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Impact of digital trends using IoT on banking processes

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Abstract

The internet of things represents the next phase of the digital revolution that will transform the lives of consumers. While the Internet does not usually extend beyond the electronic world, connected objects represent the extension of the Internet to things and places. The purpose of this article is to present the different uses of IoT in finance and to analyze the impact of digital trends and IoT on the procedural scheme of a traditional bank. It would be interesting to gather the different types of digital trends that similarly impact processes of a bank. We will treat these trends in the same way to carry out the digital transformation using these new techniques.

Keywords: digital trends, Internet of things, banks, processes.

1. Introduction

They are everywhere, know everything and are intelligent: they are connected objects. The Internet of Things seems to be the worthy representative of a future technological, economic and social revolution. It has definitely a bright future, in which everything around us becomes a source of communicating information, paving the way for a multitude of more useful applications. This is undoubtedly the evolution that will have the biggest impact, since there are tens of billions of "devices" that will be connected very soon.

The new behaviors and uses of customers, as well as the inherent mass of data available, imply ineluctable digital transformations for the Bank's stakeholders [1]. Thus, the digital transformation of any institution, including financial ones, is driven by new trends in the digital world. All these changes are likely to upset the old model of

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banks as we know it, to give birth to a new style of connected banks... intuitively, processes represent the first brick to pose to carry out the digital banking transformation. Thereby, the purpose of this analysis is to study the impact of digital trends driven by the emergence of connected objects on the procedural scheme of a traditional bank.

The remainder of this paper is organized as follows. We introduce some related works in Section 2. Section 3 describes the use of IoT on financial services. We present in Section 4 the tools used to analyze the data. Results are presented in Section 5. Finally, we conclude this paper in section 6.

2. Related works

Imagine a world where all objects are able to exchange information and communicate with each other. Objects able also to interact with their users using the Internet and other communication networks. This is not a scoop, the growth prospects of the IoT sector are largely confirmed. Globally, the number of IoT connections will reach 25 billion by 2025 (According to GSMA Intelligence) [2].

Historically, the term 'Internet of Things' was firstly coined in 1998 by Kevin Ashton at the Massachusetts Institute of Technology (MIT) and defined as it "allows people and things to be connected Anytime, Anyplace, with Anything and Anyone, ideally using Any path/ network and Any service" [3]. The Internet of Things has evolved in five phases (fig.1): it begins with connecting two computers together then a large number of computers with the creation of World Wide Web. After that comes the mobile-Internet: the connection of mobile devices to the Internet then the people-Internet: connection which is supported by the social networks. Finally, it progressed to the Internet of Things: the interconnected objects world [4].

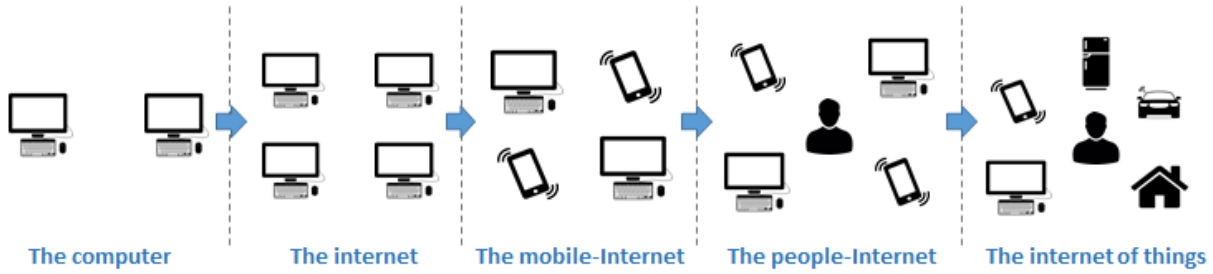

Fig. 1. The evolution of the internet of things

The Internet of Things is evolving at an exponential rate affecting all areas of daily life. Connected objects are undeniably a step towards new uses in many economic sectors. Services (e.g. banking, insurance, transport…) will surely take advantage of the ability of these technologies to collect process and exchange a multitude of data instantly and autonomously [5]. This will pave the way for new business opportunities and the emergence of a new form of "smart service" based on connected objects. Today, we are talking about connected health, smart banking and connected home as new services that bring changes in consumer behavior (mobility, ubiquity, connectivity, etc.).

In these conditions, the bank will be one of the economic actors that will take advantage of the opportunities offered by connected objects. In fact, the banking sector is investing heavily in new technologies, and according to Capgemini [6], it will continue to exploit new technologies to improve the customer experience and consolidate their relationship with this one. Connected objects are therefore new tools that banks can integrate into their digital strategy to satisfy the customers' expectation of real-time banking [7]. The main goal of digital technology is the personalization of customer experience which means offering products and services at the right time, in the right packaging and into the right channel [8].

