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PROCESS MODELING FOR BPR: EVENT-PROCESS CHAIN APPROACH

Young-Gul Kim
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Science and Technology

Abstract

Most of the recent research on business process redesign (BPR) focused on people or management related issues. Completing a successful BPR project, however, requires a disciplined method to model the target business processes effectively as well. Currently available process modeling methods fail to meet the specific BPR process characteristics (cross-functional, customer-oriented) and the ideal features of a modeling formalism (expressiveness, simplicity) simultaneously. In this paper, a new process modeling method exclusively designed to support BPR from the customer's perspective, based on the concept of event-process chain (EPC), is introduced. The EPC model is analyzed, along with five other methods, over the above criteria to prove its appropriateness for BPR and its strength as a powerful and elegant modeling formalism. We also report on the application of the EPC modeling method to three real world BPR projects and suggest its future enhancement directions.

1. INTRODUCTION

Probably the most paradigm-shifting IS topic in the 1990s has been the concept of business process redesign (BPR) (Davenport and Short 1990), also known as business reengineering (Hammer 1990). Arguing for the dramatic redesign of the current business processes, BPR differentiated itself from the traditional way of developing information systems (IS) applications — automating the current way users conduct their function-oriented tasks. Notwithstanding some criticisms and myths around BPR (Davenport and Stoddard 1994), numerous companies worldwide initiated their BPR projects since 1990 with widely mixed results (Hall, Rosenthal and Wade 1993).

While many looked into people or management related issues such as change management, communications, organizational culture, politics, top management support, and process ownership (Hall, Rosenthal and Wade 1993; Caron, Jarvenpaa and Stoddard 1994; Earl 1994; Davenport and Stoddard 1994) , very few addressed the key technical and methodology related issues of BPR. One such issue every BPR project manager struggles with is how to model the target business processes most effectively. Unlike other IS domains with powerful and elegant modeling methods (e.g., entity-relationship modeling in database, data flow diagram in systems analysis and design), BPR does not seem to have such a modeling method to guide its redesign process in a systematic way.

Originators of BPR did not provide one. Consulting companies came out with their own hastily-constructed modeling methods which range from simplistic process maps without an abstraction mechanism to an overly complex multi-volume methodology. None of them is powerful and elegant enough to gain the universal acceptance of entity-relationship (ER) model or data flow diagram (DFD). On the research front, much of the research on process modeling has been conducted on the software development process (Curtis, Kellner and Over 1992, Krasner et al. 1992), thus being too formal and engineering-oriented to be useful for modeling business processes from the customer's perspective as required in BPR.

This paper introduces a new process modeling method exclusively designed to support BPR from the customer's perspective, based on the concept of event-process chain (EPC). The EPC modeling method follows the tradition of ER and DFD in maximizing its expressive power without sacrificing modeling simplicity. The following sections will provide an overview on process modeling for BPR, describe the EPC modeling method in detail, compare EPC with other process modeling methods, discuss the EPC model's application to real world BPR projects, and suggest future enhancement directions.

2. OVERVIEW ON PROCESS MODELING FOR BPR

Process modeling is a technique for understanding, representing, and, when necessary, redesigning the fundamental business processes. Before BPR, process modeling was mainly the task of graphically modeling, using diagrams like DFD, the way users currently process their data. It also contributed to converting such diagrams into module structures or pseudocodes. Its main role was to support the development of IS applications for functional areas or specific groups of users. Naturally, its modeling orientation was toward internal employees and often its goal was to improve their productivity by automating their routine tasks.

With BPR, process modeling takes a radically different perspective. According to Davenport (1993), a process is "a specific ordering of work activities across time and place designed to produce a specified output for a particular customer or market." Instead of focusing on developing IS applications for functional areas, here process modeling aims at modeling, using diagrams like EPC, the cross-functional business processes, encompassing the entire organization (Kim and Everest 1994). Frequently, these processes are initiated by customers and the modeling orientation reflects the strong customer perspective. The goal of such process modeling is to support the "understanding and radical redesign of critical business processes to better serve its customers." This redesign effort often involves the major investment in new information technology (IT) infrastructure, but not always. In some cases, they can utilize the existing IT infrastructure, and in others, process redesign takes place without any computerization. In addition to the higher level of abstraction, process modeling for BPR targets not only data or documents as in traditional systems development, but also any object of interest including customers or physical things. Table 1 summarizes the nature of process modeling for BPR.

Table 1. Process Modeling for BPR

1. Level of Abstraction	high
2. Modeling Orientation	customer
3. Modeling Scope	cross-functional
4. Processing Target	objects of all type
5. Tools/technique	EPC diagram process map

3. EVENT-PROCESS CHAIN (EPC) MODELING

EPC modeling originates from the idea of event-transaction diagram, which was a graphical formalism to model the dynamic portion of an organization's global information schema (Kim 1993). By adopting a strong customer perspective, EPC modeling supports BPR in identifying and redesigning critical business processes. Unlike other modeling methods, it starts by modeling the target process solely from the customer's point of view. By hiding all the customer-independent internal processing activities from the model, it facilitates the identification of process bottlenecks which result in the lengthy process cycle time and the subsequent loss of customer satisfaction. Once these bottlenecks are identified, they are recursively exploded into the next level EPC model until a satisfactory solution is found. EPC diagram, a graphical representation for EPC modeling, has four constructs: event, process, branching, and wait. These four constructs are drawn on two dimensions: place dimension vertically and time dimension horizontally. These are the dimensions rarely modeled in the traditional process modeling, but comprise the core context for BPR where processes are frequently spread over functional boundaries and cycle time measurement is a crucial tool for the process redesign activities. A description of each construct is given below.

1. **Event** is defined as a **perceived change of status at one point in time which is of interest to the server organization** where the server organization is one that initiates the BPR project. This is a very specific and narrow definition of event which is often broadly defined as just "change of status." **"Perceived change of status"** specifies that, until the change of status is perceived or noticed, the server organization will not know of its occurrence, thus it is not an event yet. **"At one point in time"** means that an event should take place in a very short period of time without any recognizable duration. Here, interpretation of "very short" depends on the unit of time for the entire process cycle. Three minutes will be very short for a cycle time of three days, but not so for a cycle time of thirty minutes. **"Of interest to the server organization"** suggests that, among instances of similar nature, only the one which attracts the server organization's attention qualifies to be an event. For a restaurant owner, for instance, arrival of a dinner guest is an event while arrival of an uninvited solicitor is not. In an EPC diagram, events are depicted as circles with noun names. Figure 1 shows examples of some events.

