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Abstract title: Effectiveness of Innovative Technologies in New Zealand Farming and Supply Chain Management: A Tale of Two Companies

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Effectiveness of Innovative Technologies in New Zealand Farming and Supply Chain Management: A Tale of Two Companies

ABSTRACT

The paper investigates applications of modern technologies (GPS, TracMap, RFID) in farming and supply chain environment. Two organizations have been selected to investigate the issues related to technology deployment, customers' feedback, and effectiveness of these technologies in their operations. Some of the KPIs used include acceptance rate, customer satisfaction, idling time, fuel cost, and productivity gain. Extensive literature review has been done to get a profile of global usage of GPS and RFID. Study shows that these organizations are making good progress using innovative technologies; however, there is scope for improvement in some areas. Some benefits of GPS and TracMap devices in farming include enhanced productivity, reduced cost, less stress and greater job enjoyment, accurate spraying, accurate billing, environmental protection, and food safety. Some of the barriers in adopting these technologies include lack of awareness, unclear benefits, and unwillingness in cost sharing. Operational data have been analyzed to identify the key issues, and recommendations have been suggested.

Key words: Farming, GPS, Logistics, RFID, Supply chain management

INTRODUCTION

In the last few years, researchers have published generously on various types of technologies being used in supply chain management. For example, Guillemette et al. (2009) report that real-time location systems (RTLS) are being used in areas such as transportation, health, security, and agriculture. On-board systems and GPS technology have provided major breakthroughs in transportation fleet management. Guillemette et al further suggests that RFID technology is

helping a lot in parcel tracking, baggage handling, product returns management (reverse logistics) and counterfeit identification, shipment tracking and tracing, and control of access to restricted areas or border control (passports with RFID). In fact, positioning technologies are becoming increasingly diversified. Examples include GPS, passive and active RFID, smartcards, cellular phones, on-board systems, gyroscopes, infrared-based systems, Wi-Fi, etc. Traditionally, these technologies have mostly been used to trace goods and products, but organizations have also started using them to locate users, employees and customers (Guillemette et al. 2009).

GPS was used long back when Sputnik was launched by Russians in the 1950s. People were able to locate Sputnik's position based on the radio waves it provided. *GPS devices* are used to download the necessary information from computers which can be used in cars to give us detailed directions for the trip. Similarly, a *GPS navigational unit* can either be mounted on a car or be transferred from vehicle to vehicle. When a destination is keyed into the system, it can guide us by instructing where to turn, the time and the distance relative to each sector of the drive. Some units also help us find restaurants, shopping malls, hospitals, and accommodations which can be very useful in a new town. There are many choices of GPS to select from depending on what features are needed and how frequently we need to use them.

Literature Review

It is cool to have something in the car that knows exactly where you are and will give you directions to your destination without once getting grumpy, impatient, incredulous or hysterical. Devices and services equipped with GPS receivers are very popular with drivers, travelers, mariners and trampers these days. They can also be life saving if they are used in conjunction

with search and rescue operations, and reduce stress for tourists or new immigrants who need to drive to a job interview two weeks after arriving in a country (Bland, 2009).

Bland (2009) reports that there is relatively a low penetration (about 7%) of vehicle-related GPS devices in the New Zealand market compared with the number of vehicles on the road. Some GPS based devices like TracMaps (TMs) are used by many farm contractors to gain higher productivity and efficiency in cultivating, spraying, fertilizing, and spreading. The TM mounted on a cab or tractor draws a map on the screen, which enables the driver to see the area covered and area remaining while working. From the data from TM website, it is possible to group their 182 users into two broad categories: (a) Land users, and (b) Aviation users (Brown 2009). Land users are further put into seven subcategories (see Table 1):

Table 1 Use of TracMap in different sectors

Names of Users	No. of TracMap users in different services	% of users in different services
Misc services	55	30.39
Transport Services	38	20.99
Contractors (agricultural, farms, etc.)	33	18.23
Spreading Services	35	19.34
Spraying services	12	6.63
Fertiliser Spreading	5	2.76
Weed Control Services	3	1.66
Total land users	181	100
Total aviation users	14	

Source: http://www.tracmap.co.nz/commercial-users/commercial-users/#Aviation_users

1.0 How GPS Works?

Various trade magazines, journals, and websites have published lots of information on different types of GPS, their features, price range, and working principle. GPS is based on a constellation of 24 to 32 medium Earth orbit satellites that transmit precise radio wave signals, which allow its receivers to determine their current location, the time, and their velocity (*How GPS works*,

2009). Using three satellites, one can know the *longitude* and *latitude* of the receiver, and in case of four satellites, the *height* of receiver is also determined. The accuracy varies from 10 meters to a few millimeters, depending on type of receiver and method used (*The SYNAPSE Vehicle System, 2009*).

The receiver measures the transit time of each message and computes the distance to each satellite. Geometric tri-lateration is used to combine these distances with the satellites' locations to obtain the position of the receiver. Many GPS units also show derived information (viz. direction and speed). Although four satellites are needed for normal operation, but fewer apply in special cases. If one variable (e.g., the altitude of an aircraft) is already known, then a receiver can determine its position using only three satellites (*Global Positioning System, 2008*).

An approach to online prediction of the effect of control scenarios under various situations in the transport network is provided by Hoogendoorn et al. (2003). This combines fuzzy logic, case-based reasoning, and multi-agent approaches, and offers advantages of computational speed, use of actual knowledge directly, and the ability to learn from previous experiences.

1.1 Benefits of GPS/TracMap in farming

The benefits of adopting GPS based technology include *productivity gain, environmental protection, and enhanced food safety*. According to TracMap New Zealand, farmers cover more areas in less time (e.g., 9 paddocks in place of 7), increase water efficiency from 60 to 80%, and gain 10 to 20% in dollar terms by using TracMap (TM). Drivers can drive more accurately even with less experience. TM also provides improved fleet efficiency, reduced administration cost, reduced worry over safety and location of drivers and vehicles.

TracMap users can store hazards from the fields on their database to assist them in subsequent visits; transmit maps through the cellular network; and work in all environments from the water/dustproof system. TM can store up to 40 uncompleted jobs for later retrieval; and can also be used in non-computer controlled spreaders. TM helps client in live tracking of vehicles (except when out of cellular range); off road distance calculation for RUC refund claims; fleet service management (viz. warnings for scheduled service, RUC license expiry); and geofencing. More sophisticated GPS devices can relay specific information (viz., speed warning, quality of roads ahead, and an ideal route map) for drivers who have to make multiple stops within a small area (*source: www.tracmap.co.nz*). Some *benefits* to TM based fertilizer spreading contractors or farmers are summarized in Table 2.

Table 2 Benefits of TracMap Devices

- | |
|--|
| <ul style="list-style-type: none"> • Cost savings by ability to drive at wider spacing which reduces distance travelled. • More even fertilizer spread depending • More productive hours possible due to ability to work into the night to finish a job • Easy to return and finish partially completed work • Easy to see parts of a job completed on broken country and in multiple paddocks • Not wasting time looking for wheel marks on dry country and in silage paddocks • Not having to slow down to let the dust clear off in a following wind • Most of the customers report a 20% productivity gain by using TracMap • Easier to train new drivers who can work as a relief drivers • Less stress and more job enjoyment as drivers do a quality job more easily • Ability to calculate paddock areas before starting work, and monitor area remaining while working • Accurate area calculation at the end of the job, which leads to accurate billing. • Possible to verify the quality of work for customers. • Provides accountability for job quality by staff. • Provides a simple method of meeting any traceability and audit requirements • Ability to use maps for billing clients, often before the truck returns from day's work • Ability to use maps for claiming Road User Charge (RUC) refunds |
|--|

1.2 Benefits of GPS in Supply Chain Management

GPS based vehicle tracking systems can provide with real time information on fuel consumption, driver behaviour, RPM, engine load, etc which can help fleet managers make a positive impact

on driver's performance. Reduction in fuel costs, monitoring of driver behavior, real time diagnostics and ability to calculate carbon footprints of the entire fleet by driver and vehicle make GPS tracking system an essential investment (Tymon, 2008).

