Developing competitive advantage through tracking tools in service business : the case of a global industrial service supplier

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Abstract: This research is about the utilization of tracking tools in maintenance resource coordination to investigate the benefits of tracking in the coordination processes. Based on service industry, this study uses a pilot project, questionnaires and interviews as research methods. Various challenges were found in the field of mobile workforce management; coordination, safety at work, achieving optimization goals of cost-efficiency, quality and customer service. Many of these challenges can be facilitated with tracking. However, the possibilities of tracking utilization vary in differing business areas of case company. Four dimensions in the existing business were identified. They are connected with the mobility and management style of service technicians. Further, the main tracking opportunities were introduced into each of these business fields. The successful usage and implementation of a tracking system necessitates strong support from management. Tracking tools offer numerous opportunities for maintenance resource coordination. Undoubtedly, the tracking implementation and utilization require consideration of several managerial matters.

Keywords: Tracking, Maintenance Resource Coordination, Mobile Workforce, Field Services, Fleet Management

1. Introduction

The constant observation of new technological solutions is highly important for companies to ensure high-level customer service, their competitive advantage and cost-efficiency of the processes. The costs of these advancing technologies are lowering and many organizations are able to include them in their business processes (Gruhn and Köhler 2007). The applied technologies include, for example, mobile phones, PDAs, GPRS, GPS, NFC-tags (Matinmikko et al., 2009). In particular, the variety of mobile solutions offers potential opportunities for mobile workforce coordination. A technological solution, GPS-tracking, is already quite commonly included in the business models of many logistic companies for the optimization of transportation (Kornak et al., 2004). However, not only conventional logistic companies can benefit from tracking, there are various examples on other industries which have also noticed these technological opportunities for mobile workforce management (Wang et al. 2005, Gruhn and Köhler, 2007; Matinmikko et al., 2009).

Mobile workforce coordination plays an important role in distributed systems where different processes act concurrently in a dynamic business environment (Mousavi 2011). In mobile workforce coordination, there are three main characteristics: Accuracy, Fairness and Automation. Accuracy describes tasks which have to be assigned to the right people at the right time as well as tasks should be attainable and not lost. Fairness in the mobile workforce that, as the resources of the system is human, the tasks for them must be assigned in a comparatively equal manner. Automation refers to tasks allocation which should be an automated process with minimum human involvement. (Mousavi 2010, Mousavi 2007)

The major challenges in mobile workforce coordination are human resource risks and environmental risks. Human resource risks include the unexpected unavailability of mobile workforces due to factors such as health problems. Environmental risks are unpredictable communication cuts between the coordination system and mobile workers. (Mousavi 2012) Several studies have identified the difficulties in mobile resource management (Blumberg, 1994; Dobni, 2004; Gruhn and Köhler, 2007). It was observed in the research that the mobility of the workforce complicates management and coordination activities, but at the same time increases the possibilities for tracking utilization. It is especially challenging in mobile workforce management to ensure the efficient information flow between clients, coordinators and technicians (Gruhn and Köhler, 2007), take care of safety at work and to supervise the subordinates remotely in the mobile field services (Murphy and Wood 2008). Additionally, achieving the optimization goals of cost-efficiency, quality and customer service (Gruhn and Köhler 2007) as well as preserving employee motivation under profitability demands is not straightforward either.

Mobile workforce coordination and management is a challenging phenomenon in a dynamic business environment. Based on the literature review it could be stated that there are not many empirical studies published about mobile workforce coordination from the management and organization perspective. There are published research results available from the tracking and mobile coordination technology point of view, but the research gap in business literature seems to be in the management of mobile workforce coordination. That is why this article is focused to combine technology approaches of mobile workforce coordination as well as business management challenges.

The evaluation of technical opportunities also interests the case company because it is committed to developing innovative technologies for equipment and service businesses. However, even though many advanced mobile technologies already exist and are perhaps in use in the private sector, companies are known to be hesitant for their introduction because of the lack of overall, easy to implement solutions (Gruhn and Köhler, 2007). Therefore this research about tracking utilization in the maintenance resource coordination was launched. The purpose of the study is to investigate whether tracking can benefit coordination processes in the case company, and if yes, how the advantages can be achieved. Moreover, the objective is to identify the most important tracking tools that offer numerous opportunities for maintenance resource coordination. It provides a platform to consider other influencing factors while implementing tracking into successful business processes.

This study investigates the following research question:

Does tracking benefit the coordination processes in the case company, and if yes, how the advantages can be achieved?

The main question is answered with the assistance of three sub questions:

> *1) What is the maintenance business environment and what are the opportunities of tracking tools particularly in the case company?*
> *2) Do tracking tools benefit maintenance resource coordination in the case company?*
> *3) How the benefits of tracking can be achieved in the case company?*

The above-mentioned questions provide an opportunity to explore this phenomenon from a literature point of view along with its practical implication in the real-time environment. This study is a unique combination of evaluation and utilization of tracking tools in diverse business settings by highlighting the challenges and influencing factors.

The first sub question is studied initially from the literature to better understand the general mobile workforce environment and opportunities of tracking tools. Later, similar matters are investigated in the case company for recognizing factors which

affect the utilization of tracking in their diverse business environment. The differences in service processes and varying influencing factors are identified. The studying of the case company is continued by investigating the two last sub questions. Firstly, the benefits and possible usage models of tracking are investigated by conducting a pilot project and by clarifying the points of view and practices from the areas where tracking is already used. Additionally, questionnaires are sent for countries where tracking is not used for identifying the challenges of mobile workforce coordination and for surveying the attitudes and opinions towards tracking.