2. **Process** is defined as **an activity or a series of activities performed by customer or between customer and server organization over time, often as a response to the triggering event(s).** Here, **"over time"** suggests some recognizable time duration in contrast to the "very short time" for events. Activities performed solely by the server organization without customer involvement are not treated as a process, thus not shown on the EPC diagram. Time for such activities is simply treated as delay in service from the customer's perspective as to be discussed later. Within an EPC diagram, processes are represented by rectangles with names in (verb + noun) form. Figure 2 illustrates some EPC process examples.

3. **Branching is conditional splitting of a event-process flow into multiple sub-flows, based on the value(s) of certain status variable(s).** It is not a required construct since the same information may be represented by qualifying event

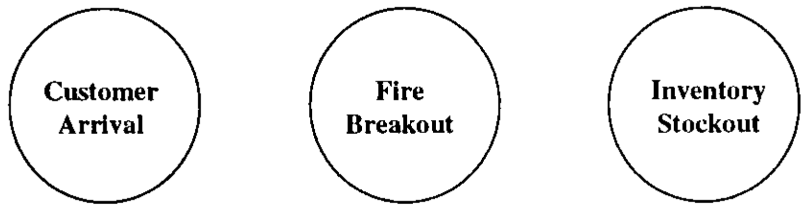

Figure 1. Examples of EPC Events

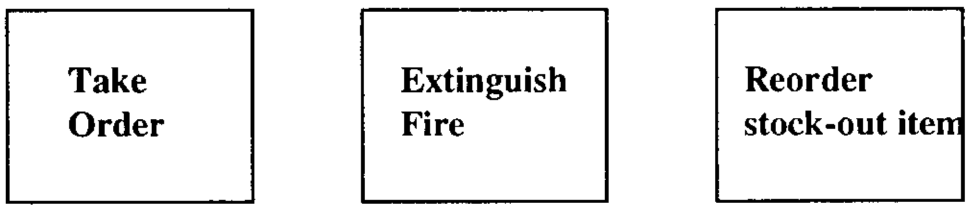

Figure 2. Examples of EPC Processes

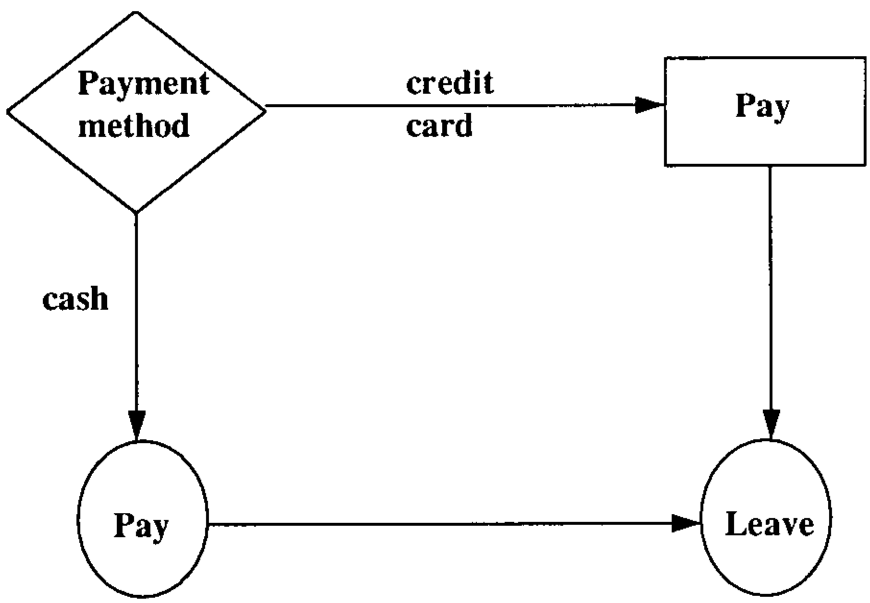

Figure 3. Example of EPC Branching

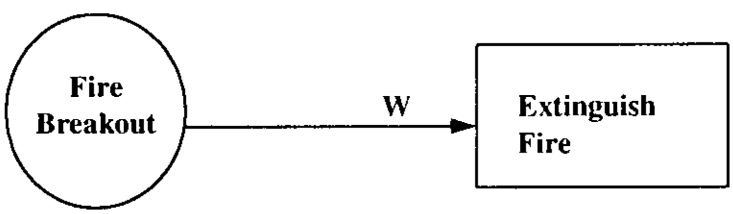

Figure 4. Example of EPC Wait

or process names appropriately. Branching, however, is a strongly recommended construct for EPC modeling since it makes the EPC diagram more readable and easier to understand. In an EPC diagram, branching is represented by a diamond symbol with two or more outbound flows, each with a caption. An example for EPC branching is shown in Figure 3.

4. **Wait** is the **significant average delay before start of an event or a process due to a queue or other unfavorable conditions of the server organization.** Such unfavorable conditions may include when a document sleeps on the boss's table for days to be authorized or when customers or documents have to travel too far for service. Here again, being **"significant"** depends on the time unit of the process cycle. Wait is expressed as **"W"** in an EPC diagram as in Figure 4.

4. CREATING AN EPC DIAGRAM

To understand EPC modeling in more detail and learn how to draw one with the constructs previously introduced, we will use the following scenario depicting the out-patient's hospital visit process at the fictitious "ABC" hospital. Figure 5 shows an EPC diagram corresponding to the scenario.

> At 1:30 p.m., John Smith arrives at the ABC hospital for stomach ache. He first goes to the registration desk in the lobby area to register for the doctor consultation. For this, he has to fill out a form, verify his insurance status, wait in line for a while, and pay in advance the doctor's fee. After receiving a consultation slip from the registration desk, he heads toward the internal medicine department on the second floor. It is 2 p.m. by then. Arriving at the internal medicine department's nurse station, John submits his slip to a nurse and waits for his turn. Usually, he has to wait at least an hour even with an appointment. Consultation with the doctor lasted about fifteen minutes as usual. The doctor diagnosed a food poisoning and prescribed a few medicines for John. With the prescription, John returns to the cashier's desk in the lobby area to pay for the prescription. Now, he goes down to the hospital's pharmacy in the basement and submits his "paid" prescription to the receptionist there. After waiting for another half an hour, he receives his medicine. As he leaves the hospital, John realizes it is already 4 p.m., too late to return to work. John wonders if anything can be done to this miserably slow process

From Figure 5, we can identify two major features of the EPC modeling: **customer orientation** and **abstraction**. First, customer orientation is evident in that every event and process in an EPC diagram involves the customer of the process. Here the customer does not necessarily have to be a person. It can be a document, phone-call, or a physical object to be processed by the server organization. What the server organization does independent of the customer is completely hidden from the diagram in the form of **"wait."**

Second, abstraction is key to the EPC diagram's simplicity. There are two types of abstraction in EPC modeling: process and wait. For process abstraction, as in DFDs, small processing steps and waits between or prior to them are aggregated into a larger process, to be decomposed later if necessary. This prevents an EPC diagram from being overly cluttered, thus making it very readable. In Figure 5, for instance, if more needs to be known about the process P1 (registration), it can be exploded into a lower-level EPC diagram with subprocesses like form filling, insurance verification, advance paying, and any intervening waits.

