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PERCEIVED KEY DETERMINANTS OF PAYMENT INSTRUMENT USAGE: A FUZZY COGNITIVE MAPPING-BASED APPROACH

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Abstract. The recent economic climate has had direct repercussions on people's daily lives. This has occurred not only in how they use payment instruments, but is also evinced in new concerns adjacent to technological advances, people's safety and the credibility of financial institutions. In this regard, the banking sector has had a crucial role in countries' economic development, making it increasingly important to understand how the banking system operates and what payment instruments are available to users. Relying on specialized literature and the application of fuzzy cognitive mapping, this study aims to understand the cause-and-effect relationships between customers' preference factors in using payment instruments. The results show that *usability aspects* and *safety concerns* constitute the factors which users pay more attention to. Strengths and limitations of our proposal are also discussed.

Keywords: payment instruments, customer usage preferences, decision aid, FCM.

JEL Classification: C44, C45, M10, G20.

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Introduction

The increasing transformations in the environment in which financial institutions operate have caused changes in the way they act. Many European countries have recently been confronted with the difficulties inherent to processes such as new strategy implementation, the creation of new products and services, and the need to adapt to and adopt emerging technologies and distribution channels (Reis *et al.* 2013). In this regard, it seems important that financial and banking institutions should maintain a steady rhythm of adaptation and competitiveness, in order to be able to compete with new actors with a high technological and commercial capability. Following this line of thinking, economic agents, customers and shareholders in particular have been aligning their expectations with new technologies, thus increasing their level of demand with the options put at their disposal (Ahmadirezaei 2011; Dangolani 2011; Reis *et al.* 2013).

While it is remarkable the way that the availability of information and the ease in relationships between economic agents potentiate the development of the banking system and, in turn, that of the existing payment systems, consumers' choices are based on certain determinants which condition their preferences as to the payment instrument to use in daily transactions. In this regard, understanding the factors which influence customers' choices seems to be increasingly relevant for banking institutions, particularly if taking into account that those same choices may influence the planning and investments made by banks at the distribution channel level (Pinto, Ferreira 2010; Gogoski 2012; Reis *et al.* 2013). As such, this paper aims to identify the determining factors affecting customers' choices regarding existing payment instruments, as well as to analyze the cause-and-effect relationships among those determinants.

From the methodological point of view, this study makes use of fuzzy cognitive mapping, so as to ascertain, with a panel of decision makers, which factors are behind customers' choices for a specific payment instrument. Although it is known that the fuzzy cognitive mapping approach allows static, dynamic and loop analyses of results for the modeling of dynamic systems, it can also be used for (simple) knowledge representation (*cf.* Peng *et al.* 2016). Indeed, in the current study, rather than analyzing system dynamics, our focus will be on the cognitive structure of factors affecting customers' choices regarding existing payment instruments. The epistemological stance thus taken differentiates our work from extant literature reporting fuzzy cognitive map applications, which has generally been more focused on the analysis of variable dynamics, rather than on knowledge sharing and representation *per se*. Given that the current study is process-focused, particular attention is given to the group knowledge sharing witnessed at the time of creation of the fuzzy cognitive map (FCM).

The next section presents the literature review, so as to provide the framing of the study. Then, the methodological framework of the applied techniques is provided. The following section presents the results, indicating the determinants which have a greater influence in customers' choices and highlighting the practical implications of the insights obtained. The last section concludes the paper, highlighting the study's contribution and limitations, and presenting ideas for future research.

1. Literature review

Payment systems play an important role in financial markets, as they facilitate commercial exchanges between consumers and producers and promote the stability and efficiency of the financial sector and of the economy at large (Hancock, Humphrey 1997). As Kahn and Roberds (2009: 1) state, *"payment systems are the plumbing of the economy – a collection of conduits that is essential, pervasive, and boring (until there's a malfunction)"*. In practice, we can note that these systems function as an intermediation network, which is concerned with the transactions among economic agents. Given the complexity that usually exists in modern payment systems, one should keep in mind that any payment system is equipped with payment instruments or means which make possible the movement of funds, *i.e.* they constitute a set of tools or procedures that make possible the transfer of funds from a payer to a payee (Kokkola 2010).

According to Hancock and Humphrey (1997), Kokkola (2010) and Ramos *et al.* (2011), there is a wide variety of different payment instruments, which should be analyzed individually, as they present particular characteristics and, moreover, depend on the type of relationship and transaction between payer and payee. In practice, as the authors state, payment instruments can be categorized into: (1) *cash payments*, which are associated with low value face-to-face operations among individuals or between an individual and a vendor (Kokkola 2010); and (2) *non-cash payments*, which involve the transfer of funds between bank accounts (*i.e.* the means used by the payer to authorize a bank transfer of funds to a payee, or by the payee to withdraw funds from a payer (Kokkola 2010)). *Non-cash payments* are normally carried out by the banking system (Hancock, Humphrey 1997) and the better known ones include: *cards*, *credit transfer orders*, *direct debit*, *checks*, *commercial effects* and *electronic currency.* Naturally, the transaction channel varies, as it can be associated to the Internet, phone banking, automated teller machines (ATMs) or mobile services, each one invoking strong customer preferences. As Reis *et al.* (2013) and Ferreira *et al.* (2016b) state, customer preferences may influence banks' planning and investment at the distribution channel level, highlighting the importance of studying this topic. Given the above, the contributions made thus far have been important, as they resort to different methodologies and rely on different epistemological bases. Table 1 summarizes some of these studies, highlighting their contributions and limitations.