2. Literature review

Effective information technologies result in efficient logistics and supply chain management. Development in mobile communication technology has transformed the operations in the supply chain and logistics industry. Tracking tools including warehouse automation, distribution, and inventory control are popular and extensively used to improve logistic operations. Mobile workforce coordination has developed the possibility to control operations from anywhere in the field of maintenance (Büyüközkan, Arsenyan, and Ruan, 2012).

2.1 Mobile workforce coordination in the field of maintenance

Maintenance resource coordination can be seen to present one type of mobile workforce coordination. These mobile business activities, their challenges and methods for general mobile workforce coordination are presented by underlining the factors connected to the maintenance environment. Firstly, it is important to understand what is meant by the concept *coordination of mobile resources* and what its goals are. Zahran (2005) uses the term *real time Mobile Resource Management (MRM*) for these kinds of coordination activities. The goal of maintenance resource coordination can be seen to provide competitive services for customers with good quality and cost-efficient processes. On the other hand Salmela and Lukka (2005) underline that in addition to the information needed in the coordination process, the right people and technological aids are also needed. They are especially important when aiming for quality assurance in the provision of the services. Furthermore, the coordination goals include improved cost-efficiency, flexibility, customer service and service quality.

Schumacher (2001) has highlighted two groups of approaches in Artificial Intelligence 1) Knowledge-Based and Behaviour-Based. He proposed behavioural-based approach in modelling a Multi-agent System (MAS) to manage the coordination amongst agents. However, it necessitates a precise description of objective dependencies where these dependencies are accomplished. Coordination has been acknowledged by several researchers as a significant characteristic of MAS in vibrant environments (Mousavi, et al., 2012; Brazier, et al., 2002; Malone and Crowston 1994). Furthermore, Zhang et al. (2015) provided a resource management structure in combined mobile networks which maintains multiple-traffic.

2.2 Challenges of Mobile Workforce Coordination

Naturally many of the coordination challenges are due to the mobility of employees, the complexity of the coordination environment and these challenges are increased by the optimization goals for the processes. In particular, mobility complicates work coordination because the mobile worker's arrival time has to be estimated correctly for the customer. Additionally, supervision, planning as well as performance measurement is more difficult without the physical presence of managers. Mobile workers' coordination should also be done in such a way that the opportunities for knowledge sharing are offered and principles of learning organization are applied. The complexity and optimization factors of the mobile process are taken in to account in the analysis framework for the mobile workforce by Gruhn and Köhler (2007).

2.2.1 Influencing factors – Human perspective

The coordination of the mobile workforce is challenging because many variables require consideration, especially because of the human perspective in the activities. When considering the mobile worker, the main thing to note is that each worker has different skills and he/she might have autonomy to reject the task (Gruhn and Köhler, 2007). Moreover, Evangelista and Sweeney (2014) found that human resources are the main barriers to information and communication technology (ICT) acceptance. The skills of the mobile worker can be divided into two categories: experience and training (Trentham and Scholl 2008). The coordination process also needs to take into account the area (location) and costs associated with the worker. Furthermore, Jing et al. (2009) add that the worker also has status, which includes location as already mentioned, but also state (availability) and load (waiting time before being able to accomplish the task). Therefore, the worker's load and prioritizing skills are very essential for effective work, because as Dobni (2004) states, "the ability to be productive is largely a function of the ability to focus on one project or task for a concentrated period of time".

2.2.2 Influencing factors of the task

Not only the workers have factors which need consideration in the management process, the coordinated tasks also have plenty of characteristics as a cooperation model, time restrictions and assignment type to be taken into account (Gruhn and Köhler 2007). Tasks might require not only extra workers, but can also be dependent on outside resources (Trentham and Scholl 2008), for example, dependent on tools etc. Secondly, the type of assignment defines whether tasks are assigned as a list or as single tasks (Gruhn and Köhler 2007). Thirdly, tasks are affected by time restrictions. The coordinator must keep in mind that time is an important factor for providing competitive advantage in logistic activities. Similar time considerations are also in use in general logistics. Harrison and Hoek (2005) mention the P (performance) and D (demand) times. The first of these two, the performance time, concerns the company and its supply process. In other words, the P-time is the duration in which a product or a service

passes through the process. The second measure, demand time is more customer-oriented. It means the time that "the customer is willing to wait to have their demand fulfilled" (Harrison and Hoek 2005).

2.2.3 Influencing factors – Information flow

As noted, effective coordination process and optimization require a lot of information about the situation in the field and workers' skills as well the customer and task requirements. Traditionally, the information is gained through phone calls but as noted, constant calling interrupts the work process. The knowledge about certain influencing factors is especially important when optimizing the mobile process from the logistic- and routing-oriented view. When minimizing the travelling distance of the mobile worker, his / her location, skills, and availability are essential for the coordinator. Understandably, the coordinator must get this information from somewhere, usually from the information or coordination system. However, Gruhn and Köhler (2007) have detected that quite often mobile workforce coordination systems concentrate on the information flow towards the mobile worker and coordinator's information needs might be forgotten. Also Jing et al. (2009) have noted similar challenges, for example, support for dynamic activity assignment and selection mechanisms are difficult to establish in the changing mobile environments. Moreover, Granlund and Wiktorsson (2014) highlighted the operational challenges in developing automation in logistics, for example, developing contents and applications for operational/functional strategies.