Abstraction on wait is related to the customer orientation we just discussed. The nature of each wait is revealed (in the form of a lower level EPC diagram) only when it is unacceptable to the customer. For instance, in Figure 5, if W2 (thirty minute wait at the pharmacy) is unacceptable to the customer, W2 is exploded into a lower level EPC diagram (Figure 6) where the patient's medicine request becomes the pseudo-customer (object representing the customer which needs to be serviced), process cycle time is thirty minutes, and all the events, processes, and waits inside the pharmacy are modeled.

Then, solutions are sought that will reduce the cycle time of thirty minutes, which in turn will contribute to reducing the overall cycle time of 2.5 hours at the top.

5. EPC AND OTHER PROCESS MODELING METHODS FOR BPR

EPC diagrams are well-suited to support BPR projects. They represent the organization's critical business processes over geographical (place) and dynamic (time) dimensions exclusively from the customer's perspective. Through the elegant abstraction mechanisms and a small number of modeling constructs, EPC diagrams are easy to read and understand for end-users and management as well as for IT professionals. Table 2 analyzes the six process modeling methods for BPR in terms of process nature, modeling orientation, abstraction mechanism, place dimension, time dimension, and modeling constructs.

Here, in addition to EPC and DFD modeling methods, Wang's Process Flow Diagram (Wang 1992), Texas Instrument's Process Chain (Texas Instruments 1993), Andersen's Process Map (Andersen 1993), and DEMO(Dynamic Essential Modeling of Organization)'s ABC Diagram (Dietz 1994) formalisms were included. From Table 2, we can observe that EPC is the only modeling formalism that reinforces BPR's cross-functional, customer orientation while preserving the modeling power (can

