Quality Measurement for Mobile Crop Production Management Applications

Haeng-Kon Kim

Abstract— **Most ERP vendors proudly claim their solutions are available on mobile platforms, explaining that managers can access their ERP solution from their smartphones. The recent wave of enterprise resource planning (M-ERP) systems adoption is a significant commitment of resource and may affect almost all business processes. Mobile business boosting the popularization of the M-ERP (Mobile ERP) in the enterprise: The high penetration of mobile phones enables each employee to become an effective information carrier of the enterprise. The information application of the enterprise becomes more clear-cut. The mobile M-ERP pivots on the frequently changing key indexes of the enterprise operation, and takes the personalized and format-based data collection, analysis and processing platform as tool.**

M-ERP systems are integrated systems in that they promote cooperation among groups, teamwork, and process expertise and business knowledge. Firm that successfully implements an M-ERP system should raise revenues or decrease costs. The main purpose of this paper is to investigate the relationship among M-ERP system internal control, quality and performance in Korean firms especially for the crop productions applications. To investigate the relationship, the questionnaires were collected from 131 M-ERP – adopting Korean crop productions companies. The following results were determined by verifying six hypotheses using LISREL. Internal control support perceived quality and quality support perceived performance. We expect that the results of the research can be used as the guidance of the implementation strategy of M-ERP systems. And these results provide important insights that complement extant research findings and also raise future research issues.

Keywords: **Mobile Enterprise Resource planning, Supply Chain Management, ERP Quality measurement, Mobile ERP Architecture.**

I. INTRODUCTION

Today, most business applications (e and m-business solutions) run either on a client server system, a web based system and mobile based systems have three main components: Enterprise Resource Planning (M-ERP), Supply Chain Management (SCM) and Customer Relationship Management (CRM). However, the main disadvantage of today's systems is that the workers, suppliers and customers have to be bound to their desktops in order to take advantage of these systems. There is a need to break this tethered, desktop model by extending the e-business solutions to the mobile workers.

Mobile e-business solutions are the need of the hour, which are made possible today by advances in technology.

The recent wave of enterprise resource planning (M-ERP) systems adoption is a significant commitment of resource and may affect almost all business processes. Over the past decade, organizations have made significant investment in enterprise resource planning (M-ERP) systems. M-ERP referred to as enterprise -wide systems or enterprise systems, offer the seamless integration of all the information flowing through company-financial and accounting information. And M-ERP was one of the largest information technology (IT) environments in the past decades. But system integration has control weakness: data entry error is critical; decreasing data visibility; more complicated segregation duties etc. M-ERP is not a mere change in information system environment but an overall change in organizational structures and business processes. Therefore many firms experience a temporary decline in performance after M-ERP implementation [1][2].

The most research on M-ERP focused on successful launching of M-ERP systems, such as critical success factors for M-ERP implementations. However, the study on the interrelation between the M-ERP system internal controls and organizational performance is extremely rare. Furthermore, it is not known if the study is actually performed, which examines the differential impacts of internal controls on the organizational performance between sound and weak internal control firms when M-ERP system is established. Research purpose of this study is to investigate the relationship among M-ERP system internal control, quality and performance [3] [4].

In this paper, we study on the critical role of M-ERP systems' internal control, information quality and performance in the factory industry. This sets out the research model of influencing factors and the performance of the M-ERP system through theoretical studies based on Management Information Systems, and the empirically tests hypotheses related to the model.

The remainder of this paper is organized as follows. Section II reviews literature of M-ERP system, Internal Control, Information Quality, performance research and current status. Section III proposes the research model and method for using the Information Quality and Internal Control to manage M-ERP system. Section IV addresses the research results based on the research model. The last section discusses research conclusion and discussion.

Heang-Kon Kim is with School of Information Technology, Catholic University of Daegu KyungSan, Daegu, 712-702, Korea (corresponding author to provide phone: 053-850-2743; fax: 053-850-2740; e-mail: hangkon@ cu.ac.kr).

