## Research on Ubiquitous Services in Film Achieve Management: a Case of National Palace Museum

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#### Abstract

"Ubiquitous" represents a concept which means —God exists everywhere. At the era of information technology, by using all kinds of information products and networks, the word represents that the ubiquitous information ideal world can be realized. However, introducing new technology could also cause other issues because of the impractical lead-in plan. Therefore, we integrated the ubiquitous computing technology with the business process to improve system efficiencies by means if well-defined BPM. Through case study, we chose National Palace Museum as our target and analyzed the operating process using module standardized tools to evaluate the difference in performance after the implementation of ubiquitous application. We have identified the KPIs for introducing ubiquitous services into museum and verified that ubiquitous service has positive benefits.

Keywords: Performance Evaluation, Ubiquitous Computing, RFID, Business Process Management, U-Museum

## 1. Introduction

By integrating internet and wireless sensor technologies, it can facilitate ubiquitous service. However, applications of Information and Communication Technology (ICT) should not be only considered as a technical matter but more importantly as an effect by means of Business Process Management (BPM) for improving the underlying business processes. Hence, the ultimate goal of this research is to integrate BPM tools into the development of ubiquitous computing services.

Most of the relic image archives management tasks are done by hands, including preservation, inventory, loaning and return etc. In addition to the consumption of unnecessary massive manpower, it's also error-prone. With aids of technology can improve the performance and enhance the efficiency of image access control management, and reduce the possible error occurrence. For this purpose, we have integrated the BPM tools into the development process of ubiquitous computing for managing relic image archives and verified the overall suits by a case study. The result shows that the ubiquitous computing for relic image archives management leads to an improvement of the quality and effectiveness.

#### 2. Situation Analysis

#### **2.1. Ubiquitous Computing**

Mark Weiser's describes a vision of ubiquitous computing in which technology is seamlessly integrated into the environment and provides useful services to humans in their everyday lives [14].

Ubiquitous computing is also known as Pervasive Computing (PvC) [13], Calm technology [15], and Ambient intelligence in Europe. There's no standard infrastructure of ubiquitous computing currently, but application-oriented and based on the needs of different adjustment. The technological advances necessary to build a computing environment fall into four broad areas: devices, networking, middleware, and applications. Figure 1 illustrates their relationships [12].



Figure 1. Pervasive computing framework [12]

#### 2.2. RFID technologies applications for ubiquitous services

After Wal-Mart's successful application of Radio-frequency identification (RFID), a technology existing for decades, innovative applications of RFID becomes the competitive edge for the most of industrial sectors. RFID is a kind of communication technology that uses radio waves to exchange data for the purpose of identification and tracking. It is being developed as an essential elemental technology for realizing sophisticated information technology in ubiquitous environment, and is spread to all social and cultural areas [4].

RFID is an auto-identification technology, which uses radio waves to transmit information. RFID systems generally comprise of three main components, namely: tags, readers, and a data processing system [6]. A tag has a unique identification number (ID) and memory that stores additional data such as manufacturer name, product type, and environmental factors including temperature, humidity, and so on. The reader can read and write data to tags through wireless transmission. In a typical RFID application, tags are attached or embedded in objects that must be identified or tracked [5]. For using in the art piece, RFID will not interfere or transform the artist's result, because they are totally invisible [9]. Like other auto- identification technologies, its underlying purpose is to allow computers to acquire identifying information about physical objects in the real world.

#### 2.3. Business Process Management (BPM)

Since late 1990s, industries began to make great efforts for Business Process Re-engineering [10]. Gradually, it is recognized that BPR alone is not able to ensure the success of business process improvement. Experiences from success and failure of BPR reveal the successful factor, i.e. goal setting and weak-point finding are certainly no less important than the re-design per se [7]. Furthermore, new and old processes must target to the improvement of business performance by means of management.

Many business and ICT projects are at risk because they don't use a methodology to select ICTs (information and communication technologies) as an enabler for the re-engineering. Applying the right ICT enabler is one of the critical steps in understanding how to leverage information to gain insight and improve productivity and efficiencies throughout the organization.

BPM is a task encompassing goal setting, analysis as well as evaluation of existing processes design of new processes with support from Information and Communication Technology (ICT) such as RFID etc. Being a task of such complexity, BPM per se needs ICT support as management tools. However, the connotation of BPM is not only limited to ICT but most important in business process (Figure 2). BPM is a matter of business innovation towards high performance rather than the technical implementation. Most importantly, BPM is a metaphor addressing the complete process life cycle and its major theme lies in the effectiveness, especially with regards to cost productivity and efficiency measures. Obviously, CSF's and KPI's play the important role in this kind of work [7].