Researchers agree that comprehensive fleet management systems (FMS) are expensive, but the initial investment should be weighed against the long-term potential savings to the company.

Some operators report that their fuel bills reduced by 40 per cent per year which is quite an impressive saving (*Deciding between the fleet management....*, 2009). A study in Sydney found that the clutches in gearboxes of some buses were wearing out faster than usual. When FMS was used in conjunction with GPS services to monitor gear changes, it was found that the vehicles with worn clutches were being moved from a stationary position using second gear – so, drivers were riding the clutch. Driver retraining resulted in an instant reduction in vehicle maintenance costs (Bland, 2009).

Francis and Karl (n. d.) compared two traffic schemes (the U-turn, and the signalized intersection) in terms of fuel consumption rates, time duration, velocity, and RPM. The U-turn takes a longer run duration, and covers 870 meters compared to 256 meters in signalized case. They concluded that inconsistent driving creates more acceleration and deceleration variations which result in much higher rate of fuel consumed. A step further is a *Web based-tracking system* which allows business owner to track down vehicles. Emergency buttons available on the vehicle can raise alarm in case of an emergency.

1.3 A profile of GPS applications

There are different types of users of GPS devices - some use them for serious business, while others for fun. Supply chain management giants FedEx and UPS always seek a competitive edge

over each other. As the two companies are encroaching into each other's primary businesses, they are stepping up their wireless deployments for operational efficiency, cost reduction, increasing reach, and doing more with the same resources. Both are using RFID and GPS technologies, wireless LANs, Bluetooth short-range wireless links and general packet radio service (GPRS) cellular networks that provide lower development and maintenance costs; greater throughput and security; and lower acquisition and deployment costs (Gruman, 2004).

According to a talk on *Radio New Zealand (July, 2009)*, many elderly people get lost due to their reduced sense of navigation, and GPS can be a great help in locating them. GPS devices are used in areas like research, exploration, space sciences, loading-unloading of cargo vessels, tracking of freights, construction of mega buildings (The Palm Islands in Dubai), rescue missions, and military operations.

GPS is used for tracking and locating vehicles, security system, fuel level and cost control, on-board navigation system, data transfer, on-board camera, and a web enabled map solutions. With SYNAPSE vehicle monitoring system one can track, locate and guard ones vehicles 24x7 by a GSM phone or a PC. This system can be used to follow the movement of passenger and valuables or dangerous cargo (fuel, building materials, dangerous chemicals, etc). Some lighter applications include playing golf, fishing, treasure hunting, etc. A GPS can help a golfer in *selecting* clubs accurately; *mapping* the fairway manually by walking the course and setting waypoints, and *clicking* a button that looks like a flag near each tee box and hole. GPS helps us find coffee shops, Wi-Fi spots, libraries or a public place. *Website* www.waymarking.com allows us to a place, and then store the waypoint in our GPS. We can then access to those places,

coffee shops, birthplaces of famous people, best restaurants in small towns, pizza places close to shopping malls, and churches by denomination (*Six Innovative Uses for GPS, 2007*).

Some parents can use GPS in their teenage drivers' cars to keep a track of them, while others to help protect precious items from being stolen. Advances in GPS technologies have made fleet tracking solutions more feature-rich and affordable. Monitoring mobile assets is now easier and more cost effective than ever before. "With the growing availability of low-cost GPS and data acquisition transponders, accurate maps and wireless networks, you can track the location of your vehicles, monitor their speed, engine temperature and oil pressure and even set off alarms if the vehicle enters a forbidden zone, all at a cheaper cost than before" (*Phil Parent, 2009*).

Phil Parent (*Phil Parent, 2009*) suggests that the benefits of tracking vehicles in real time can help you manage a pick-up and delivery fleet. You can immediately see which vehicle is closest to the pick-up location and assign that driver to that address. For a time-sensitive customer, you can forecast when your vehicles will be at their destination. If you keep records of duration, mileage, fuel used for chargeback to a client, you can import data and create payroll, invoices, RUC or financial reports. And if you integrate your fleet management solution with financials, ERP, and business intelligence (BI), you can spread the benefits to your entire organization.

Fleet tracking solutions: In New Zealand, different types of fleet tracking solutions are available in the market. Most of the 'plug-and-play' options provide real-time, online monitoring of vehicles and reporting. The advanced packages can capture additional information, support audio communications and can interface with third-party solutions such as financials, BI and ERP. Customized solutions include advanced features such as route optimization, spatial analysis, advanced mapping and customized reporting (*Phil Parent, 2009*). Phil further assigns very high

importance to a digital street map for any GPS solution. Many in-car navigation and fleet management systems (viz. TomTom, Argus Tracking, Navman and Locate+) use SmartNAV digital database sourced from GeoSmart (www.geosmart.co.nz). Others are Critchlow Associates (www.critchlow.co.nz), used by Minorplanet, and LINZ (www.linz.govt.nz) used by Armada/Snitch (*Phil Parent, 2009*).

So, how prevalent is fleet management in New Zealand? “We haven’t even scratched the surface yet,” says J. McLean, Director of Snitch. “With the prices of fuel and staff eating up production budgets, people have to work much smarter. And keeping better track of mobile resources can go a great distance in reducing these costs. Sometimes we get questioned on the ‘big brother’ aspect of fleet management, but once we explain how it is all about efficiency and better customer services, people see the advantages,” he says (*Phil Parent, 2009*).

Beyond fleet management: Technology website *The Register* reported the LAPD’s StarChase Pursuit Management System uses compressed-air laser-sighted launchers mounted on a patrol car to fire ‘a miniature GPS receiver, battery and radio transmitter, embedded in an epoxy compound’. The radio data channel is cellular, so that absconding villains can be tracked anywhere within network coverage. This will reduce collateral damage while trying to nab a criminal (*Phil Parent, 2009*).

1.4 GPS Linked Accidents

A report in the UK suggests that about 300,000 car crashes per year are caused by GPS. And as per a survey, “1.5 million drivers have swerved through traffic when following their sat-nav's instructions a little too closely”. Other errors caused by GPS include driving onto a railway line,

driving wrongly down one-way streets, hurtling into ditches, getting stuck under bridges and ignoring road signs (*GPS Causes 300,000 Brits to Crash, 2008*).

Here is another one from a NZ newspaper. *“In a holiday hurry, a person piled his family into the car and asked his GPS for the quickest way from his home to his destination, but following his GPS directions, “he and his fiancée headed east into the mountains, turning off a highway on to local roads and finally getting stuck in the snow. They had no cell phone service and ran short on formula for their 11-month-old daughter.”* They were finally rescued, but their peril left law enforcement officers and travel advisers perplexed about drivers who set aside common sense when their GPS systems suggest a shortcut. They recommend GPS users to have a paper map as a backup, a survival kit for the winter, configure GPS for "highways only," or a similar setting to avoid getting directed to byways in the winter, top off gasoline tank, charge cell phone batteries before going into remote areas, and pay attention to the weather (*The Perils of GPS, 2010*).