II. RELATED WORKS

A. Functions of Mobile M-ERP

M-ERP system is comprehensive software packages that seek to integrate the complete range of business process and functions in order to present a holistic view of the business from a single information and information technology architecture. M-ERP systems can provide a wide array of benefits that are both tangible(e.g., reduced personnel, inventory, IT and procurement, transportation, and logistic costs; improved cash flow management, revenue, and profits) and intangible(e.g., increased visibility of corporate data, speed of decision making, and control over global business operations; improved customer responsiveness and business processes). There are several Mobile ERP functionalities to be equipped with the solutions as followings:

Early update of alarm information. The alarm of the max. and min. inventory, the alarm of the delayed MOs and any other alarm messages will be sent to your mobile phone at the first moment possible. You do not need to worry about the loss caused due to an overlooked key event.

Subscribing enterprise management information – just like subscribing a paper. This function can send you the expected business and report information at the specified time. You can be kept posted with the latest information of various aspects of the enterprise – just like skimming through a newspaper.

Reviewing and approving work flow at anytime and anywhere. Employee vacation review and approving, PO review and approving and any other review and approving events, small and big alike, can be handled at anytime and anywhere. It goes free of the restriction of time and space. The fast response capability of the enterprise is improved.

Real-time query of information regardless of the location. When you want to know about some data, you can do it with so much as an SMS, no matter where you are.

Implementing personalized information customization. Self-defined personalized report, self-defined personalized bill review

Traditional enterprise applications have been built around the wired networks and hence do not adequately address the need of extending the enterprise systems to the mobile employees and customers. However, now it is technologically possible to build mobile applications providing "anywhere, anytime" access to an organization's employees and customers. The information required to do any job can be made available wherever it is required.

B. Internal Control on M-ERP

Internal control on M-ERP is a process -affected by an entity's board of directors, management, and other personnel-designed to provide reasonable assurance regarding the achievement of objectives in the following categories: (1) reliability of financial reporting, (2) effectiveness and efficiency of operations, and (3) compliance with applicable laws and regulations.

Internal control research has addressed how the auditor document or model internal control separately from how they evaluate those controls (Felix and Niles 1988). Gadh et al (1993) presents a prototype model that can evaluate internal control systems based on its own evaluation rules and internal representation of those systems [5].

As Vasarhelyi (1998) notes, information must be correct, in real-time, utilizing systems that are reliable by design and not by correcting the data after the fact. This paradigm shift emphasizes the internal control systems that govern the design, development, implementation, and monitoring of tourism information systems [6].

M-ERP helps companies control their purchasing, inventory, manufacturing, finance, and human resource activities by centralizing information collected from dispersed geographical sites (Ragowsky and Somers, 2002) [7].

Kopp and O'Donnell(2005) examines whether organizing information about internal controls around business processes instead of control objectives produces stronger category knowledge during training and improves decision performance during internal control evaluation. They find that novices who were trained to evaluate internal controls using business-process-focused materials developed stronger category knowledge and identified more internal control issues during using a internal control evaluation task. Their findings suggest that the process focus may be a more effective framework for organizing internal control evaluation tasks as in figure 1 [8].
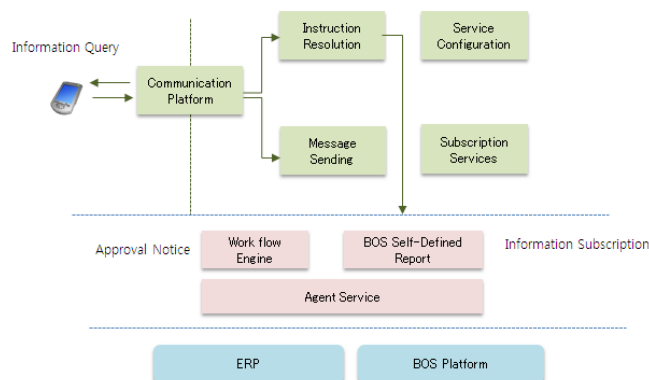

Fig 1. Overview of architecture for Internal Control on M-ERP

C. M-ERP Quality

To manage effectively, one must measure and analyze. To measure, however, one must define what to measure. Defining what Information Quality means, therefore, is crucial in managing information as a product. In the process of defining what information quality means, the participants will engage in problem identification and problem solving in the context of their own organizational setting. They must identify the necessary organizational processes and technical solutions for managing the information product.