3. Problem description

The digital revolution has transformed the banking sector. Over the last twenty years, traditional banks have to rethink their way of operating and their services to respond to those changes. IoT represents one of the essential

supports for a bank to implement its digital transformation. Thus, to assist banks in the integration of IoT in their products and services, we analyzed the correlation of the digital trends using these technologies on the different banking processes. For this analysis, we used data clustering methods and fuzzy logic under R ecosystem.

3.1. IoT on financial services

Connected objects are undeniably one of the opportunities that banks must embrace to stay competitive. Nowadays, consumers expect a lot of innovation from their bank and especially from the new digital one that will offer them the appropriate services to their new way of connected life [9]. Below, we explain 7 digital trends using IoT that have a direct impact on financial services: mobile banking, M-banking, crowd-based financing, virtual money, high frequency trading firm, cyber criminality, big data and IT analytics.

- Mobile banking

Account management on things: Faced with the new trend of digitizing services, consumers are now claiming ease, seamless and instant access to all banking services. Thanks to the internet of things, it is possible to access to his banking account from any digital interface. Also, biometrics represents all computer techniques designed to automatically recognize an individual based on his or her physical, biological or even behavioral characteristics. Biometric data is unique, permanent and specific to individuals (DNA, fingerprints, etc.). It allows an account access and banking service management from any object having a digital interface.
Substituting physical signatures: Several banking services and products require physical signatures that can be replaced by "Wet Ink" technology: the cloning on paper of physical signature made via any touch screen device. Thus, the physical presence of the consumer is no longer necessary.
Real-time monitoring of collaterals and assets: IoT technology allows banks to monitor and track the status of the assets financed (car, appliance, machinery industry ...). Thanks to the digital identity of people and objects, the request for financing and the transfer of ownership could be automatic and entirely digital. It is also possible to monitor the quality of collateral by monitoring the condition of the assets and judging whether to keep them physically or not. For example, if a bank finances an engine whose refunds are not made, the bank may deactivate it remotely.

- M-banking

Automated payment through a great number of endpoints: Internet of Objects formerly limited to tasks such as counting the number of steps or measuring the heart rate are now renewed and allow payment. The future of payment is moving towards a diversification of means of settlement. Now all eyes are on instant payment. Encouraged by regulators, this technology becomes essential. Today, trust in contactless technology is fueling the growth of the connected devices market. Also, biometrics technology offers a fairly comfortable level of security for increasingly innovative connected objects. This ability to integrate contactless on any object makes them more attractive to consumers. Thus, the future will bring all the more innovations that any object can become a means of payment. A number of companies are already working on the next step with, for example, Levi's and Jacquard by Google developing the "Commuter Trucker Jacket" jacket that integrates contactless payment directly into the sleeve. So, even if our jacket can make payments, imagine what will be on your pockets!
Wallet of things: The wallet is a device that can store money without the need for a bank account and make payments directly to any payment terminals. Any device or equipment will host an attached, pre-funded wallet to automatically and instantly manage its expenses.
Smart Contracts: The owner of Burj Khalifa in Dubai, the tallest tower in the world disconnects the elevator system for tenants who are late for their rent. Thus, in the near future, it will be possible to connect an action (here, the deactivation of the elevator) to a condition (the non-payment of rent) automatically through smart payment contracts. So, banks can now offer consumer products in an automated and instantaneous process.

- Crowd-based financing

Crowd-based financing is a mechanism for collecting financial flows - usually small amounts - from a large number of individuals via an internet platform - to finance a project. It can also benefit from the emergence of the IoT by using its new technologies, terminals and platforms. It will also allow analyzing the quality of borrowers and their

repayment habits by evaluating and scrutinizing the different IoT's data.

- Virtual money

Blockchain is one of the technologies to track in the years to come. It could revolutionize many sectors of the economy, starting with banking and insurance. It allows you to store and transmit information transparently, securely and without a central control. It looks like a large database that contains the history of all the exchanges made between its users since its creation. The blockchain can be used in three ways: for the transfer of assets (currency, securities...), for better traceability of assets and products and for executing automatically contracts ("smart contracts"). It can be used on IoT platforms to cope with digital challenges: having an analytical model tracking which records the data generated during an IoT process, ensuring security by imposing sharp identification rules and finally settling instantaneous payments between devices and network participants [10].