1.5 Conflicting views on GPS applications

Some employers equip their company vehicles with GPS tracking systems despite claims that this invades staff privacy and has even contributed to a death in the past. Employers believe that they get detailed time sheets showing every stop made, parked time, driving time, distance covered, maximum speed and an estimate of the amount of fuel used. Business owners can also log on to a website to view the current position of any of their vehicles at five-minute intervals. The law prohibits monitoring of employees when they are off work. "So in theory employers are supposed to turn off the location-tracking devices when their employees are not 'at work', but they won't always know when that is, which makes it highly likely that employers will be in breach of the act (*GPS tracking can drive employees over edge, 2009*).

2.0 RFID (Radio Frequency Identification)

The history of RFID goes back to the period of WW-II, when the British used RFID to identify their aircraft returning from sorties over occupied Europe. In the late 1960s, the USA began using RFID to tag and monitor nuclear and other hazardous materials” (Mullen and Moore, 2005, P. 3). Today RFID is used for a wide range of applications such as automatic toll collection; access control (personnel and vehicle); security; equipment tracking; payment at gas pumps; fast food chains and other retail outlets (Mullen and Moore, 2005, P. 5).

Applications of RFID in livestock management include: automated optimal feeding, drugs and supplements administration, and automated record keeping. It can also monitor the temperature in the ear canal or the body of animals to check health of livestock. The EU requires RFID tagging of sheep, goats and pigs being supplied by overseas suppliers. The tagging of books DVDs/CDs in libraries automates stocktaking, helps find lost books, and even prevents theft (RFID in New Zealand and Australia, 2006).

According to an estimate (RFID for Animals, Food and Farming, 2008), the use of RFID in food supply chain is set to rise to about \$5 billion mostly spent on the systems and the tags in 2018. In due course, the tagging of individual items will attract the most investment, benefiting all in the supply chain but tagging of conveyances, pallets, cases, vehicles and equipment will also be important. RFID is used to track, monitor condition, prevent errors and theft, and even locate from a distance. This increases sales, improves customer satisfaction and reduces costs. Research also suggests that legislation is driving the use of RFID for safety (with livestock and pets), for the rapid and optimal response to disease outbreaks, proof of vaccination, registration and so on.

Sabbaghi et al. (2008) examined four processes in a supply chain (*demand management, order fulfillment, manufacturing flow management, and return management*) which are impacted by RFID. According to them, RFID enables an organization to significantly change its business processes both in terms of efficiency or reduced costs, and effectiveness. RFID offers significant strategic value potential for companies in developing an integrated model of supply and demand chain to drive revenues and innovation and to gain competitive advantage. Companies that implement the appropriate business processes to leverage the data collected by RFID and its conversion to information will accelerate the benefits.

2.1 How prepared are NZ marketers and users for RFID?

By using RFID tags that can be monitored from remote readers, companies can collect accurate and detailed information in real-time. Thanks to modern technology “*the devices have become smaller, smarter, more durable and cheaper*” (Ferguson, 2002, P.138). Ferguson (2002) contends that the ‘*silent commerce*’ of this object-to-object communication will be transformational, and “*as RFID systems become more sophisticated and widespread, they will begin to reshape companies, supply chains, even entire industries. It is no exaggeration to say that a tiny tag may one day transform your business*” (P.139).

According to Lapidé (2004), RFID offers operational advantages such as speed, ease of use, flexibility of deployment, and opportunities for unobtrusive use. Companies using RFID can monitor stock in real-time to prevent out-of-stock problems, as tagged products can be tracked anywhere in the world. However, monitoring does not end when the product is sold; if active tags remain on goods after a purchase is made, retailers can track what other purchases consumers make, which products they place with their goods and where they buy them. As McCullagh (2003) states, “*it becomes unnervingly easy to imagine a scenario where everything*

you buy that's more expensive than a Snickers will sport RFID tags, which typically include a 64-bit unique identifier yielding about 18 thousand trillion possible values” (P.24).

According to Lai and Zhang (2005), there are various challenges and opportunities for Chinese companies in the adoption of RFID. Challenges include China's standards, costs, business environment, business models, and untested market, and the opportunities are China's huge market, advances in several industries, a rapid increase in logistics demand, and China's role as a world-class manufacturing center.

2.2 Who is leading and lagging in RFID race?

The global use of RFID is increasing rapidly from a US\$2.7 billion in 2006 to over \$26 billion in 2016. Australia and New Zealand are leading in RFID application in some areas but lag in others. For example, cattle in Australia (by law) and milk samples in New Zealand have used RFID tagging, but in other areas such as retails, and cargo handling, they are lagging and they need to benchmark against the best practices elsewhere. The IDTechEx, a knowledgebase of over 2000 case studies of RFID in 76 countries, lists 41 case studies in Australia and 8 in New Zealand but the number in both countries is now rising rapidly as new data are entered. They will increasingly reflect the increase in item level tagging as it moves up to overtake pallet and case tagging. This is good news, because both producers and shippers will benefit from item level tagging whereas pallet and case tagging is often done under sufferance without payback.

In Australia, RFID has been used in airport, animals and farming (tagging of cattle, fish, horses and sheep). Other areas of RFID applications include books, libraries, archiving, financial services, security and safety applications, pipeline location, forensic samples tracking, police car tracking, visitor tagging, e-passports, tagging sex offenders and boats. As reported, healthcare

facilities, land and sea logistics and postal services are laggards in using RFID in Australia. There are some cases of RFID applications in leisure, sports, military and manufacturing. The retail and consumer goods industries in Australia are on the move in RFID all involving conveyances and cases. There is real leadership in the passenger transport/ automotive sector with eight major schemes covering car immobilizers, transit ticketing and non-stop road tolling.

2.3 RFID in New Zealand

New Zealand has two cases of RFID in libraries, one each in financial/security/safety, leisure/sports and two in retail/consumer goods and passenger transport/automotive - in this case rail. Fonterra, the world's largest milk cooperative, has appointed system integrators for a major use of RFID for error prevention, record keeping and efficiency in New Zealand. According to a report (*RFID in New Zealand and Australia, 2006*), 16,000 tags will be used for the vats, 500,000 for the sample vials, and a total of 3,000 readers are being purchased, and there is more to come as Fonterra replaces all barcodes with the more reliable and versatile RFID.

Fonterra has installed RFID tags on more than 14,000 vats which can automatically identify the farm, as well as the vat that the tanker is connected to. They are also able to link farm and vat information, collection dates and times, as well as collection volume and temperature to the sample at the point of collection. RFID tags are also being incorporated into new sample vials throughout New Zealand. (*Kiwi ingenuity at its best, n.d.*)

Fonterra takes bio-security very seriously which is clear from the CEO, Andrew Ferrier's statement, "*We are viewed very positively in the world, we've never had issues with Foot and Mouth and we've certainly never had issues with BSE, but we have to be prepared for it. So, one of the things that we are doing is improving our traceability system. If ever there was an*

outbreak of any significance we need to be able to trace that right back to the cows on the farm. We would need to know where did this come from? We'd need to know at which of our 23 plants it originated, what products it got to and what customers” (Foreman, 2006). “That’s why we are in the process of putting RFID tags in all the vats owned by Fonterra in New Zealand. We’ll be able to trace milk from the vats to the tanker and up through the supply chain.” Another unique characteristic of Fonterra is that its suppliers, over 11,000 farmers, are also its shareholders.

2.4 RFID Controversy

Most new and emerging technologies are met with controversy until implications of the technology are fully understood, and RFID is no exception. A consumer group CASPIAN (Consumers Against Supermarket Privacy Invasion and Numbering) protests against RFID technology, especially in the supply chain and calls human RFID implants as the ‘Mark of The Beast’. The main opposition relates to concerns over individual privacy, and big brother philosophy. The group is against the idea of governments and big corporations monitoring every move of consumers, and feels that in the absence of enough regulations, the use of RFID technology does increase anxieties over privacy. If standards and regulation were to increase then some of the benefits of the technology may be felt by the wider population. There also needs to be more research done into health risks posed by increasing amount of radio frequency around towns and cities and risks of implanting chips in people.

