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Transaction modeling on e-Commerce

Modelado de transacciones en comercio electrónico

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Abstract

This article presents the formal representation of the sale and purchase transaction process that occurs in electronic commerce (e-Commerce). E-Commerce is an area of study that has acquired a marked interest in recent times. A direct transaction between provider and consumer is analyzed with two variants of the resulting model that follows the criteria considered from a representation of conceptual maps. The conceptual map resembles a graph, with labels of concepts associated with the nodes and labels, of connectors between concepts, associated with the arcs. The description of the process, using conceptual maps, is accompanied by a narrative of events. Conceptual maps are used because they are a resource that facilitates the presentation of complex processes and gives way to their formalization. Formalizing a process is convenient because it enables its subsequent analysis, modification, improvement, control, and/or monitoring. The previous formal representation consists of a graph and a series of equations derived from the narrative sequence of the conceptual map.

E-commerce, ICT, Modeling

Resumen

Este artículo presenta la representación formal del proceso de transacción de compraventa que ocurre en el comercio electrónico. El comercio electrónico es un área de estudio que adquiere un acentuado interés en últimas fechas. Se analiza una transacción directa entre proveedor y consumidor con dos variantes del modelo resultante que obedece a los criterios tomados en cuenta desde una presentación dada en mapas conceptuales. El mapa conceptual se asemeja a un grafo, con etiquetas de conceptos asociados a los nodos y etiquetas, de conectores entre conceptos, asociadas a los arcos. La descripción del proceso, utilizando mapas conceptuales, se acompaña de una narración de sucesos. Se utilizan los mapas conceptuales porque son un recurso que facilita la exposición de procesos complejos y da paso a su formalización. Formalizar un proceso es conveniente porque posibilita su posterior análisis, modificación, mejora, control y/o seguimiento. La representación formal aludida, consiste en un grafo y una serie de ecuaciones que se derivan de la secuencia narrativa del mapa conceptual.

Comercio electrónico, TIC, Modelado

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Introduction

In recent years, the development and use of *information and communication technologies* (ICT) have driven change in society (Coccia, 2019), economic (Makoza, 2020), and political paradigms worldwide (Klymash, Demydov, Uryvskyi, & Pyrih, 2020) (Adam, 2020). The extensive use of the *ICT* is as a highway that facilitates the massive communication breaking the barrier of distance and time (Dhamacharoen, Kumpusiri, & Waiyakarn, 2019) (Arrieta Avendaño & Ruiz Verde, 2020).

The high penetration of the use of ICTs covers both organizations (Kim & Kim, 2020) and people (y Murillo de la Cueva & D'Antonio Maiceras, 2019). In organizations, the use of ICTs is observed in market studies (Nasida Binta Wahab , Salauddin , & Moniruzzaman, 2019), administration (Islam, 2016), *e-Commerce* transactions (Xin, Yiming, & Chang, 2020) (Velázquez López, Martínez Carballo, & Torres Hechavarría, 2021), etc. On the other hand, ICTs are present among people in many aspects of their daily lives and it is accentuated in the use of platforms to establish social networks (Shahbaznezhad, Dolan, & Rashidirad, 2021) (Aldemar, 2020) and buy things online (Ah Fook & McNeill,, 2020) (Morillo Ridaura & Baviera Puig, 2021). Then, there is notable growth in *e-Commerce* (Agarwal & Terry, 2015).

Various studies have been carried out in relation to *e-Commerce* such as marketing (Xiang, 2020) (Li, Guo, Sheng, & Chen, 2020) , market study (Ebad, 2018), customer satisfaction (Anisah & Suhendra, 2018), production level (Wang, Chai, & Liu, 2018), quality (Gajewska, Zimon, Kaczor, & Madzík, 2020), etc.

