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The Impact of Introducing Information Technology to the Service Part Logistics

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■ Abstract ■

The mobile communication technology would be one of the most appropriate means for achieving process innovation in the actual business area. This article performs a simulation study to examine the effect of introducing a mobile technology to the after-sales service and its logistics process. The performances of the two different systems, before and after introducing a mobile technology, are examined based on operational cost, operational efficiency, and customer service level using a discrete event simulation. The real-world data, extracted from a leading Korean electronics firm, was collected for this study. The results show that the TO-BE(after) model outperforms the AS-IS(before) model over all the performance indices. And the effects of introducing the mobile technology are more significant on the more tightly controlled inventory policy.

Keyword : Service Part Logistics, Information Technology, Performance Evaluation

1. Introduction

Advanced information technologies have rapidly transformed traditional (human-oriented and off-line/batch) business processes, to an on-line/real-time environment. Mobile data communication is the most representative technology among them. With the development of

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mobile communication devices, various multi-functional PDAs, which can read barcode and print receipt by on-line, have been actively introduced to the service processes (for example, delivery, sales, inventory management, etc.). If the latest IT technology were fully in commercial use, the data transmission could be reached at a maximum speed of 10Mbps and the use of mobile technology would soon be disseminated among various industries.

Unfortunately, however, the introduction of new IT technologies is often accompanied by large investments and high failure risks [2, 15]. These characteristics made corporate decision makers more conservative in setting IT policies and reluctant to adopt new technologies. For this reason, more analytical tools should be chosen in analyzing the IT investment [2]. This article attempts to evaluate the effect of introducing a new IT technology, the mobile data communication, to the after-sales service (here after A/S) process.

The field service quality of A/S is a significant factor in market competition for products such as home appliances, computers, communication equipments, and medical equipments [1, 7]. In recent years, many leading worldwide firms grew to conceive the A/S department as a profit center, which is responsible for improving both customer satisfaction and financial performance. It is reported that the A/S department of manufacturing firms in the U.S. earns about 30% of product sales and each service engineer contributes the annual revenue of $215,000 on average [3].

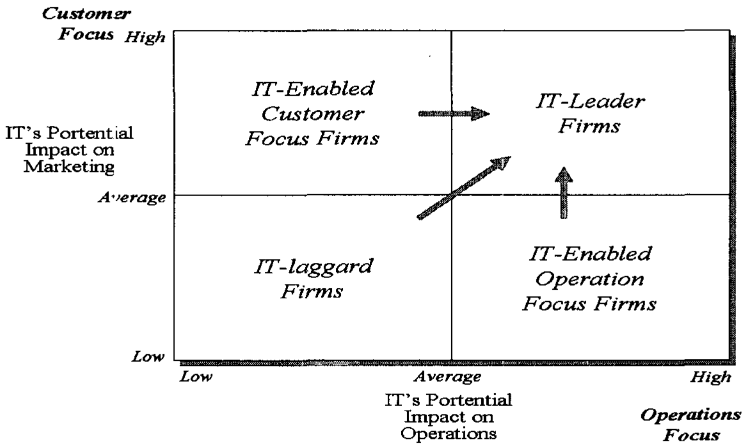
On the contrary, the Korean firms' recognition on the A/S department still falls behind those of global firms. Most Korean firms have regarded the A/S department as a cost-centric function, supporting the sales or marketing departments. On this score, they have been reluctant to invest in SI (System Integration) projects for the operational innovation of the A/S department. Furthermore, they have kept their A/S processes as human labor oriented as possible and concentrated the efforts on enhancing their corporate images through employees' attitudes (for example, responsiveness, reliability, assurance, etc).

The annual report from the U.S. Department of Commerce [4] showed that the IT-intensive firms in the non-farm business sector far outperformed the less IT-intensive firms in terms of productivity growth. Only 0.58 % productivity increase has been reported for the latter and 2.95% increase for the former during the period of 1989 to 2000. These figures raise the issue of escalating Korean firms' conceptualization of the A/S department.

A typical A/S process practiced in Korean firms is chosen to formulate an AS-IS (current) model and the process is in turn re-engineered into a TO-BE (future) model, where the mobile communication technology is exploited. The performances of the two models are compared based on the real-world data extracted from a leading Korean electronics firm (Company A hereafter). Analyses are focused on operational effects.

2. Related researches

The research on improving business processes by introducing IT technology is summed



<Figure 1> The customer service topology for introducing IT

up by Karimi et al. [12]. They proposed a contingency model shown in <Figure 1>, describing the potential impacts of IT on marketing and operations. The introduction of mobile technology to the A/S process is conducted for the purpose of enhancing customer services and field operations. If successfully introduced, the strategic position of a company is expected to take a step toward the group of IT-Leader Firms in <Figure 1>.

Regarding the IT investment effect on logistics, the following research was performed: the models for evaluating the investment effect of an advanced manufacturing technology [2, 9, 14], the evaluation model for IT investment on SCM [13] and warehouse management [17], and the empirical study for the introduction effect on the service parts logistics [3]. Especially, Yao et al. [17] examined the effect of IT investment from an operational standpoint. They performed a survey to analyze the impact of real-time information processing after introducing a RFDC (Radio Frequency Data Communications) system in the warehouse, reporting that the RFDC system realized a 6.2% increase in materials handling unit per hour and a 5.6% decrease in handling costs. Besides, the accuracy for locating and counting inventories increased to 99.9%, order-picking units increased by 5.2% per hour, while order-picking costs per unit decreased by 6.3%.

