The Impact of IS Investment on Bank's Performance based on MCDM Techniques

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Abstract: While banks are investing heavily in information system (IS), the results of studies of the relation between those investments and superior performance of the firm are mixed. Many studies have analysed the impact of IS investment on firm performance, without taking into account the non-financial firm's performance, This paper proposes a framework to evaluate the non-financial bank's performance based on an approach combining two most used MCDM methods and the impact of IS investment on this performance. The results of this study that dealt with fifty banks show that IS investment does not insure superior performance.

1 INTRODUCTION

The relationship between information system (IS) and firm performance is among the topics that are worrying researchers as well as leaders who invest heavily in IS, and want to discover if those investments are rewarded by the improved firm performance.

However, results from research that have study this relation are contradictory; some authors have confirmed the positive impact of IS investment on firm performance (Barua et al., 1995) (Rai et al., 1997) (Dedrick et al., 2003) (Ada et al., 2012) (Lim & Trim, n.d.). While other found no significatif impact of IS investment on firm performance (Koski, 1999) (Strassman, 1990) (Ho et al., 2011).

The mixed results can be explained by firm's sector, work methodology and the choice of research model's variables (Kleis, 2012) (Liao et al., 2015) (Saunders & Brynjolfsson, 2016).

The majority of literature's studies deal with financial firm's performance forgetting the non-financial aspect of the performance.

This paper investigates the impact of IS investment on non-financial performance of banks using actual data from fifty banks. Besides, this study proposes a combined approach of mutli criteria decision-making methods (MCDM) to evaluate the non-financial bank's performance.

The structure of this paper is as follows: section 2 and 3 present respectively an overview of works related with non-financial performance, IS investment and its impact on firm performance and the most used MCDM methods. Next section exposes work methodology and main results. At the end, we present concluding remarks.

2 LITERATURE REVIEW

2.1 Non-financial Performance

The evaluation of firm's performance has long been based on financial results through financial indicators (Gijsel, 2012), but this purely financial vision has been strongly criticized, in this way we do not assess the true and global firm's performance. The overall performance sought at the firm level need to be assessed on the basis of financial and non-financial indicators (Bogieevie et al., 2016).

Performance measurement system is a group of techniques implemented by leaders to evaluate the performance of firm's activities (Neely et al., 2000). Authors have fixed the examples of the most popular techniques for proposing a set of performance measures such as: balanced scorecard (Kaplan & Norton, 2005)and performance hierarchies (Lynch & Cross, 1991).

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Nevertheless, the choice of appropriate indicators to evaluate performance is one of the most critical projects due to the multidimensional aspect of performance and yet the indicators are not an independent process that can be applied to all types of firms.

The performance measures based on non-financial indicators have been widely applied by researchers (Drury & Tayles, 1995) (Gomes et al., 2004) (Imsail & King, 2007) (Ibrahim & Lloyd, 2011).

With the multitude of non-financial performance indicators, in this work, we choose to use the most used indicators (Milan & Aluç, 2017) (Zhelyuk & Popa, 2009) (Strandberg, 2014) such as: customer satisfaction, market share, employee feedback, and human resource…

2.2 IS Investment and Firm Performance

Since 1980, the authors began to study the impact of investment in information system on firm performance (Solow, 1987). The finding of previous studies can be grouping to three possibilities. Studies confirming the positive impact of IS investment on firm performance (Kwon, 2007), in 2005, the results of study (Lee & Kim, 2006) has showed that IS investments cause economic performance, other studies have confirmed the positive impact between the IS investment and performance but taking in each time specific variables to the study and based on different theories. According to studies based on the IT productivity paradox and RBV theory (Jung, 2009) (Anderson et al., 2003) (Huang et al., 2006) (Otim et al., 2012), they confirm the negative impact of IS investment on firm's performance. Finally, some studies (Ho et al., 2011) (Motiwalla et al., 2005) showed that IS investment does not impact firm performance.