2.3 Tracking

Mobile workforce coordination includes many challenges especially connected to the efficient information flow from the situation in the field. An extended feature for the coordination system is GPS tracking (Gruhn and Köhler 2007) which automates the information flow to the dispatcher. GPS and other positioning systems can be used for providing the location information for the real-time tracking of a vehicle or a person. In particular, in the business environment this application can be used in various operations, for example for the coordination of the mobile workforce. The advantages are underlined by Goel (2008); he stresses that tracking of vehicles can significantly reduce the information gap between drivers and dispatchers and improve the flexibility as well as performance in the organization. Similarly, Battini et al. (2015) investigated the routing strategy in a distribution network when the driver learning effect is considered. They investigated and provided an operative and flexible tool in decision making for routing strategy. Their study demonstrated the best routing strategy depending on the investigated parameters.

Nowadays, goods-centric tracking and tracing of logistics products need constant observation which helps to improve control over business logistics operations. Shamsuzzoha et al. (2013) wrote about the recent technological developments used in manufacturing operations in tracking and tracing goods. They identified the most

important technologies used in controlling the logistics operations and filled a research gap of their performance and feasibility evaluation before implementation in supply network.

In this study, the term *tracking* is used as Goel (2008) presents: "Tracking describes the continuous determination of position and state of shipments and vehicles". The term is extended to include also the tracking of mobile workers, not only vehicles. Usually, tracking systems include tracker units which transmit the location information to an internet application through communication channels and servers. In numerous systems, the tracker receives the GPS signal and sends the current location through GPRS connection to the tracking application's server as presented in Figure 1.

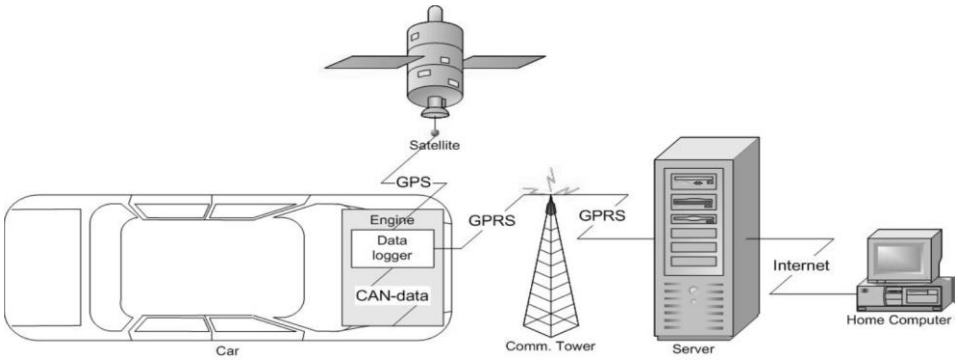

Figure 1 Set-up of a travel survey system (Denys et al. 2007, p. 6)

2.3.1 Tracking Systems

Tracking is used for instance, in fields such as security services (guards), property maintenance and construction sites (Wang et al. 2005; Gruhn and Köhler 2007; Matinmikko et al. 2009). The main elements in tracking systems are software and hardware. Quite often the tracking software is a web-based application where it is possible to see the location of vehicles or mobile workers in real time (TomTom 2009, PPCT 2009, Helpten 2009, Minorplanet 2009, and Qualcomm 2009). These kinds of GPS-based, real-time fleet-monitoring systems facilitate the optimal coordination of mobile work. Many logistics companies have included GPS tracking and tracing tools in their business models for the optimization of transportations (Kornak et al., 2004).

The tracking applications often enable two-way communication between the dispatcher and the mobile worker. There are (at least) two systems, one in the back office (the web-based tracking application) and one in the tracker itself (for example, a navigator type terminal device). Furthermore, the tracking application can be integrated into the existing systems in the company as Goel (2008) presents. His illustration of the vehicle tracking system's hierarchy is presented in Figure 2 where the traditional tracking system is referred to "*Messaging and Fleet Monitoring System – MFMS"* (in the middle of the figure). A possibility for integration is that the MFMS builds a bridge between the existing information systems in the company, such as order management and static

planning systems and the fleet communication system where the actual data is provided from (Goel 2008).

Additionally, the diagram presents how the tracking system can use traffic and travel information either by viewing it in the vehicle or through the fleet monitoring system (MFMS). As mentioned, some of the tracking applications offer interfaces for transmitting the stored information to other business applications, for example to accounting, billing or to the CRM systems (Goel 2008; C-Track 2009). Not only multiple connections between tracking application and business information systems are established, but the tracking systems can also utilize location information transmitted by various positioning methods. Furthermore, the databases of some applications can handle location data from many sources (Oracle 2009).