In *e-Commerce*, transactions are the most critical condition in the sale-purchase process (Barkatullah & Djumadi , 2018) (Ilmudeen , 2019). Some studies affirm that the future of e-Commerce depends on the development of extra-judicial mechanism for conflict resolution adapted to internet dynamics (Przemysław Polan, 2017) (Albrecht, 2018). The mechanisms are called *online dispute resolution* (ODR) and they need to be able to provide the same security and trust to consumers and merchants, however there is no agreed international ODR (González & Nava González, 2020).

Electronic transactions have been studied from different points of view, for example: from the point of view of the *provider* (Cardoso & Martínez, 2019) (Acosta Carlos , Gómez Ramos , & Peña Quitiaquez, 2020), from the point of view of the *consumer* (Sheshasaayee & Logeshwari, 2018), from the point of view of the State (Dumortier, 2014), from the bank's point of view (Salamah, 2017), etc. To make the transaction process explicit from any point of view, a formal method of representation is proposed in this paper. This article is organized as follows. The following section presents the glossary of definitions followed by the theoretical framework about conceptual maps used. The transaction modeling example is shown, and a variant is also included. 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.

Consumer (Cmer): the entity that acquires a P through a purchase-sale transaction (pst).

Entity: the organization or individual.

Purchase-sale transaction (pst): Process to pay with money and receive a P in exchange. To simplify the language, this will be called transaction only.

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 consumed and provider, respectively. They are called as econsumer *(eCmer)* and eprovider *(ePder).*

Or operator: logical operator that origin a false conclusion when the premises are false.

Conceptual map formalism

A *conceptual map* is a tool of knowledge representation that resembles a bi-graph where each concept is a node. Arcs are used to relate concepts. The distribution of a *conceptual map* follows a logical link.

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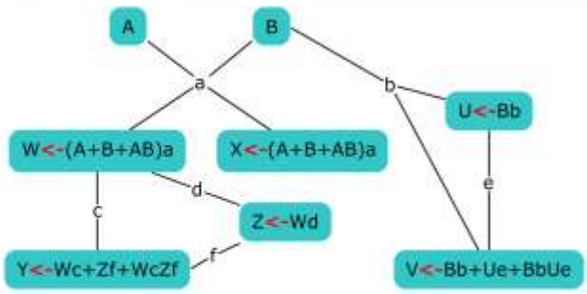

Figure 1 Logical *conceptual map* with arcs input criteria
Own Source

Input criteria

Figure 2 shows that the *W* concept is justified by the *or operator* on *A*, *B*, and the modifier *a* that relates them to *W*, (1).

$$\begin{aligned} W &\leftarrow (A \text{ or } B)a \\ &\leftarrow (A + B + AB)a \end{aligned} \tag{1}$$

After the distributive operation, the (2) is obtained and it is reading as *if aA or Ba or (A and B)a then W*.

$$W \leftarrow Aa + Ba + (AB)a \tag{2}$$

Some elements cannot be present in *W* because they are incongruous and/or unnecessary to it explain. Then *W* could also be justified by (3).

$$\begin{aligned} W &\leftarrow Aa \\ &\leftarrow Ba \\ &\leftarrow Aa + Ba \\ &\leftarrow Aa + (AB)a \\ &\leftarrow Ba + (AB)a \end{aligned} \tag{3}$$

The *Aa* element is the *A* concept modified by *a*. In other words, *A* is related with *W* by *a*. The *Aa* is equivalent to *aA* and, the *(AB)a* means that each concept is modified by *a*, (4). The concept could be referent to an action. In this case, *(AB)a* indicates that *Aa* and *Ba* occur at the same time.

$$\begin{aligned} Aa &\equiv aA \\ (AB)a &\equiv AaBa \end{aligned} \tag{4}$$

The *X* node is justified by the same nodes of *W* but *X* is always different that *W* by (3). The *time variable* is present to determine the difference between them. The concept *V* is explained by two concepts with a different relationship to each one. Here, the operator *or* is present as equation (1) that explained *W*.

