broadly speaking, service organisations fall into two main categories (Agnihothri *et al.*, 2002). These are facility-based, where customers access the service at the service provider's location, such as travel agents, banks, post offices, etc., and field-based, where the service is provided at the customer's location. The latter also includes remote repair and self-help instructions on the Internet.

There are three sub-categories (Figure 1) within field-based services: delivery and collection, emergency services and after-sales service. After-sales service, referred to as field service within this paper, includes the installation, maintenance and repair of capital equipment, consumer goods, utilities and facilities. Field service management is the practice of managing field service through a variety of techniques; an attempt to optimise processes and information utilised by companies who send staff 'into the field'.

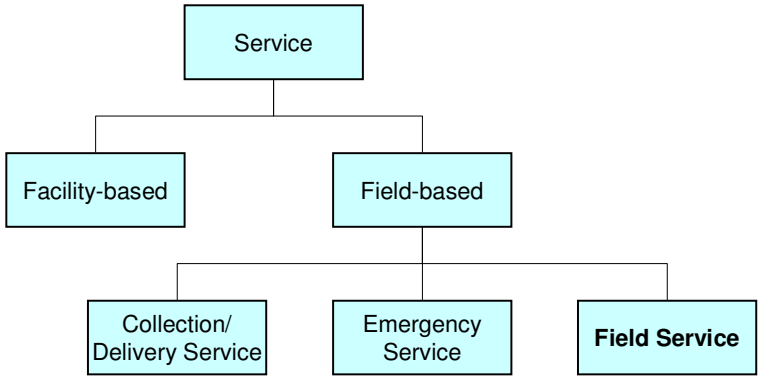

Figure 1 Classification of Services (Source: Agnihothri *et al.*, 2002)

Field service differs not only from facility-based services but also other field-based services. With facility-based services, the revenue from the service provided is explicit. The same is true of delivery and collection services, yet the revenue from field service is vague. Service organisations are usually contracted to maintain the client's commodities to an agreed standard over a set period of time for a fee. Over that period of time, little maintenance may be needed or a lot, something the service provider and the customer do not know when agreeing the terms of the service level agreement (SLA).

The technology and technology services available to support field service management falls into three categories, as defined by the Service Management Buyer's Guide 2007. These are management software, field service support and mobile communications. It is the latter on which this paper focuses – mobile devices with wireless communication capabilities – a technology ideally suited to working in the field. In these cases, the overall mobile data solution usually includes at least one software component utilised in the back office that will interface with the mobile devices, e.g. a scheduler, falling into the category of management software. There are therefore at least two technology suppliers, one for the software and one for the hardware (Figure 2), and the relationships between both of the suppliers and the client are of great importance.

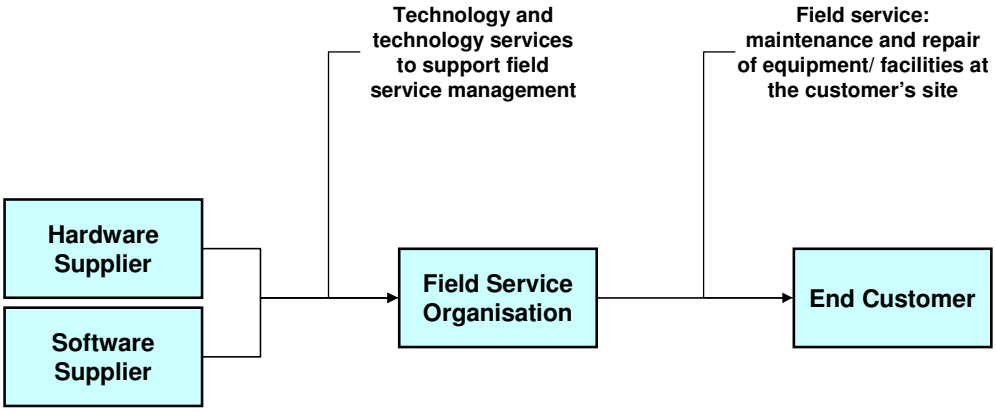

Figure 2 Roles and Relationships involved in New Technology Adoption

It is the nature of field service that the engineers are dispersed throughout the region covered (Turner, 2006), often with a lot of paperwork that can easily be misplaced. In addition, for back office to know the status of any engineer or job, they have to call the engineer for an update or wait for the engineer to return to their depot with the completed paperwork. By operating in this way, field service is associated with slow response times and inaccurate information, and service organisations and their clients have often seen this as a necessary evil. However, growing awareness of available technology has led to more service companies seeking a mobile data solution (Downton, 2007). Yet mobile technology adoption in field service management poses a unique problem for field service companies. The implementation involves issuing a device to each engineer in the department or company, and for many service organisations this is a huge logistical exercise. This makes it paramount that the adoption process goes as smoothly as possible.

2.2 Literature Review

2.2.1 Field Service Management

There is very little research into technology in field service management and even less into mobile technology adoption in this sector. The existing literature mainly focuses on the benefits gained by adopting mobile technology (Barnes *et al.*, 2006) and how to select Internet or mobile technology to maximise these benefits (Agnihothri *et al.*, 2002). Evans (2002) specifically gives attention to mobile business solutions, highlighting field service as a possible application due to the large scope for process improvement. He places emphasis on the adoption drivers and barriers, and how awareness of these will allow business management to make informed decisions.

Most of the research on technology adoption in service organisations predominately focuses on Customer Relationship Management (CRM) application software (e.g. Chang *et al.*, 2002; Xu *et al.*, 2002), used by a company's Marketing, Sales and Help Desk departments. However, there is more written on adopting new technology in other sectors.

2.2.2 Technology Adoption Process

Although they did not look further than adoption decision in their study of Canadian small to medium manufacturers (SMMs), Langley and Truax (1994) suggest four contextual elements to explain how a strategic commitment is reached. The first is the *information* element whereupon the managers are bombarded with information on new technologies, from suppliers, trade associations, etc. Secondly, there are the *sensitising* elements which are internal or external changes that improve the chance of strategic commitment. Conversely, the third element is *inhibiting***,** which reduce the potential. Finally, they identified *precipitating* elements which finally tip the balance in favour (or against) of the technology. By defining them as contextual elements and not outlining a stage prior to the commitment, emphasis is place on the informality prior to strategic commitment. They further comment that these contextual elements are idiosyncratic in nature and in ordering, with no discernable pattern, fitting a *serendipitous* type of process model. In addition, they propose that even once formal procedures begin for technology investment specification, context factors still have an influence, although the nature of influence may change.

When it comes to the technology choice, the process is explicit and formal, leaving a paper trail. The suggestion is that activities undertaken during the technology choice can be grouped into three: *diagnostic*, defining and confirming priority projects, listing specific technologies, etc.; *feasibility studies*, detailed specifications of the type of system needed, analysis of how such a system would fit within the company, payback, etc.; and *supplier evaluation and selection*. At the financial justification stage, Langley and Truax (1994) found the processes are similar to that of political justification, and that reports for the technology choice are reused for the financial justification and vice versa. This is despite the technology choice being an internal process and the source of SME finance external.