According to Table 1, it seems evident that some of the reasons for which customers prefer a given instrument are related to technological innovation and the new distribution channels available, which tend to be more appealing and captivating for younger target groups. However, it seems equally evident that the studies carried out to date are unable to explain the manner in which the determinants of customer preference interrelate with each other. In other words, perhaps more important than identifying the determinants themselves might be to understand the cause-and-effect relationships emerging from their analysis. As Kim and Lee (1998: 303) state, *"knowledge engineering is one of the most important tasks in developing expert systems. One of the primary objectives* […] *is to develop a complete, consistent and unambiguous description of the knowledge base*". In this regard, the present study resorts to cognitive mapping techniques to analyze the cause-and-effect relationships among the factors determining customers' preferences in the usage of payment instruments.

Table 1. Contributions regarding the study of customer preference factors in the usage of payment instruments

Authors	Method	Contribution / Originality	Limitations Acknowledged by the Author/s
Sohail & Shanmugham (2003)	Hypothesis Testing	Examines the trends of the e-commerce revolution in the banking sector	The online questionnaire method and the sample size are limited
Manrai, L. & Manrai, A. (2007)	Hypothesis Testing	Identifies important factors of the customer's perceptions with implications to management with regard to the problems of "bank switching" and "bank loyalty"	Only portrays the change of a bank for a private service
Calisir & Gumussoy (2008)	Triadic Elicitation Method	Compares the perceptions of the youth, regarding the usage of the banking service on the Internet, to six other channels	The population is quite small and there was no attempt to distinguish between the various types of operations that can be carried out
Dick (2008)	Structural Demand Model	Estimates the effects, on commercial banks' customers, of the drastic changes they have been experiencing	Does not discriminate between the main groups of consumers: families and non-financial companies
Gholami *et al.* (2009)	Technology Acceptance Model	Identifies the factors incentivizing the customer to adopt online banking.	There are limitations as to the number of variables and countries studied.
Khare *et al.* (2010)	Multiple Linear Regression	Predicts which online banking attributes are important according to different customer profiles	The sample is made up of unequally distributed age groups
Masrek *et al.* (2014)	Structural Equation Model	Analyzes the meaning of trust in technology to predict customer satisfaction with mobile banking	The sample size was reduced due to some questionnaires having being spoiled or not returned
Dauda & Lee (2015)	Random Utility Model / Random Coefficients Model	Analyzes consumers' patterns of choice with regard to future online services	The study focuses only on customer preferences for future online services, excluding some customer behavior intentions based on the perceptions of usage of current systems. The sample is only made up of potential customers of the bank
Junadi (2015)	Unified Theory of Acceptance and Use of Technology	Determines the meaning of the factors which influence acceptance of e-payment technology	The study conducts a unidirectional analysis
Montazemi & Qahri-Saremi (2015)	Grounded Theory Literature Review method	Identifies factors affecting the adoption of online banking	There is insufficient data for analysis and, while there are conceptual similarities, the measures envisaged for each factor may vary in different empirical studies

2. Methodology

2.1. Background on cognitive mapping

Frank and Badre (2015) and Sponarski *et al.* (2015) refer to cognitions as mental processes used to perceive, think, remember and understand, as well as to represent the act of using those same processes. Cognition is a complex process arising from the interactions of vast populations of neurons and interconnected cerebral systems (*i.e.* interactions between neurological structures and the motor system). These processes can be artificial or natural, conscious or unconscious, and can be analyzed and applied in numerous research areas.

Human cognition relates to various concepts, among which are the mind, reasoning, perceptions and learning. In other words, through daily living, individuals acquire knowledge in their mind which allows them to generate sensations endowed with meaning and value. In this way, the relationship between the quantity and the quality of the information obtained has repercussions, and affects individuals' minds. This occurs because individuals relate that which is created in their minds with real perceptions (*i.e.* real images which are observed), endowing those creations with meaning. Cognitive maps thus appear as a way to understand mental processes and the manner in which these interact with reality.

According to Kitchin and Freudschuh (2000), cognitive maps can be used in three different ways: (1) to describe the way people learn, remember and process information about their surroundings; (2) to describe the process of thinking about the cause-and-effect relationships; and (3) as a methodological approach, in order to understand cognition in general (*i.e.* through the construction of a cognitive map). It is worth noting, however, that the use of maps to visualize, understand and describe phenomena and/or reality is not new. Indeed, Carlucci *et al.* (2013) indicate that maps are one of the oldest tools representing non-verbal communication, in addition to being highly descriptive. Gavrilova *et al.* (2013) complement this idea, stating that maps are visual tools which facilitate representation and communication of information, providing support for its identification and interpretation, and facilitating its codification and consultation, through the stimulation of mental associations.

