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E-commerce transaction modeling formalisms

Formalismos de modelado de transacciones en comercio electrónico

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Abstract

This article presents the modeling of the *purchase-sale transaction* (pst) in *electronic commerce* (e-commerce) using different formalisms. *E-commerce* is an area of interest that is gaining rapid momentum in recent times because of the pandemic. In this work, the *pst* is a basic scheme that particularly excludes the participation of the intermediary that manages the reception and/or transfer of money. With the above, it is intended to minimize the number of actors involved in the *pst* to make relevant the contrast of the power representation of different formalisms to facilitate the analysis and make improvements. Firstly, *conceptual maps* are among formalisms that facilitates the exposition of complex processes. A next formalism is the *coverage tree* which allows to follow the flow of the *pst* in a clear way. The *pst* can be abstracted into a mathematical expression, however, it loses the power of visual scheme. The *pseudocode* is a way of representing computational processes that, in this case, allows modeling the *pst* also. Flowcharts are a tool associated with the development of programs that allow visually displaying the events of the *pst*.

E-commerce, ICT, Modeling

Resumen

Este artículo presenta el modelado de la *transacción de compra-venta* (tcv) en el comercio electrónico utilizando diferentes formalismos. El comercio electrónico es un área de interés que cobra un acelerado impulso en últimas fechas. La *tcv* mencionada es un esquema básico que particularmente excluye la participación del intermediario que gestiona la recepción y/o transferencia de dinero. Con lo anterior se pretende minimizar el número de actores involucrados en la *tcv* con el fin de hacer relevante el contraste del poder de representación de diferentes formalismos para facilitar su análisis y hacer mejoras. Los *mapas conceptuales* se encuentran entre las formas formales que facilitan la exposición de procesos complejos. Un siguiente formalismo es el *árbol de cobertura* el cual permite seguir el flujo de la *tcv* de forma clara**.** La *tcv* puede abstraerse en una *expresión matemática***,** sin embargo, pierde el poder de exhibición visual. El *pseudo código* es una forma de representar procesos computacionales que, en el caso particular**,** permite modelar la *tcv*. Los diagramas de flujo son una herramienta asociada al desarrollo de programas que permiten mostrar visualmente los eventos de la *tcv*.

Comercio electrónico, TIC, Modelado

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Introduction

In recent times, there has been an accelerated impulse in the use of *information and communication technologies* (ICT) (Raissi & Matoussi, 2019) . *ICT*s are being used massively in areas that range from daily to professional (Mishna, y otros, 2021). To give some examples, it can mention social relations (Chernova, Skvortsova, Loginova, Sariev, & Polshinskaya, 2019), *e-business* (Kosaka, Wu, Xing, & Zhang, 2021), learning and teaching (Kiliçkaya, 2018), marketing (Ahmad, 2021), political advertisement (Franklin Fowler, Franz, Martin, Zachary, & Ridout, 2020), administration (Galazka, Beynon, & Edwards, 2018), distance work (Cetrulo, Guarascio, & Virgillito, 2020), games and recreation (Wibawa, Rochimah, & Anggoro, 2019), news (Vosoughi, Roy, & Aral, 2018), among others.

In the context of *e-business*, *e-commerce* is considered a fundamental area of study to explain the economic development of contemporary society (Li, Du, Zhang, & Mao, 2018). There are various studies in relation to *e-commerce* such as: production optimization (Maciulyte-Sniukiene & Butkus, 2020), market research (Busca & Bertrandias, 2020), logistics resources (Li, Shen, & Huang, 2019), social marketing (Jung, Seungjun, & Kim, 2020), digital security (Raju & Vivekanandam, 2019), remote communication (Mero (Järvinen), 2018), and quality of service (Dhingra, Gupta, & Bhatt, 2020).

In *e-commerce*, *electronic transactions* are the most critical condition in the *buying-selling process* (Cardoso & Martínez, 2019). Mechanisms for resolving commercial disputes (Onyema, 2019) are studied in order to be refined and/or generalized at the international (Fentiman, 2018) level. Of course, digital security and relevant legislative development (Grazia, 2018) are heavily involved here.

There are some reviews about *electronic transactions* in *e-commerce* (González Castolo, Ramos Cabral, Zataraín Durán, & Hernández, 2021) (Stephen , Mazey, Baglione, & Storholm, 2019). These reviews take into account *providers* (Luk, Choy, & Lam, 2018), *consumers* (Trivedi & Sama, 2020), laws (Barkatullah & Djumadi , 2018), financial logistics (Ilin, Kalinina, & Barykin, 2018), and/or taxes (Argilés-Bosch, Somoza, Ravenda, & García-Blandón, 2020).