- High frequency trading firm

Smart algorithmic models: thanks to the Internet of Things, the size and speed of data will continue to grow. Companies that will be able to use these data efficiently and quickly will have a better chance of developing efficient algorithms allowing maximum gain and targeted maneuvers.

- Cyber criminality

Faced with the growing need to secure bank transactions, financial institutions are offering innovative solutions based on biometrics, a technology that makes it possible to recognize an individual based on their unique physical and behavioral characteristics. Indeed, there are two essential steps in the user journey that require different levels of security: authentication and validation. Ongoing technological progress offer strong security solutions based, for example, on biometrics. In this sense, Barclays has developed a system of recognition of venous impression (more secure than the fingerprint because almost impossible to duplicate) to validate transactions, pay or subscribe to offers [11].

- Big data and IT analytics

Personal financial management: PFM is a novelty of the 21st century. Online personal financial management services were born in the United States in the 2000s. The principle of the PFM is simple: allow customers to have an accurate picture of their accounts, their incomes and their expenses. The offer of this type of service is varied, but there is a set of features and recurring principles. The set of PFM solutions provides the client a panorama of all the flows that come and go from his accounts. Using the data generated by the IoT, the future generation of PFM tools will help banks to offer customized services and more tailored to their clients. All that is needed is that an IoT generates alerts or signals to track the customer's consumption and why not activate /deactivate specific products managed by the bank.

Know Your Customer: KYC is commonly used in banking to refer to the procedures of identification and customer knowledge. KYC means "Know Your Customer". It should be noted that in the banking sector, KYC procedures are essentially set up to comply with regulatory and prudential requirements to prevent fraud and money laundering. The data collected during these procedures can obviously give rise to marketing uses. The use of IoT with a unique and universal digital identity will define the financial behavior of a customer to help offering appropriate services and products ... for example a credit card with promotions on shops frequented by the customer.

3.2. Banking processes

In this analysis, processes of a traditional bank are divided into three families (realization processes, supporting processes, management processes), 20 macro-processes, 73 processes, 224 under-processes that describe the different banking activities (Table 1).

3.3. Data description

To analyze the impact of IoTs on banking processes a correlation matrix C: processes/digital trends have been constructed. This matrix is filled through a questionnaire sent to financial experts via LinkedIn, Gmail ... the values

of the matrix are between 0 and 1. The structure of matrix C is detailed below (the matrix C is large so we have just detailed the family processes, macro processes and the digital trends analyzed):

Table 1. Characteristic of the matrix C

Key features	Description
C matrix rows (level 1): family processes	Realization processes
	Supporting processes
	Management processes
C matrix rows (level 2): macro processes	Develop and Improve of Products and Services
	Sell products and services
	Manage the customer relationship
	Perform banking operations
	Realize the market operations
	Perform securities transactions
	Realize international operations
	Manage credit requests
	Provide legal support and compliance
	Develop agencies network
	Develop human capital
	Manage accounting and finance
	Align and optimize the information system
	Develop logistics and infrastructure
	Manage communication
	Pilot and implement the strategy
	Audit and ensure general and permanent control
	Ensure the governance and management of the banking activity
	Pilot and control risks
	Develop growth drivers and share management
C matrix columns (level 1)	Mobile technology
	Financial technology
	IT security
	Data intelligence
C matrix columns (level 2)	Mobile payment
	M-banking (Mobile banking)
	Crowdfunding
	Virtual money (bitcoin, ripple…)
	High frequency trading firm
	Cybercriminality
	Big data and IT analytics

4. Data analysis

To analyze the Correspondence matrix C we will use the hierarchical classification analysis based on fuzzy jaccard dissimilarity. The correspondence matrix C is in the form 223×7, to transform it into a square matrix 7×7, we use the fuzzy jaccard's distance on the transpose of C: C^T. So, we obtain the Digital Dependency Matrix DDM which represents the dependence between digital trends. The analysis of DDM to group the digital trends will be done using hierarchical ascending classification. Those data mining methods will be implemented on R ecosystem.

- **Hierarchical ascending classification:** it is an automatic classification method used in data analysis to divide a set of individuals into a number of classes. The method assumes that there is a measure of dissimilarity between individuals; in the case of points located in a Euclidean space. The hierarchical ascending classification is said to be ascending because it starts from a situation where all individuals are alone in a class, then are gathered in larger and larger classes.