As a methodological approach, cognitive maps were first introduced as such in Tolman's (1948) study *Cognitive Maps in Rats and Men*. Tolman (1948) defended that behaviors and emotions are not only analyzed as individual situations, but are also influenced by a set of underlying perceptions and interpretations (*i.e.* the way people react depends on how they perceive or interpret the situation at hand). According to Eden (2004: 673), cognitive maps are used to describe an individual's thinking about a problem. As the author states, a *"cognitive map is the representation of thinking about a problem that follows from the process of mapping"*. Carlucci *et al.* (2013), in turn, declare that cognitive maps are used with the purpose of organizing and storing knowledge, so as to reduce individuals' cognitive load and improve the mechanisms of perception and analysis of real situations, not only describing the problems but also enabling the improvement of learning. Indeed, cognitive maps are a useful tool that allows cause-and-effect relationships between variables in a certain problem or phenomenon to be modeled.

Papageorgiou and Salmeron (2013), Ferreira and Jalali (2015) and Ferreira *et al.* (2017) consider that cognitive maps have been increasing in notoriety because they represent an im-

portant methodological approach, which takes human metacognitive perception as its starting point, and allows complex decision problems to be structured and clarified. Given that human decision processes take place in a subjective and potentially difficult to explain context, cognitive mapping has been playing an increasingly important role in supporting decision making, insofar as *"it provides a means of representing the way in which a decision maker models his decision-making environment, in terms of the concepts he himself uses"* (Klein, Cooper 1982: 64). Indeed, cognitive maps take on a relevant position in what regards communication and decision, because they constitute a structuring instrument for complex decision problems, allowing experiences and ideas to be shared, and promoting discussion and learning between the participants involved. Wellman (1994) also indicates that cognitive maps take on the form of a qualitative graph of decision makers' subjective beliefs, with a focus on the cause-and-effect relationships between the concepts (*i.e.* cognitive maps are a qualitative model based on the definition of variables and on the cause-and-effect relationships these present) (Wellman 1994; Carlucci *et al.* 2013; Jalali *et al.* 2016). In this regard, there are many studies using cognitive maps not only as a useful tool for decision making, but also as a mechanism which analyzes people's perceptions of complex decision problems. This makes cognitive maps valuable both as a decision-making support instrument and as a possible communication tool (Axelrod 1976; Carlucci *et al.* 2013; Gavrilova *et al.* 2013; Ferreira *et al.* 2016b).

In a more specific perspective, and according to Carlucci *et al.* (2013), cognitive maps have two main functions: (1) a *descriptive function*, stemming from the visual representation provided by maps to structure the decision problem at hand (*i.e.* they allow unnecessary cognitive load to be reduced); and (2) a *function of support to decision making*, in which maps are seen as an approach to systems thinking and a support to the processes of generation and elaboration of ideas, not necessarily connected to a specific question or to a context. The cognitive maps introduced by Axelrod (1976) are representations of an individual's causal beliefs, represented by points and arrows. In the map, the points represent concepts, and the arrows are cause-and-effect statements relating the concepts between them. Eden (2004) complements this, referring that cognitive maps are characterized by their structural hierarchy and are usually represented as a graph, where the goal appears at the top. This structure, however, is frequently drawn as a circle or presented as a chain. As an example, Figure 1 presents part of a cognitive map.

As Figure 1 illustrates, cognitive maps represent a network of ideas which are hierarchically structured and connected by arrows that indicate cause-and-effect relationships (Axelrod 1976; Kosko 1986; Wellman 1994; Eden 2004). The arrows can present positive (+) or negative (–) signs, depending on the cause-and-effect relationship between the concepts. In this regard, the existence of such relationships between concepts for decision making allows the participants to, during the development of the map, learn and improve their perceptions of the decision problem, re-evaluating and re-structuring their points of view. It should be noted, however, that there are various types of cognitive maps (Fiol, Huff 1992). Nevertheless, the importance of this type of representation, whether for decision making or for communication, can be perceived, especially in situations of scarcity of information and/or a high degree of uncertainty, as in the case of understanding which factors determine customers' choices in using a given payment instrument.

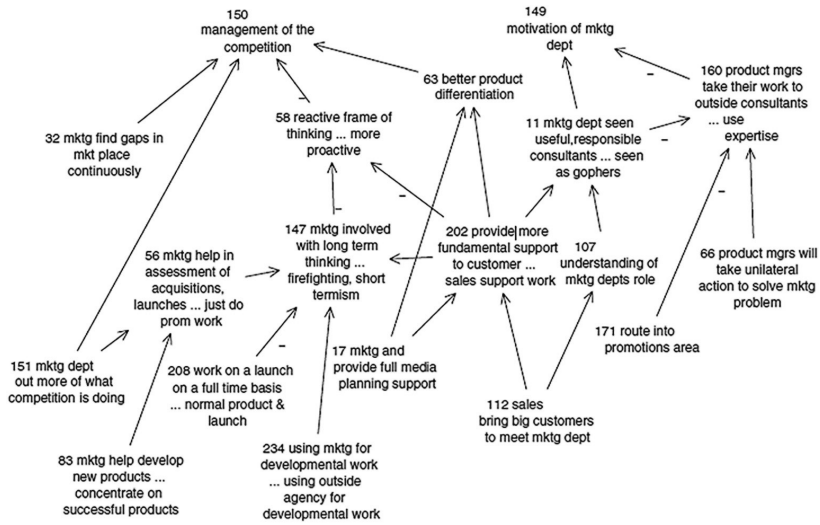

Fig. 1. Example of a cognitive map [partial view]
Source: Eden (2004: 675).

