

An Exploratory Research on Adoption of Mobile Commerce Technology in the Supply Chain

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Abstract: The increasing utilization of mobile commerce technologies in e-business raises the question of their use in supply chain integration and management. This article presents a multiple case study investigation of the adoption of mobile technology in the supply chain. A technology-organization-environment framework of the contextual influences on technological innovation adoption is used to inform an analysis of three companies' adoption and use of mobile data solutions for sales automation, freight tracking, and service support. Analysis of the three case studies found that the relative advantage of the technological innovation and the information intensity of the company were the most important factors influencing adoption. Other factors that appeared to influence adoption included the compatibility of the technology with the company's business approach, the presence of top management support, and the degree of organizational readiness. Environmental factors such as competition within the industry or business partner influence seemed less influential for these pioneers of mobile technology use in supply-side activities.

Keywords: IT adoption; IT innovation; mobile commerce; supply chain

I. Introduction

A number of studies have examined the potential for mobile commerce to be applied to SCM. Mobile technologies are envisaged to have the most impact in areas of SCM such as e-procurement, materials handling, warehousing, inventory management, logistics and fulfillment, asset tracking, sales and field force automation, and dispatch management. For example, it has been argued that mobile applications integrated with a company's enterprise systems can provide greater visibility into supply chain operations, leading to real-time order status information and more responsive service management [7]. When deployed to mobile employees such as sales representatives or technical field service teams, mobile technologies can automate data collection, deliver necessary information to employees wherever their location, and reduce the time needed to update data from the field for the rest of the company, resulting in improved workforce productivity, process efficiency, data accuracy, and service quality [9]. The idea that mobile commerce can transform SCM is reflected in the development of concepts such as

“untethered” [11], “adaptive” [7], and “responsive” [8] supply chains. However, there are few empirical studies that focus on the adoption and implementation of mobile commerce in the supply chain activities of companies—those that do have tended to report on financially modest or relatively simple applications that support mobile activities (operational mobility) rather than the mobile transmission of data (transmission mobility) [9]. In contrast, this article examines the adoption of more complex mobile applications that support transmission mobility as well as operational mobility, and integrate with existing company information systems and have the potential to change operating procedures and activities.

Since the organizational adoption of mobile commerce technologies in the supply chain is not well understood, the author use an exploratory case study approach to provide an analysis of three Chinese companies' development and use of mobile data solutions. She first draws on the IT innovation adoption literature to inform her analysis. Then, she summarizes this literature and presents a conceptual framework based on technological, organizational, and environmental factors influencing the innovation adoption decision. Thirdly, she outlines the research method used in the study before presenting her analysis of the three case studies. The final part of the article synthesizes some conclusions from the cross-case comparison.

II. Organizational Adoption of IT Innovations

There is a long-standing interest in the adoption of IT innovations in the study of information systems. In this article the author is concerned with the primary adoption of an innovation by an organization, rather than its secondary adoption by individuals in the organization. By organizational adoption of an innovation the author means a process beginning with initial awareness and evaluation of a new technology or product, followed by a decision to purchase and implement the innovation, and finally its acceptance or assimilation within the organization [5]. Researchers have utilized a number of approaches in attempting to explain why organizations adopt IT-related innovations. Probably the most common approach used is one based around the identification of a set of contingency factors that collectively explain the innovation adoption decision or outcome [4] [5] [6]. Many contingency or factor studies of IT innovation adoption tend to follow a “technology-organization-environment” model pioneered by

DePietro, Wiarda, and Fleischer [3]. The number of empirical studies following this approach provides support for its usefulness and, following calls to extend this framework to other innovation domains [2] [12] [13], the author has used it to organize her exploratory study of the contextual influences on the organizational adoption of mobile commerce technologies in the supply chain.