Chan et al. [2] classified the evaluation method of IT investment into three approaches: strategic evaluation approach, economic evaluation approach and analytic evaluation approach. And they summed up the pros and cons of each evaluation method. They criticized the fact that most of the previous studies had been focused on the posterior effect analysis and even some prior analyses were mainly focused on financial measurements (such as payback period, ROI, NPV, IRR, etc.). Irani [9] and Kaplan [10] also pointed out that the previous methodologies, largely dependent on accounting information, might not be appropriate in assessing the introduction effects of IT technology and furnishing proper information required for investment decision-making. The introduction effects of IT investment are intangible and indirect, take a long time to be realized, and are often bound up with other factors in a complex way [5, 9, 11].

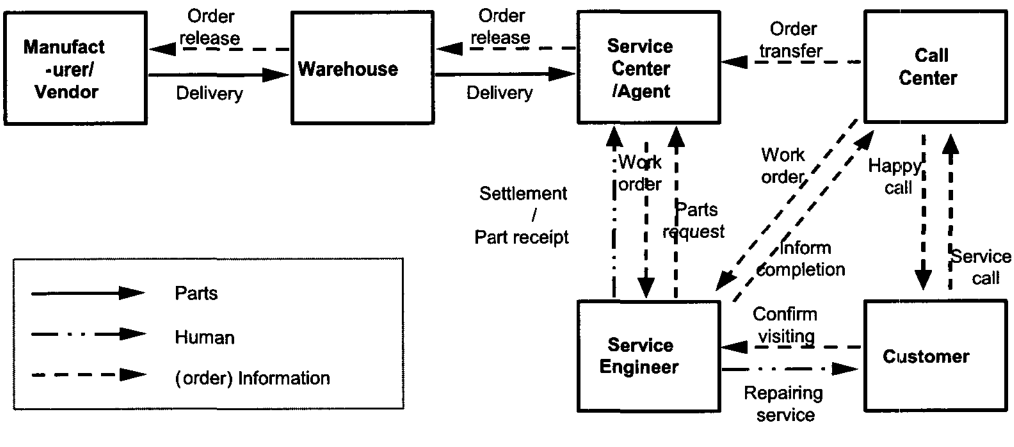
3. The typical service logistics process

<Figure 2> shows the typical A/S operations process.

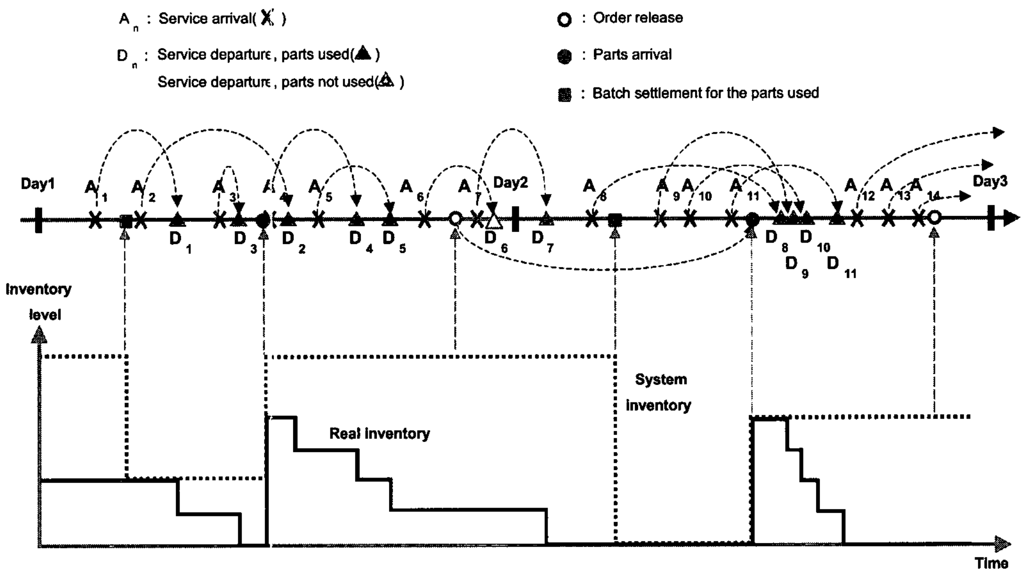
A/S supply chain has multi-level distribution network from customer to manufacturer/vendor [3]. The process can be divided into three operations : the call center operation receiving customer calls and delivering them to field service engineers, the field service operation performing repair services at install bases, and the logistics operation replenishing parts for service centers.

As soon as a service request is registered, the work order is delivered to a field service engineer either by phone directly from the call center or through his service center/agent. He lists up the work orders and visits the customer's site after confirming his visit. If he does not carry the parts required for the repair, he will stop by his service center or service agent to pick up the parts before visiting the customer's site. However, if the local service center or the agent does not possess the parts, the service will be delayed until the parts are replenished from the warehouse. Upon completion of the work order, the engineer informs the call center by telephone and immediately takes action to deal with the next service call. Part usage and repair fees will be settled in a batch, when he comes back to the service center the next day or thereafter. Information exchanges are mostly done by phone. However, most companies prohibit the phone-based reporting of the crucial activities, such as the account settlement of part usage and repair fees.