- **Classical jaccard's index and distance:** are two metrics used in statistics to compare similarity and diversity (in) between samples. Let two sets A and B, the index is:

$$J(A,B) = \frac{|A \cap B|}{|A \cup B|} \quad (1)$$

Jaccard's distance measures the dissimilarity between sets. It simply consists of subtracting the Jaccard index from 1.

$$J_\delta(A,B) = 1 - J(A,B) \quad (2)$$

- **Fuzzy set concept**

A fuzzy set A is denoted as $\{(x, \mu_A(x)), x \in \Omega\}$ where $\mu_A(x)$ is the grade of membership of x in A. Here $\mu_A(x)$ is a real number satisfying $0 \leq \mu_A(x) \leq 1$. The complement of the fuzzy set A is denoted by A_c and is defined by a membership function: $\mu_A{}^c(x) = 1 - \mu_A(x), \forall x \in \Omega$ (3)

Let A and B be fuzzy sets that A, B ⊆ U, u is any element (e.g. value) in the U universe: u ∈ U

The cardinality:	$\text{Card}(A) = \lvert A \rvert = \sum_{u \in U} \mu_A(u)$	(4)
Standard union:	$\mu_{A \cup B}(u) = \max\{\mu_A(u), \mu_B(u)\}$	(5)
Standard intersection:	$\mu_{A \cap B}(u) = \min\{\mu_A(u), \mu_B(u)\}$	(6)
Union cardinality:	$\text{Card}(A \cup B) = \lvert A \cup B \rvert = \sum_{u \in U} \max(\mu_A(u), \mu_B(u))$	(7)
Intersection cardinality:	$\text{Card}(A \cap B) = \lvert A \cap B \rvert = \sum_{u \in U} \min(\mu_A(u), \mu_B(u))$	(8)

- **Fuzzy jaccard's index and distance:**

Let: P: the set of processes

Tr: the set of 7 digital trends analyzed in section 3.1

C^t: The transpose of the digital transformation matrix (that shows the impact of digital trends on processes)

J: The matrix resulting from using the jaccard index on C^t.

DDM: the dependency digital matrix (DDM): the matrix resulting from using the jaccard's dissimilarity on C^t.

$$C^t = C^t{}_{ij}\ ; C^t{}_{ij} \in [0,1]\ ;\ DDM_{ij} = 1 - J_{ij} = 1 - J(Tr_i, Tr_j) = 1 - \frac{|P(Tr_i) \cap P(Tr_j)|}{|P(Tr) \cup P(Tr_j)|} = 1 - \frac{\sum_{k=1}^{223} \min(Tr_{ik}, Tr_{jk})}{\sum_{k=1}^{223} \max(Tr_{ik}, Tr_{jk})} \quad (9)$$

5. Results and discussion

In this part, we will use the tools previously defined to analyze the data. First of all, we calculate the Jaccard's distance of DDM and use the HAC to draw the dendrogram (Fig.2). Then, we represent the inertia jumps of the dendrogram according to the number of classes (Fig.3). We see clearly the biggest jumps of inertia in 2 and 4 classes (Fig.4). Finally, we represent the partitions 2 and 4 on the dendrogram (Fig.5)