The technology-organization-environment model proposes that organizational innovation adoption is influenced by three elements of context: (1) the perceived attributes of the technological innovation, (2) organizational characteristics, and (3) environmental conditions. Prior studies of innovation adoption have identified a complex and rich group of potentially relevant factors within each of these three elements—too many for a single study to examine [5] [10]. The adoption model the author uses in this study is shown in Figure 1. It includes three high-level factors for each contextual element, which the author believes have an influence on organizational adoption of mobile commerce technologies in the supply chain. Each factor is discussed hereafter.

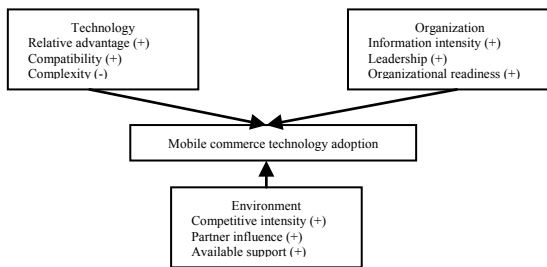


Figure 1 Contextual influences on mobile commerce technology adoption ('+' and '-' indicate a positive or negative influence on adoption, respectively)

III. Method

The research objective was to provide an empirical exploration of why organizations might adopt mobile commerce technologies in their supply chain activities. Because her understanding of this technological innovation context is relatively undeveloped and lacks a strong theoretical base, the author used an exploratory case study approach [1]. Further, a case study approach facilitates her focus on the contextual conditions of mobile commerce technology adoption [13]. The author applied the preliminary model of mobile commerce technology adoption, shown in Figure 1, to three case studies of organizations that had adopted mobile data solutions in their supply chains.

The primary source of data was semi-structured interviews conducted during 2009 with key informants in three Chinese companies. The interviews were based on a common set of questions designed to elicit information on the company and its operations, its use of IT, the decision to adopt mobile technologies, the perceived benefits of the technology, factors facilitating or inhibiting adoption, the implementation process, and any implications of adoption

for the company. The interviews were digital voice recorded and transcribed for qualitative data analysis. This involved both within-case and cross-case thematic analysis organized around the theoretical propositions identified previously [13]. The interview data were supplemented with secondary data sources, including publicly available information on the companies and their activities. Table 1 summarizes the interviews and background details of the three case study companies.

Table 1. Case studies

	DairyCo	FreightCo	ATMCo
Business	Dairy manufacturing and marketing	Freight, logistics and warehousing	ATM manufacturing and marketing
Company size	2300 employees	1400 employees	2500 employees
Turnover	RMB ¥8 billion	RMB ¥2 billion	RMB ¥1.5 billion
IT team	40 employees	30 employees	60 employees
Application	Mobile sales automation	Mobile freight tracking	Mobile service support
Interviewees	IT Manager Systems administrator Commercial manager	IT Manager Logistics manager Stock controller	IS manager Customer service manager

In the following sections the author presents her analysis of the three case studies. Each case is structured around a brief description of the company and the mobile data solution studied, followed by a discussion of the three types of contextual influence identified in the research model outlined in Figure 1: attributes of the technology itself, organizational characteristics, and wider environmental or industry conditions. Selected quotes from the interviews are used to illustrate the analysis.

IV. Mobile Sales Automation At DairyCO

DairyCo is a Chinese company. It manufactures and distributes a range of dairy product lines to a large retail customer base via mobile sales representatives. The company emphasizes speed and efficiency in order taking and fulfillment as essential to maintaining customer satisfaction. DairyCo has a medium IT department for routine maintenance of the company's information systems.

Technology Attributes

DairyCo clearly perceives a relative advantage in their mobile data solution: "The benefits have certainly been there and pretty much delivered to our expectations" (Commercial Manager). The mobile data solution effectively automates the sales process, eliminating the paper work, which sales representatives were previously doing. Lightweight tablet PCs have replaced the "huge, big briefcases of paper" (Systems Administrator) previously carried by sales representatives. The added information and functionality provided by their mobile data solution enables DairyCo's

sales representatives to undertake promotion management, conduct in-store deals, and manage customer relationships on a one-to-one, real-time basis. This was seen as enabling a shift in their role: “We see the [mobile] unit becoming even less an order entry unit and much more of a business management tool” (IT Manager).