Figure 2. ICT strategies in the BPM roadmap [7]

## **3. Research Methodology**

## 3.1. Fundament of the research

The basis of this study is the BPM methodology results from our long-term research up-to-date. The goal of the BPM methodology is to align the improved business processes with the ultimate business vision and the strategic objectives. The BPM work thus deploys the business vision into performance factors on deferent levels, as following:

- Key problem narratives
- Highlight Charts: Information showing own judgment or preference
- Top-level financials: No. and performance ratio
- Key factors: KPI at corporate level reflect or examine specific measures of CSF regarding problems in highlight charts
- Detailed KPI responsibility reports

## 3.2. Working Procedures of the integrative BPM

In order to realize aforementioned BPM, we have developed the working procedure into the following phases (shown as Figure.3):

- Consensus forming and Mutual Understanding
- Process Re-appearance
- Process Analysis
- Process Re-design



Figure 3. Business Management Process for applying RFID[7]

#### 3.3. Process Re-appearance phase: BPMN/BPEL

In order to capture the process model and be more familiar with the existing processes by the museum, we have collected related data as a reference for process analysis. A field observation, including interview, was also arranged to ensure the data accuracy. BPMN/BPEL [16] is then applied to construct the model as reappearance of the process where the results of this work may be further used to develop usable web services in the future.

#### 3.4. Process Analysis phase: Pool-Lane chart

The aim of this phase is to improve each process by using Pool-Lane Chart [11] to figure the physical movement lines along the business operation. By means of the chart, we are also able to examine the rationality of each physical movement line, identify problems, find solutions and set achievable targets. The Pool-Lane Chart with respect to operation-unit relationship is shown in Figure 4. The potential needs for RFID applications can also be explore through visualizing these operation processes.



Figure 4. Pool-Lane Chart with respect to Operation-Unit Relationship

#### 3.5. Research into the integrative BPM method by means of case study

The case study has been employed as the research method and a museum was chosen as the research objective. The study also analyzes the business process with module tools to evaluate the difference in performance before and after the implementation of ubiquitous computing service. Among others, the following BPM tasks and computerized tools stand for the most crucial parts of the study

#### 4. Case Study

#### 4.1. U-Intellectual Properties Systems of National Palace Museum

Image Archive Management System of National Palace Museum (herein referred to as NPM) was chosen as the research objective. Since the last decade, NPM has achieved the great success in digital heritage development, which includes the Digital Archives, Digital Museum and E-learning project [17] [2]. Based on the previous achievement, NPM decided to step further to build the U-Museum service. Image Archive Management System is one of the U-Intellectual Properties Management System under U-Museum project (Figure 5), and it was undertaken by the Department of Marketing and Licensing.



Figure 5. U-Intellectual Properties Management System of NPM

In the previous project, NPM has digitized enormous amount of museum collections into digital form, and reproduce them into a variety of formats, such as multimedia DVDs, films, web sites, publications, and products. Before applying ICT, the operation of relic image archives (include positive film and digital images) were all done by hand and recorded loaning information by paper work. In order to effectively manage these products, NPM decided to use ICT such as ubiquitous technology (mobile appliances, RFID, wireless sensor networks and etc.,) in this management system. This system aims to manage the positive film archives and the digital images. Prior to the application of digital cameras, the museum had stored a great amount of positive films taken by traditional cameras. In order to integrate two types of image archives, the RFID tags were attached to the outer of positive films. Then each film could be found by RFID readers, which can automatically transmit data to management system. In this way, the administrators can easily find out the required image and process the image loan service or image licensing.

#### 4.2. Process Re-appearance phase (AS-IS)

After the field-observation, we described the image archives management process in three parts, i.e. (1) New Films Creating, Films In-stock (sub-process), (2) Films loaning, Films Out-stock (sub-process), and (3) Expired Films Recalling. Units involved in the image archives management process are Licensing Division, Film Archives Library, Photo Room and Loaning Units. Following is the AS-IS process of the image archives management which is described by standard modeling tools BPMN we have selected (Figure 6 and Figure 7).



Figure 6. Films in-stock process (AS-IS)



Figure 7. Films Out-stock process (AS-IS)

#### 4.3. Process Analysis and process re-design phase (TO-BE)

In this phase we described TO-BE process by standard modeling tools BPMN shown in Fig.8 and Fig.9. Comparing with AS-IS process (Figure 6 and Figure 7) we found that after applying the system, the mainly change of image archives manage process is in Film Archives Library. For example, through the system, RFID readers can automatically transmit data to management system. In this way, the administrators can easily find out the required image and process the image loan service or image licensing.