In contrast, in their study of American community hospitals, Meyer and Goes (1988) propose a stage prior to the strategic commitment. Designated the *Knowledge-Awareness* stage, it consists of three sub-stages leading to the *Evaluation-Choice*. These are apprehension, where individuals learn of the innovation's existence, consideration, where they consider the innovation's suitability, and discussion concerning adoption. The second stage, *Evaluation-Choice*, is almost concurrent with Langley and Truax, and consists of the acquisition proposal, followed by fiscal evaluation and political-strategic evaluation,. The final stage is *Adoption-Implementation* where there is trial, acceptance and expansion. Between the first and the second stage, there is the strategic commitment, and between the second and the third, the adoption decision.

2.2.3 Facilitating and Inhibiting Conditions

Through quantitative and qualitative research, Meyer and Goes (1988) propose a sequential model of assimilation of innovative technology that suggests three classes of antecedents: contextual, innovation and those arising from their interaction. Similarly, Gallivan (2001) suggests three classes of facilitating conditions: organisational, innovation, and those related to the work task itself. The first group, the organisational or contextual attributes, are equivalent to the organisational climate, as discussed by Klein and Sorra (1996). They propose that "the stronger an organization's climate for the implementation of a given innovation, the greater will be the employees' use of that innovation, provided employees are committed to innovation use" (Klein and Sorra, 1996, p.1061). The 'climate' is seen as the environment the organisation operates in, the organisational structure, the business strategy

and the views of the decision makers (Meyer & Goes, 1988; Klein & Sorra, 1996; Gallivan, 2001; Agnihothri et al., 2002; Evans, 2002).

The technology and how it meets the needs of the user also affect implementation (Meyer & Goes, 1988; Klein & Sorra, 1996; Gallivan, 2001; Agnihothri et al., 2002; Evans, 2002). It is proposed that the attributes of the technology (e.g. ease of use, return on investment) affect technology adoption, acting as possible barriers or drivers. Furthermore, where the specifications of the technology closely meet the need identified, innovations are more likely to be assimilated.

Finally, in addition to facilitating conditions, Gallivan (2001) proposes two more constructs between the adoption decision and the adoption process. The first is managerial intervention, "the actions taken and resources made available by managers to expedite… adoption, including mandating usage" (Gallivan, 2001, p 61). The second is subjective norms; the beliefs of the affected personnel about the expectations others within the organisation may have on the technology adoption. These subjective norms affect the end-users attitude to the innovation, and any related training. Managerial intervention is also raised by Weiss (1994), who argues that when the expectation of technology improvements is high, the adoption process is more likely to be suspended prior to the adoption decision while the firm awaits the new technology.

2.2.4 Summary

When looking at technology adoption, the literature is divided at the top end. Prior to the strategic decision, there is much to support a serendipitous model, and yet the same can be said for the sequential. With so many variables, such as industry and organisation size, both models may hold. There is a need to explore if either holds in field service, and if neither holds, if there is evidence to suggest a model may exist. Furthermore, technology is not adopted in a vacuum, with the extant literature suggesting that the environment, the stakeholders and the suitability of the technology for these all play a part in successful implementation of technology. For field service, one need ask what the most important drivers and barriers are for the adoption of mobile technology, and what action can be taken my adopters and suppliers to make the 'climate' for adoption as favourable as possible.

3 Conceptual Framework

Drawing on the existing literature, a conceptual framework was developed (Figure 3) for the process. The purpose of this was to provide guidance for the research, as will be discussed in Section 4, and act as a basis for the final process model. Such models are helpful in explaining how technology adoption occurs; highlighting the context of the adoption and any links between this and the outcome (Gallivan, 2001).

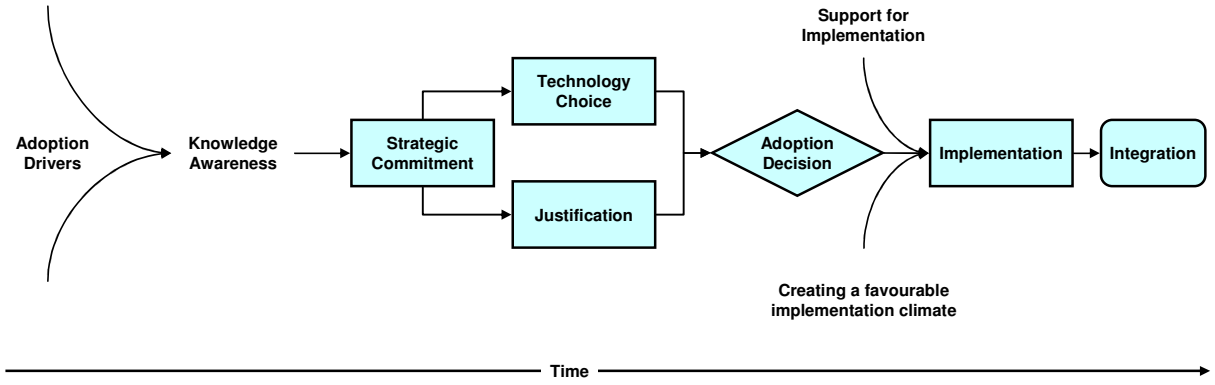

Figure 3 Conceptual Framework

(adapted from Meyer & Goes, 1988; Langley & Truax, 1994)

It may be self-apparent, but technology adoption is not a spontaneous event. There are drivers that lead to it, highlighting problem areas that need a solution. However, these problem areas may have been in existence for some time, with no viable solution. It is not until the organisation becomes aware of possible solutions that a strategic commitment is considered. Therefore, extending part of the model proposed by Meyer and Goes (1988), the conceptual framework includes a knowledge awareness stage, which in turn leads to a strategic commitment as outlined by Langley and Truax (1994). The nested technology choice and justification are a combination of the two models, with the justification being not only financial, but also political-strategic. If the appropriate technology can be found, and the justification approved, an adoption decision is made and contracts are signed.

Following the adoption decision, the literature suggests that action should be taken to provide support for the implementation, including an implementation plan, in addition to ensuring that the new technology is implemented into a climate that is complimentary. However, the nature of these actions when adopting mobile technology into a service organisation is unclear. Once the organisation has been made ready for the technology, the implementation begins. As the field workforce of service organisations are dispersed, this poses an interesting logistics question, as mentioned in Section 2. After all these stages, ample time and resources will have been invested by the organisation, hopefully leading to a full integration.

This conceptual framework outlines the basic stages of mobile technology adoption within field service management, as drawn from the literature, acting as a theoretically grounded model for the process. Its existence gave the research a path; to test whether the theory held true in practice, to provide detailed expansion of each stage and answer the following research questions: What is the process of new mobile technology adoption in field service management? What are the major barriers to the adoption process? What is the role of the supplier and the acquirer in the adoption process? How does the ecosystem surrounding the technology affect the adoption process?