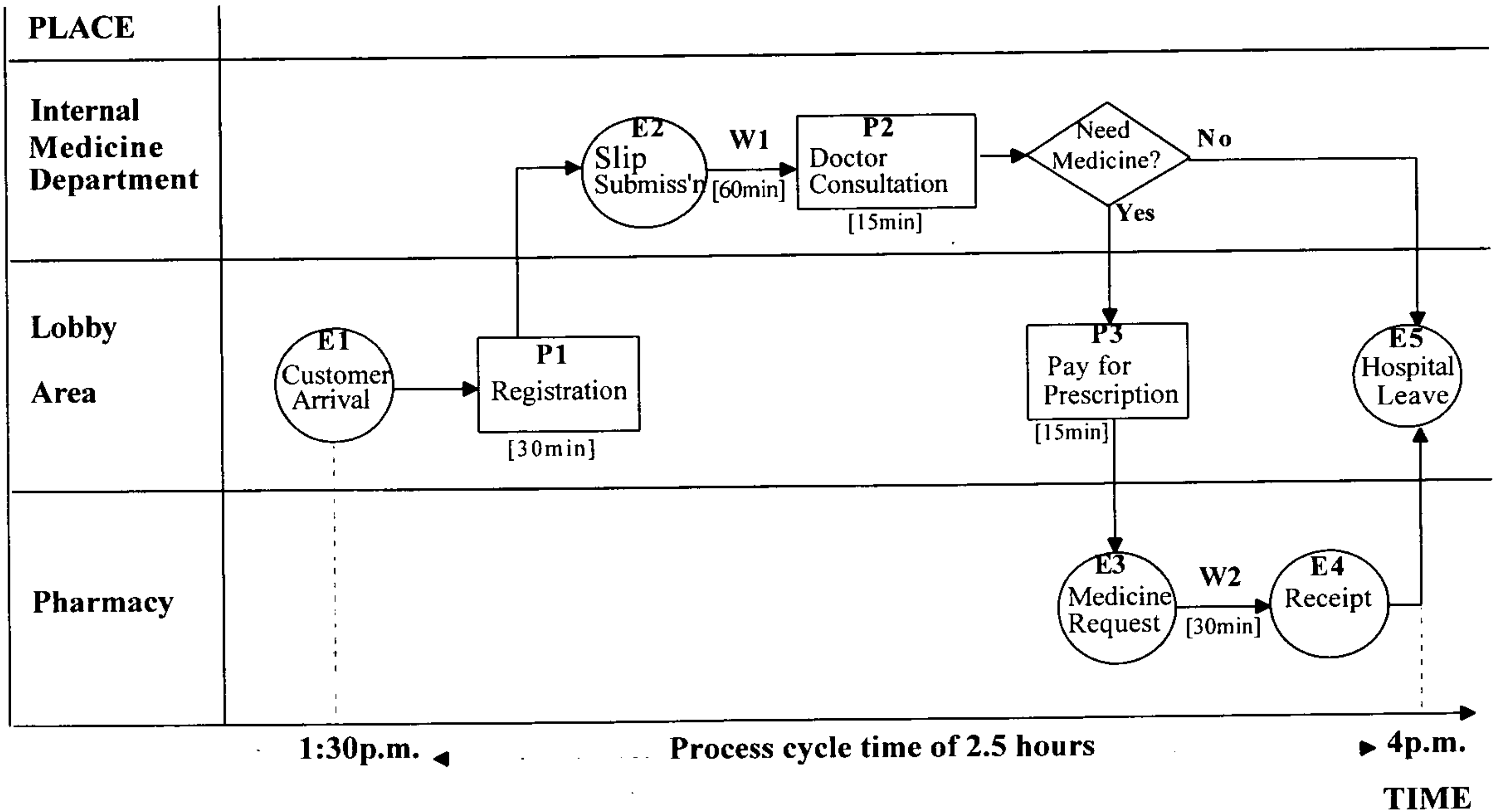

Figure 5. EPC Diagram for the ABC Hospital's Outpatient Visit Process

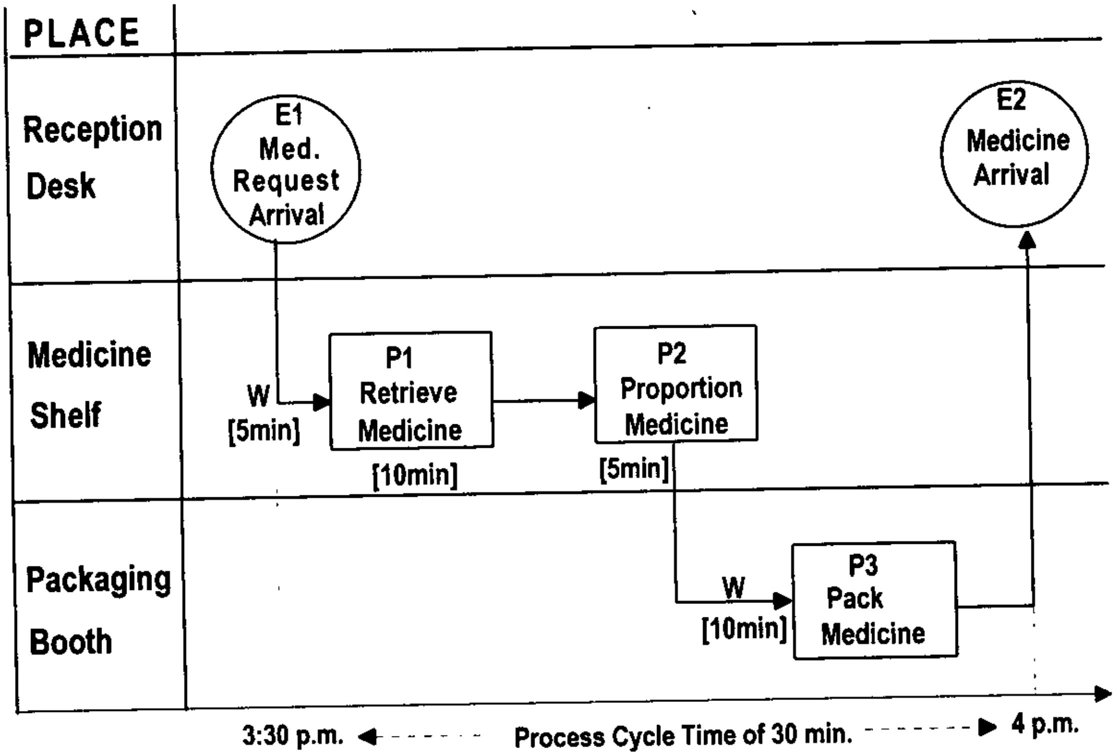

Figure 6. EPC Diagram Exploded from W2 in Figure 5

express time and place, event/process distinction) and elegance (support explosion of process and wait) of such universal modeling formalisms as Entity-Relationship (ER) and Data Flow Diagram (DFD). Wang's Process Flow Diagram and Andersen's Process Map lack the abstraction mechanism for model explosion and mix the customer and server orientation in the same process model. Texas Instrument's Process Chain does not support the customer orientation and its two modeling constructs fail to provide as much semantics as provided by other methods. DEMO's ABC Diagram is, like DFD, not cross-functional and its six modeling constructs provide rich but hard to understand semantics. DFD seems to be the least appropriate BPR process model due to its functional, server-oriented process nature without considering the place and time dimensions.

6. PRINCIPLES FOR REDESIGNING E-P CHAINS

While identifying the process bottlenecks was straightforward for the EPC diagram in Figure 5, in most of the real world EPC diagrams, it is not. Real world EPC diagrams are much bigger and more complex than the one in Figure 5 and, within each EPC diagram, there are often multiple E-P chains (or routes). The following principles will facilitate your redesign process of E-P chains greatly.

P1. Start with the Most Critical E-P Chain

Within each EPC diagram are usually more than one E-P chain due to the existence of the branching construct. In Figure 5, there were two E-P chains: one for the patients who need medicine and one for those who do not. When there is more than one E-P chain, always start the process redesign with the most critical one and continue with the rest while resources are available. The E-P chain which carries the most traffic becomes the most critical E-P chain and will be redesigned first. This will be beneficial for two reasons. First, when resources for redesign are limited, improving the most critical process first maximizes the resource utilization. Second, when the most critical E-P chain is successfully redesigned, it frequently opens up solutions for the other chains or eliminates the need for redesigning the others. In Figure 5, since most patients need medicine, the longer E-P chain becomes the more critical chain and will be redesigned first. When it is redesigned, the shorter one does not need any redesign of itself since all its waits and processes are completely overlapped with those of the longer chain.

Table 2. Analysis of Process Modeling Methods for BPR

	EPC	DFD	Wang - PFD	TI - P. Chain	Andersen - P. Map	DEMO - ABCD
Process nature	Cross-functional	Functional	Cross-functional	Cross-functional	Cross-functional	Functional
Modeling orientation	Customer-oriented	Server-oriented	Mixed	Server-oriented	Mixed	Mixed
Abstract'n mechanism	Explosion	Explosion	None	Explosion	None	Explosion
Place dimension	Yes	No	No	No	Yes	No
Time dimension	Yes	No	Yes	Yes	Yes	No
Modeling constructs	Event Process Branching Wait	Data flow Process Data store Ext. Entity	Operation Delay Transport'n Storage Inspection Decision	Process Flow	Process Decision	Actor Transac'n Ext. Bank g-link e-link I-link

P2. Reduce the Number of Processes

Since processes usually take up a considerably longer duration than events and the higher number of processes tends to create the higher number of waits, whenever possible, eliminate the unnecessary processes. In Figure 5, process P3 for prescription payment can easily be eliminated by allowing the patient to use credit-card and automatic fund transfer option during registration.

P3. Transform the Processes into Events

When a process cannot be eliminated, the next best solution to reduce the cycle time is to make it an event. This is where EPC's distinction between event and process becomes its strength since this is usually the best opportunity to introduce information technology as a solution. In Figure 5, the registration process P1 can turn into an event by issuing each patient a smart card with all the personal health history and bank account information. As soon as the patient enters the hospital, he will slide his smart card through the registration machine and head directly to the doctor's office. By the time he arrives at the doctor's office, he is already registered, all his expenses that day will be handled through his bank account, and the doctor's office is already aware of his arrival thanks to the electronic notice from the registration machine. He does not have to carry and submit the consultation slip any more. So, the event E2 is gone.