In this paper, the *electronic transaction* process is shown with formal tools in order to contrast them. In this work, the *pst* is modeled with a *conceptual map*, *pseudocode*, *coverture graph*, and *flowcharts*. Moreover, this procedure could be applied to more complex systems without any problem.

This article is organized as follows. The incoming section presents the glossary of definitions. Next, the *pst* is modeled with many formalisms such as *conceptual map*, *pseudocode*, *coverture graph*, and *flowcharts*. Finally, the conclusions are given.

Definition glossary

Greed state (Gs): the emotional level at which a consumer (Cmer) is willing to buy a product.

Product (P): a service and/or object that is offered in the market.

Purchase-sale transaction (pst): Process to pay with money and receive a P in return.

Consumer (Cmer): the entity that acquires a *P* through a pst.

Entity: the organization or individual.

Provider (Pder): the entity that offers its *P* looking for a pst for said *P*.

In the context of e-Commerce, the Cmer and Pder are online consumer and provider, respectively. They are called as econsumer (eCmer) and eprovider (ePder).

Direct pst: ePder receives the payment for a product from eCmer directly.

Indirect pst: the payment is made with an intermediary.

Hybrid pst: the payment could be received directly and/or indirectly.

$\wedge$: It is and operator, and is used to represent event parallel execution.

$\vee$: It is or operator, and is used to represent optional events.

Δ: It is strong operator, and is used to finish events before the next events.

Direct *pst* modeling whit conceptual maps

The *direct pst* has four basic blocks that are interrelated as shown in Figure 1. The blocks are related to actions or events were performed and/or occur in them. Each block represents an actor in *pst*. All blocks are considered animated actors because communication is present among them. The protagonist actors, *ePder* and *eCmer*, have indirect communication.

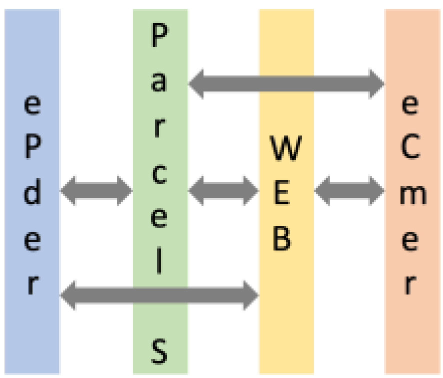

Figure 1 Actors in direct pst
Own source

The *direct pst* is shown in Figure 2. Table 1 has its description. Conceptual maps are practical tools because they are expressive to visualize complex process. The rendering power of conceptual maps is limited because *loops* have imprecise description, and the *pst* flow gets confused without its description.