3 MCDM METHODS

3.1 Analytical Hierarchy Process

The analytical hierarchy process (AHP) is a powerful tool that can be used to analyse decision (Saaty, 1970).

It can be used when multiple or conflicting criteria are present also when the process of making decision is based on both qualitative and quantitative decisions.

The AHP method takes into account a set of evaluation criteria and alternatives to choose later the best decision among others based on the criteria of the study. The AHP implementation consists of three main steps (Saaty & Penivati, 2008).

An AHP analysis uses pairwise matrix A {m*n} to measure the item's impact on one level of the AHP hierarchy on the next higher level.

Each entry a_{ij} of A represents the importance of criterion i relative to criterion j (with; $a_{ij}a_{ji}=1$):

- If aij > 1: i is more important than j;
- If aij < 1: i is less important than j;
- If aij =1: same importance.

The normalized decision matrix A_{norm} is derived by A using Eq (1):

$$C_{ij}=a_{ij}/\sum_{j=1}^{n} a_{ij} \text{ / i, j= 1,2…n} \quad (1)$$

Finally, the weighted normalized decision matrix is built using Eq (2) under the form (3):

$$W_i=\sum_{j=1}^{n} C_{ij} \text{ / n= 1,2…n} \quad (2)$$

$$W=\begin{bmatrix} w_1 \\ w_2 \\ \dots \\ w_n \end{bmatrix} \quad (3)$$

3.2 Topsis Method

TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) method developed in 1981 (Hwang & Yoon, 1981)is one of the most used MCDM methods that depend on distance to positive ideal solution and negative ideal solution.

The positive ideal solution (Wang & Wu, 2012) is composed of all the good values of criteria, wile the negative ideal solution include all worst values of criteria.

TOPSIS method procedure steps (Roszkowska, 2011) as follows:

- Construction of normalized decision matrix:

$$r_{ij}=\frac{x_{ij}}{\sqrt{\sum_{j=1}^{J} {x_{ij}}^2}} \text{ / j= 1,2…J; i=1,2…n} \quad (4)$$

Where x_{ij} and r_{ij} are original and normalized score of decision matrix.

- Construction of weighted normalized decision matrix:

$$v_{ij} = w_i * r_{ij} \text{/ j= 1,2…J; i=1,2…n} \quad (5)$$

- Determination of positive ideal solution and negative ideal solution:

$$A^{+}=\{(max_i\, v_{ij}|j\epsilon J),(min_i v_{ij}|j\epsilon J'\},\ A^{+}=\{v_1{}^{+}, v_2{}^{+} \dots v_n{}^{+}\} \quad (6)$$

$$A^{-}=\{(min_i\, v_{ij}|j\epsilon J),(max_i v_{ij}|j\epsilon J'\},\ A^{-}=\{v_1{}^{-}, v_2{}^{-} \dots v_n{}^{-}\} \quad (7)$$

J and J' represent respectively maximization and minimization values.

- Calculation the separation measures of each alternative from positive ideal solution and negative ideal solution:

$$S_i{}^{+}=\sqrt{\sum_{j=1}^{n}\left(v_{ij}-v_j{}^{*}\right)^2} \quad (8)$$

$$S_i{}^{-}=\sqrt{\sum_{j=1}^{n}\left(v_{ij}-v_j{}^{-}\right)^2} \quad (9)$$

- Calculation the relative closeness coefficient to the ideal solution:

$$C_i{}^{*}=\frac{S_i{}^{-}}{S_i{}^{-}+S_i{}^{*}} \quad \text{Where } 0\leq C_i{}^{*}\leq 1 \quad (10)$$

- Closeness of the alternatives to the ideal solution is ranked according to the value C_i^* the best alternative is that having the highest value.

4 IMPLEMENTATION

4.1 Work Methodology

Existing works on firm's performance and IS investment has looked at this subject from only the financial aspect of performance and all most the studies use only data collection and meta-analysis.