2.2. Cognitive Maps and Fuzzy Cognitive Maps

Kosko (1986) provided a valuable contribution to cognitive cartography when, in the 1980s, he created the so-called Fuzzy Cognitive Maps (FCMs), by combining cognitive maps with fuzzy logic. In practice, *"fuzzy cognitive mapping is a flexible tool that has been successfully applied in a large number of disciplines"* (Kok 2009: 124). In this regard, FCMs are considered a structuring tool which enables the representation and study of people's and systems' behavior (Calais 2008; Kok 2009; Salmeron 2009; Kang *et al.* 2012; Carlucci *et al.* 2013; Jetter, Kok 2014). For Kim and Lee (1998: 304), FCMs are *"fuzzy signed directed graphs with feedback, and they model the world as a collection of concepts (or factors) and causal relations between concepts"*. In turn, Kang *et al.* (2012), Salmeron and Gutierrez (2012) and Vidal *et al.* (2015) argue that FCMs represent an interactive structure of concepts (*i.e.* thinking network), in which each one interacts with the others, showing their dynamics and the different aspects of the system's behavior. In other words, according to Kok (2009), Salmeron *et al.* (2012), Salmeron and Lopez (2012) and Lopez and Salmeron (2013), FCMs portray a system of beliefs for a given domain, being composed of concepts *C*, which represent the system's main drivers, and are connected by directional arrows, which represent the cause-and-effect relationships between them.

As Carlucci *et al.* (2013) state, FCMs have two significant characteristics to be highlighted: (1) *the cause-and-effect relationship between concepts/criteria follows a fuzzy logic*, which is to say, it is no longer only signs that are used to indicate the type of causality (positive or negative), but a numeric interval ranging from –1 to 1 is also used, representing the degree of influence/intensity between the concepts; and (2) *the system is dynamic and involves feedbacks*, where a change in one of the concepts affects the others, allowing a temporal dimension to be added to the operations of FCMs. Papageorgiou *et al.* (2012: 46) thus state that an

"FCM is a dynamic tool because cause-effect relations and feedback mechanisms are involved". In this regard, an FCM's structure consists of concepts/nodes and arcs connecting them. Figure 2 illustrates, as an example, the conceptual structure of an FCM, where C_i is a concept/criterion and w_{ij} represents the degree of influence/intensity in the relationship between the criteria *i* and *j*. Each concept represents a characteristic in the system and is associated to a fuzzy value A_i in the range between [0, 1] or, in a binary logic, {0, 1}.

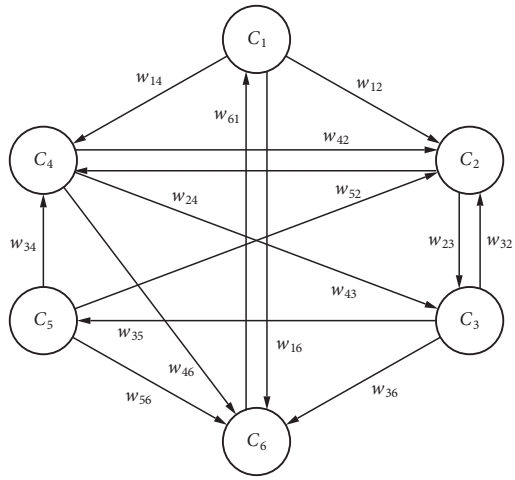

Fig. 2. Example of an FCM
Source: Kang *et al.* (2012: 78).

As for the weights of the arcs, they assume fuzzy values in the interval [–1, 1] or, in a trivalent logic, {–1, 0, 1}. In other words, there are three possibilities for each cause-and-effect relationship between the concepts/criteria: (1) *positive causality* ($w_{ij} > 0$) (*i.e.* an increase/decrease in the value of C_i increases/decreases the value of *Cj*); (2) *negative causality* ($w_{ij} < 0$) (*i.e.* an increase/decrease in the value of C_i increases/decreases the value of C_j); and (3) *no causality* ($w_{ij} = 0$), which indicates an absence of relationship between C_i and C_j (*cf.* Kosko 1986; Kim, Lee 1998; Kok 2009; Salmeron 2009; Kang *et al.* 2012; Papageorgiou *et al.* 2012; Carlucci *et al.* 2013; Ferreira, Jalali 2015; Ferreira 2016).

Despite their graphical importance, FCMs are supported by an underlying mathematical model, which consists of a $1 \times n$ state vector *A*, where the values of *n* concepts are included; and an $n \times n$ matrix of weights, also known as an adjacent or connecting matrix, holding the values/weights of the interconnections w_{ij} with regard to the *n* concepts included in the FCM. The proposed matrix typically presents values equal to zero in all the entries of the main diagonal, meaning that a criterion seldom causes itself and that the value of each criterion is influenced by the values of the interconnected concepts as well as its previous value. In this regard, an FCM may freely interact and, at each interaction, the criteria assume new values. According to Kosko (1986) and Kang *et al.* (2012), formulation (1) allows the value of each criterion/concept to be calculated, based on the influence of the interconnection between concepts whose values are in the interval [–1, 1].