Inventory management plays an important role in the A/S process by providing service parts/devices on time [8]. As most of the field service operations are performed at the geographically dispersed customer's site, service engineers are busy either traveling to service calls or repairing a machine [3, 6]. Therefore, they usually carry the frequently needed parts in their vehicles to reduce the response time and the usage of parts cannot be updated immediately but reported to the inventory management system in batch later. Consequently, the inventory



〈Figure 2〉 The typical A/S process



〈Figure 3〉 Manual trace of A/S processing

〈Table 1〉 Sample statistics of Company A (n=3,818)

Variables	*Service lead-time (L)*	*Service flow time (F)*	*Difference (F-L)*
Average	615.78	2445.62	1829.84

managers at service centers cannot ascertain the real stock level, and frequent shortages or overages occur.

<Figure 3> shows the manual trace of consecutive service processes, from registering service requests to adjusting inventory accounts in the database. The dotted line depicts the inventory level recorded in the system at a local service center and the solid line the actual balance on hand. The actual on-hand inventory includes both the inventory stocked in the center and the inventory carried by field service engineers. Thus, the gap between the dotted line and the solid line indicates the error in inventory counting, the main factor that makes the inventory management inefficient.

The discordance between the actual and the recorded inventory levels is due to batch processing and can cause the following problems and in managing A/S parts.

a) Buffer stock increased
b) Frequent shortages
c) Delay in service
d) ATP (Available-To-Promise) service unavailable

Moreover, the seriousness of batch processing can be addressed from the following statistics. <Table 1> shows a sample statistics of 3,818 service calls drawn from 2 years of transaction data in the service centers of Company A, where

service lead-time = service completion time-service registration time,

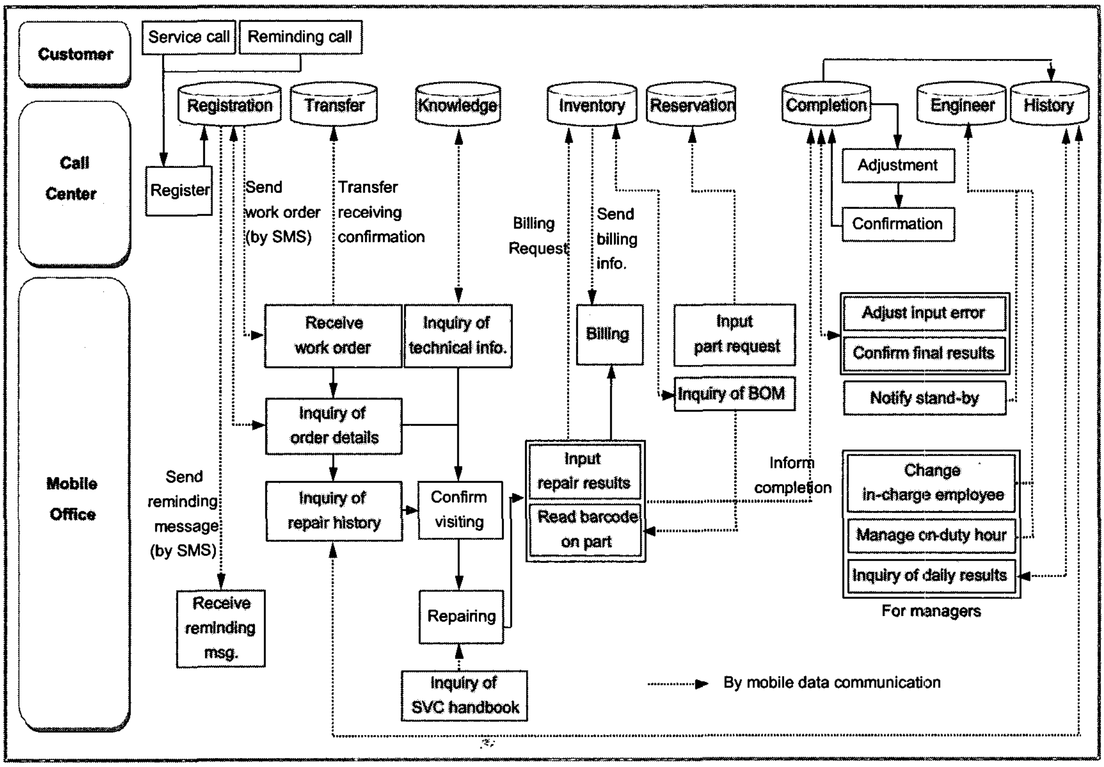
service flow time = completion time for account settlement-service registration time.

The average service lead-time is 615.78 minutes and the average service flow time is 2445.62 minutes, resulting in a gap of 1829.84 minutes on average between the actual completion time of a service and the account settlement time for the parts consumed in the service.

4. Re-engineering the A/S logistics process by introducing mobile communication

The difference between the actual and recorded inventory is due to the lack of communication channels to synchronize part usages and inventory records in the database. The current inventory management system does not provide the inventory visibility for the A/S supply chain. Consequently, inventory managers place replenishment orders based on their personal experiences and estimations without a full grasp of actual inventory levels. Furthermore, the inventory management gets worse because the interval between service calls, service lead-time, service flow time, and service delay time are all stochastic variables in nature.