The mobile data solution has enabled DairyCo to improve the efficiency of its order processing and logistics. It is also considered to be a source of competitive advantage through the way that it integrates and synchronizes information regarding customers, products, and distribution, enabling the company to manage its key customer accounts more efficiently: “Historically we were very good at transactions and you’ve got good competitive advantage by being able to transact better than anybody else. But now it’s not about transactions, it’s about knowledge management.” (IT Manager)

The current tablet PC technology is considered to be a significant improvement over previous units in terms of weight, screen size, and processing power. While some transmission and coverage issues had been experienced with the cellular network originally used to transmit the data, data is now transmitted over a GPRS wireless network selected because of its continuous availability, connection stability, high speed, and relatively cheap (data-driven) rates. Ironically, the speed and efficiency of the wireless transmission led to an unintended increase in projected data costs as sales representatives began transmitting data after every sales call (until reined in).

In terms of its compatibility, DairyCo’s mobile data solution matched the business approach of the company in a number of ways. For example, the units allow sales representatives to manage customer relationships with key accounts in person rather than from head office. Similarly, sales representatives take a proactive role with small retailers: “It’s all about presence in the marketplace and being there in front of them and actually influencing buying patterns” (Systems Administrator). The mobile data solution was also compatible with the IT infrastructure and approach used by DairyCo. The existence of the company’s ERP system and the simultaneous rollout of its sales and distribution modules provided the necessary complementary technology for the mobile data solution to function effectively.

Extensive training was required to up-skill the sales force in using both the mobile computer units and the extended range of functionality. The tradeoff of the more powerful, large-screened tablet PC units was their complexity, which made them more prone to breakdown and damage when dropped or mishandled. In addition, the mobile data solution project grew in size and complexity, creating some difficulties in coordination between the various departments involved in its use: “I think the biggest thing was that it ended up bigger than it was ever planned to be ... Sometimes what you find is that when you revisit it that a lot of the facility there isn’t being used to its capability” (IT Manager).

Organizational Characteristics

The adoption of mobile technology for sales automation reflects both DairyCo’s history of IT use (including sales automation) and its innovative attitude towards IT. DairyCo had been actively monitoring and developing the e-business side of its operations since 2000: “[DairyCo] has always been at the front of deploying that kind of technology to the market ... We tend to pick up the new technologies quickly if we can see there’s a clear business input” (Systems Administrator). The small IT department within DairyCo actively looks for ways to utilize new and innovative IT in the company’s operations. However, the decision to explore new technological options in sales automation was a strategic one taken by DairyCo’s senior management. According to the IT Manager, “That type of leadership has always been there ... The current management is very, very supportive.”

An unwillingness of some sales representatives to embrace the new technology initially slowed adoption and use of the mobile data solution within the company. Some lacked computer literacy, were reluctant to change established ways of doing things, or were reluctant to utilize the new functionality in front of customers in case they showed their inadequacy. As the Systems Administrator explained, “Some of our reps have been with the company for a long time ... and putting a computer in front of them was terribly daunting.” However, with time and training this barrier was overcome, with many of these representatives becoming advocates for using the new technology.

Environmental Conditions

DairyCo perceives themselves as leaders in their industry, particularly in gaining competitive advantage through the innovative use of IT for knowledge management. In relation to their use of mobile technology, “We were seen to be again, you know, market leading and out there doing things at the forefront basically” (Systems Administrator). DairyCo’s largest customers, major supermarket chains, were beginning to move their suppliers to electronic ordering and invoicing, and DairyCo’s significant investment in sales automation technology meant that they were well-perceived by these key customers. The proactive contact and support provided by DairyCo’s GPRS wireless network provider was mentioned in these interviews as positively influencing the company’s adoption of a wireless data solution.