P4 Minimize the Travel Distance

When your E-P chain moves up and down many times during one process run, it is a red flag. Either your facility or process is ill-designed. Think of a new process design so that your service may come to your customer instead of having your customer chase your service.

P5. Make Processes/Events Parallel

Whenever possible, make your processes and/or events run parallel. In Figure 5, with the smart card use, process P1(registration) and P3(prescription payment) can be done simultaneously while the event E3 (medicine request) can be done by the doctor during his consultation with the patient.

P6. Reduce Wait Before Process but Eliminate Wait Before Event

Not all wait should be treated equally in EPC. Wait before an event is a more serious problem than the same amount of wait before a process. Think of baseball fans. They will wait in line comfortably to watch the baseball game (process), but, when the game is over, nobody likes to wait to exit the stadium (event). In Figure 5, patients would tolerate some wait before seeing a doctor but they will hate to wait just to receive the medicine. So,

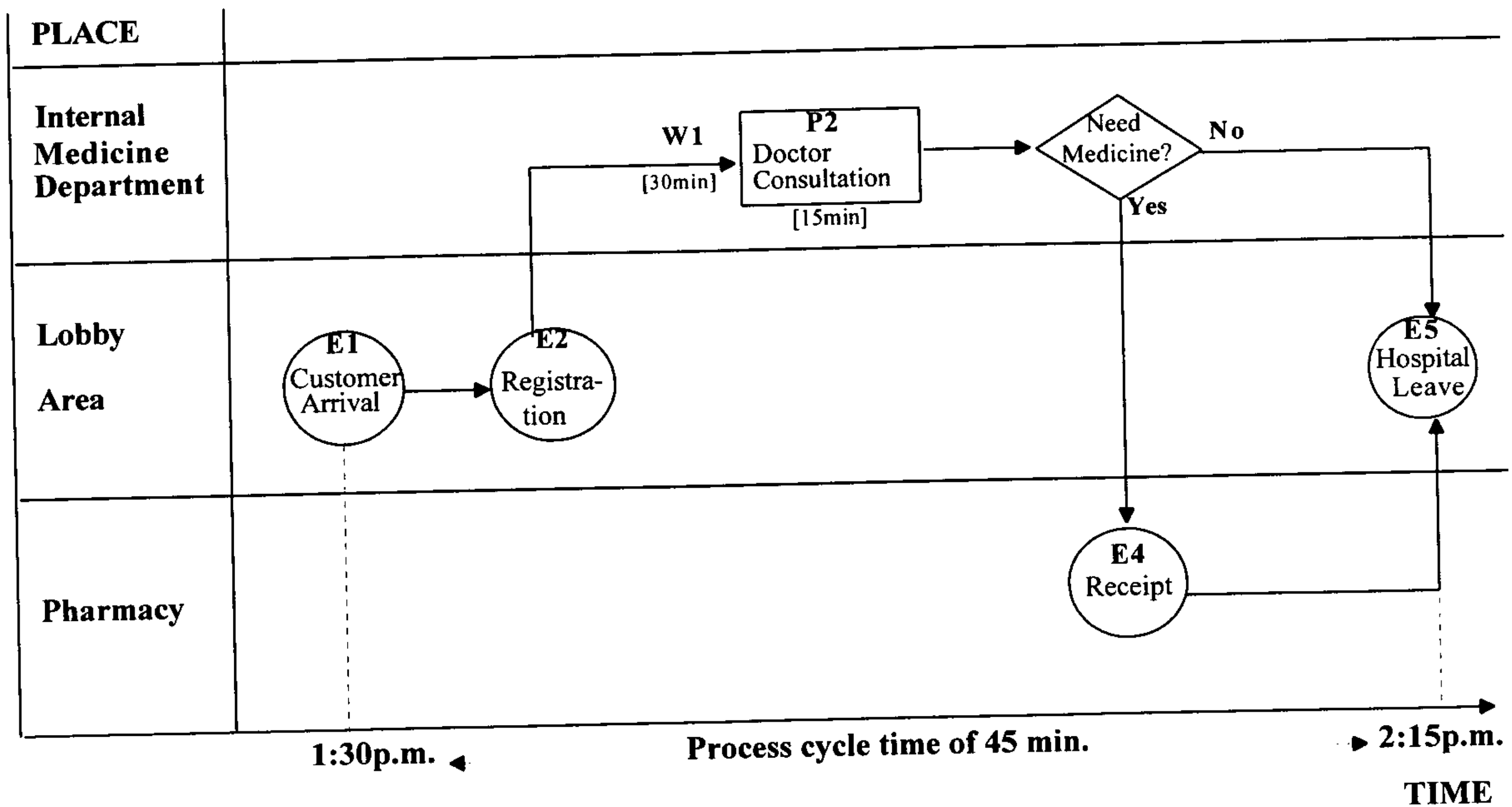

Figure 7. ABC Hospital's Outpatient Visit Process after BPR

by adding more doctors and improving the appointment schedule, the ABC hospital reduced W1 by half an hour. For W2, since the medicine request is transmitted electronically to the pharmacy during the patient's consultation with the doctor and they automated most of the activities inside the pharmacy, there is no wait any more. By the time the patient arrives at the pharmacy, his medicine is already waiting for him. Figure 7 shows how the ABC hospital's outpatient visit process has changed after BPR.

7. USING EPC MODELING FOR BPR: STEP BY STEP GUIDELINE

Modeling the critical business processes, which often cut across multiple departmental boundaries and involve various people with diverse roles and expectations, is not a trivial task. Just knowing the names and definitions of EPC modeling constructs would not help much. To use EPC modeling for a successful BPR project, availability of a step-by-step guideline is crucial. Following are the six steps that will guide you through an organized and economical way of modeling your organization's major business processes.

S1. From firm's CSFs, identify candidate business processes

→ Always start with the critical success factors (CSF) of your organization. If CSFs, those small number of management factors that should be absolutely well-managed for your company's success, are not known yet, identify them first before chasing after processes. From those CSFs, derive the candidate business processes which is responsible for creating, affecting, or monitoring those CSFs.

S2. Develop an EPC diagram for each candidate process

→ As described earlier, EPC modeling is completely customer-oriented. When creating an EPC diagram for the candidate process, show only the events and processes where customers are directly involved. Everything else is treated as wait.