4 Research Methodology

Clearly, in order to gain an in-depth understanding of mobile technology adoption in field service management, case study approach is more appropriate as opposed to quantitative methods. Accordingly, the research carried out for this paper was in the form of case studies. These involved telephone interviews, emailed questionnaires, archive study and document reviews. Eleven companies assisted with the research – three technology suppliers and eight acquirers (see Appendix I) – and the multiple case design allowed the conceptual framework to be tested in an assortment of circumstances; not only between the suppliers' views of the process and the acquirers', but between the different categories of acquirers. These were capital equipment, with two acquirers, utilities, with three acquirers, and facilities maintenance, also with three. Unfortunately, none of the consumer goods service organisations contacted were able to help with the research.

Using Eisenhardt's (1989) process of building theory from case study research, a research design was formed as shown in Figure 4. This illustrates the research progression through selecting cases, shaping the data collection instruments and protocols, collecting and analysing the data, forming the hypotheses, comparing the results with literature and drawing conclusion.

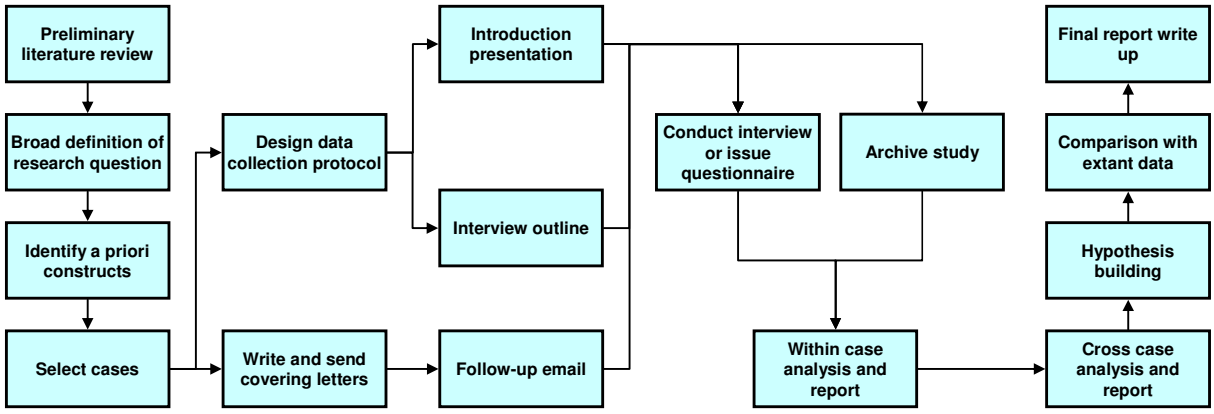

Figure 4 Case Study Process (adapted from Eisenhardt, 1989)

It was hoped that researching the adoption process from each side of the relationship would produce a more comprehensive picture of the adoption process, so technology suppliers were selected as cases, in addition to technology acquirers. The supplier cases were selected in the expectation that they may be able to recommend clients willing to assist with the research. After the practice and extant literature was reviewed, and mobile technology selected as the area for further research, suppliers were short listed to those supplying handheld terminals and PDAs and/or mobile communications software. As a result, 12 suppliers of mobile devices, and software for these devices, were contacted.

Three technology suppliers assisted with the research. The first, S1, is a supplier of handheld devices and PDAs, offering a managed service. This includes the GPRS network, repair and replacement of the devices, training and help desk support. The second, S2, designs software for mobile devices, targeted specifically at field service, offering an off the shelf package, as well as bespoke. The final supplier, S3, manufactures ruggedized notebooks and handhelds, and offers customers of purchasing service packages to cover the implementation period.

The service organisations were selected once confirmation had been received from the technology suppliers. The case histories were reviewed for the details of the contact within the organisation responsible for managing the implementation programme, followed by an internet search for the service organisation. Using this method 14 acquirers were selected, with an additional one recommended by S2. These 15 acquirers each offer maintenance and repair services for capital equipment, consumer goods, utilities or facilities. Eight (labelled A1 to A8) were willing to be cases for the research, although none of these was consumer goods organisation.

Once the cases were selected, and confirmation received, it became apparent that face-to-face interviews were unworkable due to geographical and temporal constraints, and in some cases the latter made telephone interviews unfeasible. However, in order for cross-case analysis to be worthwhile, the questions answered needed to be identical within the case groups. Therefore two interview outlines were constructed, one for the suppliers and one for the acquirers (see Appendix II and III). These outlines had a style that could be used as a questionnaire if necessary, and in the four cases where contacts were unable to spare time for a telephone interview, the relevant outline was emailed to them, along with a short presentation explaining the research and its aims.

After each interview, or after each questionnaire was returned, a case report was compiled based on the notes taken from the interview or the question responses, in addition to the supplier case histories (in the instance of the technology acquirers) and any documentation shared. They were divided into eight sections – company background, adoption drivers, technology awareness, supplier awareness, adoption process, barriers, post-implementation and other – each with narrative descriptions of what occurred in that particular case. This produced increased familiarity and allowed the adoption process to be easily identified for each case. It in turn accelerated cross-case analysis, as suggested by Eisenhardt (1989).

The cross-case analysis was carried out on many levels (Figure 5). The purpose of this was to look for any patterns, in general and within each subgroup, that supported or contradicted the framework. Given the number of cases, and the levels of cross-case analysis, it was hoped that doing so would offset premature or incorrect conclusions. Each cross-case report was divided into adoption drivers, supplier and technology awareness, adoption process (with subsections for each stage identified within the group), barriers, post-implementation and other. As with the within-case analysis, this format allowed further cross analysis. This method of data handling enabled the research to go beyond initial assumptions, increasing the probability of explicit and consistent theory (Eisenhardt, 1989).

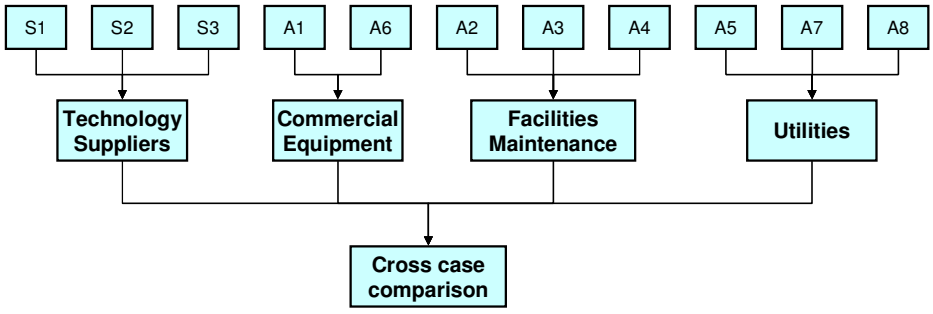

Figure 5 Hierarchy of within-case and cross-case analysis

5 The Findings

The results of the case studies can be easily broken into stages concurrent with the conceptual framework, as shown in Figure 6. These start with the adoption drivers, and increasing knowledge awareness. The decision makers then make a strategic commitment, although such a commitment does not necessarily result in a concrete adoption decision. Before this decision, there are the parallel stages of technology choice and justification of the proposal, with the former commencing earlier than the latter. After the adoption decision, there are various activities to prepare the technology and organisation for the new system including solidifying the system design and training. There may also be a trial, but not always, as discussed in section 5.5. The implementation itself takes the form of a stepped rollout, leading to integration. Throughout, the acquirer must face and overcome adoption barriers.