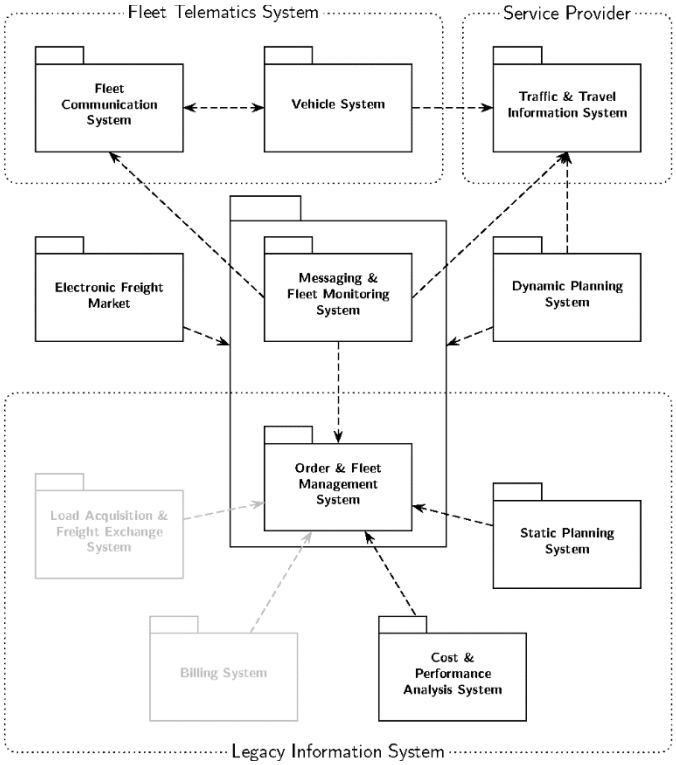

Figure 2 **Hierarchy of tracking system, Goel (2008)**

In addition to the presented software, tracking also requires hardware. The devices needed in tracking are quite often the GPS receiver and modem unit which transmits the position information to the information system. Devices for vehicle tracking are provided by many companies, for example by Aplicom, Indagon, Mitron, Sunit, TomTom, PPCT, Qualcomm, Minorplanet, etc. can be installed out of sight of the driver and they can be quite small, approximately 10 by 10 cm (Denys et al. 2007). The tracking units in the vehicles quite often include a memory card, a GPRS-modem and a GPS-receiver.

2.3.2 Implementation of a Tracking System

If management decides that a tracking system is to be taken into use in the organization, the implementation process might be challenging. The dispatcher type mobile workforce coordination can benefit easily from the tracking, but if mobile workers are very autonomous and empowered, the use of tracking might be more complex. As McShane and Steen (2009) present, the idea of empowerment deals with managers trusting their subordinates. The prejudices are discussed by Matinmikko et al. (2009), where they pointed out that companies which have not tried these new methods for mobile workforce coordination, there are not enough contacts to employees if work orders are sent via mobile phones.

Interestingly, companies which used work order management based on technological devices did not point out any problems associated with the connection between employees and employer. This reflects on the prejudices connected to new methods. Along with pilot projects and concrete actions, these prejudices are often noticed to be wrong (Matiminmikko et al. 2009). Simon (2008) highlighted an implementation strategy for tracking systems "should avoid invoking paranoia by saying you'll be monitoring each driver's every move 24/7. Instead, explain to drivers the benefits of a fleet GPS program, how it can work to their advantage and ultimately make them more money."

2.3.3 The Legislation of Privacy Protection

In many countries several law issues need consideration when planning the use of GPS tracking in business activities. The legislation varies in countries; Rainio (2003) mentioned that re-drafting of laws connected with tracking has been going on over the past several years. In the United States for example, there are strict instructions for emergency call tracking but tracking in business use is less regulated. Japan has updated its privacy protection acts recently as well as EU has been forming directives for cellular positioning laws in member countries. In summary, tracking legislation is under construction in many countries (Rainio 2003; Tervo-Pellikka 2000). Thus, the relationship between employees and employer should be built on mutual respect and trust. On the one hand, there should be trust towards the employer's actions. It can be seen that tracking systems can either increase organizational justice with increased possibilities for control of rules or easily decrease the feeling of justice if tracking is used wrong and without the understanding of the privacy issues.

2.4 Theoretical model summary

The overall goal in maintenance can be seen from two points of view, either from the basis of an outsourced service provider or from the customer point of view. The service provider should pay attention to the customers' needs. Therefore, it can be concluded that the maintenance process should be designed in a preventive approach to ensure well-functioning machinery and avoiding breakdowns. However, emergency services should not be forgotten and the On-call processes need consideration as well. The

breakdown maintenance coordination can be seen as a very challenging task because of the faults' unpredictable nature. Therefore, efficient coordination and well-managed information flow are important factors for the success of an outsourced maintenance company.

Tracking can be a beneficial tool for overcoming many of the challenges mentioned in the literature. Literature highlights that technologies are not enough alone, managerial matters are also important. That is why the advantages of tracking for mobile workforce coordination can be fully realized only if the current processes and non-technical issues in the company are also taken into consideration. The tracking systems quite often use GPS as a positioning method, but other options also exist. Furthermore, a tracking unit can be in the vehicle or carried by the worker (mobile phone, PDA). The tracking unit transmits the location information through a network connection to a server from where it is used by a tracking application. On the other hand, the implementation process of tracking might be challenging. It should be well-planned and clear when introducing the system for employees. Additionally, implementers should prepare themselves with change resistance as well as get acquainted with local legislation about privacy protection.

Keeping in view the importance of coordination in maintenance and tracking implementation in business processes, this study demonstrates how business processes can be improved by using different methods. This study combines different methods to demonstrate the highlighted factors to prove reliable results.

3. The research environment and methods

3.1 Case Company

The case company offers services for maintaining industrial equipment. The services are divided into two in this report, service 1 and service 2 for describing two different types of maintenance objects. The company strategy is to provide the best customer service with innovative products and services, utilizing a demand-driven and cost-efficient supply chain. The organization has business activities all over world. The customers of the case company are mainly in the field of general manufacturing, but also harbours, primary metals and resellers play a significant role.

3.2 Methods and Material

This study employs a mixed method research approach where two important standards assist in the choice of methodology (Hurmerinta-Peltomäki and Nummela 2004), because this methodology institutes an association between theory and empirical data. Mixed method in this study is selected based on the fact that the research question is designed to capture a complete picture of the phenomenon, cover the important elements of the research problem, and to find innovative solutions (Bryman, 2004).