Every node has associated one or more modifiers. This is highlighted in *Y*, (5).

$$\begin{aligned} Y &\leftarrow Wc + Zf + WcZf \\ as & \\ Z &\leftarrow Wd \\ then & \\ Y &\leftarrow Wc + Wdf + WcWdf \end{aligned} \tag{5}$$

In *V* node is presented an atypical case, (6).

$$\begin{aligned} V &\leftarrow Bb + Ue + BbUe \\ as & \\ U &\leftarrow Bb \\ then & \\ V &\leftarrow Bb + Bbe + BbBbe \end{aligned} \tag{6}$$

Then *Bb* is different from *Bbe*. The *Bbe* is a simplify expression of *(Bb)e*. In this case, the expressions generated by (4) are limited (7).

$$\begin{aligned} Bbe &\equiv (Bb)e \\ &\equiv (bB)e \\ &\neq bBe \\ &\neq b(Be) \end{aligned} \tag{7}$$

Output criteria

Figure 2 shows that *W* and/or *Z* concepts justify *Y* with the *c*, *f* modifiers, respectively. Additionally, *W* with *d* justifies *Z*. The *A* and/or *B* concepts justify *W* with *a* modifier (8).

$$\begin{aligned} A &\rightarrow Wa + Xa + WaXa \\ as & \\ Z &\rightarrow Yf \\ W &\rightarrow Yc + Zd + YcZd \\ &\rightarrow Yc + Yfd + YcYfd \\ then & \\ A &\rightarrow (Yc + Yfd + YcYfd)a + Xa + \\ &\quad (Yc + Yfd + YcYfd)aXa \\ &\rightarrow Yca + Yfda + YcaYfda + Xa + \\ &\quad YcaXa + YfdaXa + YcaYfdaXa \end{aligned} \tag{8}$$

The expression of the node *A* has been expanded for the didactic purpose (7) but is enough with the initial representation as shown in Figure 2.

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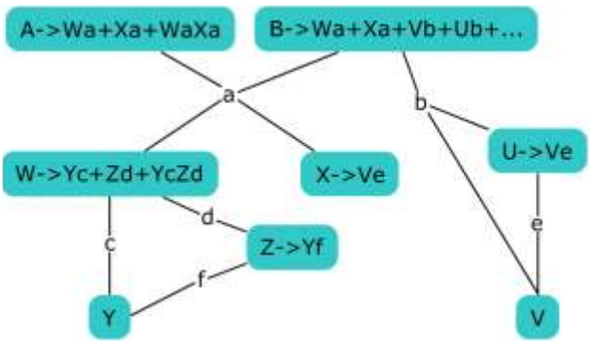


Figure 2 Logical *conceptual map* with arcs output criteria
Own Source

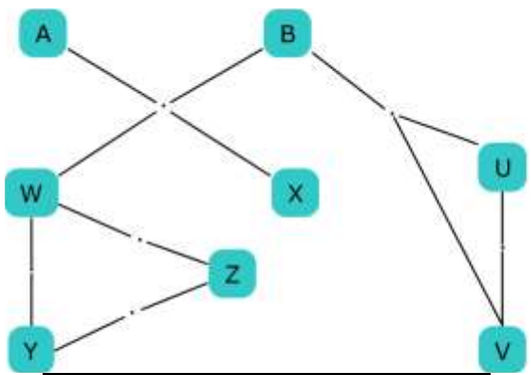
Even with a contained representation, the equation for node *B* remains large, (9).

$$B \leftarrow \begin{array}{c} Wa + Xa + Vb + Ub + \\ WaXa + WaVb + WaUb + \\ XaVb + XaUb + VbUb + \\ WaXaVb + WaXaUb + XaVbUb + \\ WaXaVbUb \end{array} \quad (9)$$

The modifier could be omitted in the contained representation when it is not critical to explain the relation. In this case (9) is expressed as (10).

$$B \leftarrow \begin{array}{c} W + X + V + U + \\ WX + WV + WU + \\ XV + XU + VU + \\ WXV + WXU + XVU + \\ WXVU \end{array} \quad (10)$$

The formal *conceptual map* could be represented with a graph and input and output equations of each node, Figure 3.