The key to solve this problem is to make inventory decisions based on the actual level of inventories by synchronizing the parts consumption with the inventory account adjustment. The mobile communication technology would be one of the most appropriate tools for solving this problem.



〈Figure 4〉 TO-BE process by introducing mobile technology

<Figure 4> shows the TO-BE process, reengineered assuming that the mobile technology is introduced.

Upon receiving a customer's service request at the call center, a service engineer is chosen in real time and a work order is transmitted to the engineer instantly through SMS (Short Message Service). As soon as he confirms the work order on line, the information of order confirmation is transmitted to the server. He can obtain the detailed information on that service call, the technical information required for executing the service (for example, the service history records of the products or the customer) through on-line transactions. If reminding calls are received from the next customers on doing the pre-allocated works, the messages are transferred instantly to the engineer through SMS. It is possible to make inquiries to the service handbook while performing repair services at the customer's site. When the repair service is completed, the details can be updated into the database server in real-time.

If the engineer does not carry service parts needed for repair, he places an on-line order for the parts to his service center through the mobile communication system. When the parts are kept in stock at the service center, the parts are reserved for use and the ATP service can be provided to customers. In addition, service engineers can confirm and modify the input data of their completed works anytime although they are moving around constantly. The managers at the service center can also keep track of the status of what the engineers are doing.

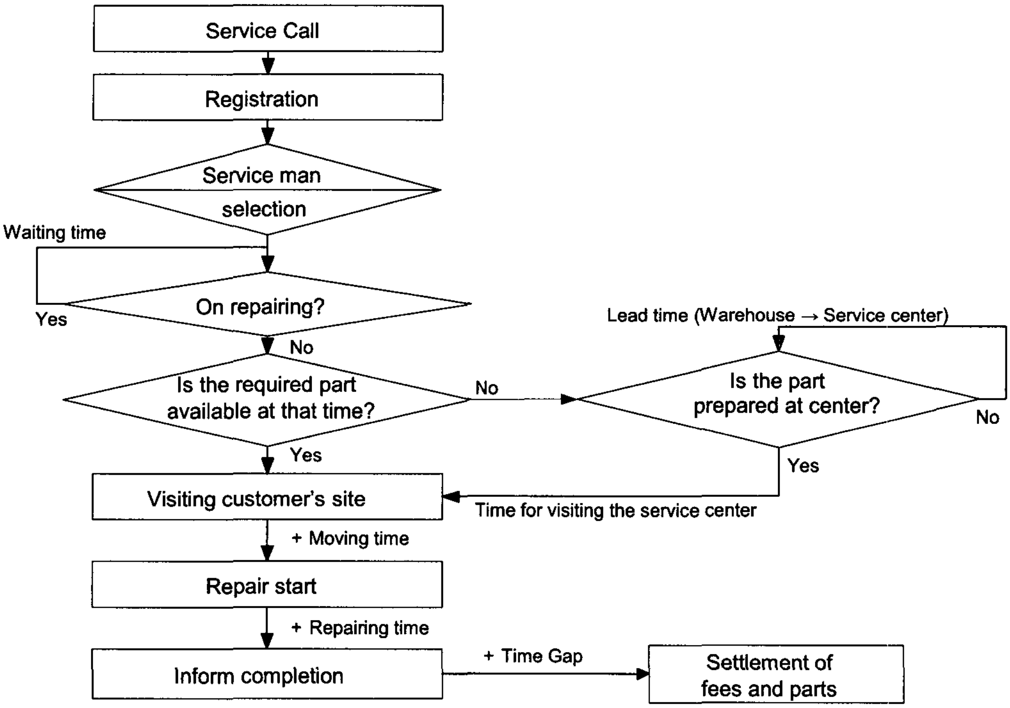
The mobile technology can upgrade the off-line/batch processes to on-line/real-time. It guarantees that the inventory management system be synchronized with the real inventory status all the time. The technology can make it possible to transmit, inquire, update, and modify related information in real-time, resulting in shortening the service process and enhancing the operational efficiency of the A/S processes. Finally, it should result in operational cost reduction, high customer satisfaction, and service quality improvement, which will be examined in the sections to follow.

5. Simulation modeling

This study focuses on operational analysis, examining the composite effects of the changes in operational processes by introducing the mobile technology. The principal effect would be the enhancement of customer service through the real-time operations and the integration of information. It is not easy, however, to quantify various introduction effects and integrate them in decision-making since the A/S parts logistics is involved with a multi-level supply chain.

Van der Vorst et al. [16] emphasized the difficulties of formulating algorithms and models for the multi-echelon inventory system with stochastic demand and batch/periodic ordering and suggested the discrete event simulation as the most realistic methodology in modeling the multi-echelon supply chain. Zhao [18] also claimed that the simulation model would be more useful for evaluating various logistics plans.

The discrete event simulation is chosen as a research methodology to perform a prior analysis on the introduction effects of new IT technologies. The main objective of the simulation study is to verify if customer satisfaction, in-



<Figure 5> A/S Process Diagram for Simulation Modeling

ventory costs, and profits can be improved as expected to the target service level changes.

5.1 The Description of the A/S Process

The simulation model for the A/S process can be depicted as in <Figure 5>.