The concept of information quality is more important than ever to business. Just as quality in goods/services has the capacity to satisfy people needs (Dotchin & Oakland, 1992; Rajagopal et al., 1995) [9]; information quality in decision-making has the capacity to satisfy internal and external customers. Hence, information quality has different implications under different decision dimensions. When EUC activity becomes an essential organizational trend, it can provide internal and external customer service--where the service form is presentation of information and the content is the quality concept. The meaning of information quality, speaking on the basis of information systems concepts and purpose (data-information-decision-action), is

that which achieves effective outcomes in making the right decisions. Decisions must be based on good, high-quality information, so information quality improvement is the critical element for EUC. But it is difficult to evaluate the value of information quality; moreover, the evaluation must be based on the actions resulting from all kinds of decisions made by the information user (Davis & Olson, 1985) [10]. To manage effectively, one must measure and analyze. Kinney (2000) studies research opportunities in internal control quality and quality assurance. He discussed the importance of pursuing broad internal control quality and quality assurance research topics of wide practical and scholarly interest [11].

D. M-ERP Technologies

A wide range of technologies are available today for deploying mobile applications for client side, server side and for connectivity technologies.

Client Side Technologies. Various end user devices are available for mobile computing these includes: PalmOS devices, Windows CE devices, bedded JAVA devices and Other Proprietary handheld devices, Mobile Phones and Notebook PCs.

Server Side Technologies. The enterprise data and most of the application components reside on central servers, which communicate with the client devices through wired or wireless networks. The two competing server side platforms, these are Microsoft Platform and Java Platform. Microsoft Platform consists of the Windows NT or Windows 2000 operating system, IIS as the web server, SQL server as the RDBMS and various other software components such as Mobile Information Server from Microsoft. JAVA Platform consists of some flavour of the UNIX operating system (Solaris, Linux, AIX, HP-UX, etc.), with a Web Server/Application Server (e.g. Weblogic, Websphere) and an RDBMS such as Oracle or DB/2. The programming is done using JAVA, JAVA Server Pages (JSPs), Enterprise JAVA Beans (EJBs) and other JAVA platform components.

Connectivity Technologies. Wireless LANs there are two main competing standards for short distance wireless connectivity between various devices, Bluetooth and IEEE 802.11. For wireless connectivity across long distances, there are many competing standards - GSM, GPRS, CDMA, and WCDMA.

E. M-ERP Performance

Delone and McLean (1992) discussed that individual impact in the the information system success model is closed related to improvement of my or my department's performance [12]. Hitt, Wu and Zhou (2002) study investment in M-ERP: business impact and productivity [13]. They determined that M-ERP adopters are consistently higher than non-adopters in performance and productivity shortly after completion of the implementation. Likewise, adopters had higher market valuations both during and after adoption. Somers et al.(2003) study confirmatory factor analysis of the end-user computing satisfaction instrument: replication within an M-ERP domain [4]. They confirm that end-user computing satisfaction maintains its psychometric stability when applied to users of M-ERP. Fethi and Ferah (2004) examines various usability factors affecting end-user satisfaction with M-ERP systems. The results indicate that both perceived usefulness and learnability are determinants of end-user satisfaction with M-ERP systems. And perceived ease of use and system capability affect perceived usefulness, while user guidance influences both perceived usefulness and learnability.

III. DESIGN ARCHITECTURES

A. Our M-ERP Design Considerations

A mobile applications strategy for the enterprise is based on the following main considerations:

Application functionality considerations, Technical considerations and financial considerations

The most important exercise is to identify the business areas of the organization that will benefit the most from mobile applications and define the functionality of the applications. This requires a detailed analysis of the organization's operations and its existing IT infrastructure. In the following paragraphs, we will give a general overview of enterprise business applications and the key areas suitable for mobile applications. The front office applications cover the customer facing side of an organization and are commonly called as Customer Relationship Management (CRM) systems. CRM systems provide applications for the sales force, call center and customer service areas and provide functionality for taking orders, configuring complex products and providing effective service and support to customers.