V. Mobile Freight Tracking At FreightCO

FreightCo is a supply chain logistics provider with operations in China. The company offers a full range of logistics services, including managed warehousing, and domestic distribution, linked with IT and information systems. FreightCo operates a nationwide fleet of delivery vehicles in China servicing a large customer base. It coordinates its distribution operation through a centralized database supplied with real-time freight tracking data from delivery drivers in the field. FreightCo tends to outsource

much its development work, with its IT team working on systems maintenance and IT innovations.

Technology Attributes

At FreightCo, the mobile data solution implemented for freight tracking removed the need for paperwork and reduced the administrative workload on the distribution fleet drivers, leading to considerable efficiency gains: “Basically we’re piling through the freight, or the paperwork about the freight, in a much more efficient manner ... The piles of paperwork that we would have had would have been enormous” (IT Manager). The automated system also decreases the chance of errors, improves the timeliness of information, and increases the speed at which information becomes available to customers: “[It] gave us the advantage of managing our network much better, in such a way that we knew where the freight was much better, we knew what our timing was, we knew we could monitor when things went wrong.” (IT Manager)

FreightCo sees information and technology as central to its business of providing “intelligent” logistics solutions for its customers.

The use of a GPRS wireless network for data transmission was seen by FreightCo as superior to the previous trunk radio network used, as it increased the amount of data that could be sent from a mobile unit at any one time (including, for example, customer signatures captured directly on the screen of the handheld devices) and also the overall data transmission capacity available to the company’s distribution fleets. As the IT Manager observed: “[GPRS] was becoming a necessity ... The more trucks we put on, the more delays we were getting with the data backing up and not coming through ... [GPRS] seems to be unlimited.”

The mobile data solution for freight tracking is compatible with FreightCo’s business model and desire for technology leadership: “We’ve always had this fundamental business model of being the best ... Although many companies may have said, ‘Well, what’s the benefit of ... having the mobile communications today?’, We didn’t look at it like that” (IT Manager). Going mobile also allowed the company to cope with the huge growth that it experienced and continues to experience as a result of its business strategy.

Organizational Characteristics

As a company, FreightCo is proactive in keeping its IT capability ahead of the business in order to respond to new challenges in the business environment: “we wanted to take ideas to customers before they required it of us, so you know we wanted to be very forward thinking” (IT Manager). IT is essential in linking together and managing the company’s range of logistics services. Expenditure on IT is high and the IT department actively seeks “innovative solutions and ideas” (IT Manager). While adoption of the new mobile technology was initially IT-driven, FreightCo’s management was quick to see the benefits and supported the innovation. As the company’s IT Manager recounted: “We just had a

belief that it would be better and we talked directly to the owners of the business and they thought it would be better and away we went.”

Initially, the owner-driver contractors who comprise FreightCo’s distribution fleets resisted accepting the new technology. The required expenditure on new technology may have been one reason for this, although FreightCo did subsidize half the cost of purchasing the handheld units: “There was a lot of resistance by the drivers ... Resistance to change and technology. Yeah, they didn’t want to do it” (IT Manager). However, when FreightCo more recently acquired a competitor’s fleet, the newly arrived owner-drivers were generally receptive to using the new mobile data solution. The IT Manager suggested that this was because of the benefits to drivers were evident by then.

Environmental Conditions

The most important environmental influence on FreightCo’s adoption of mobile technology was the competitive intensity of the logistics industry in which the company operates. As noted earlier, FreightCo’s use of information provides them with a perceived competitive advantage: “We wanted to be ahead of the competition like we always are” (IT Manager). The availability and benefits of a supported GPRS network were acknowledged by FreightCo’s IT Manager: “There’s just going to be an exponential expansion ... and you’ve got networks that are prepared to invest the money in it.”

VI. Mobile Service Support At ATMCO

ATMCo is a large Automatic Teller Machine manufacturing and marketing company that uses field crews from outsourced contractors to maintain and repair its machines in China. Good customer service is important to the company, so response times to the many emergency callouts the company experiences are critical. In 2003, ATMCo implemented a mobile data solution purchased from an overseas vendor and then customized for the company.