Inductive reasoning is a technique of observing a phenomenon and formulating a generalization or theory whereas deductive reasoning follow positivism paradigm. The methods for data gathering include questionnaires, interviews, observation and a pilot project. The methodology of the research includes three parts: a literature review about the subject, analysing the current state and process in the company and testing the tracking in a new and somewhat different environment. Therefore, the research is empirical connecting both descriptive and normative methods (Kasanen et al., 1991).

A small-scale pre-research was done to gain better understanding about the subject and its characteristics. The empirical results of the research were gained with the help of a tracking pilot project in Finland and the experience of tracking use in Canada, the Netherlands, the United Kingdom and the USA. People in the pilot project as well as in the countries mentioned were contacted, interviewed and/or asked to fill in a questionnaire. For clarifying the situation in the countries where tracking is not used, the business environment and possible needs for tracking from other countries were introduced. Through the information gathered, the research is able to provide an answer to the question if tracking benefits the maintenance resource coordination in the case company or not and investigates the utilization opportunities.

3.2.1 Pilot project

For getting first-hand knowledge about the tracking, a pilot project (during autumn 2009) was requested from the company with a tracking supplier contacted in advance. The idea was to have a two-month-test period with 20 tracking units. The test period was carried out in a branch of the same city where the supplier is located. Other branches and suppliers were considered, but for obtaining results within the time limits as well as facilitating the installations and getting support, the supplier was contacted beforehand and the branch was chosen. After considering the extent for the research as well as equality among the technicians, it was seen best to install the trackers in all of the branch's vehicles.

The qualitative results were collected from questionnaires, interviews and observations. The qualitative results of the pilot project consisted of four questionnaires for the branch manager and technicians: the first two made at the beginning of the pilot period and the other two afterwards. Also the technicians and the branch manager were interviewed using a semi-structured questionnaire at the end of the pilot period.

3.2.2 Other methods

Other methods used were connected with the information gathering of tracking experiences already used. Tracking systems in the case company were researched by gathering information from implementers and obtaining access to the used tracking systems. The information gathering was done through emails and face-to-face interviews as well via telephone, and these were documented in written format

immediately. The need for tracking was also analysed through discussions, emails, semi-structured interviews as well as through a questionnaire. Furthermore, a questionnaire was used for investigating the possible experiments of tracking as well as attitudes and need for technical assistance in the maintenance resource coordination. Replies were gained from 13 countries, with a total of 29 respondents. Moreover, a questionnaire in Finnish was sent to branch managers in Finland (for Service 1 and Service 2 managers), in total 10 replies were received. To summarize, about 70 people in the company were contacted. To summarize, about 70 people in the company were contacted.

3.2.3 Material used

The material used in the research included descriptions about the current services of the company, data from the annual report and company website, process descriptions from an information system harmonization project as well as the quantitative data of the pilot branch. The quantitative data consisted of fuel purchases and financial figures from the finance department as well as the driving logs of the technicians who joined the pilot. Unfortunately, there were difficulties in obtaining the driving logs from the pilot branch. Additionally, some material was received from the countries where tracking was already used. This material included access to the tracking systems, tracking policies as well as results from the pilot project conducted in the UK.

4. Results

4.1 Current Processes

The case company has varying coordination processes and the practices in the branches differ. The processes are described in a general manner and by giving insight to the future plans. Additionally, details about differences in geographical areas are offered based on the questionnaires. Currently there are various applications for maintenance work and different forms of using them (4-6 information systems, paper work orders in some countries, hand-helds, laptops etc.).

4.1.1 Nordic Countries

Respondents from Nordic countries mentioned that the technicians are encouraged to be self-directive and take care of certain customers in Finland. Business cards are made for technicians so that the communication between them and the customers would be encouraged. One of the respondents explained that the customers are able to contact people in the case company easily when they have a choice to call technicians directly or through the branch if they prefer. Interestingly, when replying a question of “where/ to whom the customer would like to contact for informing the On-call tasks?” only two out of six respondents from Sweden and Denmark picked service technician or a person in duty as first choice. This has been seen as a workable way of operating according to

the respondents where technicians have good knowledge about their customers to provide better services.

4.1.2 Europe

Out of seven respondents from Europe, including Finland, Sweden, Denmark, Austria, Hungary, Russia, Spain and Ukraine (consisting of branch and other managers), four respondents included service technicians in their list of customers contact about On-call tasks. The other three mentioned the branch office, branch managers and call centre. They mentioned that most of the technicians use a service vehicle except some of them who use other vans in their operations. Shared vehicles in use were highlighted by well-informed respondents who have large contracts or offer services for ports. All of the technicians have mobile phones, navigators and laptops in their use. Scheduling and logs at work have been quite important aspects in coordination of preventive maintenance.

4.1.3 America

Respondents from America included the USA (3 replies), Chile and Mexico (1) and Canada (7 replies from branches where tracking is not yet used) have highlighted the number of technicians working. The current coordination trend in America is totally opposite to the Nordic countries or the rest of Europe. In America, the trend is for customers to contact the branch office (branch manager, service supervisor / manager) or a call centre and service technicians (additionally other marked the person on duty). This clearly shows evidence about the office-cantered management style in the branches. The one respondent who had marked a service technician on the current contact list (or the one with a call centre or with a person in duty on the current list) left them out from their future situation listing.