The customer facing professionals of an organization (sales and service personnel) are typically mobile and the effectiveness of their activities depends a great deal on the timely and accurate access to information. Hence, applications for the mobile sales and service personnel of an organization are the most suitable candidates for mobile applications. Some of these application areas are outlined below:

Sales Force Automation: Order Entry, Order Management, Lead Management, Point of Sale, Pricing and Configuration, Appointment and contact management Customer Support: Call Dispatch and Tracking, Customer Tracking, Technical Support Guides Field Service: Call Dispatch and Tracking, Logistics Management, Parts and Spares Management and Ordering, Parts Inventory Management, Field Manuals and Knowledge Tools.

There are some areas in back office application also, which can benefit from mobile applications. Some of the suitable back office application areas are: Asset Tracking, Inventory Management, Logistics Management, Order Entry, and Procurement Management

After the application areas have been identified, the next major step is to identify the suitable technical solution. Various technical considerations are involved in choosing the right technical solution. Some of the main technical considerations are outlined below: Suitability for the Application: Does the technical solution have any unique capabilities to provide the features required by the application? Use of Existing IT Infrastructure: Does the solution make the best possible use of the existing IT infrastructure of the organization? Integration with Existing Applications: How easy it is to integrate the mobile application with the existing M-ERP/SCM/CRM systems of the organization?

Ease of Use: Simplicity of UI, ergonomics of the device.

Standards: Does the solution use the popular industry standards?

Connectivity: What means of wired and wireless connectivity are available in the territories covered by the application and which are supported by the proposed solution.

Upgrade Path: How is the technology for handheld devices and wireless connectivity going to evolve? How will the proposed solution upgrade to these advances?

Synchronization: How will the data on the handheld device synchronize with the central data?

Development Tools: Are good development tools available for the platform?

Development Resources: Are software developers with skills in the chosen platform available?

Flexibility: How flexible is the solution. How easily can it be customized or changed?

Security: Are organization's security requirements supported by the solution?

Scalability: How scalable is the solution with respect to the volume of data, number of users and number of transactions?

Reliability: What are the reliability requirements in quantitative terms? Does the solution support these requirements?

Ease of Management and Support: How easy is the management and support of the application? Can the management and support be done remotely?

Finally, any investment in technology needs to be justified by ROI considerations. A detailed financial analysis would be required for financial justification of an investment in mobile applications. However, we strongly believe that the benefits of the mobile applications are so compelling that ROI justification would be easily possible. The figure 2 shows the process of Mobile ERP development in our study.

Fig. 2. Process of design for M-ERP

B. Our M-ERP development model

The purpose of this study is to understand the critical role of the M-ERP system internal control, quality and performance in the factory industry. This paper examines the relationship of M-ERP system internal control, quality and performance. The figure 3 sow the basic modules to develop the M-ERP.

Since early 1990s, M-ERP system has been accessed through computers to deal enterprise Information System more quickly and efficiently. Via Internal Controls, the relevance and reliance to its objective has been more secure.

Also enterprise information yielded by M-ERP System and efficiency of the information value has been considered very important. However, when it comes to contemporary studies, researches on M-ERP system Internal Controls and Quality, performance have not much been accumulated, so it is needed to be approached with diverse methods.
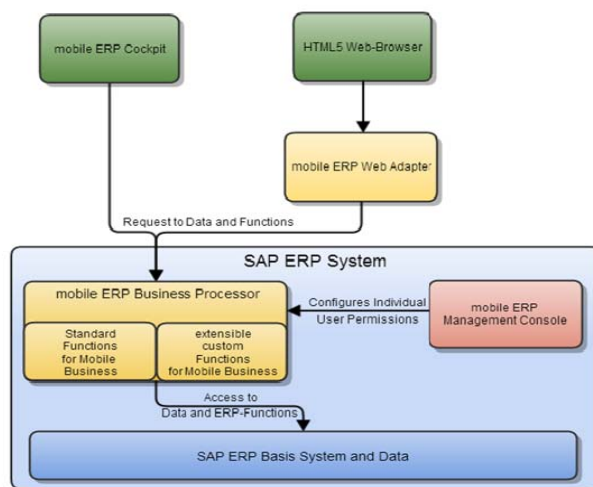