Technology Attributes

The new mobile data solution was perceived as better than the previous system based on two-way radios and various paper-based forms, and its benefits matched ATMCo’s expectations. Invoices are now created automatically from data relevant to a service request entered in the field, reducing the need for administrative data entry, decreasing costs and speeding up the invoicing process. Other benefits included a reduction in data duplication or redundancy, with a consequential decrease in the risk of errors in data entry: “So the main drive is reducing paper, data quality, and only capturing data once” (IS Manager). The efficiency of the emergency response process also improved markedly, with faster response times and more accurate information sent to and from field crews: “We were collecting data at the call center but it was never making it to the guys in the field ... Now, everything gets passed through ... so the sort of level

of accuracy of information that the guys in the field are getting is much higher” (Customer Services Manager).

The information provided via the mobile data solution has enabled the call center to deal with customers’ complaints efficiently and effectively, and to keep them informed of progress in a timely manner. Because information is updated from the field in real time and made accessible to the call center operators: “We know when they’re [field crew] on-site. We know that the job has been completed ... We can follow up all the details ... It’s made a huge difference to us in terms of resolving customer complaints because all the information is actually there” (Customer Services Manager). This use of accurate, real-time information to maintain continuous ATM services and improve customer service is consistent with ATMCo’s role as a network provider of ATM services.

Aspects of the complexity of the mobile data solution did become issues. For example, the limited battery life of the PDAs (which often stay docked in the field crews’ vehicles in order to remain powered) and the range of the Bluetooth wireless connection between the PDA and the mobile phone modem (about 10 meters) effectively shape the crews’ use of the technology. ATMCo’s IS Manager described how aspects of the mobile data solution were designed to cope with crews periodically moving out of coverage. The crews are able to continue to work with the application off-line, updating the job status and then uploading the data when they come back within range. Screen layout and sequence on the PDAs was also modified to enhance the application’s operability in field conditions.

In fact, the mobile data solution was deliberately developed in a way that accommodated the conditions and characteristics of field crews, who were consulted extensively.

Organizational Characteristics

ATMCo has invested significantly in adopting new technology. It generates, on a daily basis, large volumes of multidimensional and interrelated asset, customer, financial, and operational data, which is compiled and displayed in a number of formats to allow users to select and drill into various areas for information. Business intelligence provides information analysis and distribution, data visualization, and spatial analysis for decision making and planning: “We’re ... an IT focused [company] and we believe in IT solutions too. And it was most definitely a business decision that we needed to, that we wanted to go down that track [in adopting mobile technology].” (Customer Service Manager) ATMCo’s IT team takes a reactive approach to IT solutions for the company, focusing on supporting business requirements rather than “pushing” technology: “We’re really in there to try and understand the business needs before we even talk systems” (IS Manager). The impetus for the adoption of mobile technology was from top management: “It was top down. It was a benefit that our executives ... saw. And so, like, everybody’s using wireless

dispatching in field crews and we should actually also be using it” (IS Manager).

ATMCo uses outsourced field crews, which meant that the contractors had to be convinced to adopt and use the new mobile data solution, including taking responsibility for maintaining the mobile technology itself: “We’ve provided a certain number of the devices to start with but then from then on they’ve got to buy their own, they’ve got to support their own hardware, that type of thing. So we had to sell it into them as well” (Customer Services Manager). However, ATMCo provided them with training. Project team members would go into the field with the field crews, “holding their hands” as they used the mobile technology: “You have to break the habit of what they would normally do” (Customer Services Manager).

The field crews generally accepted and used the new mobile units, despite management’s concern that the modern “white collar” technology might be perceived as out of place in the *blue collar* field environment and that the field crews would *struggle with it*. In fact, although it was technology that most of the crews had not experienced before, “They picked it up pretty quickly ... I think we thought that we’d have more problems teaching them than sort of we did” (Customer Services Manager). The field crews who selected to participate in piloting the system actually refused to return the units at the end of the pilot, wanting to continue using them, and placing unforeseen demands on the company’s resources as they continued supporting the pilot while developing the full mobile data solution.