The A/S process in Company A is transformed to a simulation setting, applying the following practical guidelines and assumptions:

a) The AS-IS model is formulated such that inventory updating will be made in the next morning or the morning of the second day after the repair.

b) Warehouses are fully capacitated, implying that all orders from service centers or agents are satisfied on time. All transactions between factories/vendors and warehouses are excluded in the simulation.

c) A general periodic ordering system is applied in replenishing parts from warehouses. That is, a service center/agent will release orders to the warehouse once a day. The warehouse delivers the requested parts to its service centers the next morning after night preparation.

d) All service engineers visit their service centers to pick up parts once every morning in principle. When the service center does not carry the requested parts, however, the service engineers may not visit. If not in stock, the current service call is delayed and the next call will be processed instead.

e) All services are completed at the first visit and the re-breakdown is registered as an-other service call.

f) Daily average inventory levels are measured on the basis of 24:00 everyday.

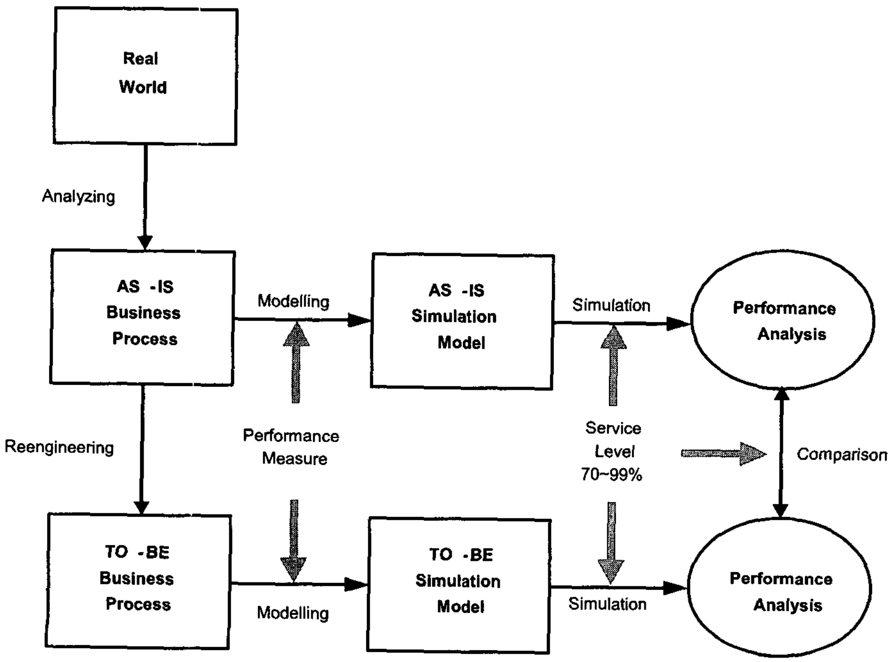
g) All service centers operate from 9:00 to 20:00. If some service calls are not completed, they will be carried forward to the next day.

The inventory managers at all service centers apply an one-day periodic ordering system such that:

$$E = \mu_{T+L} + z_a\sigma_{T+L},$$
$$OH = OH_{CTR} + OH_{ENG},$$
$$Q = E - OH = \mu_{T+L} + z_a\sigma_{T+L} - OH,$$

T : order cycle time
L : replenishment lead-time
μ_{T+L} : average demand during (order cycle + lead-time),
σ_{T+L} : standard deviation of demand during (order cycle + lead-time),
$z_a\sigma_{T+L}$: safety stock corresponding to a service level of 100(1-a) %
z_a : the value of standard normal variable corresponding to a service level of $100(1-a)$ %
E : maximum inventory level or target inventory level
Q : order quantity
OH : total on-hand inventory
OH_{CTR} : on-hand inventory in service center
OH_{ENG} : on-hand inventory with service engineers

Total on-hand inventory(OH) consists of the inventory held in the center (OH_{CTR}) and the inventory carried by service engineers(OH_{ENG}). First of all, a target service level, 100(1-a) %, is set for each service item, followed by the setting of the target inventory level(maximum inventory level, E) corresponding to the service level. For systematic inventory management, Company A manages its inventory on the basis



<Figure 6> Experimental design

of part price and usage volume. The inventories in Company A are classified into six categories and the target service level is properly set up for each category. That is, items are categorized into groups A, B and C on the basis of the usage volume, each group again sub-categorized into the high price group and the low price group.

5.2 Experimental design

A simulation model should be designed to reflect real-world processes as closely as possible, and it should be flexible enough to simulate various practical situations with the same model. <Figure 6> shows the experimental design for this simulation.

At first, an AS-IS business process has been modeled by analyzing the current business process in the real world. In Korean firms, as mentioned previously, the performance measures of the A/S process tend to be oriented toward the aspects of customer satisfaction rather than the operational efficiency. Consequently, most inventory managers prefer to adopt a conservative inventory policy, keeping as much inventory as possible for protection against uncertainties. As the status of moving items cannot be reported to the managers as soon as they are consumed, the AS-IS model assumes all inventories carried by field service engineers as consumed.

The AS-IS process was reengineered to a TO-BE business process assuming the introduction of a mobile technology. In the TO-BE model, the on-hand inventory includes not only the stock held in service centers but also the unused items carried by service engineers, for the TO-BE model has the capability of updating inventories in real-time.