<http://www.spsychips.com/>

3.0 Research Methodology

The paper investigates some of the issues linked with the deployment of innovative technologies such as GPS, TracMap, and RFID in NZ farming and business environment. Two companies

selected for detailed investigation are TracMap New Zealand from the farming sector, and Conroy Removals Ltd (CRL) from supply chain environment. A set of questionnaire was also sent to six major NZ supermarkets (Pak n' Save, Briscoe's, The Warehouse, Dick Smith, New World, etc) to get some feedback on the barriers in adoption, use and benefits of RFID in their operations. Literature survey on GPS, TracMap and RFID was conducted based on articles and web based information, and the answers to some specific questions were obtained through interviews and emails. A brief description of these two companies is given next.

3.1 Company 1: TracMap, New Zealand

TracMap NZ was created in 2005 by a leading agricultural consultant Colin Brown, after he identified a gap in the market for a rugged and easy to use GPS guidance and mapping system. TracMap offers GPS tracking equipment for vehicles (Figure 1) used in farming, spraying, and fertilizing. The onboard unit maps the paddock, fertiliser application and weather conditions, and it also sends the data via cellular modem to the farmer for production purposes and the local council for regulatory compliance purposes. Supported by the detailed maps, even a less skilled fertiliser truck driver can work accurately during day or night as the maps capture all the hazards of terrain and obstacles. Study shows a gain of upto 20% in productivity, and with GPS mapping fertiliser application can be tailored to the soil's needs. While GPS systems are common overseas for cropping in straight lines in relatively flat, and vast fields, TracMap is customized for the hilly and small paddocks. TracMap is growing at 10% a month, and is offering a wide range of devices for applications in irrigation control, heli-spraying and data collection in grape harvesting. According to Collin Brown of TracMap, there is still a big challenge in getting the farmers to use such sophisticated tools in their own management (Oram, 2008). To gain some feedback on the use of GPS by various clients, a set of questionnaire had

been sent to Grant Gibson, the Senior Manager of TracMap, and his responses are presented next in a Q & A format. (Sources: www.tracmap.co.nz & messages from grantg@tracmap.co.nz)

3.11 TracMap Q & A

When was TracMap first introduced in NZ, and do we have any other devices in the same league? The first units were put into fertiliser trucks in October 2006. The company and development was started in May 2005, so it was very quick between starting work on the idea and installation of the first system. The Oct 06 installations were prototypes, and of course there were a number of issues, however, customers stuck with us, and issues were resolved, and subsequent redesign of the hardware and constant debugging of the software got us to where we are today. The company was initially formed with a focus on the first market of fertiliser spreading trucks. This gave us our leg up, and was the focus for the first 18 months. We delivered to that market, and over half the fertiliser trucks operating in NZ now run a TracMap system. The system was also sold to spray contractors. (Source: www.tracmap.co.nz)

Since installing our first units in trucks in 2006, TracMap has grown to be the largest AgGPS provider in the country, with Truck, Tractor, Bike, Effluent Management, Live Fleet Tracking and Aviation units now on the market. Over half the fertiliser spreading lorries in NZ use TracMap guidance systems. While accuracy in fertiliser spreading and tracking is still our core market, our customers continue to surprise us with the diversity of uses they find for TracMap units.

Tell me something about your users and core markets?

Fertilisers/Spray contractors: There is a huge take-up due to simplicity, fit for purpose, proven technology and the productivity gains from the system. Generally, contractors operate with the

TM335, while the farmers spreading fertiliser use TM333 or TM334 - the 'cut-down version of the Contractors system. We have great feedback, some testimonials are on the website. We now sell more into this market than the original market of Contractors. Technology is getting accepted, and use is more common. Gains made are through better staff management, efficient placement of product, and feedback via website.

Farmers/ Irrigation: On hill country, particularly around Central South Island, there is huge irrigation being undertaken with K-Line and long lateral sprinklers. In the past there had been no system to assist in moving these sprinklers to the correct location. This is something that we developed, and is getting great uptake. The payback from accurate placement of water, and the subsequent growth rates has been excellent. These guys generally use TM344 system which can display farm maps on screen, including irrigation layout.

Council Services: This is a new market which we have started to focus on since the recession impacted Dairy and farming in NZ. Guys working for Councils (viz. mowing, spraying, road repairs) find TracMap very beneficial in terms of getting the right location, doing right job when they are there, and capturing applications for sending back to those that provide the contracts.

Aviation: We have developed a system for aviation for an operator in Otago, and this has gone phenomenally well. This is leading our export, simple to use, robust, and reliable with great back-up. Competing products in the market have one month turn around (have to get sent back to States if any issues). Due to the fact our hardware (except the lightbar), is the same in land based and aviation, we have a one day turn around. We have our distributors offshore stocked with spares just for the sake of servicing.

Do the users have any infrastructural problems (viz. broad band, cellular phone or satellite coverage constraints)? We use external GPS receivers to get the best accuracy for the lowest cost for our systems, so this is one issue that we are constantly battling to stay up with the game. We find this difficult, as most of our competitors are very large corporates with sizable R & D budgets, who also develop GPS engines. They embed them into their devices at a fraction of the cost. We have to compete on a non-level playing field regarding GPS receivers. Many users require accuracy greater than autonomous GPS receivers can handle, requiring a differential signal. The cost of this is prohibitive for some markets (vineyards/orchards in particular).

Broadband access in farms is a key enabler to the increased uptake of information coming off the farm. *Cell coverage* is an issue for our contractors. They send information in via the systems to the back office. We still run CDMA in our systems. We have just enabled the software to take USB modems, which means our system can work globally as long as the modem is correct.

What percentage of farmers are using TracMap or any other GPS based devices in their operations? We have approximately 800 units in the NZ market at the moment, of which 400 belong to the dairy farmers. There are about 11,000 dairy farms in NZ, so penetration for TracMap systems would be 3 - 4% total. There are a few other competing systems out there, but they would not make up a great %. At present, dairy farms are the core market, due to profitability of sheep/beef. Cropping farms will have a far higher uptake of GPS technology.

What are the challenges faced by marketers in delivering or deploying these devices?

(i) Cost to develop: It is not cheap, and companies, particularly in NZ, need to be well funded, which raises the larger issue around angel investing. *(ii) Size of market* and dependency on so many things outside your control. Generally, marketing to rural NZ is difficult. Sheep and Beef

industries have had a long stretch of bad returns, so they are not looking to invest in technology. Dairy has been reasonably good over the past three years, however, given their level of indebtedness, a drop in the price of milk solid from Fonterra, spending drops (as seen when forecast payments dropped from over \$7 to \$4). It does not matter if the investment is going to pay back, farmers have just stopped spending. For a company in it's infancy, if the market drops overnight, due to exchange rates / commodity prices etc, it is very difficult to continue. (iii)

Competitor: Trimble, a large corporate from the US is selling their systems cheaper in NZ than Australia in direct competition to TracMap. Good things about marketing in NZ is to get honest feedback. (iv) *Closeness to the market:* If it works in NZ, it will work internationally. Attitude and experience of people working for the company.

What are the users' feedback after they have used these devices for a significant period of time?