4.2 Experiences from Tracking Installation

The benefits of tracking have already been noticed and experienced by some units of the case company. Firstly, tracking was implemented in the UK in 2005 and there are over 200 vehicles being tracked already. Other countries where tracking is used are Canada, Netherland and the USA. In total, there are about 350 tracking units installed in the service vehicles of the case company. Basic information about the systems is summarized to Table 1. The USA has two fields because tracking is currently in use in western areas of the USA and in Springfield, OH; there was a test of mobile phone tracking recently.

Table 1 Experiences of tracking systems

Country:	Canada	Netherlands	UK	USA - West	USA	Finland - pilot project
Currently in use	Yes	Yes	Yes	Yes	No	No

Number of tracked technicians	60 techs	60 techs + staff	220-250 techs	20-25 techs	10 techs	12 techs
Method of tracking	Vehicle tracking	Vehicle tracking + navigator	Vehicle tracking	Vehicle tracking	Mobile phone GPS	Vehicle tracking + navigator
Implementation time	Since mid-2009	Since mid-2007	Since mid-2005	Since 2006-2007	A test of 3 months in 2008	A test of 2 months in 2009
Safety at work features	Yes, extreme braking, speeding	Yes, location information	Yes, regular checks in the morning	Speeding	-	Yes, alarm button and location information

4.3 Management Styles for Tracking

In units of the case company, management styles, information systems and processes differ. For example, in Finnish Service 1, the technicians are self-directive. They are in contact with customers and plan their own work independently. In addition, they use personal laptops and electronic work orders in their daily operations. In the Netherlands and the UK, however, they prefer to use paper work and customer contacts are managed from the branch office. The Nordic countries, especially Finland, differ as it is their tendency to favour self-directive technicians over dispatcher-style management. Similarly, in Finland, a comparison has been done between service 1 and service 2 environments in terms of technicians' mobility because of the nature of different business units. There are long-term partnership agreements with service 2 clients, therefore the technicians work at only a few clients.

4.4 Challenges in task coordination

The main challenges for effective maintenance task coordination in branches were investigated via open-ended questions about the current situation. The respondents replied with a view of "further improvements needed" for On Call-tasks' coordination and preventive maintenance. Most of the respondents agreed that both of the coordination activities could be improved, but the majority of them had the impression that preventive maintenance tasks need more attention than the On-call activities. Thus, special support for planning and analysing preventive maintenance activities seems to be needed from the management. Particularly, the improvement needed for On Call-tasks was strongly recommended from Canada, Finland, and Spain but preventive tasks planning and scheduling was suggested by respondents from Canada, Denmark, Spain and Sweden. On the other hand, respondents from Hungary and Sweden did not strongly recommend the improvements for On Call-tasks and preventive maintenance.

The challenges of effective maintenance task coordination were observed in connection with technicians (optimizing the availability, location, skills, load), planners (being well-organized, having enough skilful coordinators), customers (to co-operate efficiently) and with spare parts (availability at the right time). Particularly, the availability of parts and technicians was highlighted by respondents and some

mentioned the challenges connected with offering ETAs (Estimated Time of Arrivals) for customers. Challenges are connected to the planners as well. Proper job fit, training, and experience of the personnel assigned to the task, such as service supervisor or service manager can be the most potential challenges for the planner. The scheduling might be difficult due to customer's reasons as well.

Challenges are connected to the planners as well: "proper job fit, training, and experience of the personnel assigned to the task [planning, scheduling, etc.]...such as service supervisor or service manager" and "We are need in more operatives in the branch." What is more, the scheduling might be difficult due to customer's reasons as well: "For preventive maintenance, the main challenge is coordinating a time with the customer around their production schedules while trying to avoid overtime/weekend scheduling." A notion of missing tools and planning support along with observations were made to make sure that everybody works on their own style. Swedish branch manager added that there should be "a system where the technicians do not have to visit the office, wireless modems are the best source of it." Many of them mentioned that challenges were connected more to the planning of preventive maintenance and to overall management matters in the branch than to the On-call task coordination.

The challenges connected to automated driving logs were explained especially in the questionnaire in Finnish. 70% of Finnish respondents strongly agreed that driving logs should be automated and only one respondent strongly disagreed. Furthermore, the global questionnaire clarified opinions towards control elements in the branches. Many replied to these questions about mistrustful customers and the breaking of rules by marking "not at all" whereas the majority of the replies were "I remember few times". Some even reported about the weekly or monthly misuse of the vehicles. Especially higher level managers' estimations about the situation were more pessimistic than branch managers. Moreover, *the more exact control of work hours* was favoured by all branch managers.

4.5 Opinions about Tracking

The opinions about tracking were varied by nature in data collection. One third of the respondents to the global questionnaire in English were positive towards tracking and about one third opposed the idea, the rest remained neutral. The On-call task coordination question got mostly neutral answers (11), but more positive (9) than negative replies (5). Overall, the negative replies for the use of tracking commented on giving signals about mistrust towards technicians as well as that costs were just an extra burden to branches. They suggested that good managers should be aware about their subordinates' tasks without a need for tracking. Some added that most benefits of tracking would come to safety at work matters, not to the coordination or supervision aspects.

As mentioned, the Finnish branch managers were very positive towards tracking, only three managers remained negative, one resisted strongly by commenting “no need, extra costs”. The other two could not see the benefits because they know their technicians’ location and they only have one service vehicle in the branch. However, the positive comments included ideas that tracking facilitates the tasks of the branch manager. Comments were also made that the job might sometimes be quite challenging because the employees are working on many customer sites and therefore supervision is hard. Lastly, it was suggested that the technicians only resist if they have something to hide and continued by stating at the moment they do, but it is just difficult and time consuming to prove it.