$$A_j^t = f\left(k_1 \sum_{\substack{i=1 \\ i \neq j}}^{n} A_i^{t-1} \omega_{ij} + k_2 A_j^{t-1} \right), \quad 0 \leq k_1 \leq 1, \quad 0 \leq k_2 \leq 1. \tag{1}$$

According to Kang *et al.* (2012), A_j^t (where $A_j^t \in [0, 1]$) consists in the activation level of concept C_j in moment t. In turn, f represents the activation function (for details, see Trentin 2001; Salmeron 2009; Glykas 2010), and the coefficient k_1 expresses the influence of the concepts' interconnection to a new value of A_i for concept C_i. As can be seen in Figure 2, the concept/criterion C_6 is influenced by concepts C_1, C_3, C_4 and C_5. As such, a new state vector A_{new} appears by the multiplication of the state vector A_{old} by the weigh matrix W. In this way, the variables' strength (*i.e.* ranking) can be obtained at the end of the simulation, allowing the visualization of how the system is understood in a fuzzy logic. For it to be possible to determine the system's state, it is necessary that several simulations be done. In allowing complex decisional situations to be analyzed, FCMs resemble neural networks. Carlucci *et al.* (2013: 213) highlight that the *"FCM is appropriate for data poor situations"*. They are powerful dynamic models of understanding, which reveals their importance in decision-making support.

3. Application and results

This study proposes to develop a fuzzy evaluation model whose objective culminates in identifying the factors influencing customers' choices of payment instruments. In this regard, the use of the methodology presented above intends to explore the applicability of FCMs in the context in question. As already pointed out, FCMs allow static, dynamic and loop analyses of the results to be produced, to model dynamic systems. Still, as clarified at the outset, in this study, perhaps more important than analyzing system dynamics might be to identify the cognitive structure of factors affecting customers' choices regarding existing payment instruments. This is a result of the constructivist stance assumed from the beginning.

Carlucci *et al.* (2013) state that it is possible to initiate an FCM creation process through any of the following techniques: (1) from questionnaires; (2) by extraction from written texts; (3) by drawing it from data that shows cause-and-effect relationships; and, lastly, (4) through interviews with people who draw a map directly, such as one or more experts or a work team, for instance. In this study, and following Kim and Lee's (1998) orientations, the development of the FCM was initiated through group meetings, *i.e.* face-to-face sessions with experts, named decision makers, who had specific knowledge about the subject in question (see also Ferreira *et al.* 2016a). Other factors were also taken into account in choosing the decision makers, such as their availability for participating in two group meetings with an approximate duration of 4 hours each.

The sessions were conducted by two facilitators (*i.e.* researchers) and the panel of decision makers included 4 professionals from the banking sector and 2 individuals who frequently use payment instruments – according to Eden and Ackermann (2001: 22), the facilitator should *"relate personally to a small number (say, three to ten persons)"*. These panel members were from the Central-West region of Portugal, half of them were female, with ages between 20 and 50 years old and their interaction was important to confront differing points of view

(*i.e.* customer logic vs. banking institution logic). In other words, the fact that the group was composed by participants from different banks and of different hierarchical levels, and by frequent users of various payment instruments, ensured the discussion was spontaneous and heterogeneous, allowing the debate underlying the structuring process to be enriched, and incorporating different perceptions in the cognitive structure that served as basis for the formulation of an FCM. Given the constructivist nature of this methodological approach, it should be noted that the focus lies in the process, rather than the end result. This suggests the technical procedures used may work well with any other group of decision makers. As Bell and Morse (2013: 962) state, *"there is less emphasis on outputs per se and more focus on process"*.

3.1. Developing the Fuzzy Cognitive Map

In order to elucidate participants on how the work session would proceed, an introduction was made enunciating the objectives and principles of the methodology to be applied. The next step consisted of presenting the trigger question: *"Based on your values and personal experience, which factors influence a customer's choice in the use of payment instruments?"*. This question was asked by one of the facilitators and served as the starting point to the debate among the participants, allowing an environment of sharing of knowledge and experiences to be fostered.

In this study, the response to the trigger question relied on the *"post-its technique"* (Ackermann, Eden 2001), which is characterized, as the name indicates, by the use of post-its, and in which each decision maker writes one (and only one) criterion in each post-it that s/he considers pertinent in responding to the problem presented. For this process to be completed and satisfy the members of the panel, discussion and negotiation become key elements. From an operational point of view, large sheets of paper were placed in the meeting room and, in an initial stage, post-its were made available as required by the members of the panel. Following this stage, the decision makers were asked to group the criteria by clusters (*i.e.* areas of interest), with a total of six clusters having been found: *safety concerns*; *return to the client*; *image*; *services provided*; *usability aspects*; and *specific constraining factors*. Finally, participants were asked to sort the post-its in terms of importance, placing the most important criteria at the top of each cluster and the least important at the bottom (see Ferreira *et al.* (2016a) for more details). Figure 3 presents snapshots of different stages of the structuring process. Although illustrative, these snapshots are important to highlight the humanistic, interactive and constructivist nature of the procedures followed.

Based on the *Decision Explorer* software (www.baxia.com), Figure 4 illustrates the final version of the "collective" or "strategic" map, which was validated by the decision makers following analysis and discussion.