Fig. 3. M-ERP modules

Therefore this paper set out the research model that the relationships of M-ERP system internal control, quality and performance (see Figure 4)
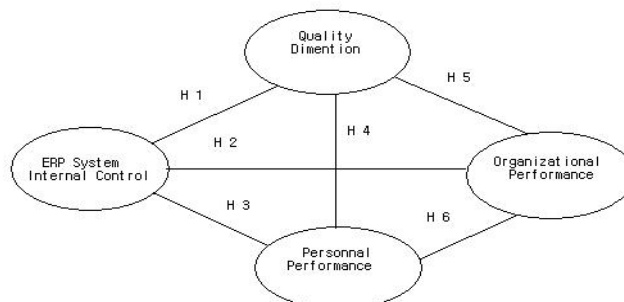

Fig. 4. Relationships of M-ERP system internal control, quality and performance

To achieve this purpose, the following hypotheses are made.

<Hypotheses 1(H1)> M-ERP system internal control will have a positive influence over quality dimension.

<Hypotheses 2(H2)> M-ERP system internal control will have a positive influence over organizational performance.

<Hypotheses 3(H3)> M-ERP system internal control will have a positive influence over personal performance.

<Hypotheses 4(H4)> Quality dimension will have a positive influence over personal performance.

<Hypotheses 5(H5)> Quality dimension will have a positive influence over organizational performance.

<Hypotheses 6(H6)> Personal performance will have a positive influence over organizational performance.

C. Applied Method

For the survey sample, the data were gathered from those people who work in M-ERP system management offices of factory companies and organization. Through theoretical studies based on Management Information Systems, empirically tests hypotheses related to the research model.

The questionnaire consisted of five parts (Table 1). The first part involved a question about the respondent company' M-ERP internal control (planning & organization, acquisition & implementation, delivery & support, monitoring). The second part involved a question about the respondent company' M-ERP quality domains (system quality, information quality, service quality). The third part consisted of the items measuring personal performance (usability, usefulness, satisfaction). The 4th part consisted of the items measuring organizational performance. The 5th part involved demographic questions designed to solicit in information about the respondent, their organization, and the extent to which they use the M-ERP system.

Internal control, quality domain, personal and

Measure domain	Measure item	Number	Question No.	Scale
M-ERP system internal control	Planning & Organization	5	1.1 ~ 1.5	
	Acquisition & Implementation	5	1.6 ~ 1.10	
	Delivery & Support	3	1.11 ~ 1.13	
	Monitoring	4	1.14 ~ 1.17	7 point Likert Scale
Quality domain	System Quality	5	2.1 ~ 2.5	
	Information Quality	4	3.1 ~ 3.4	
	Service Quality	4	4.1 ~ 4.4	
Personal Performance	Usability	4	5.1 ~ 5.4	
	Usefulness	4	6.1 ~ 6.4	
	Satisfaction	5	7.1 ~ 7.5	
Organizational Performance	Organizational Performance	9	8.1 ~ 8.9	
Profile	Company	11	9.1 ~ 9.11	nominal scale
	Personal	6	10.1 ~ 10.6	

organizational performance were measured by 3-9 items each. Likert scales(1~7), with anchors ranging form "strongly disagree" to "strongly agree" were used for all questions.

TABLE I. QUESTIONNAIRE STRUCTURE

The model was tested by multiple regression analysis using SPSS11.0 and SEM (structural equation modeling) using LISREL (linear structural relations, is a statistical software package used in structural equation modeling) 8.54 on a sample of 131 respondents who have worked with the M-ERP system in a factory industry.