Interestingly, the majority of respondents of the questionnaire in English, who answered negatively to the tracking implementation question (in total 8), also estimated that technicians would resist (1) or strongly resist (5) the implementation process. When asked about the favoured tracking method, whether it should be a personal tracking unit or located in the car, the majority preferred vehicle tracking. Their explanations include interest in the driving logs as well as vehicle tracking is favoured because “I would prefer one that is attached to the vehicle so it cannot be lost”. One favoured Personal Digital Agent (PDA) because “it would offer other services too” and it would be possible to send tasks to the handheld. For tracking in general, there were responses about safety at work matters as well. Majority of the respondents (60% and 80%) in both questionnaires estimated that traditional navigators would help the service technicians' work.

5. Discussion

5.1 Use of Tracking in Financial terms

When considering the implementation of new technology, undoubtedly financial matters connected to the investment are highly interesting. In addition to coordinator’s time savings and technicians’ driven time and kilometres reduction, one way to save time in a day with tracking is to automate the driving log process. A technician presented an estimation that the obligatory manual driving logs use at least one to five minutes of their time in a day. These calculations indicate that there are various ways to cover the direct costs of tracking. Undoubtedly, a large organization such as the case company can profit their size in the implementation process (for the costs of applications, the experiences from tracking tests, etc.). However, these cost saving calculations were only gained from a few business environments, variations may exist.

5.2 Dimensions in the Existing Business

There are differences in management styles and processes in the case company as presented in the results. These variations (the mobility and the degree of self-directivity of technicians) affect the utilization of tracking. The differences are illustrated as dimensions in the existing business (for showing variables in the business environment).

The variables are important because the greatest benefits of tracking vary depending on the application environment as seen in the theory. The need for tracking was investigated in the case company. As a result, various kinds of challenges were reported in results, for example there were more positive views about coordination, "On-call task coordination could be improved with tracking" than negative. However, many mentioned few tracking-cantered problems, such as challenges connected with effective preventive maintenance task coordination and spare parts. Nevertheless, in some areas especially controlling elements were also underlined. In conclusion, tracking raised opposing opinions not only between managers and workers but also among managers of different areas. Therefore it seems that if tracking is taken into use more widely in the case company, the differences must be understood for better utilization of tracking and the support of all managers must be gained.

In the case of tracking, the most relevant observed differences of the branches seem to be connected to the varying levels in the mobility of technicians as well as in the degree of self-directivity / dispatching in the branch. Each of the fields in this fourfold table includes varying opportunities for the utilization of tracking. First of all, the top right box (D2) presents the traditional mobile workforce coordination with a central dispatcher (which is the case for example in many branches in the UK).

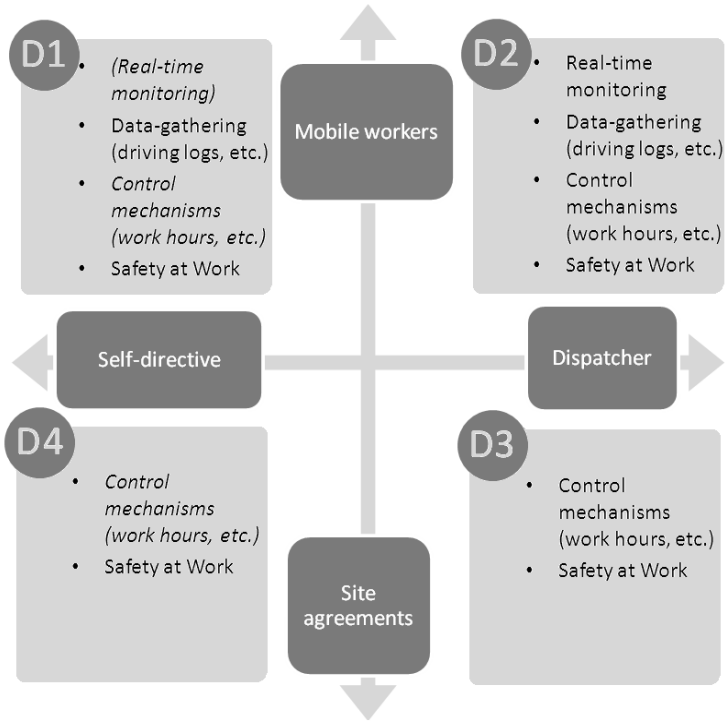

Figure 3 Dimensions in the Existing Business

In contrast, the bottom-left corner (D4) presents quite an immobile environment with straight contacts from customer to the technician. The possibilities of tracking seem to be less numerous and restricted to controlling (and possible safety at work) features. This has been proven by some managers (Service 2-Finland, Sweden) and noticed in the

pilot project with self-directive technicians. The supervision and controlling mechanisms could be used if the supervisor is not located on the same site. However, perhaps the resistance would not be that high in the bottom right box (D3) where still quite immobile technicians need more supervision due to having a coordinator for scheduling and planning. Therefore in these environments, control mechanisms and safety at work features could be used, and real-time monitoring might not be that important because the workers are still working at regular sites and the locations are known.