Input arc to node			Output arc from node		
Node	←	Eq	Node	→	Eq
A	←	…	A	→	…
⋮	⋮	⋮	⋮	⋮	⋮

Figure 3 Formal *conceptual map* representation
Own Source

Transaction modeling

If payment for a product is received directly by the *ePder*, then it is a *direct transaction*. The payment could be with an *intermediary* and this case is an *indirect transaction*. When the payment could be received directly and indirectly is say *hybrid transaction*. In this work, the *direct transaction* is shown in Figure 4. Table 1 has its description. The *a*, *b*, *c*, *d*, *e* arcs are essential to explain the relationships between some nodes.

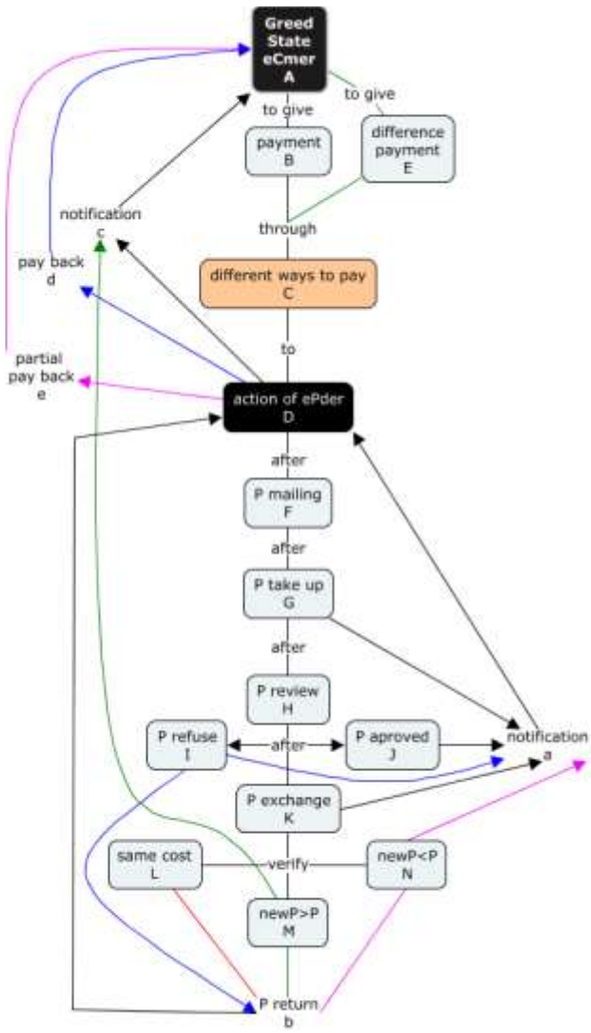


Figure 4 *Conceptual map* of *e-Commerce* transaction
Own Source

Node	arc	Description
A		The *eCmer* has a *Gs*
B		*eCmer* going to pay to *ePder*
C		The payment is through different electronic ways
D		After *ePder* received the money, he has taken steps to attend *eCmer*
	c	The *eCmer* is notified that *ePder* has been received the money
F		*ePder* send *P* in a parcel service
G		The *eCmer* receives *P*
	a	Notifies to *ePder* that *eCmer* has *P*
H		*eCmer* does review *P* and takes a decision (*I, J, K*)
I		*eCmer* refuses *P*
	a	Notifies to *ePder* that *eCmer* has refused *P*
	b	*eCmer* returns *P* to *ePder*
D		*ePder* has taken steps to attend *eCmer*
	d	*ePder* return the payment to *eCmer* and the transaction is finished
J		*eCmer* is satisfied with *P*
	a	Notifies to *ePder* that *eCmer* is satisfied with *P* and the transaction is finished
K		*eCmer* wants to change *P* and three cases are presented (*L, M, N*)
	a	Notifies to *ePder* that *eCmer* wants to change *P*
L		Price *P* is the same as the new selected *P*
	b	*eCmer* returns *P* to *ePder* and the transaction cycle continue
M		Price of the new selected *P* is higher
	b	*eCmer* returns *P* to *ePder*
	c	Notifies to *eCmer* that it is necessary to cover a price difference
A		*eCmer* takes steps to cover a price difference
E		*eCmer* going to pay the difference to *ePder*
C		The payment is through different electronic ways
D		After *ePder* received the money and *P*, he has taken steps to attend *eCmer* and the transaction cycle continue
N		Price of the new selected *P* is lower
	b	*eCmer* returns *P* to *ePder*
	a	Notifies to *ePder* that the price of the new selected *P* is lower
D		After *ePder* received *P*, he has taken steps to attend *eCmer* and the transaction cycle continue
	e	*ePder* return the partial payment to *eCmer*