Farmers spreading fertilisers can now do 9 paddocks instead of 7 with the same amount of fertiliser by applying it accurately. Productivity gains are up generally 15% to 20%. Irrigation users say they wish they had the system years ago. Testimonials are on the website, and there is a good submission on three users of TracMap and the benefits they have obtained. We had Channel 99 do a feature on TracMap that we are trying to get and put on web soon. (Source: <http://www.tracmap.co.nz/news/news/grasslands-2008.html>)

RFID has been in use in NZ in some selected sectors, but is not very popular with retailers as compared to many other developed countries. What could be the possible reasons for not going full speed on RFID? I am not an expert on RFID. However, lack of promotion, and debate over application (particually in Agriculture), has led to low uptake in my view. Some of the issues include: farmers not wanting to bear the cost for what they consider questionable benefits. On

the other hand, if we don't adopt, we will be left behind, particularly with health issues in Agriculture, and the lack of suitable traceability will be a barrier to trade globally.

And here is what *Iain Beaton* of New World has to say about RFID in response to my questions.

(a) *How do you see the benefits of using RFID in your operations?* We currently don't use RFID in our store. The benefits are: loss prevention on high value products (e.g. health & beauty lines, electronics, and meat). (b) *What are the barriers in having RFID deployed in your operations or in retails in general?* The barriers are: the set up cost of equipment, and cost of RFIDs to place in or on the products. We have thousand of product lines with low margins, whereas a *clothing shop* has less lines at higher margins which makes it more cost effective for them. I am aware that some manufacturers are building this into their labeling (*Iain Beaton, New World Groceries Supermarket, Greenmeadows*).

3.2 Company 2: Conroy Removals Ltd (CRL)

CRL was established in 1972 as a family business which operated in Hawke's Bay region for the first few years before expanding throughout New Zealand. Later, it received ISO 9001:2000 certification for providing a high quality service. To respond to the business environment, it was vital to monitor the fleet of vehicles efficiently, and thus GPS units were installed. The company signed a deal with *Minor Planet* in 2003 for GPS support which is helping CRL's transport system by analyzing, and tracking the vehicles' locations. The two key softwares supporting CRL business are GPS and *Moveware* whose functions are detailed in Table 1 & 2. *Moveware* keeps record of transactions, past jobs and resources which can be used for analysis. CRL's mission is to be the most preferred company for relocation of furniture and household effects.

Services provided by CRL include (a) *export removals* handled by overseas companies after the items have left NZ ports; (b) *import removals* that CRL receives from overseas companies; (c) *local removals*, and (d) *intercity removals*. The company also provides storage facilities for clients who may need to store their items for various reasons (e.g., they may not be able to move into their new homes right away or might not have enough room to store everything). This service allows clients to safely store their items for a specific period of time on a payment. CRL also provides their clients with removal packages, trucks and personnel for loading, transporting, and unloading. Each branch has its own cubic meter rate, and the charges differ on weekdays and weekends. Other services include cleaning, and insurance of items during the removal cycle. CRL's international domains are Australia, the UK and the USA, but it is in the process of expanding its operations into new areas.

3.21 Shipping Process at CRL

The shipping process consists of six steps (Figure 2) as described briefly. *Client contact*: A client requests for a quote by e-mail or phone, and the quote can be settled on phone if small volume need to be moved, otherwise a sales person will schedule a time for inspection. *Inspection*: Sales person visits client's house, inspects the inventories, and measures the volume using an estimate volume sheet. *Send quote*: Two or three days after the inspection, the sales person sends a quote to the client including insurance option. If client agrees on the price, then sales person will arrange date and shipping time. *Transporting*: Packers will arrive at client's place on the scheduled time and start loading inventories into vehicle. If the destination is within NZ, the truck should be able to send the items within 24 hours. *Port*: Sometime client may ask CRL to send inventories overseas, in that case, the container will be sent to the port for shipment. If the container is sent to other countries such as UK or Australia where CRL have opened their

branches, then the local branch will take care of the container. If container is sent to other counties where CRL do not have branch, then the CRL will contact other local removal company to send the container. *Processing speed*: The process of sending quote to the client may take two to three days. However, if clients need quote urgently, the sales staff can supply that in a day.

3.22 How does GPS work at CRL?

GPS device helps CRL when it comes to travelling to the areas that drivers are not familiar with. Drivers can request for print out of destinations to avoid getting lost along the way. Clients also need to keep CRL updated about their inventories by calling operations team at the office. The GPS device installed on CRL's vehicle sends signal every minute to the satellite floating around the Earth orbit. CRL could send the signal every second but that may overload the system. The satellite sends the signal back to *Minor Planet Computer server* (Figure 3) to filter the data before sending them to *CRL computer server* at the head office. The data can then be analysed by the computer and personnel, and they will be automatically updated. The operations team can access the database through their computers which allow them to watch vehicles' activities such as location, speed, and distance travelled. Each data is stored and kept for possible evaluation in the future.

3.23 Supply Chain Network for CRL

The company apparently follows a '*hub and spokes model*' for consolidation and transportation of household items for their clients. The hubs are located in five places in New Zealand (viz. Auckland, Tauranga, Napier, Wellington, Christchurch), and one in Australia (Brisbane). CRL's *domestic transport* in the North and the South islands of NZ take place mainly by road network using own trucks. The two islands have relatively limited rail network which makes the road

network even more vital in the supply chain of CRL. *Overseas operations* are carried out mainly by sea routes due to the bulky nature of household items (airfreight option is uneconomical).

All the *hubs* are strategically located near the ports so the items can be brought there by road or rail network (*spokes*) for consolidation and onward transportation both in NZ and overseas. The organizational structures of CRL at different hubs are fairly flat and functional which is quite common for the medium size enterprises. The main supply chain partners of CRL are shown in

Figure 3.