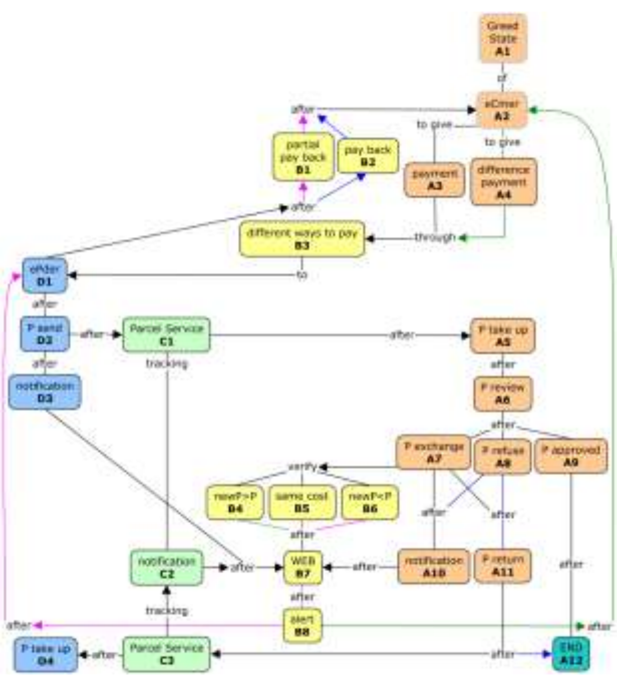

Figure 2 Conceptual map of direct pst cycle
Own source

node	Description
A1	The eCmer has a Gs
A2	eCmer is ready to continue or finish the pst
A3	eCmer is going to pay to ePder
B3	The payment could be made in different electronic ways
D1	After ePder received the money and/or P return, ePder has taken steps to serve eCmer
D2	Logistics to send P to eCmer in a parcel service
D3	The ePder notifies through WEB portal that P was sent
B7	WEB register
C1	Parcel service transit
C2	Tracking P also involves when it is received …B7, A5…
A5	The eCmer receives P
A6	eCmer reviews P and takes a decision: exchange, reject or approved
A9	eCmer is satisfied with P ○ Indirect elements notify ePder that eCmer is satisfied with P but, are not mentioned here
A12	The pst is finished (END)
A8	P refuse
A10	Notifies to ePder that eCmer has refused P or wants to change P …B7, B8…
B8	The alert is activated after registering on the WEB the refuse of P or the change of P
A11	Logistics to send P to ePder in a parcel service
C3	Parcel service transit …C2, B7, D4…
D4	The ePder receives P …D1, B2…
B2	ePder returns the payment to eCmer and the pst is finished …A2, A12
A7	eCmer wants to change P and one of three cases are presented (B4, B5, B6)
B4	Price of the new selected P is higher ○ B7, B8: Notifies eCmer that it is necessary to cover a price difference ○ A2: eCmer is ready to continue the pst ...A4…
A4	eCmer is going to pay the difference to ePder ○ B3: The payment is through different electronic ways ○ D4: eCmer returns P to ePder ○ D1: After ePder received the money and P, ePder has taken steps to attend eCmer and the pst cycle continue …D2…
B5	Price P is the same as the new selected P ○ B7, B8: Notifies ePder that the money is OK ○ D4: eCmer returns P to ePder ○ D1: After ePder received P, ePder has taken steps to attend eCmer and the pst cycle continue …D2…
B6	Price of the new selected P is lower ○ B7, B8: Notifies ePder that the price of the new selected P is lower ○ D4: eCmer returns P to ePder ○ D1: After ePder received P, it has taken steps to attend eCmer and the pst cycle continue …D2
B1	ePder returns the partial payment to eCmer ○ This is a parallel and asynchrony event, and it is necessary to end pst …A2…

Table 1. Description of *e-Commerce* transaction
Own Source

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In Table 1, bullet points describe nodes that continue from the node that is described here. *Successive dots* as a prefix to a label node mean that the cycle transaction continues to it. If the successive dots are a suffix a node, then the cycle transaction continues from it.

Direct *pst* modeling whit coverture graph

Figure 3 shows the *tree coverture* of *direct pst*, and this was obtained from the *conceptual map* of *direct pst*. Green nodes are the end of the branch. Nodes with *successive dots* mean that the *direct pst* circle continues.

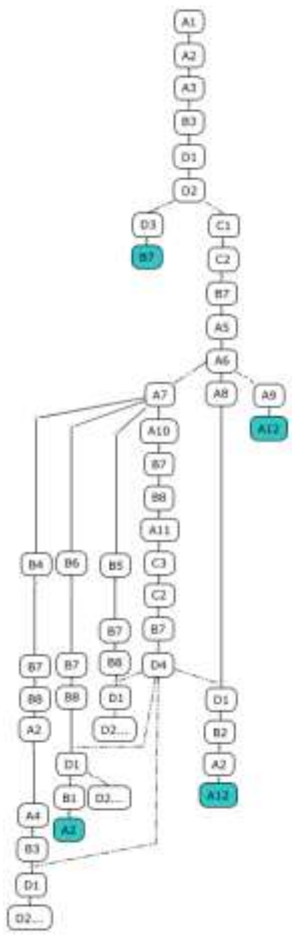

Figure 3 Coverage graph of direct pst
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Figure 3 describes the *direct pst* flow that cannot be represented with conceptual maps, Figure 2. *Loops* have an indirect representation. However, the *coverture graph* cannot distinguish among sequential or parallel event.