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

The entry and/or exit arcs to *D* or *A* does not occur at the same time. This asynchrony is noticeable when using different colors.

Figure 5 and Table 2 are the formal *conceptual map*.

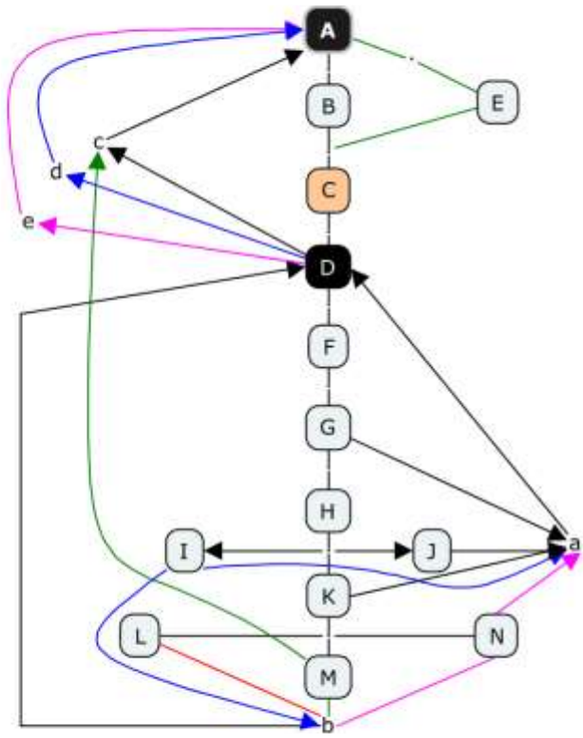


Figure 5 Graph to represent the transaction
Own Source

input arc to node		
B	←	*A*
E	←	*A*
C	←	*B+E*
D	←	*C+(G+I+J+K+N)a+(I+L+M+N)b+ (G+I+J+K+N)a(I+L+M+N)*
F	←	*D*
G	←	*F*
H	←	*G*
I	←	*H*
J	←	*H*
K	←	*H*
L	←	*K*
M	←	*K*
N	←	*K*
A	←	*(D+M)c+Dd+De+DcDd+DcDe*
output arc from node		
A	→	*B+E*
B	→	*C*
E	→	*C*
C	→	*D*
D	→	*Ac+Ad+Ae+F+FAc+FAcAe+FAe+AcAd*
F	→	*G*
G	→	*H+Da+HDa*
H	→	*I+J+K*
I	→	*Da+Db+DaDb*
J	→	*Da*
K	→	*Da+L+M+N+DaL+DaM+DaN*
L	→	*Db*
M	→	*Db+Ac+DbAc*
N	→	*Db+Da+DbDa*

Table 2 Equations on each node of the graph
Own Source

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Figure 6 shows the *tree coverture* of *e-Commerce transactions*, and this is obtained from Table 1. The green nodes are the end of the branch. The nodes with three dots mean that the *e-Commerce transaction* circle continues. The nodes move from one to the other as their description completes.

From Figure 6, the *a, b, c, d, and e,* arcs may originally be nodes on the Figure 7. The description and *tree coverture* do not change. The formal description is presented by Figure 8 and Table 3.