Environmental Conditions

The outsourced contractors who supply the field crews are an important business partner for ATMCo. The contractors’ senior management apparently recognized the potential benefits of using wireless technology for dispatching field crews, and that at some stage they would need to adopt it: “I think they were quite pleased that we made the choice to actually roll it out, that they didn’t have to do something themselves ... I think they were pretty supportive. They could see the end result should be beneficial for their business” (Customer Service Manager).

Maintaining “robust connections” between the handheld PDA units and the GPRS wireless network, remains problematic according to ATMCo’s IS Manager. The company initially used wireless cards in the PDAs to access the GPRS network, but experienced a high level of disconnections, hence the shift to using dedicated mobile phones as modems. However, there were still problems with disconnections, which appeared to be related to the standard that handles communication between the GPRS network and the mobile application: “That standard is still a grey area. It’s not just related to [our application]; we are also talking to other people in the industry and we’ve found that they lose a lot of connections ... Bit annoying, but we working with [network and application providers] to resolve it” (IS Manager).

Support from the original application vendor also became an issue, as while the application worked satisfactorily on the original handheld units used, it did not necessarily do so on the latest technology purchased by the contractor users: “We’re having some problems with newer technology, getting it to be able to support the software ... That’s been another issue to stop us rolling it [the mobile data solution] out wider, because there’s been changes of device and [the vendor] hasn’t necessarily kept up with that side” (Customer Service Manager).

VII. Discussion

According to the three case studies, the author has the following findings.

Perceived *relative* advantage appeared to be influential in all three companies’ adoption and use of mobile data solutions. The benefits they achieved related to (1) administrative efficiency, in the form of paperwork reduction and time savings; (2) improved data accuracy and timeliness; (3) improved operational efficiency in supply chain operations; (4) enhanced roles for company users of the mobile technology; and (5) competitive advantage. The *compatibility* of the mobile data solution adopted with a focus on customer service observed in all three companies was also a common factor across the three cases. Complexity only appeared relevant in two of the case studies, where it was perceived to increase the level of user training required.

All three companies are *information-intensive* in that information processing is an important part of their business and that IT is integral in managing customer services. The importance of this factor was reflected in the history of IT use in the companies and their proactive and innovative attitude towards IT, and e-business in particular. *Leadership*, in the form of top management support for the innovation adoption, was also a common theme across all three case studies. Even where the initial awareness of the innovation was not management-driven, management adopted a supportive attitude to the business use of new technology. With respect to *organizational readiness*, an interesting distinction emerged between the positive influence of *technical readiness* and the negative influence of *user readiness*. While the role played by two of the companies’ IT teams in actively seeking innovative uses for IT was a positive influence on adoption of mobile commerce technology, the lack of readiness of some intended users to embrace the new technology tended to slow adoption or increase the time and training needed.

Although the author expected wider environmental or industry conditions to play an important role in shaping innovation adoption decisions in the three case studies, overall they seemed to play less of a role than technology attributes or organizational characteristics. This may reflect the pioneering status of the three companies in their respective industries in China with respect to the use of

mobile commerce technology in the supply chain. Industry *competitive intensity* was reflected primarily in DairyCo’s and FreightCo’s desire to be market leaders through the use of IT. *Partner influence* also played some role, with some of DairyCo’s major customers innovating with electronic transactions themselves, and ATMCo’s subcontractors providing support for the innovation based on their recognition of the benefits of the mobile dispatch technology. While *available support* was a factor in the adoption experience of these two cases, it did not seem to be a direct consideration in terms of the adoption decision itself. DairyCo received proactive support from its wireless network provider, while ATMCo found itself reliant on vendor support because of changing or problematic technology.

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