5.1 Adoption Drivers

The workforce is the most expensive asset a service company has. A team of field engineers require a lot of back office support, and in low technology firms, this is usually in the form of a large administration team. In recent years, there have been many mergers and takeovers within the service industry, leading to larger workforce levels, raising logistics problem, and with paper and phone based systems, visibility of this workforce and traceability of their actions is difficult to achieve.

With tighter regulations, customers giving greater consideration to the standard of service they receive and maturing industries where revenues from product sales area stagnating, adoption drivers fall into three intersecting categories. The first is *Compliance*, to achieve high levels of all of the regulatory measures for sector leading compliance. This gives rise to drivers for assistance to workforce traceability, prevention of lone working in dangerous situations through the provision of accurate information, and overall, improved ability to audit actions. The second is *Service*, to supply the best quality service to customers, improving the customer experience by allowing engineers and back office access to up-to-date asset history, scheduling, etc. The final category is *Value-Cost*, to provide all of the above whilst maintaining the best value for money, including reducing drive time and other none value added activities, reducing staffing in the field and/or the office, and reducing telephone traffic.

Many of the drivers further lead to the recognition of the need for accurate and up-to-date information. In all cases, one of the major drivers for adoption was the increased need for traceability of engineers and job status. This would primarily allow the service organisations to reassign jobs to engineers who were completing their workload faster than expected from engineers that were not. The secondary reason was to give clients the option of scheduling the service appointment and to update them if the engineer is to be late.

Overall, the technology adoption is part of a business improvement to become more competitive, driving the company towards a mobile data solution integrating a scheduling system, asset database and a network of mobile device. The aim is to improve efficiency, productivity, information accuracy and communication, while reducing costs, staffing, paperwork and none value added processes.

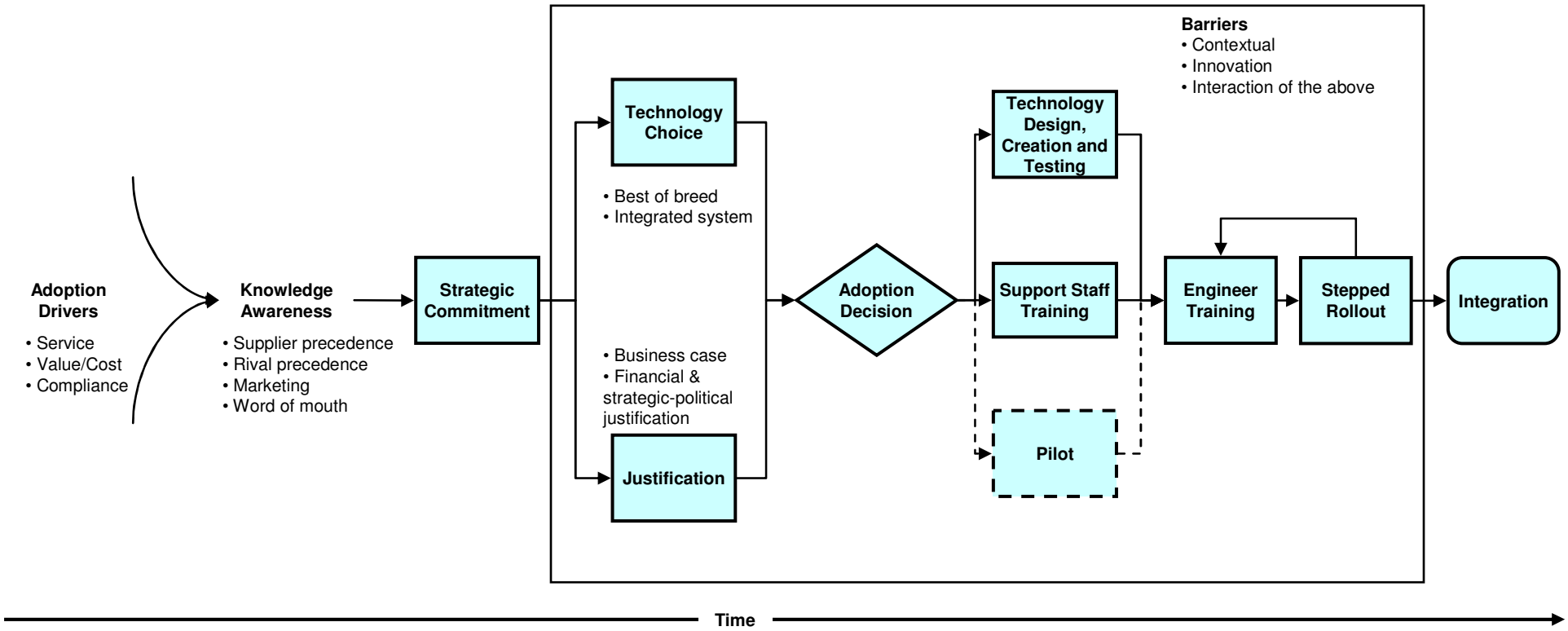

Figure 6 A Process Model of Mobile Technology Adoption in field service

5.2 Knowledge Awareness

Once the company becomes aware of a problem, they do not go straight out and solve it. They need to know that solutions exist or at least believe that there is the potential to create one cost effectively. The service organisation usually becomes aware of the technology through rival precedence, supplier precedence, marketing or word of mouth. However, once the service organisation is aware that a solution exists, they must decide if they wish to go with an integrated system, opt for best of breed or create a solution in-house. The latter option takes more time and resources, has more likelihood of failure, and is usually taken when the first two options become unviable, as in the case of A1.

Integrated systems usually have a central database with optional modules, all with a similar look and feel, making the overall system user friendly. These systems do not require middleware/interfacing which can be expensive, and the licenses needed are usually less than with best of breed. Furthermore, accessing shared data is easier for the lack of interfaces. However, the system's functions may not exactly match the organisations needs. This usually requires greater modification of processes to suit, and not necessarily for the better, leading to dissatisfied end users.

Best of breed options usually have greater functionality, with bespoke features allowing increased productivity or efficiency, yet the initial investment is higher. Having multiple systems working together also requires greater internal IT support and interfaces. In addition, if there are any faults or breakdowns in the system, there is the issue of culpability, with the multiple suppliers laying the responsibility with one of the others.