S3. Measure process customer satisfaction

→ Collect data on the level of customer satisfaction for each candidate process. For processes with low customer satisfaction, find out why.

S4. Measure process cycle time

→ You can compute the process cycle time for each possible route along the EPC diagram by adding up all the process and wait durations.

S5. Determine the critical processes by benchmarking

→ By comparing the results from the prior two steps (S3 and S4) against those of your competitors or your own process goals, identify the critical processes to be redesigned.

S6. Redesign the critical processes

→ Apply the EPC-redesign principles to the critical processes recursively from the process server's perspective. By transforming the customer's wait into the server's new process, trace down and eliminate the source of process delay.

8. APPLICATION OF EPC MODELING TO REAL-WORLD BPR PROJECTS

EPC modeling has been applied to three real BPR projects in Korea so far. The first project was done at the Korea Advanced Institute of Science and Technology (KAIST). Nine three-person teams analyzed and redesigned the processes of the institution which, over the past 25 years, has never experienced such a radical change before. Fourteen administration officials also participated as partners to the analyst teams. Using EPC diagrams and Texas Instruments' integrated CASE tool, IEF, the nine teams of analysts were able to finish 100% of the process redesign and 70% of the IS application designs within 3.5 months. Appendices A and B show the EPC diagrams for Vacation Management process before and after BPR.

The second BPR project was performed at one of Korea's top three advertising agencies. The company used to be a leading agency in Korea in terms of sales volume and ad quality. Now it is losing many of its talented employees and has started a major management innovation initiative. BPR was part of such an] innovation effort. Nine MIS people and seven advertising employees participated in the effort for six months including the time for EPC and data modeling education. With all the major processes successfully redesigned with EPC and the enterprise data model established, the project is entering the IS implementation phase. Appendices C and D show EPC diagrams for the weekly Billing Forecasting process before and after BPR.

Finally, the third BPR project is currently being conducted at a large dairy product company. It has more than 1,000 distributor chains all over the country. The company started major MIS activities only three years ago and is still in the process of completing its host-based IS application development. BPR is being executed not to support the current IS environment but to provide a vision for the twenty-first century company operations and the flexible IT infrastructure to support them. The project is still validating the various redesign alternatives for the company's critical business processes. Appendices E and F show EPC diagrams for Receive Order process before and after BPR.

In all three projects introduced, EPC diagrams were used as the process modeling vehicle. It was perceived by all the participants to be extremely easy to understand and learn. Many non-IS business managers were willing and able to draw the EPC diagrams for their processes and the presidents of all three organizations personally participated in sessions verifying the EPCs produced. The only limitation of the EPC modeling was that it did not yet have its own automated tool environment.

9. FUTURE DIRECTIONS FOR EPC MODELING

Now that EPC modeling has been applied successfully to real world BPR projects, we can think of future directions for its further development. First, we plan to develop an automated tool environment for EPC either as a stand-alone process modeling tool or as a component of an integrated CASE toolset. Second, to try out the proposed new process design before committing sizable organizational resources, we are currently extending the EPC modeling to include various performance and resource related parameters which may in turn be testable through an animated simulation using commercially available simulation tools. Finally, efforts are being given to integrate EPC modeling with the traditional ER data modeling and DFD methods as well as with the new object-oriented modeling paradigm.