A network-modeling tool, SLAM, was used to convert AS-IS and TO-BE processes into corresponding simulation models. It provides a network framework for modeling the flow of entities through processes and AWESIM has been used as the modeling software.

In formulating simulation models, the service level is used as a main design variable. As inventory managers can deal with uncertainties by controlling the level of safety stock, the service level reflects the managerial disposition of an inventory manager. The simulation has been run at seven different service levels between 70% and 99% to show various patterns according to the selection of different inventory policies. As conservative inventory managers tend to secure more inventories on hand, they would prefer to set higher service levels.

The performance is measured in three directions, service enhancement, cost reduction, and the enhancement of operational efficiency. Stock out rate, average service lead-time, fill rate within 24 hours and fill rate within 2 hours is chosen for service enhancement, the level of inventory is for the operational cost reduction, and the ratio of inventory turnover is for the operational efficiency enhancement. The definitions of six variables are shown in <Table 2>.

Since the performances are compared between before and after introducing a mobile technology, one set of simulations was run on the same random generation seeds and demand rates for AS-IS and TO-BE models. The performances of the two models are evaluated in two dimensions; the performance gap in terms of each performance variable at a different service levels and the changing pattern of perform-

〈Table 2〉 Summary of Performance Measurement

Aspects of measurement	Variables	Definitions
Service enhancement	*Stock out rate*	The number of delays due to stock-out divided by the number of service calls
	Average service lead-time	The gap between service completion time and service registration time
	Fill rate within 24 hours	The number of service calls completed within 24 hours divided by the number of service calls
	Fill rate within 2 hours	The number of service calls completed within 2 hours divided by the number of service calls
Operational cost reduction	*Average Inventory*	The average inventory level measured on the basis of 24:00 everyday
Operational efficiency enhancement	*Inventory turnover ratio*	The monthly sales revenue divided by the average inventory

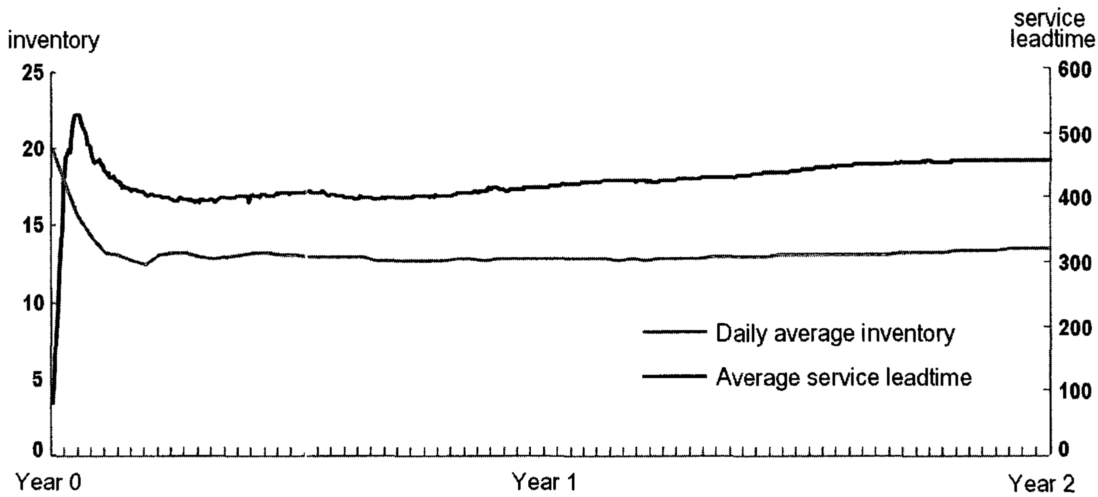
ance variables across the different scenarios. All inputs for simulation are extracted from the actual data of Company A.

6. Simulation result analysis

The simulation period was two years. Two cumulative indices, daily average inventory and average service lead-time, have been traced for two years. <Figure 7> shows the tracing results that the operated simulation models are enough steady after the first year.

<Table 3> compares the simulation results of the AS-IS model with those of the TO-BE model. Both simulation models were run with seven different service levels respectively, that is, with 70%, 75%, 80%, 85%, 90%, 95%, and 99%.

Two of the performance variables, the stock-out rate and the inventory turnover ratio, were



〈Figure 7〉 Tracing results of the two cumulative indices

<Table 3> Overview of the Simulation Results

Measure	Scenario	Target Service Level							RANGE
		70%	75%	80%	85%	90%	95%	99%	
Daily average inventory	AS-IS (A)	2.41	3.51	4.74	6.61	8.76	10.45	15.89	13.48
	TO-BE (T)	2.07	2.90	3.80	5.64	7.51	9.12	13.56	11.49
	Improvement(A-T)	0.34	0.62	0.94	0.97	1.25	1.33	2.33	1.99
	Ratio (%)	14.11	17.66	19.83	14.67	14.27	12.73	14.66	
Fill rate within 24 hours	AS-IS (A)	55.21	66.37	82.11	92.09	96.96	98.85	100.00	44.79
	TO-BE (T)	76.95	86.59	92.64	98.11	98.66	99.92	100.00	23.05
	Improvement(T-A)	21.74	20.22	10.53	6.02	1.70	1.07	0.00	21.74
	Ratio (%)	39.38	30.47	12.82	6.54	1.75	1.08	0.00	
Fill rate within 2 hours	AS-IS (A)	12.02	16.63	22.63	28.08	31.04	32.50	34.05	22.03
	TO-BE (T)	20.06	24.41	27.50	30.57	32.24	33.46	34.10	14.04
	Improvement(T-A)	8.04	7.78	4.87	2.49	1.20	0.94	0.05	7.99
	Ratio (%)	66.89	46.78	21.52	8.87	3.87	2.89	0.15	
Average service lead-time	AS-IS (A)	3,972	2,546	1,077	693	551	496	455	3,517
	TO-BE (T)	1,090	823	679	547	506	478	454	636
	Improvement(A-T)	2,882	1,723	398	146	45	18	1	2,881
	Ratio (%)	72.56	67.67	36.95	21.07	8.17	3.63	0.22	