Figure 8. Films In-stock process (TO-BE)



Figure 9. Films Out-stock process (TO-BE)

After describing TO-BE process, we used Pool-Lane Chart to figure the physical movement lines along the image archives operation and also able examine the rationality of each physical movement line and identify problems. Table I shows the Pool-Lane Chart of Films Out-stock process, through the chart we can see that the outbound process can be independently complete by one unit. It is the most simple and the best line of the operation. Some tasks can be completely replaced by ubiquitous service i.e. the operation of counting and checking films. By applying the system, it significantly reduced the process shown as Table 1 and Table 2.

	Photo Room	Licensing Division	Loaning Units	Film Archives Library
Prepare films according to application forms				*
Copies of films or not				
Access on films from dry box				No
Make copies films				
Films check in			No	
Verifying films				
Notice loaning units				Yes

Table 1. Dispatch Flow of archives Out-stock process (AS-IS)

	Photo Room	Licensing Division	Loaning Units	Film Archives Library
Print application list from system				
Access on films from dry box				•
Recognized by RFID reader of work station				Ţ
Notice loaning units				•

Table 2. Dispatch Flow of archives Out-stock process (TO-BE)

## 5. Discussion

The outcome of this research is a novel development approach for the RFID-based ubiquitous services, which can align the system design with the business vision and strategy. For this purpose, BPM tools such as BPEL/BPMN and Pool-lane Chart are integrated into the development of the system of ubiquitous technology. The overall suits is implemented and verified by means of a case study on the ubiquitous technology for improving the museum relic image archives management. Through the case study, including field observation and interviews, targeted expectation can be classified into two parts, i.e. quantitative KPIs: time and manpower, quality KPIs: security and transparency of image archives dispatch flow. As the consequence, this paper also presents the evaluation of the improvement by the quantitative as well as qualitative KPIs.

#### 5.1. Quantitative KPI Improvement: Time and Manpower

After integrating BPM tools into the development of the ubiquitous computing technology, some improvements have been identified. Table III illustrates in-stock pre and post system applying improvement (time and manpower).

Table IV shows out-stock pre and post system applying improvement (time and manpower). Each image archive in-stock process, we can save 70 man-min (84-14), and the reduction rate is 83.33% (70/84). Each image archive out-stock process, we can save 51 man-min (66-15), and the reduction rate is 77.27% (51/66).

Activity	AS-IS(min/person)	TO-BE(min/person)
Checking Films	1/1=1	1/1=1
Report on disqualified films	3/1=3	3/1=3
Creating Films Info.	30/1=30	-/-=0
Print and paste RFID tags	-/-=0	5/1=5
Counting the No. of Films	45/1=45	-/-=0
Films Inventory	10/1=5	5/1=5
	84	14

Table 3. Improvement of Inbound Process in relation to Time and Man-Power

Activity	AS-IS(min/person)	TO-BE(min/person)
Prepare films according to application forms	15/1=15	-/-=0
Print application list from system	-/-=0	5/1=5
Copies of films or not	12/1=12	-/-=0
Make copies of films	3/1=3	-/-=0
Access on films from dry box	10/1=10	5/1=5
Films check in	12/1=12	-/-=0
Verifying films	12/1=12	-/-=0
Recognized by RFID reader of work station	-/-=0	3/1=3
Notice loaning units	2/1=2	2/1=2
	66	15

Table 4. Improvement of Outbound Process in relation to Time and Man-Power

# 5.2. Qualitative KPI Improvement: Security and Transparency of Image Archives Dispatch Flow

The case study shows two kinds of advantages from ubiquitous services. One is more accurate information, and the other is image archives movement trajectory in the complete supply chain. The quality improvements include security and transparency.

• Security: By using RFID tags, the system can verify the loaning numbers and correct image archives at different check points. Thus, we can detect the image archives during transportation to ensure its security. RFID tag is also durable and anti-counterfeiting, so data is accurate and the image archives safety can be improved.

• Transparency of image archives dispatch flow: In the Film Archives Library the image archives moving line can be easily traced and found. By data exchange, the archives can be easily tracked and transferred when needed.

#### 6. Conclusions

To obtain the best benefits of ubiquitous services, we need to integrate the ubiquitous computing technology with the business process to improve system efficiencies by means if well-defined BPM. The research has identified the KPIs for introducing ubiquitous services into museum relic image archives management. As the most important result of this study is that by integrating BPM tools into the development of ubiquitous computing, we can verifying that ubiquitous service has positive benefits.

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