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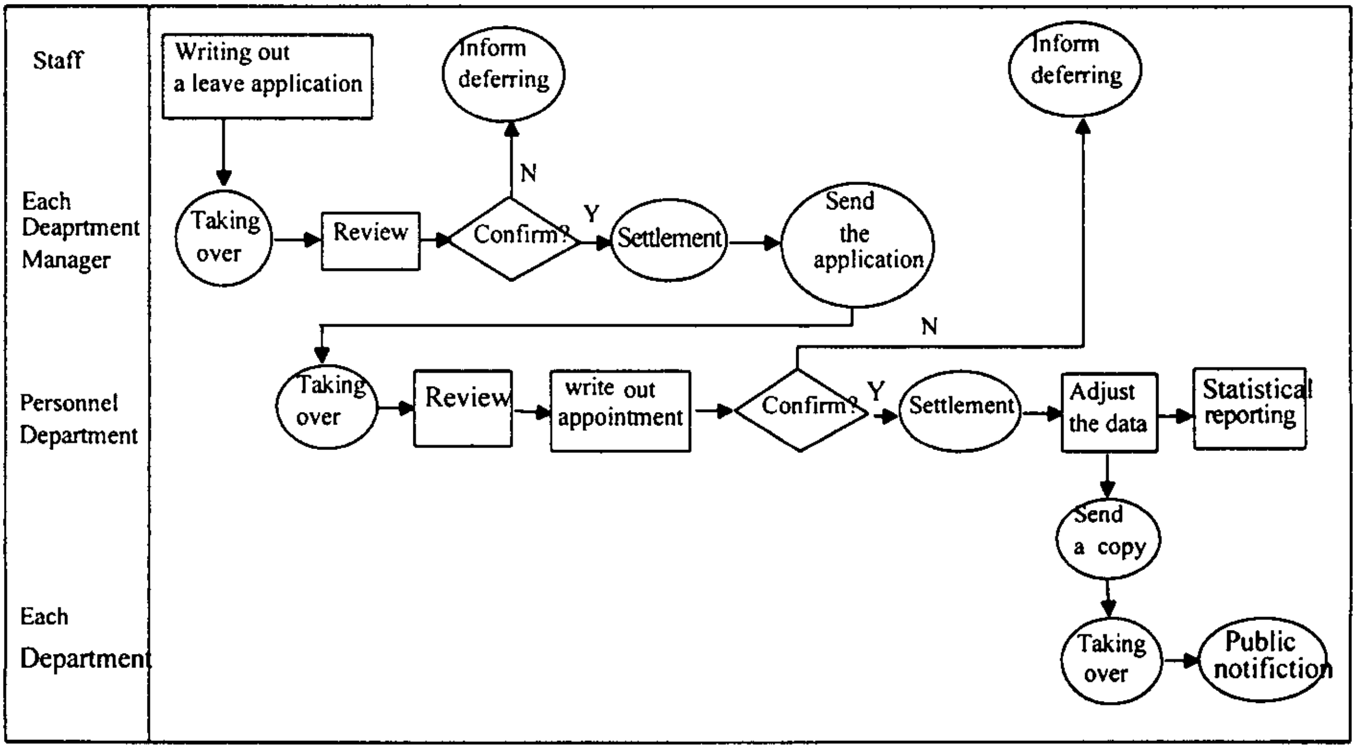
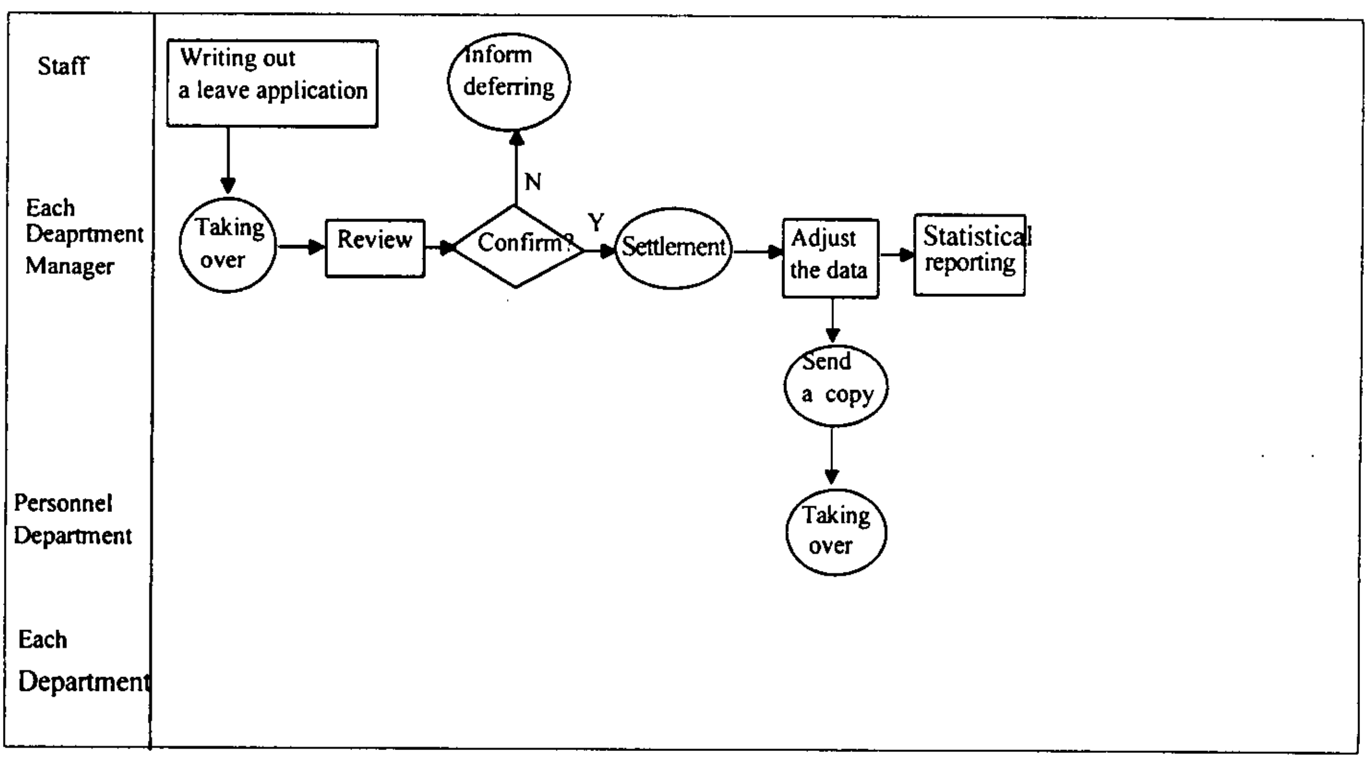
Appendix A. EPC for Vacation Management Process before BPR