We survey the users of M-ERP system in Korea. The sample company was almost evenly split among factory industry; They implemented by SAP (5; 3.8%), Oracle (11, 8.4%), K-system(11, 8.4%), KIS-M-ERP(6, 4.6%), UniM-ERP (24, 18.3%), SMM-ERP (74, 56.5%) package.

The sample respondent was 30 years old; have used the system for approximately 5.6 years; and represented a wide range of positions within the organizations. The target group was M-ERP system end-users and respondents indicated that they used the system several times a day.

IV. EVALUATION AND ANALYSIS FOR M-ERP RESULTS

A. Evaluation

A confirmatory factor analysis using LISREL 8.54 was conducted to test the measurement model. Reliability and validity of the constructs were estimated by Cronbach's alpha (see Table 2).

TABLE II. DESCRIPTIVE STATISTICS OF CONSTRUCT

Factor name	Variables	Mean	Standard deviation	Cronbach's alpha
M-ERP system Internal control (M-ERPIC)	PNO ANI DNS MOI	4.1191 4.4183 4.6851 4.1374	0.9423 0.9096 1.0231 1.1722	0.7935 0.8092 0.8186 0.8119
Quality dimension (QUALI)	STQ INQ SVQ	4.4787 4.4372 4.4562	0.7587 0.7483 0.7749	0.7082 0.7679 0.8979
Personal performance (PEPER)	USA USE SAT	4.4516 4.5281 4.5541	0.8198 0.9131 0.9816	0.8975 0.8825 0.8765
Organizational performance (ORPER)	ORP	4.4475	1.0280	0.9406

The highest mean is DNS (4.6851) and the lowest is PNO (4.1191). And most of all mean higher than 3.5(7 likert/2). Cronbach's alpha for all constructs were above the 0.70 threshold for field research. Therefore, all constructs in the model had adequate reliability and validity. In addition the correlation matrixes of the constructs are as shown in Table 3.

TABLE III. CORRELATION MATRIX

	M-ERPIC	QUALI	PEPER	ORPER
M-ERPIC	1			
QUALI	0.740***	1		
PEPER	0.399***	0.639***	1	
ORPER	0.440***	0.737***	0.845***	1

*** p<0.01

As the result of the study, the relations between internal controls and Quality had statistical significance. The quality has a statistically influence on the M-ERP systems' performance. And internal controls have a statistically influence on the M-ERP systems' performance. The fit of the overall measurement model was estimated by various indices provides by LISREL (see Table 4). Goodness-of-fit (GFI) is 0.91, Adjusted goodness-of-fit (AGFI) is 0.80, Normalized fit index (NFI) is 0.92.

Path analysis was used to analyze the hypotheses on whether internal controls had an effect on performance through the quality dimension. When the result of an analysis using LISREL 8.54 was examined, index numbers (GFI, AGFI, RMR) that represents acceptable values for the model displayed adequate levels, which in turn showed the suitability of this particular model.

And hypotheses 1, 4, 5, 6 are accepted from test. But hypotheses 2, 3 are rejected from test (see Table 4 and Figure 2).

TABLE IV. RESULT OF HYPOTHESES TEST

| No.	Hypotheses	Accept/Reject
1	M-ERP system internal control will have a positive influence over quality dimension.	Accept 0.74(0.01)
2	M-ERP system internal control will have a positive influence over organizational performance.	Reject -0.13(0.06)
3	M-ERP system internal control will have a positive influence over personnel performance.	Reject -0.16(0.10)
4	Quality dimension will have a positive influence over personal performance.	Accept 0.76(0.00)
5	Quality dimension will have a positive influence over organizational performance	Accept 0.44(0.01)
6	Personal performance will have a positive influence over organizational performance	Accept 0.62(0.00)
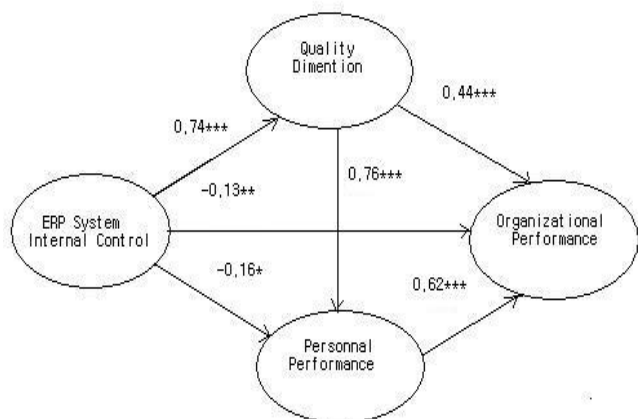
Fig. 5. Relationships of M-ERP system Analysis Results