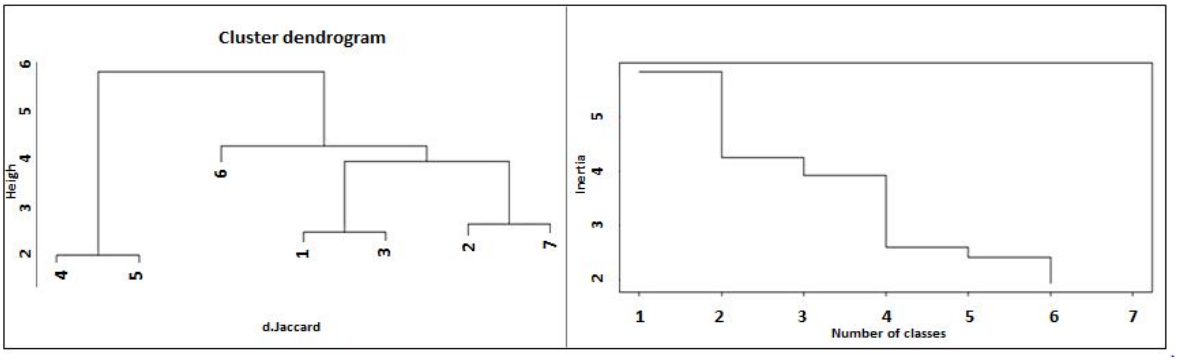

Fig.2: The dendrogram using HAC

Fig.3: Jumps of inertia of the dendrogram

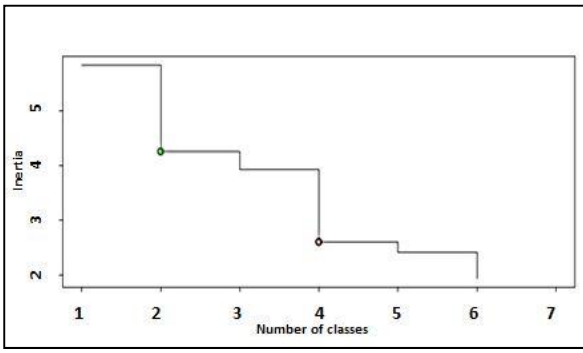

Fig.4: Coloring Jumps of inertia of the dendrogram

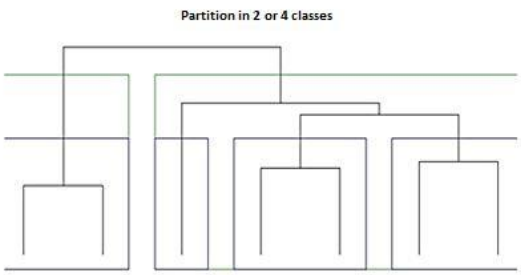

Fig.5: Partitioning the dendrogram in classes

The analysis with Data clustering highlights 2 groups of digital trends detailed below:

Table 2. Results of data analysis

Group 1		Group 2	
Class 1	Mobile banking	Class 1	Mobile banking
	Crowd-based financing		Crowd-based financing
	M-banking	Class 2	M-banking
	Big data and IT analytics		Big data and IT analytics
	Cyber criminality	Class 3	Cyber criminality
Class 2	Virtual money	Class 4	Virtual money
	High frequency trading firm		High frequency trading firm

We note that group 1 is composed of 2 classes and group 2 is composed of 4 classes. We retain the group 2 because the groupings are more detailed. Note that groups mix between fintechs, mobile technology and data intelligence. Cyber criminality represents a trend which has a horizontal impact on all banking processes.

- **Class 1:** Just like payment, crowd-based financing fintechs start disrupting more and more the peace enjoyed by financial institutions. As banks seek to minimize their balance sheet exposure in small and medium-sized businesses, fintechs try to take advantage from the situation with proposing appropriate services to customers. In our analysis, mobile banking is classified in the same class as crowd-based financing, those two trends influence banking processes in the same way. Thus, one could assume that in case of collaboration with fintechs and using the mobile-related IoTs as substituting physical signatures and real-time monitoring of collaterals and assets, the mobile will become the most appropriate platform for crowd-based funding. Thus, these trends will influence the management of transactions and bank payments.

- **Class 2:** The mobile payment represents one of the non-undeniable sources of big data and IT analytics, it makes it possible to define the behavior of the customer and his habits. Thus, to promote their adoption and use, mobile payments must provide users with more than the convenience without money but rather an added value adapted to both their person and their situation. Today, fintechs have already begun to take advantage of big data by offering a targeted and real-time offer to customers. Also, while banks are using credit scoring models that are still not so reliable, tracking consumer payments with a crypto graphical and secure history will be able to evaluate consumers on the basis of a global credit score. Bank risk management will surely evolve to use a new type of data and propose an innovative range of products.

- **Class 3:** The IoT has indeed new security flaws. Thus, the majority of connected objects have not been developed with a primary security concern and minimal configuration options. In some cases, there is a lack of authentication or authorization protocols. Cybercrime has a horizontal impact on all banking processes, especially authentication and identification of customers when executing different banking services. Several checkpoints should be put in place to protect customer data from cyber-attackers.

- **Class 4:** Billions are traded daily via a slow, complicated system that requires a lot of expenses. For example, crypto-currencies that are managed by cheap and fast technologies can revolutionize the world of payments and severely disrupt the transaction management processes operated by banks. The blockchain allows access to borderless payments. Also, it takes a lot of logistics to move money around the world; a bank transfer requires an average of three days because of the complexity of the financial infrastructure: intermediary, correspondent bank, custodian ... a whole network set up that will have to be maintained later. Besides, the swift that is used to issue the transfer orders will gradually give way to the blockchain that manages the flow of money in a more fluid and efficient way.

6. Conclusion

Change does not happen overnight. The IoTs are still in their infancy but promise a better future. Some believe that technological advancement and new digital trends will replace traditional banks, while others argue that they will complement the traditional financial infrastructure by making it more efficient. The whole model of the bank as we know it will move to another more connected and digital driven organization [12]. New digital trends are changing one way or another several banking processes: risk management, transactional model, information system… In the future, we will propose an intelligent proceeding to conduct the digital transformation of companies by studying the impact of new digital trends using systemic theory on the internal modelling.

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