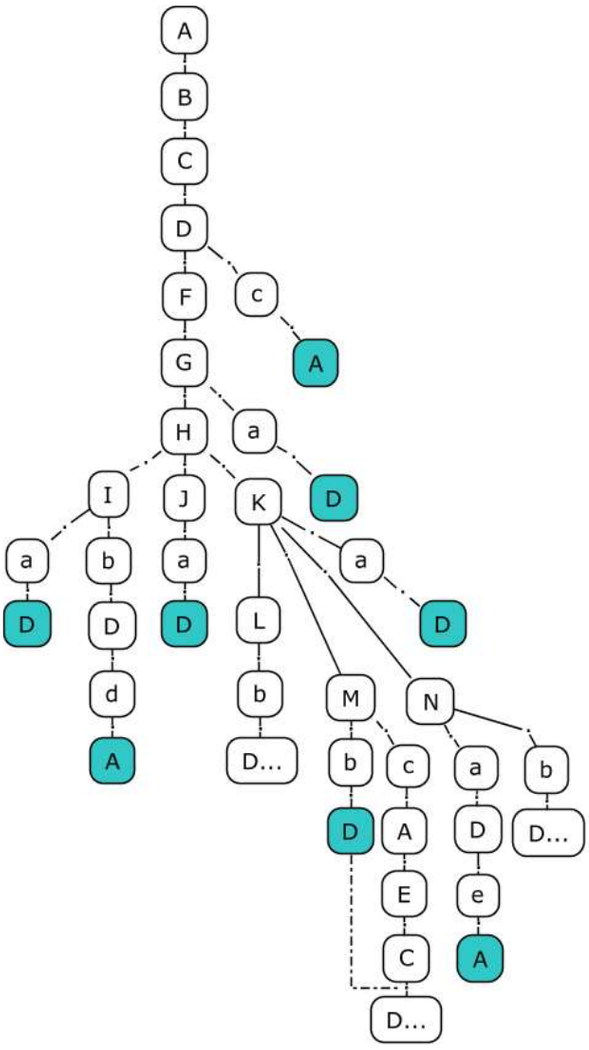

Figure 6 *Tree coverture* of *e-Commerce* transaction
Own Source

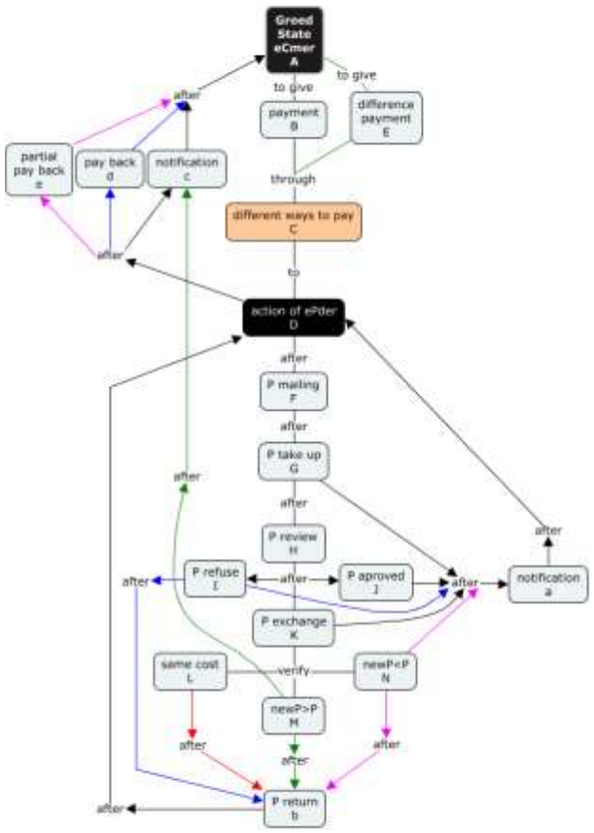

Figure 7 *Conceptual map* of *e-Commerce* transaction without relevant arcs
Own Source