B. Results

Since the early 1990's, M-ERP system have been implemented and managed in order to deal with enterprise information faster and precisely, and the suitability for the purpose and the reliance through internal controls have been more ensured. And also products yielded by M-ERP system and the efficiency of the information value have been considered very important. But when it comes to existing studies, studies on internal controls and information quality which have an influence on the performance of M-ERP system are not much accumulated, so it is needed to approach with various methods. This study is for the purpose of understanding performance of M-ERP system more closely by means of perceiving relations between internal controls and information quality. That is, this study is to assess internal controls and information quality and to connect those with performance. This thesis is for the substantial study on whether information quality influenced by M-ERP system internal controls has an effect on performance, when internal controls of M-ERP system are good.

The relations between internal controls and information quality had statistical significance. The information quality has a statistically influence on the M-ERP systems' performance. And internal controls have a statistically influence on the M-ERP systems' performance. Through information quality, M-ERP system internal control will have a positive influence over performance. Consequently, the more investment in internal controls and quality, the greater the performance of the M-ERP systems. Therefore the higher the performance of the M-ERP systems through increased investment in internal control and information quality, the higher will be the value of the M-ERP system as a whole.

V. CONCLUSION AND FUTURE WORKS

As companies face diverse changes, staff members require increasing amounts of information to manage task uncertainty and complexity. Information technology continues to improve. Information technology has a lot of advances; workstations and personal computers are commonplace. Commercial software which is easy to use and offers user-friendly interfaces is plentiful. Company management has resulted in users being able to use, develop and control appropriate M-ERP systems.

Information technology has been playing a fundamental role in the factory industry for a long time. The Internet particularly is increasingly emerging as a perfect platform to bring enterprise information direct to the customer. Web-based M-ERP systems, however, are required not only to offer online brochures but also to provide both value and service. The M-ERP system meets this challenge by focusing on three crucial points. First, high-quality access is provided, both by supporting e-commerce transactions and by allowing access to the system via the World Wide Web, info kiosks, and cellular phones. Second, the content is of a high quality that is achieved by enabling enterprise information providers to maintain their products directly, as well as by integrating external enterprise information sources. Finally, the M-ERP system is designed in such a way that it is easy to customize.

The purpose of this study is to understand the critical role of the M-ERP system's internal control, quality and performance in the factory industry. Therefore this paper examines the relationships of the M-ERP system's internal control and quality dimension on performance. This sets out the research model of influencing factors and the performance of the M-ERP system through theoretical studies based on Management Information Systems, and the empirically tests hypotheses related to the model.

As the result of the study, the relations between internal controls and quality dimension has statistical significance. The quality dimension has a statistically influence on the personal performance and organizational performance. Through path analysis, this study examined the influence which relations between internal controls and quality have on performance and is very meaningful in terms of the first trial. And on the point of time when there are little studies on the effect analyses among internal controls, quality dimension, performance, this study would be the promoter for the future.

The limitation on this study is to analyze only mutual effects between factors by choosing internal controls, quality dimension and performance as survey variables. The study which measure items with precision which are related to each

variable and understand measurement factors clearly should be implemented. Although this paper has already established a research framework, as exploratory research, it must also take the next step of refining, leading to the guide for future research work. This study is the first study to analyze comprehensively the relationship of the internal control, quality dimension on the M-ERP system performance, therefore further studies using generalized research methodology are recommended. And a longitudinal research design is essential to confirm the linkages among the study variables.

ACKNOWLEDGEMENTS

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