CRL's Suppliers/Enablers

Destinations/Branches of CRL

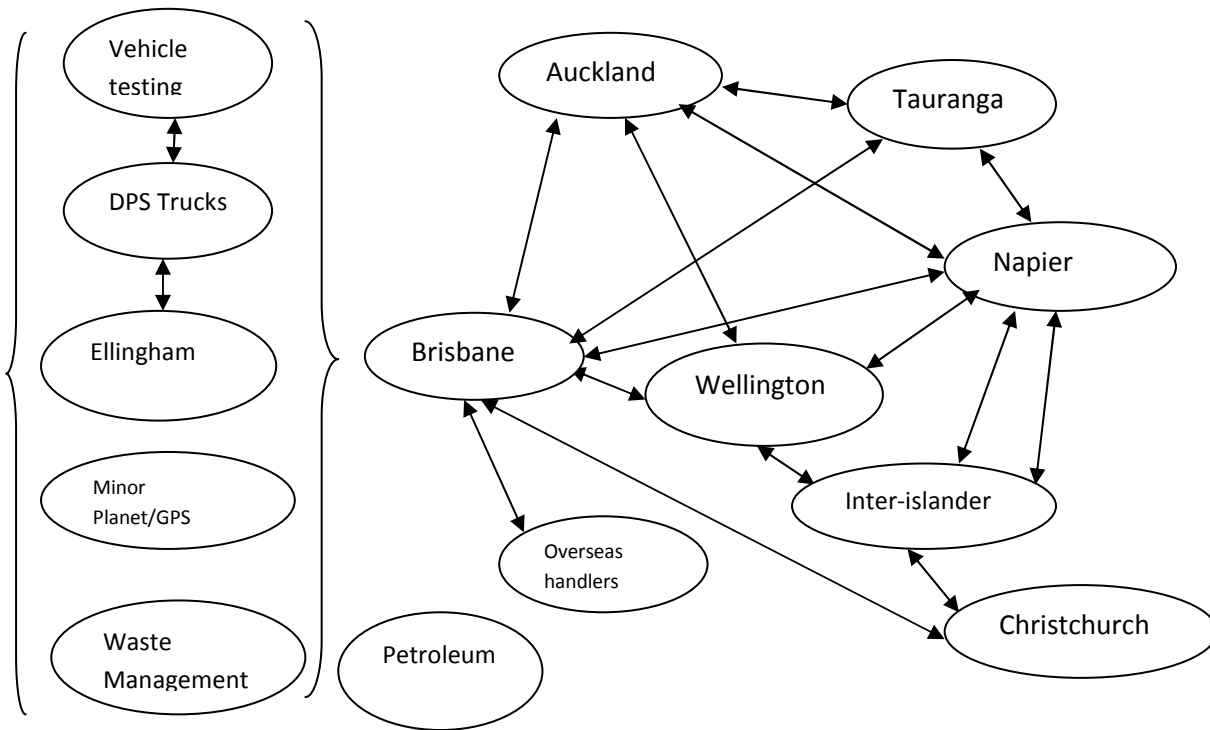


Figure 3 Supply Chain Network of CRL

Inter-islanders play a very critical role in transporting items across the two islands of New Zealand. The possibility of a bridge construction between the two islands could change the supply chain logistics drastically, but constructing one is quite challenging with the difficult terrains on both sides plus the span length of the bridge itself. Till that happens, inter-islanders

will continue to play the role of a floating bridge between the two islands. CRL being a frequent user gets a discount fare from the *interislanders*. *Minor Planet* provides with the GPS support for all the vehicles. There are a few other GPS suppliers that CRL could choose to sign a deal with. *DPS Trucks* provides regular maintenance to vehicles, and is considered an important supplier for CRL despite the fact that it can be replaced by another one. *Vehicle Testing* helps to see if CRL vehicles are roadworthy, and to this end a vehicle is tested every six months. *Ellingham Engineering's* provides spare parts for the vehicle in case of break down. *Waste Management* is responsible for the control and recycling of waste materials such as papers and stationery. There is scope for using GPS in and across all the CRL's supply chain partners.

4.0 Business Performance Analysis

This analysis includes vehicles with different types and engine sizes which may make the conclusion on fuel consumption a bit fuzzy. To avoid that, the data analysis has been done for each type of vehicle separately. The *key performance indicators* (KPIs) relevant to the CRL operations are: idling time; fuel consumption; types of vehicles; fuel cost per litre; total distance travelled; total engine running time; areas where the vehicles were driven (rural or urban); traffic intensity; drivers' habit (speeding and applying short brakes); and the weight of the inventories carried. Some of these factors and KPIs are investigated further in the following section.

4.1 Vehicle idling time and fuel consumption

It is obvious that idling vehicle consumes much less fuel than it does when travelling, but too much of idling can reduce the profitability of the company. CRL uses four types of vehicles (P,

B, R, and Y), which are used for *local; regional; intercity; and special removal respectively*. Y type has been excluded from the analysis due to inadequate data. Let

T_i = Idling time for the engine (minutes),

F_i = Fuel consumed per minute during idling time (L/min),

T_d = Driving time for the vehicle or engine (minutes),

F_d = Fuel consumed per minute during driving time (L/min),

C_f = Cost of fuel per litre (\$/L),

C_i = Cost of idling of the vehicle engine,

C_d = Cost of driving of the vehicle engine; then

$$T_t = \text{Total time for the engine} = (T_i + T_d) \quad (1)$$

$$\text{Per cent idling time} = \{T_i / (T_i + T_d)\} * 100 \quad (2)$$

$$\text{Total cost} = (C_i + C_d) = (T_i F_i C_f) + (T_d F_d C_f) = (T_i F_i + T_d F_d) * C_f \quad (3)$$

Equations 1 to 3 have been used to create Table 5 which shows that B and R types have high percentage of idling time than the P type. Generally, R and B types have larger engine sizes which make them consume more fuel than smaller vehicles (P type) while idling. Fuel alone could cost the company more than \$3,600 per year for every vehicle during idling. Further, idling may also cause the vehicles to run behind the schedule which will affect the company's reputation negatively. CRL is now planning to set the limit for idling time for each type of vehicle. It may do so by using control charts or Pareto analysis.

Can GPS reduce this fuel consumption?

Yes it can, if the idling is caused by the drivers getting lost in a new place and trying to find the correct locations leaving the engine still running. The rural houses are generally not marked as well as their urban counterparts, and the driver may find difficult and time consuming to locate,

which explains the higher idling time, and the higher fuel consumption per minute. GPS can come to the rescue by recording all the houses in different rural localities where CRL is likely to operate, and can reduce idling time and the fuel consumption for sure.

Customer satisfaction rate (CSR): The overall CSR is based on six factors: *first contact or customer touch point; sales team behaviour (politeness, clarity of information, responsiveness); documents preparation; packing quality; removal quality; and delivery time*. Figure 5 shows that the customer satisfaction level was always ≥ 3.5 from a maximum of 5 which means the company has been keeping its customers happy.

Job acceptance rate (JAR): JAR is measured by dividing the *number of quotes sent out to the clients* by the *number of jobs accepted*. The main factors influencing the number of acceptance of jobs are customer sensitivity to the price, and increase in number of competitors. This key performance allows CRL to see how customers react to the price of its removal jobs. The company has to perform a trade-off analysis between the *reduction in quote price* and *increase in the JAR*. Figure 6 shows the JAR for the company has always been more than 45 per cent. It was mostly between 50 to 60 percent except in the March 2008 when it was 70 percent. It could possibly be due to the competition or the quote price or both in the removal industry.

5.0 CONCLUSIONS

It is obvious from literature review and feedback from NZ organizations that GPS, and TracMap are gaining popularity. However, RFID is mostly confined to big companies Fonterra, but not in retails industry. They are still maintaining a wait and watch policy. Table 6 gives a very comprehensive list of existing and future applications of RFID.

TracMap NZ is growing at a rate of 10% a month, and is offering a wide range of devices for applications in areas like: farming, irrigation control, heli-spraying, and data collection in grape harvesting. TracMap is the largest AgGPS provider in the country, with Truck, Tractor, Bike, Effluent Management, Live Fleet Tracking and Aviation units now on the market. Over half the fertiliser spreading lorries in NZ use TracMap guidance systems.

CRL NZ enjoys lots of benefits from the use of GPS such as: (a) GPS provides CRL with some advantages over those competitors who are not GPS enabled. It costs fairly high to run a GPS, but it benefits CRL greatly in the long run. Operation team can use GPS to find the route, check vehicle status, and print out detail report. Removal job is considered the face of CRL where people see how it operates unlike other areas such as reception and accounting. By using GPS, the company is able to make its transport process run smartly and smoothly which makes it more reliable in the eyes of customers.

(b) CRL research suggests that Minor Planet's GPS deal is fairly costly as compared to other providers in the market, and CRL may think of switching in the future. (c) Removal price is the factor that attracts the clients the most. Thus, lower the removal price better the chance for clients to accept the quote. CRL also offers cleaning, packing supply, and insurance to its clients. These services are part of the company's strategies to *differentiate* itself from competitors in the market.

Recommendations: (i) *Set the limit for the idling time:* Each month CRL spends about \$5,000 on the fuel cost from idling, and it should set idle time limit for each type of vehicles (e.g. R and B types 2%, P type 3% per month). Some vehicles cost up to \$125 per running hour which includes the idling time. If CRL follows idling time limits, it should be able to reduce the fuel cost and

running cost, which in turn will lower the removal price, and will attract more customers. The operation team should show the data to the drivers to make them aware of the effect of idling time on operations. This will help change their driving behaviour to lower the idling time. (ii) *Change the GPS provider:* As the Minor Planet's GPS running cost is higher than others in the market, CRL can do better by switching the deal, which will ultimately reduce the operations cost. However, the points that CRL should consider for selecting new GPS provider are: set up cost, mapping and report details, and reliability. (iii) *Find the alternative fuel:* The main reason behind the high removal price is the fuel cost. As the fuel price increases so does the cost of running the vehicles, which ultimately affects the removal prices. To reduce the cost of running vehicle CRL could use bio-fuel which is considered to be the cheapest, and purchasing new vehicles that have better fuel efficiency. This option may have high initial cost, but will reduce the operations and supply chain cost in the long-run.