input arc to node		
B	←	*A*
E	←	*A*
C	←	*B+E*
D	←	*C+a+b+ab*
F	←	*D*
G	←	*F*
H	←	*G*
I	←	*H*
J	←	*H*
K	←	*H*
L	←	*K*
M	←	*K*
N	←	*K*
A	←	*c+d+e+ce+cd*
a	←	*G+I+J+K+N*
b	←	*I+L+M+N*
c	←	*D+M+DM*
d	←	*D*
e	←	*D*
output arc from node		
nsertéA	→	*B+E*
B	→	*C*
E	→	*C*
C	→	*D*
D	→	*F+c+d+e+Fc+Fe+Fce+cd*
F	→	*G*
G	→	*H+a+Ha*
H	→	*I+J+K*
I	→	*a+b+ab*
J	→	*a*
K	→	*L+M+N+a+La+Ma+Na*
L	→	*b*

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M	→	*b+c+bc*
N	→	*a+b+ab*
a	→	*D*
b	→	*D*
c	→	*A*
d	→	*A*
e	→	*A*

Table 3 Equations on each node of the graph without relevant arc
Own Source

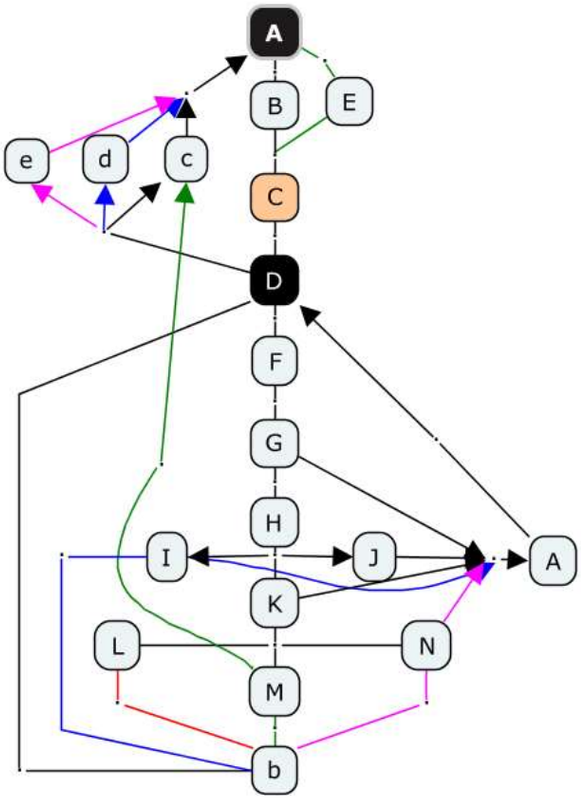

Figure 8 Graph to represent the transaction without relevant arc
Own Source

The equations from Table 3 are equivalent to the equations of Table 2. The equation (11) shows and example of this equivalence

$$\begin{aligned}
A &\leftarrow c + d + e + ce + cd \\
&\leftarrow (D + M + DM)c + Dd + De + \\
&\quad (D + M + DM)cDe + (D + M + DM)cl \\
DM &\equiv \emptyset \\
A &\leftarrow (D + M)c + Dd + De + \\
&\quad (D + M)cDe + (D + M)cDd \\
&\leftarrow (D + M)c + Dd + De + \\
&\quad McDe + DcDd + McDd \\
McDe &\equiv \emptyset \\
McDd &\equiv \emptyset \\
A &\leftarrow (D + M)c + Dd + De + DcDe + DcD
\end{aligned} \tag{10}$$

In the development of (11) some terms are null because they never happen in the transaction.

Conclusions

This paper presented a description of the elementary sale-purchase transaction. The transaction can be described using conceptual maps in an easy way, but this is not enough to analyze the process. The proposal is a formal model that facilitates his analysis. The model consists of a graph and equations of input and output from nodes. The work concludes with the model, but the research continues about the analysis method, modification method, and/or transform this to Petri net representation.

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