The following stage of the process allowed the intensity of the cause-and-effect relationships between the criteria to be analyzed. For this purpose, the decision makers were asked to define, in the second group session, the degree of influence (*i.e.* intensity) inherent to each of the connections identified in the preceding stage. Given that each decision maker has a unique personal opinion, this stage of the process was quite time-consuming and demanding, and was successfully concluded thanks to the negotiation process established among the members of the panel. To visualize the dynamics of intensity between criteria, two software programs were

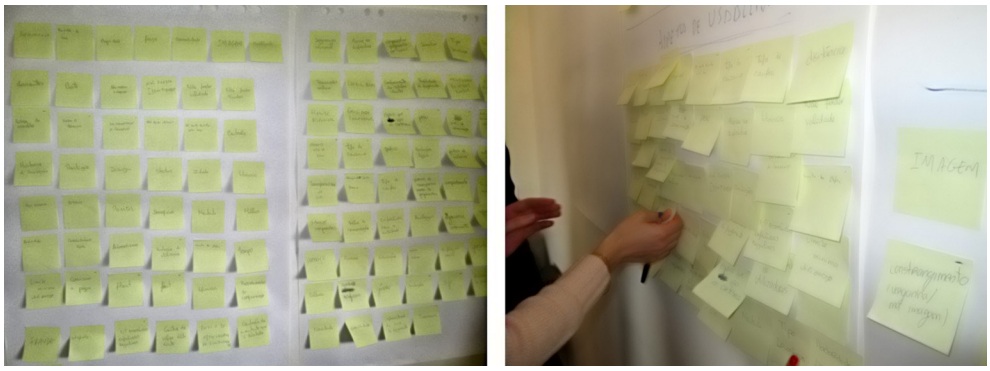

Fig. 3. Snapshots of the application of the "post-its technique"

required, namely: *FCMapper* (http://www.fcmapper.net) and *Pajek* (http://mrvar.fdv.uni-lj.si/pajek/). Figure 5 illustrates the cognitive structure of what, at a later stage, would become an FCM (for the purposes of simplifying Figure 5, the criteria were replaced by numbers. The complete version of the structure, containing all the specifications, is available upon request).

Once the FCM had been constructed, and per the method's theoretical exposition, the intensities of the various connections within it were inserted into the adjacency matrix. Size restrictions prevent us from displaying the adjacency matrix in this paper. However, Table 2 exemplifies the matrix used, where C_i and w_{ij} stand as defined by the panel members on a collective basis.

In practice, the values w_{ij} were directly projected by the decision makers following a long process of negotiation. Figure 6 exemplifies this exercise with the presentation of cluster 8 – *i.e. safety concerns* – where each connection's degree of intensity lies in the range [–1, 1].

After conducting various tests and simulations in order to achieve the system's stability, the visualization and analysis of the FCM's dynamics provided the decision makers with a vision of the impact each criterion could have in choosing a payment method. Indeed, as Carlucci *et al.* (2013: 216) state, *"once the FCM has been constructed, it can be used to model and simulate the behaviour of the system including performance objectives, process performance objectives and knowledge assets"*. The next stage was then based on the analysis of the centrality of the key determinants influencing customer's choice of payment instruments.

3.2. Analysis of the centrality of preference factors

In conformity with Carlucci *et al.* (2013: 216), *"through a proper neural network computational model,* [...] *what we can get is an idea of the ranking of the variables in relationship to each other according to how the system is perceived in the FCM"*. In this regard, Table 3 presents the factors which, according to the collective perception of the panel members, present the highest centrality indices. In practice, according to the decision makers, when a customer thinks of using a payment instrument, s/he first considers *usability aspects* (24.30), followed by *safety concerns* (13.40), some *specific constraining factors* (8.90), *return to the client* (7.50), *services provided* (6.30) and *image* (5.70) (the complete list of factors and of their respective degrees of centrality is available upon request).