Choosing the system with which to proceed depends upon the organisational culture on all levels. In all cases, the hardware is provided by a secondary supplier, as discussed in the section 5.3.

5.3 Technology Choice

The next decision facing service organisations is to choose among alternative suppliers and technologies, once a strategic commitment has been made to consider the adoption of a mobile data solution. With the cases, those who opted for an integrated system first approached their existing software provider with their problem. The supplier then suggested a mobile data solution produced in conjunction with their partner, the hardware supplier. The acquirers who decided to go best of breed carried out benchmarking and market place review, either in-house or with consultants, looking at the technology available and what the suppliers had to offer. The suppliers chosen were those with an offer that closely matched, if not met, the specifications.

After the suppliers are selected, there then follow a series of demonstration to showcase the hardware and visits to past clients to see working solutions. These visits also allow the service organisation to discuss what they should expect during and post implementation. There are additionally many meeting between the suppliers and adopter to narrow down the specifications. In a few cases, a pilot was also held, serving as an extended demonstration to illustrate the relative durability of the technology options as well as their suitability to the task. These activities all act as aids to the justification process which is run almost in parallel.

5.4 Justifications

In conjunction with the technology choice, there is the justification stage. This begins just after the technology choice has begun, allowing the implementation to team to become acquainted with the options available. The structure of the justifications depends upon the company's procedure for business change. Many of the companies have a Business Change Programme requiring the proposal be submitted as a business case or as an investment appraisal. In this situation, the problem is outlined and the possible solutions discussed. From there, one solution is recommended, with how this recommendation was reached explicitly delineated. Finally, the associated cost of each option is explained with initial expenditure and the expected return on investment (ROI) after five years. The other companies, however, had to submit a financial and strategic-political justification. These explained the ROI, total cost of ownership (TCO), etc., as well as why that solution is best, what effects it could have on daily operations and the proposed implementation plan.

In either case, it is made clear that the implementation will take time and resources, yet with careful planning, it is expected that gains in productivity could be achieved a few weeks after going live, drawing on the experiences of the service organisations visited during the technology choice stage.

5.5 Climate, Support and Implementation

Once the board has approved the acquisition, work needs to be done so that the implementation is as problem-free as possible. Regular meetings between the implementation team and suppliers are necessary, with the suppliers' project representatives effectively becoming part of the team. This commitment and support is needed throughout the process. The internal I.T. department should also be involved so that they understand the how and why of the technology. It is suggested that a test environment be created for the software, especially if the service organisation has opted for best of breed. The software and hardware can then be regularly tested for interfacing problems, any bugs and job suitability.

When it comes to training, it is a case of 'train the trainer' or dedicated training. 'Train the trainer' involves the supplier training a select group at the service organisation. In turn, this group trains the relevant personnel. The other option is a dedicated training team from the supplier to educate the necessary organisation members. While 'trainer the trainer' is a much cheaper choice, can provide the nominated trainers with an in-depth knowledge of the technology and can also make the personnel trained feel more at ease and comfortable with the technology by being taught by their peers. It is not necessarily true that those selected will grasp the technology to such a level that they could confidently teach others. In comparison, the dedicated training from the suppliers is provided by teams that have experience in educating about similar technology and will have faced a variety of the issues that may arise in the training sessions and in the field.

Of the cases studied, it was found that where 'train the trainer' was employed, there were more issues post-implementation of user acceptance. These firms confronted issues ranging from lower understanding of the technology and its purpose to repeated damage to devices. In most cases, however, acquirers purchased the dedicated training offered by the suppliers,

linked with a buddy or champion scheme. This meant the organisation got the benefit of training tailored to their workforce, with technology proficient end-users acting as advocates for the system. In some cases, buddies went out with those who were having difficulties with the technology. This allows those struggling to see how their peers cope and to discuss any issues. To adopt this method means that there are effectively two engineers working on one engineer's workload which would probably be lighter than average. Therefore, during this period, productivity can drop.

Another option employed by service organisations was that of champion or super-users. Similar to buddies, they are field engineers who have quickly understood the technology. However, they do not shadow their peers in the field but act as the first point of reference to discuss any problems and troubleshoot technical issues. Again giving the end-user the option of first raising issues with peers who have a greater comprehension of the situation aids the implementation process.

In all cases, once the technology modification of the existing and new systems had progressed sufficiently, back office training began. The purpose of this is to familiarise the call-centre, schedulers and other users with the software and the various interfaces. It may even be possible to go live on these without engaging the mobile element to allow an even greater understanding through repeated, daily use. In many cases, the back office staff fear automation, as they realise that reduced paperwork and fewer no-value-added process require less staff. Reduction of administration is usually part of the new system; administrators are often transferred to customer care or retrained as schedulers.

As previously mentioned, in most cases the back office went live before the field. Many of the organisations took advantage of this time period to trial the mobile part of the system. However, others did not, feeling a trial or pilot could result in the workforce viewing the final implementation as only a possibility. A lot of resources had been devoted to the project and all organisations had mandated that the implementation would proceed. For firms that decided against as official trial, the first few weeks of rollout acted as a pseudo-trial, as discussed later.

A trial allows the devices, protocols and interfaces to be tested without too much disruption; the implementation team can see whether what works on paper and in the test environment truly works in the field. In all the cases that had a trial, a small group of engineers was selected, representative of the ages and skills of the workforce. Through the trials, the firms were able to not only fine tune the system, but consider how the rest of the workforce could be best trained. In addition, the trial users usually had the option of becoming buddies or champions. The trials are usually structured so that the trial group receive basic tasks on their devices; this lighter than usual workload allows them to get used to working with the complete mobile data solution. Any issues found during the course of the working day can be discussed with the implementation team and suppliers at the end of the day debriefing. The software is then modified as necessary and (remotely) uploaded onto the devices at the morning briefing the next day. Hardware changes would be noted and modifications made to the devices issued during the rollout. Overall, a trial enables the implementation team to finalise what the organisation needs and wants on all level.

After the trial, field rollout begins. This is stepped and integrated with the end user training, as recommended by all the suppliers. As with the trial, it is recommended that the workforce be divided into small groups of 8 to 10 users. Each group is trained on the devices over one day, signing them out at the end of the day. The next day, half of the time is set aside for any questions, but the group will have essentially gone live by the end of the day. Extra help and support should be available, supplementary to the standard post-implementation support, in case there are any problems in the field, with another day reserved two to three weeks later for further questions.

Rollout is therefore limited by the speed at which engineers can be trained. In the case of acquirer A8, with 28,000 engineers nationally, rollout took 12 months; both the software and hardware were modified throughout. These adaptations were based on the feedback of the engineers who had already gone live, giving the later groups the best possible solution.

It is clear from the research that a lot of time and resources are invested in preparing the organisation for the new system, and preparing the system itself. Special attention is paid to the users, particularly the end-users, and whether training is in-house or supplier provided, this is only part of the initiatives to prepare the workforce for the new system. Assistance, support and reassurance from peers are obviously highly valued and the consideration given to users brings to light the importance the acquirers place on user understanding, acceptance and commitment to the new system.