Direct *pst* modeling whit a math expression

The following expressions represent the *pst_loop* equation that is abstracted from the *tree coverture* of *direct pst*.

$$pst\_loop = A1, A2, A3, B3, D1, D2 \ldots \quad (1)$$

Equation (1) is interpreted as: event *A1* occurred before *A2*. Event *A2* occurred before *A3* and so on. Three ellipses indicate that other events continue.

$$\ldots D2, ((D3 \ldots) \wedge (C1 \ldots)) \quad (2)$$

Likewise, in equation (2), events *D3* and *C1* continue from *D2*. Also, they are executed in parallel (2) as shown in Figure 2, but could be done sequentially (2a).

$$\ldots D2, D3, B7, C1 \ldots \quad (2a)$$

Equations (2) and (2a) have no real difference in practice because *D3* and *B7* are fast events. After that, the following events shown in equations (3) and (4) going to occur.

$$\ldots C1, C2, B7, A5, A6 \ldots \quad (3)$$

$$\ldots A6, ((A7 \ldots) \vee (A8 \ldots) \vee (A9 \ldots)) \quad (4)$$

Equation (4) implies that events *A7*, *A8*, or *A9* can occur. After the *A9* events occur then equation (5) is obtained.

$$\ldots A9, A12 \quad (5)$$

Event *A12* is the final node. On the other hand, after the *A8* event occurs, then equation (6) is given.

$$(\ldots A8\ \Delta D4), D1, B2, A2, A12 \quad (6)$$

The event *D1* will take place after *A8* and *D4* have finished. Next,

$$\ldots A7, ((B4 \ldots) \vee (B5 \ldots) \vee (B6 \ldots)) \wedge (A10 \ldots) \quad (7)$$

$$\ldots A10, B7, B8, A11 \ldots \quad (8)$$

Equation (8) could be expressed with parallel events as indicated in equation (9); this is similar to equation (2).

$$\ldots ((A10, B7, B8) \wedge (A11 \ldots)) \quad (9)$$

$$\ldots A11, C3, C2, B7, D4 \ldots \quad (10)$$

$$\ldots B5, B7, (B8\ \Delta D4), D1, D2 \ldots \quad (11)$$

In equation (11), the *D1* event takes place after *B8* and *D4* have finished.

$$\ldots B6, B7, (B8\ \Delta D4), D1, \left((B1, A2) \wedge D2 \ldots\right) \qquad (12)$$

Finally, the *pst_loop* equation ends with equation (13).

$$\ldots B4, B7, B8, A2, (B3\ \Delta D4), D1, D2 \ldots \qquad (13)$$

Direct *pst* modeling with *pseudocode*

A *pseudocode* of process in *direct pst* can be obtained from the conceptual maps, Figure 2.

```
input A1 //Greed State
A2 => eCmer=startTrans
i=1 //loop
do i<>0{
 if eCmer=startTrans then
  A3 //Payment
 else
  A4 //Difference payment
 end if
 B3 //different ways to pay
 j=1 //loop
 do j<>0{
  D1 //ePder
  D2 //P send
   || D3 //notification->B7 //Web
   || C1 //Parcel Service(C2 //tracking)->B7
   //Web
   A5 //take up by eCmer
   A6 //review
   input A7 V A8 V A9
   if A9=0    //P approved
    A10 //notification
    B7 //Web
    B8 //alert
    A11 //P return
    C3 //Parcel Service
    C2 //tracking
    B7 //Web
    B8 //alert
    D4 //P take up by ePder
    if A7=1 //P exchange
     //B5->out if
     if B4 //newP>P
      A2 => eCmer=adjustTrans
      j=0 //out loop
     else //B6 //newP<P
      B1 //partial pay back
     end if
    else // A8 => P refuse
     B2 //pay back
     ALL FALSE //end_if end_loop_j end_loop_i
    end if
   else //P approved
    ALL FALSE //endif end_loop_j end_loop_i
   end if
 } //j
} //i
A12 END
```

In the previous *pseudocode*, parallel events are represented with the || symbol. The *FALSE* tag means that all control variables are false. When *B5* occurs, then *j loop* continues. Note that the event *B5* is an event that is lost in the *pseudocode*.

Direct *pst* modeling with *flowcharts*

Figure 4 shows the *flowcharts* of direct *pst* where *A5*, *A6* means that *A5* occurs after *A6*.

After *B2* it is not necessary to mention *A2* because a *loop* starts from *B2*.

The parallel events are easy to identify, but due to the fast-computing process, some could be put as sequential events.

The *loops* are easy to identify. They have *i* and *j* as control variables.

After *B5* it is not necessary to mention *B7* and *B8* because the *pst* flow is well described and, they are computational events.

After *B4*, the *j* control variable is necessary for following the *pst* flow.

The *flowcharts* are more complex to interpret without prior context.

Now, reduced *pseudocode* is presented in order to show the exact representation of the original *pseudocode* with *flowcharts*.