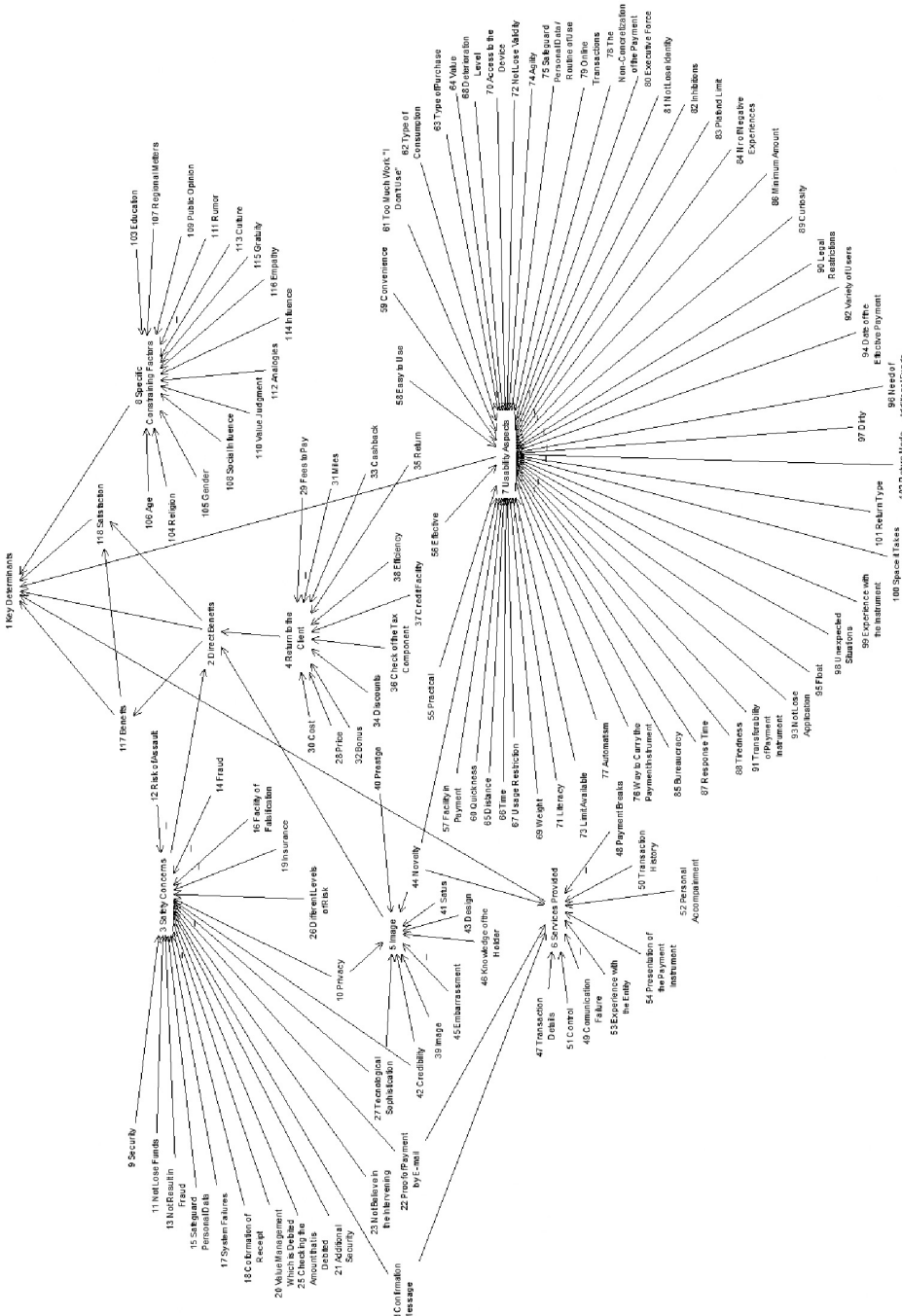

Fig. 4. Group cognitive map

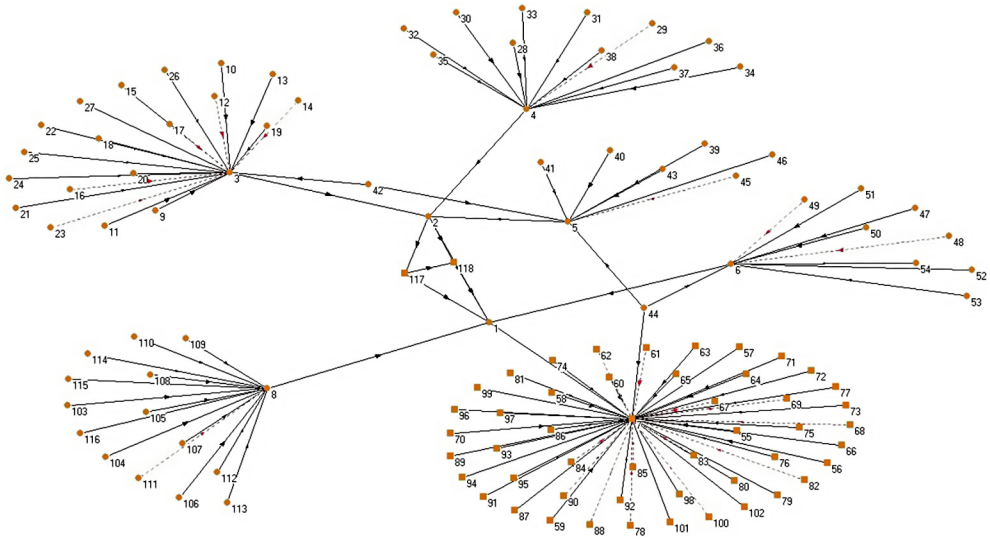

Fig. 5. Basis cognitive structure of the FCM

Table 2. Adjacency matrix

	C_1	C_2	…	C_{n-1}	C_n
C_1	0	w_{12}	…	w_{1n-1}	w_{1n}
C_2	w_{21}	0	…	w_{2n-1}	w_{2n}
…	…	…	…	…	…
C_{n-1}	w_{n-11}	w_{n-12}	…	0	w_{n-1n}
C_n	w_{n1}	w_{n2}	…	w_{nn-1}	0

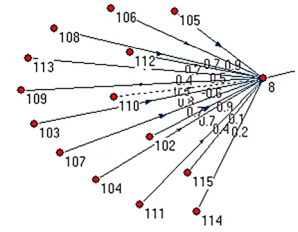

Fig. 6. Analysis of intensity degrees

Our results are aligned with the findings of Gholami *et al.* (2009) and Pinto and Ferreira (2010) with regard to the importance of *usability aspects*, in so far as this was the factor identified by the panel members displaying the highest level of centrality (this is also in accordance with the findings of Ramos *et al.* (2011), Reis *et al.* (2013), Masrek *et al.* (2014) and Montazemi and Qahri-Saremi (2015), who highlight the importance of trust in technology to predict bank customer satisfaction).