5.6 Barriers

The barriers faced by the service organisations were encountered throughout the adoption process. As soon as a strategic commitment had been made, barriers to change made themselves apparent. These fall into three groups, as discussed by the extant literature on technology adoption within organisations: contextual barriers, innovation barriers and barriers arising from the interactions of context and innovation.

The main contextual barrier faced by all is the end-user and unions. As with any business change, there are those on all levels that are adverse. In the situation of introducing mobile technology into the field, there are many reasons for this: some users do not see a need for change, there is a lot of fear that the technology adoption will be linked with job losses, as well as fear that the technology will make their jobs harder and a minority worry that if they do not learn how to use the devices they will be laid off. Finally, the field engineers are used to arriving at the depot, receiving the days work orders and spending time catching up with colleagues. Then, throughout the day they can choose the order in which to complete the jobs, and if they finish early, they may just return home. However, the new mobile data systems do not require the engineers to go to the depot, and the day's work is prescheduled. When a job is completed, notification is sent back to the office straight away, and if an engineer looks to be finishing early, further work can easily be assigned. For many end-users they see this as a reduction in job satisfaction; removing the social aspect of depot visits and taking away scheduling control. The unions take on all of these issues on behalf on the end-users, and they have also raised their concerns about using the devices to track the engineers' whereabouts.

The adoption process therefore requires discussion with union representatives on the final solution, as well as new contracts. These contracts should clarify job descriptions, protect

end-user privacy and include an appropriate use clause for the devices. The latter is particularly useful for service organisations akin to A8, who allow their field engineers to use the mobile devices – in this case, ruggedized notebooks – for personal use. Further steps have been taken by individual acquirers to allay end-user reservations, as will be discussed in section 5.7.

Additional contextual barriers encountered were board scepticism, middle management understanding, and the IT department's views. The board at A3 were doubtful that tradesmen would be able to cope with the new technology; whether they could carry out the required tasks or treat the devices appropriately. However, this uncertainty was overcome through talking with similar organisations during the technology choice stage, aiding the justification. At a lower level, in a few cases, middle management did not understand the technology or its purpose, and when those under their management came to discuss any issues they had with the proposed system, negative views were often reinforced. To overcome this, some organisations held general information days for the board and management as part of the training.

Many acquirers had problems with the perception of the solution from the point of view of internal IT. These IT departments felt that they would be able to produce the required solution. In the case of A7, the care of their IT infrastructure was outsourced to another organisation. A bespoke mobile solution was offered by the IT company as part of a SAP integration. However, this company had no experience of mobile solutions and this was done without input from the hardware suppliers. The implementation failed. The other service organisations were aware that there is a greater risk of failure when opting for an in-house solution and therefore decide on an external solution.

The innovation barriers, while decreasing due to developments in the technology and infrastructure, are not so easily overcome. One of the main issues is patchy coverage, as out in the field getting a signal is not necessarily guaranteed. In these regions the field engineers have learnt to work around this. There are also the problems of interfacing the different systems, leading to highly complex middleware with associated costs, as well as problems linked to the devices and their peripherals. These include poor battery life if the battery is not discharged frequently as well as the visibility of PDA screens in bright light.

The barriers that arise from the interaction of the innovation and context could be major blocks to the process. One of these is board indecision (Weiss, 1994), where the need for a mobile solution is acknowledged but not acted upon. This can delay the adoption decision, with waiting for newer, higher specification technology as the most common cause for this. While such indecision is understandable, implementation teams may feel frustrated at the justification stage, especially if they believe that the proposal they have put forward is ideal for the organisation.

Another issue faced is that of IT security. Where there are many users behind the firewall, the organisation's IT security policy may preclude third parties behind the firewall. Acquirers A1 and A6 both had this problem. A6 decided to proceed with an external solution, yet A1 decided to opt for an in-house solution. This decision occurred late in the process; a supplier had been chosen and contracts were about to be exchanged. They were therefore able to base the in-house system on the system they would have purchased. Yet, it is the former Service

Director's belief that the IT department would not have been able to create a system without having gone through the initial technology choice stage with the chosen supplier and that if an external solution was possible, it would have gone live much faster.

The barriers faced by the acquirers during adoption fit general technology adoption theory, yet it is clear that contextual barriers are the largest, incorporating end-users. However, the other two categories are not insignificant. While innovation barriers decrease over time as technology improves, they still exist. They can be circumvented, but their existence can reduce the overall efficiency of the final system. The third barrier type, resulting from the interaction of innovation and context can halt, delay or redirect the adoption process, and should not be overlooked. Research has shown that barriers are part of the adoption process and cannot be avoided, but awareness, preparation, engagement and flexibility can overcome these inhibiting factors.

5.7 Integration

At the post-implementation stage, effort is still required to fully integrate the new system into the organisation's operations. These mainly focus on the people aspect, as the case acquirers all agreed that the technology part of the adoption is straightforward and while it will enable a business change, without the full commitment of the people who are going to use it, the desired change will not occur.

While the adoption drivers on an organisational level are clear, the users do not often see the immediate benefits for them. This contributes to the end-user as a barrier. However, there are many drivers that should be emphasised for full integration; accentuate the positives and eliminate the negatives. In addition to reinforcing the benefits for the end-user, ample field support is needed. This includes a repair and replacement service provided by the supplier, as a broken device renders the user inoperative. In addition, support must be available whenever and wherever the engineers may need it. This is so that any faults in the system can be put right and any queries answered while causing minimal damage to productivity.

For post-implementation end-user support, the organisations continue to utilise their own end-users. To do this, acquirers A1, A2 and A7 established user groups and encouraged on-line forums. This way, issues and problems can be comfortable discussed with peers, and these initiatives provide constructive criticism which can be utilised in system updates and any further phases, providing a system best tailored to the tasks required.

Finally, a few of the service organisations realised that while the mobile data solution adopted only used one device type, one size does not necessarily fit all. Some end-users require ruggedized devices while others do not; some engineers' work days are best suited to a PDA over a notebook or vice versa. Therefore, when it comes to the stage when a device needs replacing the new device is more tailored to the individual user's needs, as opposed to the generalised needs of the workforce. Nevertheless, the acquirers in question acknowledge that to adopt a mobile data solution with multiple devices into an organisation without any previous mobile data solution would be more difficult than with one device type. This is because the initial adoption is implementation of a radical innovation, even with one device, while later upgrades are incremental.