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APPENDIX

Figure 1: An Overview of TracMap System (Source: www.tracmap.co.nz)

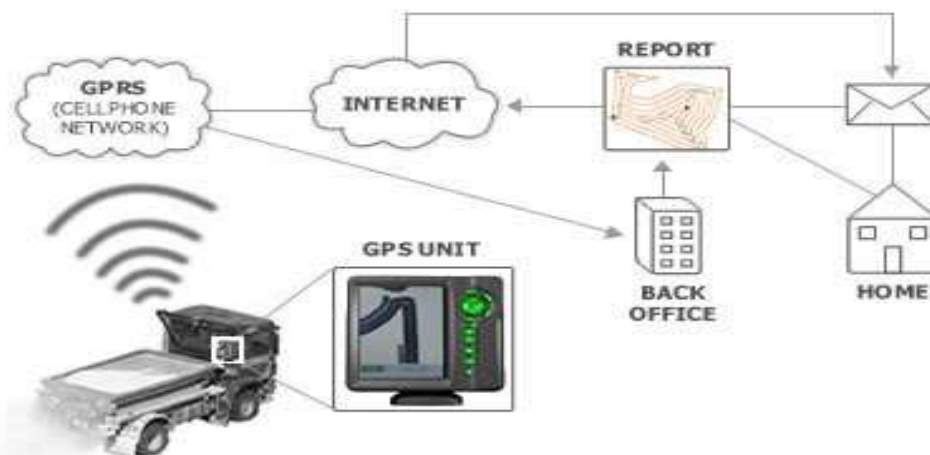


Figure 2 Shipping Process at CRL

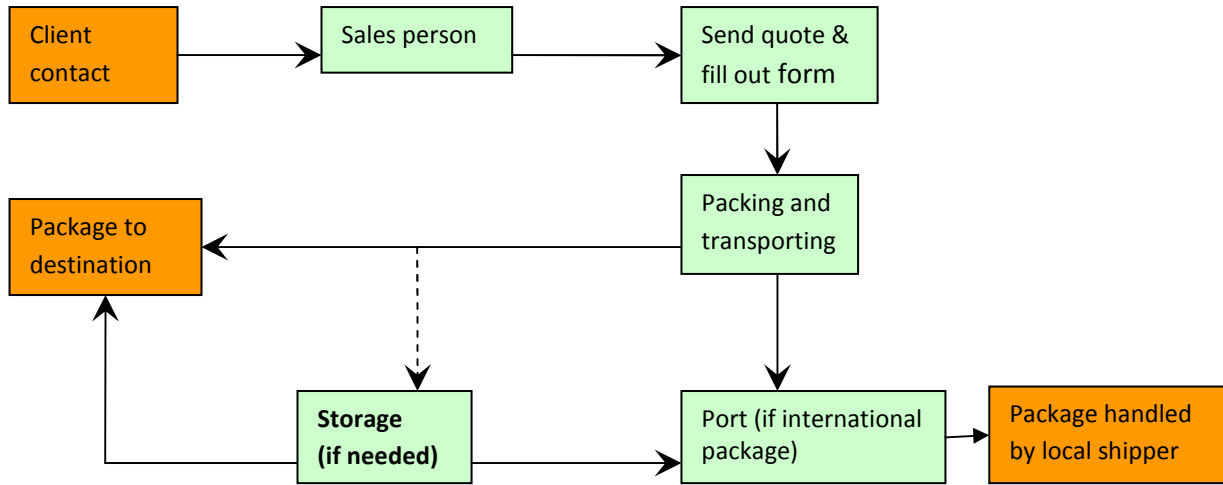


Figure 4: Functioning of GPS at CRL

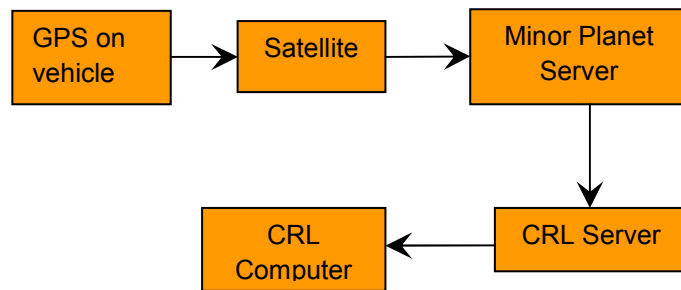


Figure 5 Customer Satisfaction Rate

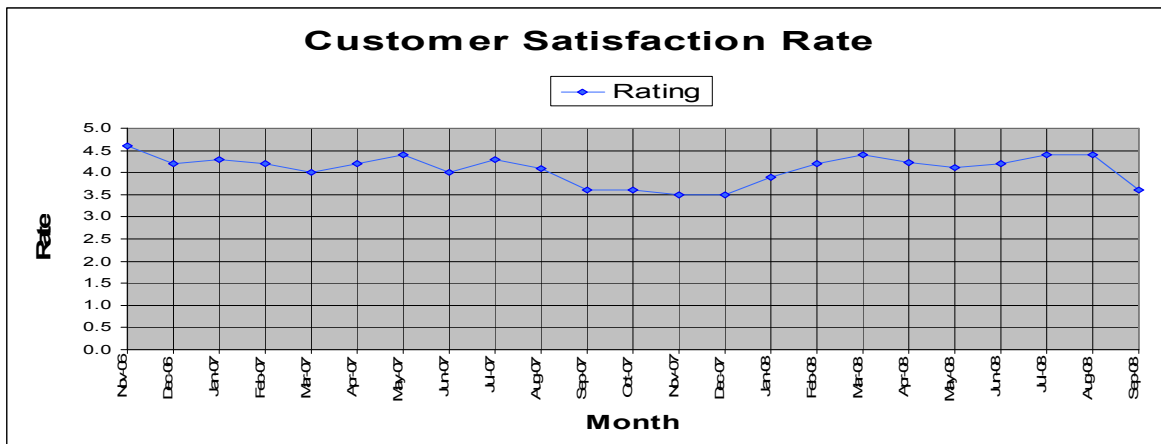


Figure 6 Job Acceptance Rate

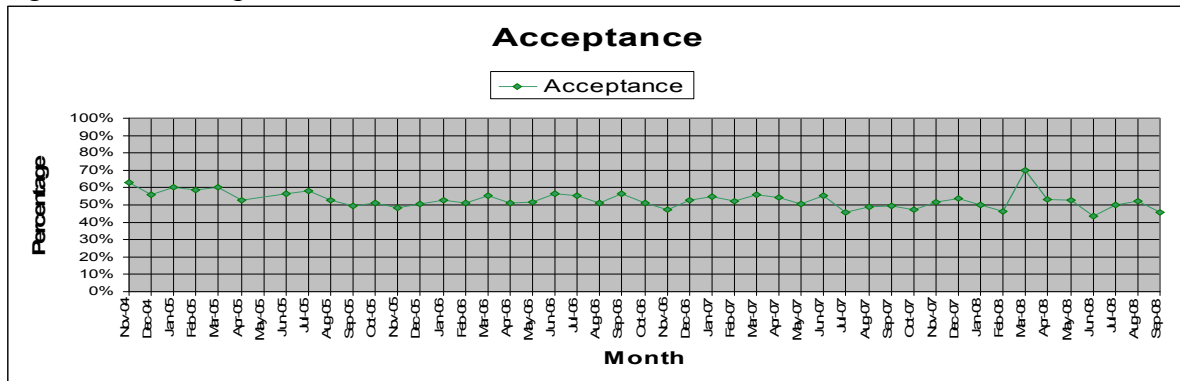


Table 3 GPS functions in CRL’s overall operations

<i>LiveTrack</i> shows vehicles activities in the real time, exact location and speed. Operation team at office can locate vehicle, and contact driver to know if vehicle is behind the schedule. The customer can also know when the truck will be arriving.
<i>PlayBack</i> replays vehicle activities from previous year up to 30 minutes before the current time, and can track irregular activities in the supply chain. Operation team can track down and see how, where, and why vehicle is behind the schedule.
<i>Route</i> gives different paths to reach the destination. In case of two or more routes, it can offer the shortest and quickest one. This function can print out detailed route, which can reduce the chance of driver getting lost in an unfamiliar area.
<i>Report</i> shows activities (viz. engine running time; hours worked; barred locations; condensed trip report; condensed time at location & stops; exceptions report (by driver, vehicle, speed), idling, service information, and speeding exceptions.

Table 4 Various Functions of Moveware

<i>Appointment</i> : shows the progress of each job and can also backup information if anything goes wrong.
<i>Diary</i> : shows the list of current jobs, its progress, and is automatically updated at midnight.
<i>Removal</i> : gives list of jobs done in past, and information (viz. client address, costing, invoicing, inventories and claim
<i>Waybill</i> : shows the record of jobs (viz. types of job, inventories volume, vehicles use, and payment date and amount).
<i>Debtor</i> : shows the list of clients, contact numbers, and total cost for each job completed.
<i>Report</i> : shows additional information added by the sales and operation team; information (viz. branch workload, insurance premium, removal summary, and analysis) which can be used to analyse performance, and do benchmarking.

Table 5 Performance of various types of vehicles

	P-type	B-type	R-type
Fuel Economy (Km/L)	9.15	4.25	2.54
Fuel Consumption (L/min)	0.08	0.16	0.29
% Idling Time	1.16	4.79	5.92

Table 6 Global Applications of RFID (Existing and Future)

<p>Access Control: Implants and smart cards hold passwords for computers to allow only specific people to the information (e.g. Mexican Attorney General's office implanted 18 of its staff members with the Verichip to control access to a secure data room); allow delivery vehicles to enter warehouses; to offices/work premises or company vehicles; to own house or vehicle. Future: Only allow machinery to work if user has a safety certificate to use it; access to authorized car parking, and automated payment parking.</p>
<p>Military: Artillery and supplies are tagged so their locations can be traced and officials notified if they are intercepted. Future: troops could be implanted and military vehicles tagged so their locations can be traced, it would be easier to identify the enemy; to aid hostage situations; workers in war-torn countries could be tagged to know their locations in case of being kidnapped; earthquake victims will have better chance of being rescued if tagged.</p>
<p>Supply Chain: Tracking of pallets, containers, cargo on road, rail and ship; EPC (electronic product code) likely to be used with bar-coding until RFID technology gets cheaper; many manufacturers and retailers use RFID tags on products, only used in warehouses at present, not on shop floor as yet. It improves stock control. Marks & Spencer, Woolworths and Tesco are leading the way in the UK. New Zealand retailers will need to catch up with many OECD countries.</p> <p>Future: No cashier in supermarket: all products chipped (when the customer leaves the shop, readers in the doors identify which stock has been purchased updating stock inventory and sending the information to the customer's bank to authorise payment for the products). It would help to combat shop lifting, although once customer has left the shop, what does the shop do if the customer has no funds in to pay? Refrigerators and cupboards with a reader would keep an inventory of all products and alert when products are dated or used and add to a shopping list which could be sent to the supermarket and items dispatched; Clothing containing tags with laundry details would inform readers in appliances on how to wash/dry the items; Tagged food products can provide tamper evidence increasing food safety and a control for bio terrorism.</p>