Table 3. Degree of centrality of customer's preference factors

Factor/Criterion	Reference	Outdegree	Indegree	Centrality
Usability Aspects	7	0.70	23.60	24.30
Safety Concerns	3	1.00	12.40	13.40
Specific Constraining Factors	8	0.80	8.10	8.90
Return to the Client	4	0.80	6.70	7.50
Services Provided	6	0.70	5.60	6.30
Image	5	0.50	5.20	5.70

Although our focus was on the key determinants of payment instrument usage revealing the highest levels of centrality, it should be emphasized, however, that the construction of an FCM in this study allowed a large number of other determinants to be identified. In particular, the issue of "image" can be easily overlooked, but can at times affect customers' choices. Indeed, as one of the participants noted, some of the concepts included in the FCM are seldom taken into account in current appraisal and planning practices, but the construction of an FCM, despite its subjectivity, allowed the group to formalize them in a very natural manner, contributing to reduce the rate of omitted variables in the decision-making framework (for further discussion, see also Ferreira, Jalali 2015).

Beyond the ranking of key determinants provided in Table 3, another aspect to be highlighted results from the ability to dynamically analyze the assessment system itself and understand the cause-and-effect relationships among the variables identified. In other words, this means that this method of structuring and analysis allows not only the determinants most influencing customer preferences to be hierarchized, according to their degree of centrality, but also to explore how an oscillation in intensity might affect the rest of the system, which in turn empowers planning decisions. Indeed, as pointed out by Papageorgiou *et al.* (2012: 45), *"FCMs are simple, yet powerful tools for modeling and simulation of dynamic systems, based on domain-specific knowledge and experience"*. Additionally, it was possible to identify several practical advantages of the FCM approach, such as: the interactivity, dynamism, flexibility and simplicity of the techniques used. Obviously, our framework is not without its own limitations, which form the basis of our recommendations.

Conclusion and recommendations

This study acknowledges the importance that payment instruments hold in people's daily lives. In this regard, an FCM was developed with the aim of increasing the knowledge on cause-and-effect relationships between the factors influencing consumers' choices with regard to the use of payment instruments. As Carlucci *et al.* (2013: 217–218) state, *"FCM as a useful tool to support decision making* […] *allows to simulate the relationships which link together the development of organizational components, the impact on organizational processes, and the achievement of strategic objectives"*.

As discussed, FCMs are characterized by their similarity to neural networks, whose practical application focuses on the analysis of complex problems (Jetter, Kok 2014; Ferreira *et al.* 2016a, 2016b). As clarified at the outset, these maps allow static, dynamic and loop analyses to be produced. The main concern/aim of this study, however, was to identify the cognitive structure of factors affecting customers' choices regarding existing payment instruments. The constructivist epistemological stance assumed allowed our contribution to be markedly different from the extant literature on FCM applications, which has generally been more focused on the analysis of variable dynamics, rather than on knowledge sharing and representation *per se*.

Transparency and simplicity in decision making are also characteristics attributed to FCMs, something which became evident for the members of the panel in this study. Indeed, according to the collective perception of these elements, *usability aspects*, *safety concerns*,

some *specific constraining factors*, *return to the client*, *services provided* and *image* are the factors most influencing the choice of a payment instrument in detriment of another/others. Beyond that, understanding the cause-and-effect relationships among the various factors for choice was something which was welcomed by the members of the panel.

In broad terms, the FCM developed in this study allows for greater transparency in the analysis of key determinants of payment instrument usage. This is reinforced by the direct involvement of a panel of decision makers, who provided consistency, functionality and realism to the system developed, and allowed for its validation. Due to the constructivist nature of this study, one should bear in mind, however, that its greatest contribution relies on the learning process inherent to the construction of an FCM. As noted by Zavadskas and Turskis (2011: 398), *"most importantly perhaps was the finding that decision analysis can be useful to help multiple stakeholders understand what they agree and disagree about, focus on the things that they disagree about and explore options that are better for everyone involved"*. In this sense, and despite its subjective nature, our framework is flexible enough to accommodate new information, allowing decision makers to immediately assess the impact of new data or determinants of payment instrument usage on the results. In light of this reasoning, the proposal presented in this study is work-in-progress, and improvements are always possible (and desirable) to strengthen banks' planning decisions in this domain.

Given the results obtained, it seems evident that FCMs hold great potential, in methodological terms, for broadening our understanding of the scope of factors which lead banking customers to choose one given payment instrument over another/others. However, some of the difficulties felt in the context of the present study should be borne in mind, such as that of assembling a panel of decision makers with availability to participate in the group sessions, as well as the need to deal with the great amount of subjectivity which characterizes the entire structuring process. In this regard, it is recommended that future initiatives consider involving: (1) other decision makers with intrinsic characteristics different from those of the present study; and (2) other contexts of applicability, namely those contemplating eventual methodological complementarities (*i.e.* allying FCMs to other methodological approaches) (see Zavadskas and Turskis (2011) and Zavadskas *et al.* (2014) for examples). This would allow, with advantages to banks and customers, to increase the interest and discussion surrounding the application of FCMs in the development of payment instruments.

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