6 Conclusions and Discussions

6.1 Conclusions

Field service is a sub-section of field based service, the repair or maintenance of assets at a client's location. The revenues associated with this service are not always explicit, but increasingly service organisations are recognising the revenue potential. Those organisations with legacy (pen and paper) systems understand that in order to fully take advantage of the potential, productivity and efficiency need to be improved. In addition, by improving these areas, the image of the company as perceived by customers and shareholders can only be improved, raising the market position. However, field service is by definition dispersed, so companies opt for mobile data solutions, combining hardware and software. This means that there are at least two suppliers, either working in partnership on an integrated package or contracted separately for a best of breed solution. Combined with the diffuse, mobile workforce, this poses an interesting logistics question for the service organisation's implementation team. As the success of the system, which can be measured through increases in productivity and efficiency as well as monetary savings, is partially dependent on the adoption process, the results of this study will be of use to both the potential acquirers and the technology suppliers. This is expounded further in section 6.2.

While very little literature exists on technology in field service, the extant literature does emphasise the benefits to be gained through technology use, especially if the appropriate technology is selected and applied correctly. Much of the recent literature on technology in service focuses on that based in the office, CRM software, with the application of such software in the service industry has become increasingly popular over the past two decades. Nevertheless, the existing literature on technology adoption in different sectors does suggest common themes. There is the strategic commitment followed by a period where the technology is reviewed and the appropriate innovation is selected, coupled with justifying the potential adoption to the relevant bodies. The adoption decision follows, succeeded by the implementation. However, literature indicates that the success of this implementation is dependent upon the climate, both internal and external of the organisation, the innovation and how these two interact.

The literature brought about a series of questions in relation to the nature of the adoption process, the major barriers involved, the roles of the suppliers and acquirer and how the environment surrounding the technology affects the adoption process. The conceptual framework generated based on the sub processes described in the literature and on the knowledge of field service management technology acted as a compass, guiding the research through data collection and analysis. The research carried out was a form of case study research, with telephone interviews, questionnaires, archive study and document review. This method was well suited to the exploratory nature of the research, and coupled with the iterative data analysis, produced informative results. These findings closely match the framework, at the top end especially. The divergence after the adoption decision is a result of there being little prior knowledge of the implementation part of the process in field service organisations.

The adoption drivers fall into at least one of three categories. They either come from the organisation's desire to offer a higher level of service, their need to better comply with regulation and their wish to increase value and reduce costs. These categories have been labelled Service, Compliance and Value-Cost respectively, and are a direct result of this

research. These drivers amalgamate with an increasing knowledge awareness, resulting from the recognition of suppliers and rivals with similar systems as well as marketing and word of mouth; this combination leads to the strategic commitment.

The steps between the strategic commitment and the adoption decision are concurrent with the framework, an amalgamation of Meyer and Goes (1988) and Langley and Truax (1994). The technology choice and justifications overlap, with the technology choice starting before the justification stage, but being finalised only when the justification ends and the proposal is signed off.

Even before an adoption decision has been made the implementation team risks barriers that could halt the adoption process. As in the literature, these were found to fall into three groups; contextual barriers, innovation barriers and barriers arising from the interaction of contexts and innovations. The contextual barriers further divide into external environment and internal environment, with the latter being the most important overall; it is this group that contains end-users. Complete end-user acceptance of the new system, understanding of its purpose and comprehension of the technology are the ideal for the perfect system, and anything less can cause disruptions to the adoption process. Training and support are therefore vital.

Prior to going live, the technology needs readying; modifying the existing system and fine tuning the new. System interfaces should not be overlooked, however, it is the people part of the solution that requires the greatest focus. Holding a general information day for management and the board can help influence organisational opinion in favour of the adoption while also educating about the functions of the system and the expected effects on daily operations. The acquirers that took this step did so as part of the overall training, but to do so prior to the adoption decision could aid the justification and give middle management a greater idea of organisation direction, allowing them to allay end user fears.

All the users need support; education and reassurance. Both the back office and the field staff training can be carried out by in-house trainers or supplier provided trainers; the second method usually results in much more comprehensive training. Either way, training is linked with the rollout. This way, the people of the organisation are eased into the new system, with its new technology and associated processes.

The support does not end after fully live; both technical and organisational assistance are requisite. The infrastructure and the devices necessitate the availability of support whenever and wherever they are in use. This means that the Service Level Agreements (SLAs) with suppliers need reviewing to ensure the necessary level of support, reducing the potential for lost earnings during a system breakdown, no matter how minor in the general scheme of things. One device out of a few thousand may sound insignificant, but if it is not repaired or replaced quickly the engineer in question cannot do his or her work. However, they will still be paid.

The research showed that organisational support should continue to reinforce and build the employees' confidence. Providing an arena for users to elucidate their views and issues, or to ask for advice from their peers can go a way towards this. These forums are also a fertile source for ideas of further modifications to the system and illustrate how involving stakeholders in the adoption process, especially the end-users and possibly customers, could

be useful. These two groups are of particular note as it is these that will interface directly with the mobile devices. However, this involvement needs not start early in the process; the feedback from any trial held prior to rollout can bring to light system modifications.

Overall, the process is fairly sequential, with steps carried out in a similar order across the cases. Another detail that is common across cases is the relationship between suppliers and acquirer; it is purely of a transactional nature, albeit a long term transaction. The suppliers offer technology and support for this technology, including training, in exchange for finance. That is to say that they do not provide support for the overall business change, just the technology change. All the suppliers made their clients aware that organisational change was necessary, but no support was offered for this. The possible reasons for this are discussed in section 6.2.

6.2 Implications and Discussions

One main product of this research is the inductive process model of new mobile technology adoption in field service companies. It builds on general, supporting the importance of contextual barriers, innovation barriers and contextual-innovation barriers. While founded on these theories, this model is specific to field service, an area where the technology adoption process is the focal point of very little academic research. The field service management literature had no models on technology adoption and, while this study concentrates on mobile technology, the resulting process model goes some way to reducing this deficiency. By introducing this exploratory research into the existing body of knowledge, a greater understanding of the adoption process and its associated drivers and barriers can be garnered.

An area of particular significance is the three categories of adoption drivers; Compliance, Service and Value-Cost. The drivers for the adoption of new technology in other sectors may fall into these categories or similar and this research has the potential to add to general technology adoption theory.

In addition to the above theoretical implications, the process model also has considerable implications for practice. As an overall stage model, it can act as a guide for implementation, outlining the steps needed as part of an implementation plan. It also highlights that when adopting a new system, the service organisation should never underestimate the value and importance of the users. They will need support throughout, even once the rollout is over and the implementation team disbanded. This support will first take the form of training, and the implementation team needs to decide whether this should be in-house or supplier provided. The research has shown that while the former is cheaper in the short term, the gains in productivity relative to the latter method combined with user acceptance mean that it may be more expensive in the long term. Initiatives that provide support after implementation are also necessary and this research delineates possible methods and the associated benefits. The same is true of trials, and this research provides organisations with the knowledge they need to make an informed decision as to whether to hold a trial or treat the first few weeks of the stepped rollout as a pseudo-trial.