excluded from the analysis for the following reason. As the two simulation models, AS-IS and TO-BE, are compared at the same service level, the result will naturally show the same stock-out rate. Note the stock-out rate equals (1 - service level). By the same token, the inventory turnover ratio will show the same result with that of the average inventory, as the two models are compared at the same demand rate at each service level. Consequently, the simulation results were collected in <Table 3> for the four performance variables - daily average inventory, fill rate within 24 hours, fill rate within 2 hours, and average service lead-time.

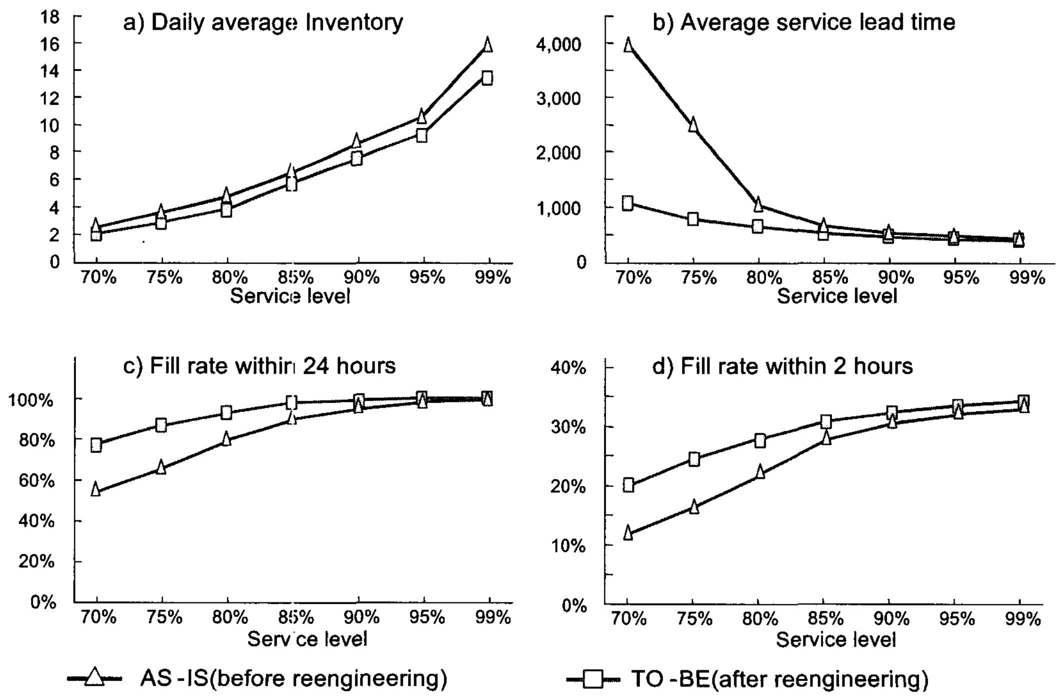
The simulation results show that adopting a mobile communication technology in the A/S process has a noticeable effect on all the performance measures.

While daily average inventory tends to increase gradually as the service level becomes higher, it is 15.42% lower on average in the TO-BE model than in the AS-IS model at the same service level. Observing each service level, a 12.73% inventory reduction was to the minimum at the service level of 95%, and 19.83% was to the utmost at the level 80%. 'RANGE' in <Table 3>, the gap between the highest value and the lowest in each row, measures the system's stability. A large value of RANGE indicates that the corresponding performance measure fluctuates more as with the change in the inventory policy. For daily average inventory, the RANGE for the TO-BE model was measured to be 14.76% lower than that of the AS-IS model. This implies that a substantial improvement can be achieved in the stability of the inventory position if a mobile communication technology is properly introduced in the A/S process.

For the fill rate within 24 hours, both AS-IS and TO-BE models show the same result, 100% fill rate, at the 99% service level. As the target service level gets lower, however, the TO-BE model becomes superior to the AS-IS model. The improvement ratios are higher at lower service levels, the TO-BE model showing an increase of 1.08% over that of the AS-IS model at the 95% level, 1.75% at the 90% level, 6.54% at the 85% level, and 39.38% at the 70% level. This implies that the effect of introducing a mobile communication technology reaches a higher level in the fill rate within 24 hours as the managed inventory level declines. The RANGE of the TO-BE model is also 48.54% less than that of AS-IS, indicating that the fill rate within 24 hours is less sensible in the TO-BE model as with the change in the inventory position.