<p>Medical: Tags were implanted into unidentified victims of Hurricane Katrina, staff then recorded information about location, physical condition and characteristics; photographs could also be stored; data could then be cross checked with the missing person database; the victim could easily be located again. All packages of Viagra in the US contain RFID and EPC so they can be identified by pharmacists and retailers as a genuine product. Viagra is one of the most counterfeited medicines in the US and it is hoped RFID technology will help reduce this. Future: Allow hospital staff to access medical records; tag newborn babies to prevent unauthorised person accessing them; tag patients so their whereabouts are always known, especially elderly or mentally ill patients. If individuals had implants that held all their medical details, if the patient was admitted in an emergency and was unconscious they could be identified and any allergies or medical conditions would be known. Also could contain next of kin information so they could be notified. Tag all medicines to combat counterfeit medicines entering supply chain and also decrease black market sales of prescription drugs as the products will be traceable.</p>
<p>Travel: (a) Some countries embed RFID chips in their passports with some built-in security features. The passports will be shielded to prevent skimming. The department will also implement Basic Access Control (BAC), which functions as a Personal Identification Number (PIN) in the form of characters printed on the passport data page. Before a passport's tag can be read, this PIN must be inputted into an RFID reader. The BAC also enables the encryption of any</p>

communication between the chip and interrogator” (Wikipedia). Eventually utilising RFID with Biometrics will make passports a unique identifier for every citizen. (b) The Oyster Card, London underground’s potential replacement of the Travelcard uses RFID technology. It provides prepaid travel which eliminates the need to buy tickets and allows you to travel by train, bus or tube. Other similar schemes are in operation in various countries. (c) A lot of toll roads in the USA now use RFID technology in smart card to receive payment. It will eventually remove the need for manned toll booths. **Future:** Instead of road tax – pay as you go taxed per miles you drive; ticketing for parking or speeding fines; congestion charging; baggage track and trace on airlines, potentially there is less risk of baggage being lost or stolen; possible replacement to satellite navigation systems.

Animals: Pet ID used to reunite missing pets with owners; tracking livestock; trace migrating birds for research and to monitor rare breeds. **Future:** Track animals released back into wild and monitor levels of rare breeds; combat pet stealing by being able to locate a tagged pet; access medical history of a pet if found and taken into rescue centre.

Law: Prisons are tagged so inmates can be tracked as a measure to increase security and combat violence; computers are alerted if the devices are tampered with; US Dollars and Euro notes are embedded with RFID chips to combat counterfeit currency. **Future:** Tag people on parole and check they don’t break conditions; track remand prisoners to stick to house arrest to reduce prison numbers; tag inmates in prisons to trace them if they escape; kidnapped victims or missing persons could be traced if implanted.

Leisure: Some casinos in Las Vegas use RFID to monitor standards of service; RFID chips to highlight if counterfeit chips are being used; a bar in Barcelona use RFID on VIP guests who can have access to the VIP lounge where drinks are not paid for at the bar but automatically taken from the guests account via communication with the tag; ski lift passes in some resorts use RFID technology; either as a hobby creating secure access or as a body adornment in line with body piercing and tattooing, a lot of people internationally experiment with RFID technologies.

Services: Some libraries tag books, CDs, DVDs, but technology could be improved to trace the items; postal service could be made more reliable by tagging each item so it could be traced in real time; DHL and FedEx use RFID technology; some laundry services use RFID tags to trace laundry items.

Source: Stacey Greenaway, Technological Innovation and the Use of RFID at the Consumer Interface.
<http://ssrn.com/abstract=969394>