Most importantly, this research draws attention to the fact that the technical change involved in technology adoption is only part of a much larger business change. This business change also requires modifying employment contracts, SLAs, processes, etc. as well as the

organisational culture. By informing acquirers of this fact prior to their embarkation on a technology adoption, they can better prepare for what lies ahead. For suppliers, this research can help them provide the tools to assist their clients through the business change and not just on the technical side.

The research is not without weakness. By using acquirers found through the suppliers, the impression of the process may be positively skewed. However, this method of garnering contacts is the most productive when time is limited. Furthermore, the case studies were not as in depth as the ideal due to the absence of face-to-face interviews and some case companies unwilling to share documentation on the adoption process. Ideally, case study interviews would have been held with many levels of the company hierarchy less than one year after going live, yet the research covers rollouts that occurred between 1994 and 2005.

Despite the limitations, this research has emphasised the vast potential that exists for research into technology adoption into field service management, both on a micro and macro level. Considerable work could be carried out to add texture to the process model. Combining a series of longitudinal case studies could not only enable study into the timescale for the process and provide greater detail on each stage; it would also facilitate research into stakeholder involvement, and their relative influence and interest, at each stage. There is further potential to extend the research and the process model to include more technology types, or produce further process models for these types for comparison. The same could be true for company size; micro, small, medium and large.

Research to add detail to the model or to expand it into further areas is undoubtedly interesting and very attractive, yet the research has brought to light an even more fascinating theme for exploration. As acquirers do not usually understand the technology or the organisation change involved, they need support and reassurance. This requires suppliers and acquirers be acutely aware of the necessity of organisational change. In the research cases, while all parties were aware, the suppliers did not provide support. Software providers, hardware suppliers and the client all need to be aware of, and work towards, the overall business solution.

However, establishing the holistic view is easier said than done. Commonly, acquirers are led by what the suppliers can supply. This means many additional benefits can be lost through lack of support of organisation change, as suppliers often cannot justify the cost of such support, either to the acquirer or to themselves. One reason for this is that organisational change is often perceived as intangible due to the lack of physical evidence of change. This means that the acquirer is more likely to credit a large percentage of the resulting benefits to the technology change. Furthermore, the suppliers may have enough of an understanding of the industry that acquirer operates in to design a mobile data solution, yet they do not understand the internal working of the organisation. This means that the organisational change necessary is unclear, adding to supplier reluctance to offer support services, especially as most supplier organisations are built on the technology and have little knowledge or applicable experience of organisational change.

However, there exist many consultancy firms that offer such support; from aiding the technology choice to highlighting areas within the acquirer's business that should be the focus of organisational change. Therefore, it would be interesting to investigate the roles of all the

organisations involved in technology adoption and what support the suppliers and consultants offer the acquirer. Questions arise about why suppliers do not offer support for organisational change, the exact nature of the services offered by the various suppliers and consultants, and if there exists a gap between the support offered and the support required.

Wherever future research into technology adoption in field service management proceeds, this research has illustrated that if researched properly and the appropriate technology is chosen, the technology acquirer can achieve satisfying results within an expected time frame.

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Appendix I – Case Companies

Company Classification		#	Company Description	Interviewees	Data Sources
Technology Suppliers		S1	Provide infrastructure/services between management systems and the workforce	Channel Development Executive	~1 hour telephone interview
		S2	Develop and implement mobile enterprise solutions and management services	UK Country Manager	~45 min telephone interview
		S3	Manufacturer of ruggedized laptops and PDAs	Sales Contact	Written questionnaire
Technology Acquirers	Equipment suppliers	A1	Manufacture and service printers for commercial and industrial customers	Service Director (retired)	~1 hour 30 min telephone interview
		A6	UK Provider of sales and customer support of heavy plant construction equipment	I.T. Manager	Written questionnaire
	Property maintenance	A2	Contract maintenance services for housing associations and landlords	Assistant Head of Building & Maintenance	~1 hour 15 min telephone interview
		A3	Housing association with in-house maintenance	I.T. Manager	~1 hour telephone interview
		A4	Energy and Technical Services: facilities services	IT & Comms – PRIME	Written questionnaire
	Utilities	A5	Provider of clean water and sewerage	ICOM - Field Operations Team Leader	Written questionnaire
		A7	Provider of water and waste water services in the UK	Data Solution Manager	~35 min telephone interview
		A8	Provider of communications solutions worldwide	National Implementation Manager for Field Systems	~1 hour 15 min telephone interview

Appendix II – Supplier Interview Outline

Research project introduction

This questionnaire outlined below was prepared by the Institute for Manufacturing for a research project on new technology adoption in field service management. It is intended to understand the process and challenges of new technology adoption in the context of service management.

Thank you very much indeed for your time!

Company information:

- Company Name:
- Number of Employees (direct and indirect):
- Briefly describe the company:
- Range of products and services offered:

Interview questions:

1. Which industries do your clients come from?
2. How do your customers usually become aware of your company?
3. What are the main drivers for adopting mobile technology?
4. What are the main reasons for choosing your company as supplier?
5. What stages does the client undertake before deciding upon a product?
6. Once the product is chosen, what steps does the client undertake before implementation? What does each stage involve?
7. How does your company communicate/interact with the client at each stage?
8. What barriers to integration does your company encounter during technology implementation?
9. Which do you feel was the most significant? Why?
10. What measures can be taken to overcome the barriers?
11. Do you have any written guidelines for aiding technology adoption? If yes, could I have a copy?
12. Could you recommend a few clients who would be willing to discuss their experiences of mobile technology adoption?
13. Is their anything more that you would like to add?

Appendix III – Acquirer Interview Outline

Research project introduction

This questionnaire outlined below was prepared by the Institute for Manufacturing for a research project on new technology adoption in field service management. It is intended to understand the process and challenges of new technology adoption in the context of service management.

Thank you very much indeed for your time!

Company information:

- Company Name:
- Number of Employees (direct and indirect):
- Briefly describe the company:
- Range of products and services offered:

Interview questions:

1. What were the main drivers for adopting mobile technology?
2. Would you categorise these drivers into different groups?
3. Were there any mitigating circumstances that lead to choosing to adopt at that time?
4. How did you select the technology suitable?
5. How did you select the appropriate supplier?
6. What were the main reasons for choosing your supplier?
7. What procedures/meetings did your company go through before making a decision on technology/supplier? E.g. financial justification.
8. Once the product and supplier was chosen, what steps were taken before implementation?
9. What did each stage involve?
10. How did the supplier communicate/interact with your company at each stage?
11. What barriers to integration did your company encounter during technology implementation?
12. Would you categorise these barriers into different groups?
13. Which do you feel was the most significant? Why?
14. What measures can be taken to overcome the barriers?
15. Once the technology was integrated, did you have any problems?
16. If yes, what occurred?
17. What, if any, action during implementation would have prevented/reduced these problems?
18. What have you and your company learnt from this technology adoption?
19. Do you have any written guidelines for aiding technology adoption? If yes, could I have a copy?
20. Is their anything more that you would like to add?