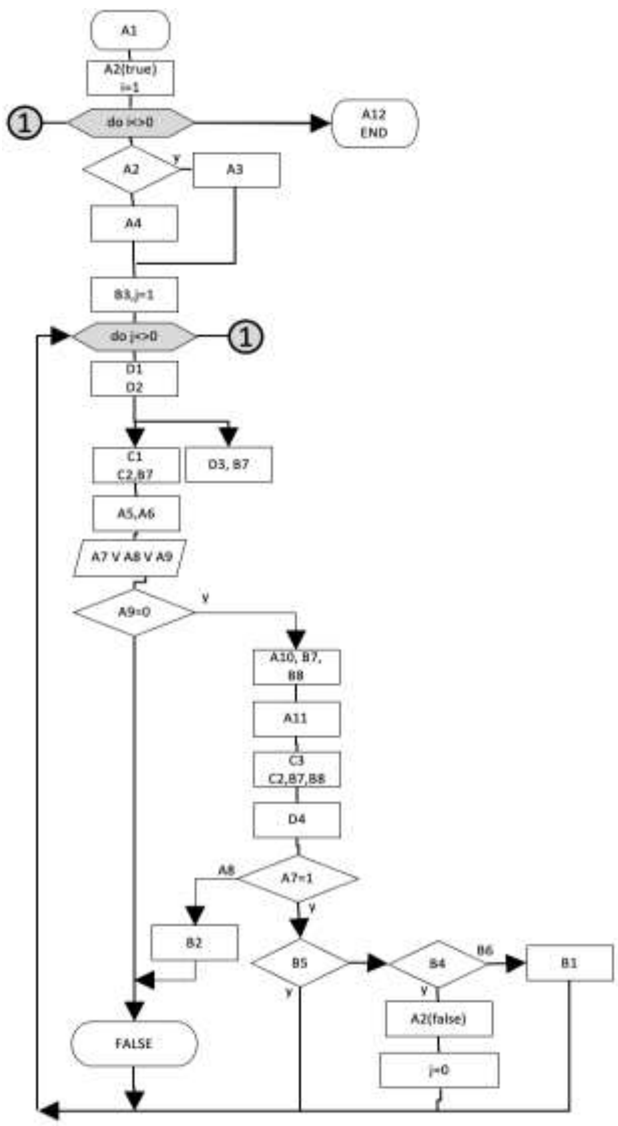

Figure 4 Flowcharts of direct pst
Own source

Direct modeling of *pst* with reduced *pseudocode*

In the following lines, reduced *pseudocode* is shown. This is called *pseudocode2* and it is a reduced representation of direct *pst* obtained from the *flowchart* in Figure 4.

```
start A1
A2=true
i true
do i <> false
 if A2 true
   A3
 else
   A4
 end if
 B3
 j=1
 do j <> 0
   D1
   D2
   ||D3,B7
   ||C1,C2,B7
   A5
   A6
   input A7 V A8 V A8
   if A9=0
     A10,B7,B8,A11,C3,C2,B7,B8,D4
     if A7=1
        //B5 same cost
       if B4=1
         A2=false
         j=0 //out_loop_j
       else //B6
         B1
       endif
     else
        B2
        all_variables=0
     endif
   else
     all_variables=0
   endif
 enddo
enddo
A12 //END
```

The *pseudocode2* is a reduced representation of *direct pst* obtained from its *flowchart* in figure 4. In this case, the symbol || represents parallel processes. The *all_variables* tag refers to the control variables as *i*, *j*.

Conclusions

This paper presented a description of the *direct pst*. The description was made using different formalisms such as *conceptual maps*, *mathematical expressions*, and computational resources (*pseudocode*, *flowcharts*). The obtained models have different advantages and limitations among them. For example, *conceptual maps* are easy tools for representing complex processes, but they are limited because they cannot show their flow without an adjunct explication. The *coverage graph* shows the *pst* but can't differentiate sequential and parallel events.

The *math expressions* are more precise to describe the *pst* but lost the visual representation and it's difficult to identify the *loops*. The *pseudocode*, as *math expressions*, is precise with the process flow but lost the visual representation. Finally, the *flowchart* is a recurse that helps to describe the *pst* with minimal elements that omit some important events.

The procedure could be applied to more complex systems without any difference. In the near future, this work will be extended to represent the coverage graph in Petri nets with the aim of optimizing the *pst*.

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