Cycle time = 24 hours

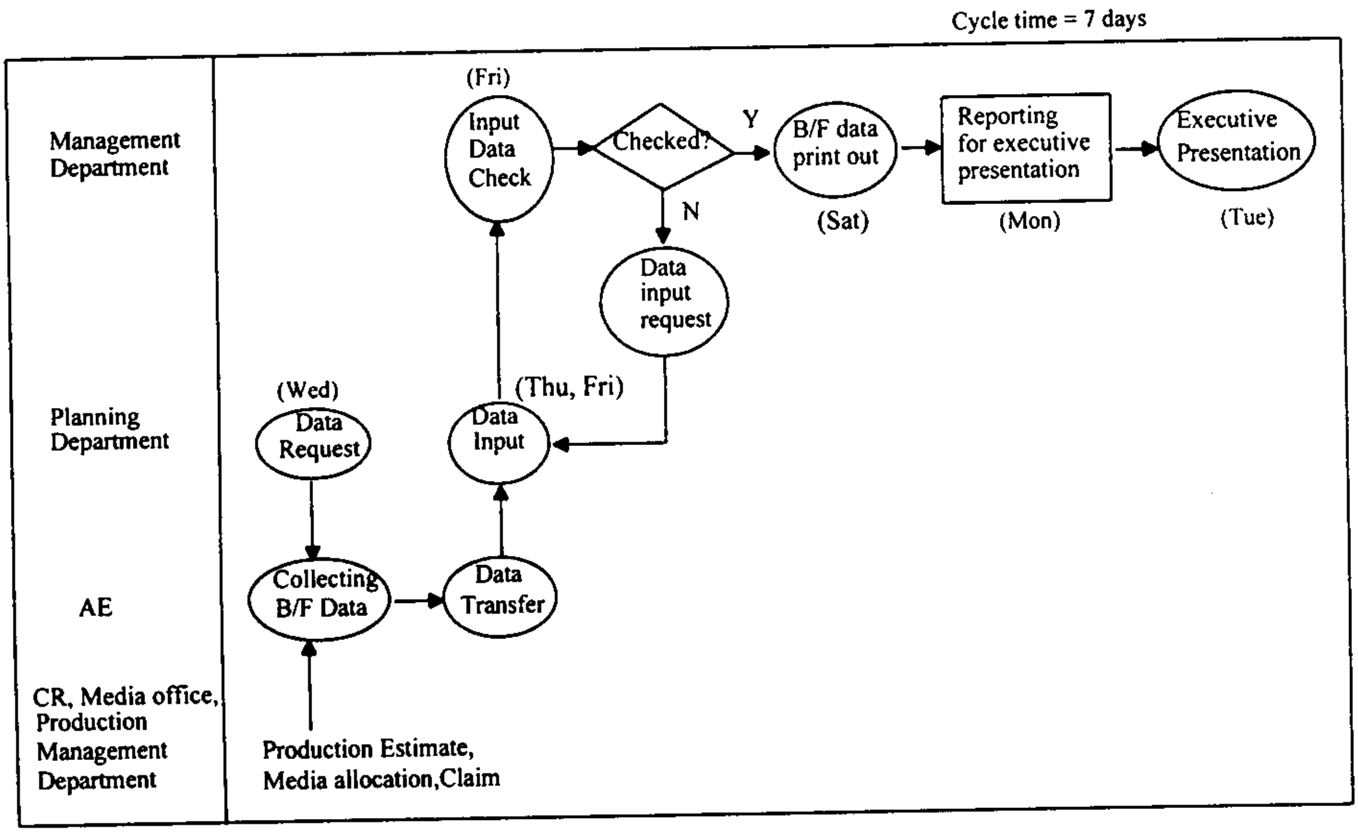


Appendix B. Vacation Management Process after BPR

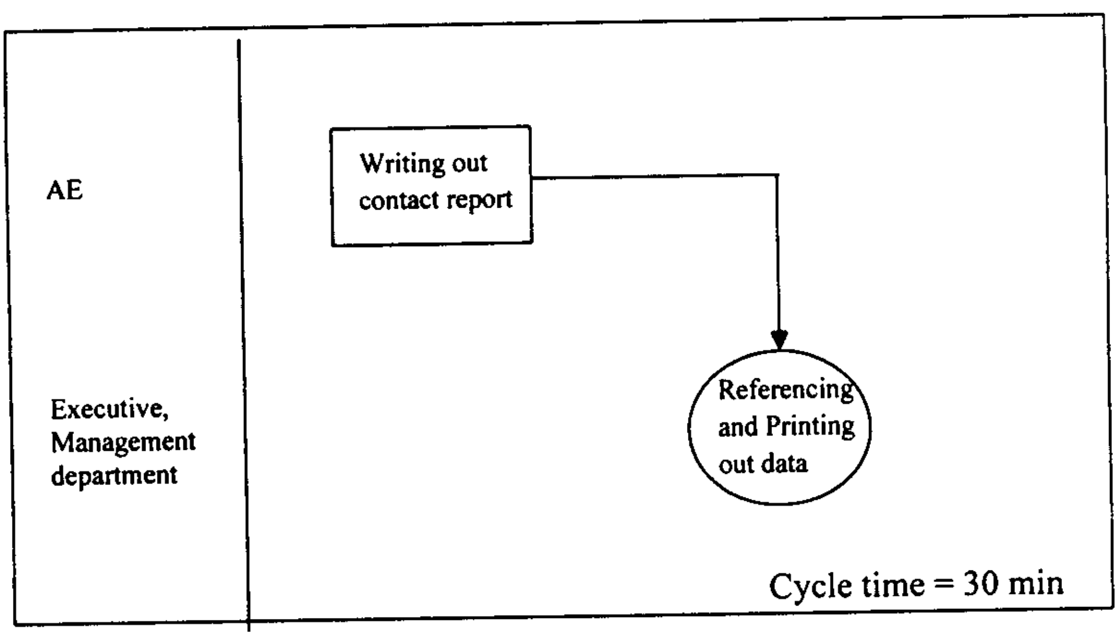
Cycle time = 1 hour



Appendix C. EPC for Billing Forecasting Process before BPR

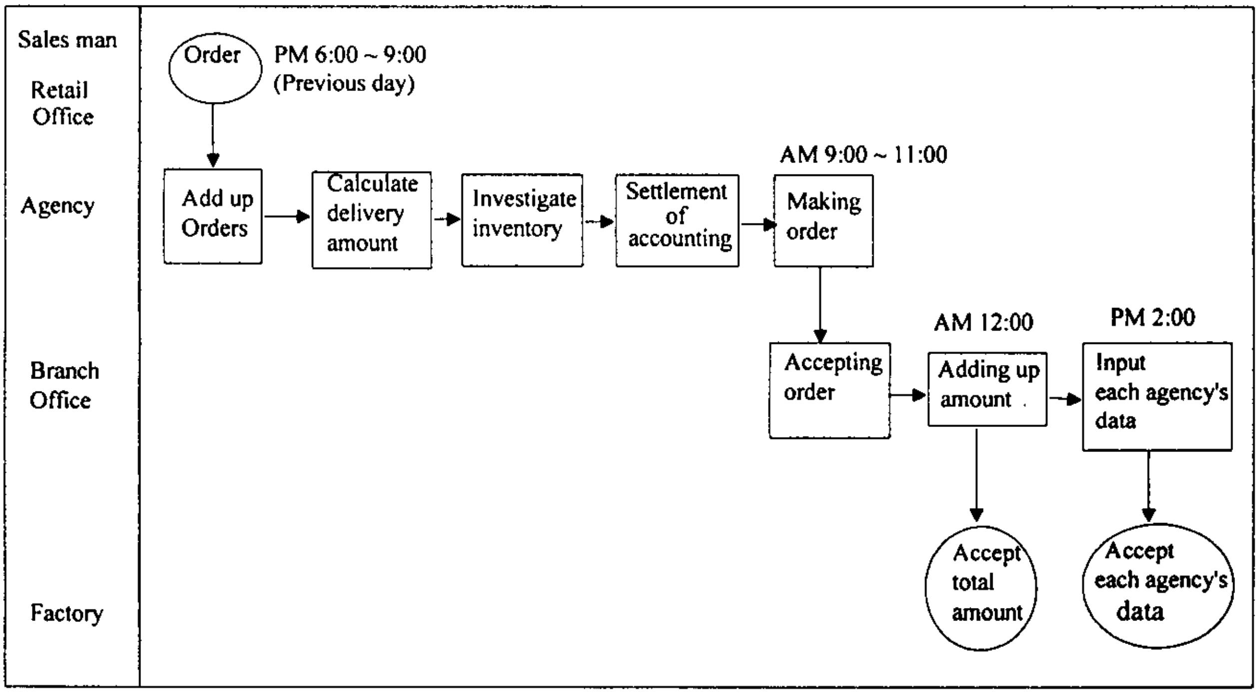


Appendix D. EPC for Billing Forecasting Process after BPR



Appendix E. EPC for Receive Order Process before BPR

Cycle time = 20 hours



Appendix F. EPC for Receive Order Process after BPR

Cycle time = 3 hours 30 minutes