The technicians from the pilot branch seem to be a good example of the dimension D1 in the top-left corner. In this field, the advantages of tracking are increased by the mobility of the workers, the high number of dynamic On-Call tasks and the need for driving logs. Additionally, some technicians in the pilot mentioned that as there was only a small team, they do not need tracking. The pilot project indicated that their resistance might be strong. In Netherlands, the route history is already used as notes for time-sheet filling. This could be beneficial in the company as long as the electronic work orders are used globally. For example, in Finland the electronic work hour reporting requires exact descriptions about each of the repairs and time used, therefore the plain tracking data and time at a customer site could not be directly used for work hour reporting. The planning activities might be facilitated for example by using the visual aids of tracking systems or by analysing average travel distances. Furthermore, the amount of On-call tasks, the customers' varying demands for speed (Harrison and Hoek 2005) and the customer base density (Blumberg 1994) affect the need to utilize tracking.

6. Conclusions

6.1 Theoretical contributions

Maintenance resource coordination can be seen to present one type of mobile workforce coordination. The concept of coordination of mobile resources is real time mobile resource management (Zahran 2005). The goal of maintenance resource coordination can be seen to provide competitive services for customers with good quality and cost-efficient processes. On the other hand, Salmela and Lukka (2005) underline that in addition to the information need in the coordination process, the right people and technological aids are also needed. They are especially important when aiming for the quality assurance of services. Furthermore, the coordination goals include improved cost-efficiency, flexibility, customer service and service quality.

Mobile workforce coordination includes many challenges especially connected to the efficient information flow from the situation in the field. An extended feature for the coordination system is GPS tracking which automates the information flow to the dispatcher (Gruhn and Köhler 2007). GPS and other positioning systems can be used for providing the location information for the real-time tracking of a vehicle or a person.

Especially in the business environment this application can be used in various operations, for example for the coordination of the mobile workforce. Tracking of vehicles can significantly reduce the information gap between drivers and dispatchers and to improving the flexibility as well the performance in the organization (Goel 2008).

The constant observation of environment and new technological opportunities is highly important for companies for ensuring high-level customer service, their competitive advantage and cost-efficiency in the processes. This research about the utilization of tracking tools in maintenance resource coordination was conducted for investigating whether tracking can benefit coordination processes in the case company, and if yes, how the advantages can be achieved.

Various challenges were found in the field of mobile workforce management and many of those can be facilitated with tracking. Especially challenging is to ensure the efficient information flow between the client, the coordinator and the technician, take care of safety at work matters and to supervise subordinates remotely in the mobile field services. Additionally, achieving the optimization goals of cost-efficiency, quality and customer service as well as preserving the employees' motivation under profitability demands is not straightforward either.

The environmental aspects would get indicators from the emissions of service operations and safety at work matters could be standardized. Most importantly, the global system would reduce the costs of tracking by unifying functions such as system and device selection, training and technical support. Undoubtedly, there would be challenges connected with the specification of requirements, technical matters and existence of current tracking systems. However, it seems that with careful planning, IT project expertise and surveying the current processes, there might be possibilities to find a solution to a global tracking system which would support the current processes as much as possible.

6.2 Managerial implications

This research provides evidence that tracking benefits the maintenance processes and coordination in the case company. The following four aspects in the branches seem to increase the need for tracking: the mobility of the technicians, the high number of On-call tasks, need for remote control mechanisms and for driving logs in the branches. Therefore it is recommended that tracking should be taken more widely into use in the case company especially in the areas of the strongest need and interest for it. The extent of the utilization can be decided by evaluating the previous four matters as well as the need for functions such as safety at work, work hour controlling, environmental indicators, planning support and its efficiency analysis. More details about the varying requirements are presented in the figure 3.

Additionally, it is worth considering the possibility of a global tracking system for gaining the benefits and economies of scale to the tracking costs as well as improving the unity of the business processes (by offering a single application with a selection of devices). With possible global change process, it should be evaluated whether the coordination processes in the branches are sufficiently optimized or should they be improved. The coordination activities could be evaluated by analysing data from tracking and other systems. It seems that extra resources for the optimization of coordination are needed in the branches or optionally "inter-company consultancy and analysis" services could be provided.

In conclusion, tracking provides benefits for the case company especially in certain business areas as observed, but tracking and technologies alone cannot improve efficiency in the organization. Understandably, many managerial perspectives also need to be considered. In particular, it might be beneficial to pay attention to the varying requirements in the numerous business areas, clarify the amount of on-call tasks as well as evaluate the mobile resource management policy (if controlling functions are needed) in the organization. Thus, it remains for management to decide how wide and what kinds of actions are required to ensure high-level customer service, competitive advantage and cost-efficiency in the future as well.

6.3 Limitations and future research

This research was conducted in a multinational case company operating in service business and that's why the results cannot be generalized into other industry areas. The research is qualitative research and therefore there are limitations in research settings which should be taken into consideration when analysing the results.

Tracking has many advantages but it needs the careful consideration of procedures for supporting it. Therefore, further research about tracking is suggested. It is recommended that the case company would investigate more customer needs and satisfaction connected with the coordination and on-call handling at the moment for ensuring their need for tracking and opinions about the best coordination style. The surveys could be done for comparing the countries with tracking and without as well as gaining clients' opinions about the different coordination styles by comparing the results in self-directive and dispatcher branches.

Comparison of tracking systems' features and user satisfaction between the countries using tracking would assist to establish the best practices for tracking use in the company as well as to evaluate the functionalities needed in the tracking system. Also the possibilities for combining location data from various tracking devices to a single global system should be further investigated. A survey about the implementation with recent start-ups would provide valuable knowledge for the possible global project.

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