For the fill rate within 2 hours, the results are similar to those of the fill rate within 24 hours. The introduction effect of the mobile technology is trivial at the 99% level (a difference of 0.15%), but the effect becomes higher with lower service levels - 2.89% at the 95% level, 3.87% at the 90% level, 46.78% at the 75% level and 66.89% at the 70% level. That is, the lower the service level, the higher the effect of adopting the mobile technology. The difference in RANGE shows again that the fill rate within 2 hours is less sensible in the TO-BE model as with the change in the inventory position.

Regarding the average service lead-time, the simulation results also show little difference at high service levels. As the service level decreases, however, the improvement effect grows



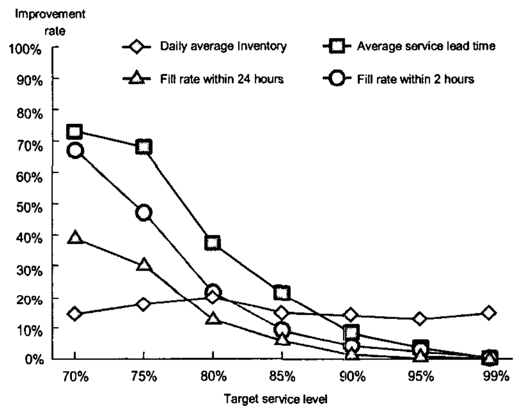
〈Figure 8〉 The Change of Performance Measures sharply: an improvement of 8.17% at a 90% service level and 72.56% at the service level of 70%. The wide difference in the values of RANGE (81.92%) indicates again that the mobile communication technology has a substantial positive effect on the stability of a supply chain.

<Figure 8> shows the patterns of the four performance measures graphically. It compares the performances of the two models at different service levels for each performance variable.

At first, <Figure 8-a> shows that the TO-BE model maintains less inventory relative to the AS-IS model at all service levels. As the service level increases, the average inventory is steeply increasing in both models in a similar pattern. <Figure 8-b, 8-c and 8-d> depict the patterns of the average service lead-time, the fill rate within 24 hours, and the fill rate within 2 hours respectively. All three measures show a similar pattern. No significant difference between the AS-IS model and the TO-BE model can be found at higher service levels. As the service level declines, however, the AS-IS model demonstrates better performance in all three variables, and the disparity grows. An interpretation is that the effect of introducing a mobile technology is higher under tighter inventory policies.

The slope of the graph in <Figure 8> can be interpreted as an index showing the sensitivity of performance measures to the change in the service level. As the target service level changes, the TO-BE model shows a stable change in the slope compared to the AS-IS model. Thus, it is claimed that the real-time inventory management environment, by using a mobile technology, enhances the overall stability in a supply chain.

<Figure 9> shows the rate of improvement achieved by the TO-BE model for the four performance measures at each service level. In the case of the average inventory, the TO-BE model outperforms the AS-IS model by 12 to 20% at all service levels. Additionally, the introduction of the new technology has a positive effect on operational cost reduction. The graphs of the other three measures show that the improvement effect is exponentially increasing as the target service level becomes lower, while there is little effect at high service levels.



〈Figure 9〉 Trends in the improvement rate

As mentioned in the previous section, the AS-IS model assumed that all inventories carried by field service engineers are counted as already consumed. In the AS-IS model, therefore, the current inventory level would have been underestimated and the replenishment order quantity conversely overestimated. If the parts, carried by service engineers, are counted in the balance of on-hand inventories, smaller order quantities would be placed to the warehouse. The performance of the AS-IS model would then be shown to be even worse.

Under the current conditions of the AS-IS, it is clear that if lower target service levels are applied to reduce operating costs, all service performance measures would radically deteriorate. The efforts for efficient inventory management would rather cause a negative influence to the system unless the A/S process is properly re-engineered in advance. That is, the availability of real-time inventory information becomes more critical under tighter inventory control, and the results of this study confirm the significance of the mobile communication technology in improving the operational efficiency as well as the customer service of A/S logistics.

7. Conclusion

This article examined, by simulation studies, how the introduction of a mobile technology influences customer service and related indexes, using the real data of a Korean electronics firm. Three aspects are examined - service enhancement, operational cost reduction, and operational efficiency enhancement, from which four performance variables were withdrawn. The results show that the TO-BE model outperforms the AS-IS model over all the performance variables. In particular, the effects of introducing the mobile technology are more significant when the inventory is more tightly controlled.

The simulation in this article is limited to the range from customers to service centers in the A/S supply chain. It is expected, however, that the effect of the mobile technology would be higher than the results indicated in this research if warehouses and manufacturers were included.

Additionally, further research would be needed to examine the following performance variables :

a) Labor cost savings through automating and shortening the A/S process activities,
b) Service quality improvement through real-time inquiry of the knowledge required for field service activities,
c) Customer service improvement by providing the ATP service,
d) Increasing customer confidence by on-line billing of service fees

The future trends in logistics management are ubiquity, visibility and real-time. The results of this study suggest that the mobile technology is a proper means of satisfying the three trends at the same time. Therefore, it is expected that the mobile technology, if adequately introduced, will play an important role in improving the lagging A/S logistics of Korean firms. In conclusion, the results of this study confirm mobile data communication an effective technology for improving the performance of the A/S process, making it possible to inquire, transmit and update the real time inventory information, and leading to a step toward the advancement of inventory management.

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