This study is focus on two main axes; it offers a framework to evaluate the non-financial bank's performance based on two famous MCDM methods namely AHP and TOPSIS, thereafter, it investigates the impact of IS investments on banks performance.

This work uses actual data providing from fifty banks, the choice of banking sector was made on the basis of its large consumption and investments on information systems.

To obtain our results, we implement a work methodology by following the steps shown in Figure 1.

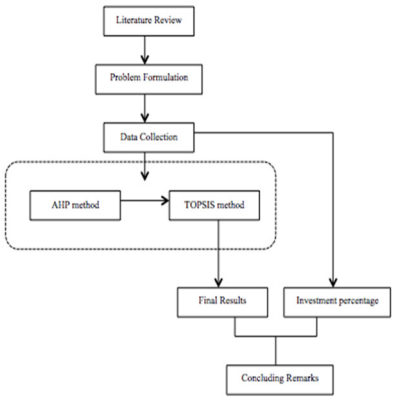

Figure 1: Research Procedure

The study begins with a literature review to get an overview of works related with non-financial performance and the impact of IS investments on this performance. Then, we formulate the work's problem to identify the inputs and outputs, in our case, we work on the bank's data to analyse the impact of IS investment on bank's performance; that's why we passed to data collection. In the step of data analysis, we used AHP method to calculate the weights of criteria and sub-criteria (Table 1) used to evaluate the non-financial performance; those criteria were taken from previous works. The weight's criteria are used next by TOPSIS method to evaluate bank's performance and to rank the different alternatives. In the step of data collection, we collect also data in relation with the percentage of IS investment to analyse afterwards the impact and to conclude with remarks.

Table 1: Hierarchical Representation of Criteria.

Main Criteria	Sub Criteria
Customer (C_1)	CustomerNumber (C_{11}), CustomerSatisfaction (C_{12}) and ComplaintsNumber (C_{13})
Expansion and Market Share (C_2)	BrancheNumber (C_{21}), NewProducts (C_{22}) and NewService (C_{23})
Employees (C_3)	Headcount (C_{31}), AverageAge (C_{32}), Satisfaction (C_{33}) and TrainingInvestment (C_{34})
Service Quality (C_4)	OnTimeDelivery (C_{41}), CommunicationCapability (C_{42}), RateDelay (C_{43}), Availability (C_{44}) and Access (C_{45})

Environment (C_5)	TotalPaperConsumption (C_{51}) and EnergyUse (C_{52})
Security (C_6)	RiskRate (C_{61}) and Breakdown (C_{62})

5 ANALYSIS RESULTS

In the previous section, we have presented the conceptual model adopted to evaluate the bank's non-financial performance. Figure 2 is a visualization of Table 1 representing six main criteria chosen to evaluate bank's performance (customer, expansion and market share, employees, service quality, environment and security) and sub-criteria (three sub-criteria to evaluate customer, three sub-criteria to evaluate expansion and market share, four sub-criteria to evaluate employees, five sub-criteria to evaluate service quality, two sub-criteria to evaluate environment and two sub-criteria to evaluate security).

To calculate the weights of criteria and sub-criteria, we implemented Eq (1)-(2)-(3). As can be seen from Figure 3, customer (w_1=0,36) is the most important non-financial criterion followed by expansion and market share (w_2=0,20), employees (w_3=0,17), service quality (w_4=0,16), environment (w_5=0,07) and security (w_6=0,03) is the least important non-financial criterion.

We can conclude that customer is the most influent criterion (Bolton, 1998) (Bolton et al., 2004) on firm's non-financial performance which is a logical result given the importance of the customers who are the mark of a good firm's image and who insure the others criteria especially market share and service quality.

Based on these results, we have implemented TOPSIS method to rank the fifty banks on terms of non-financial performance as shown in Table 2. In the stage of data collection, we worked by the value's conversion to facilitate data entry.

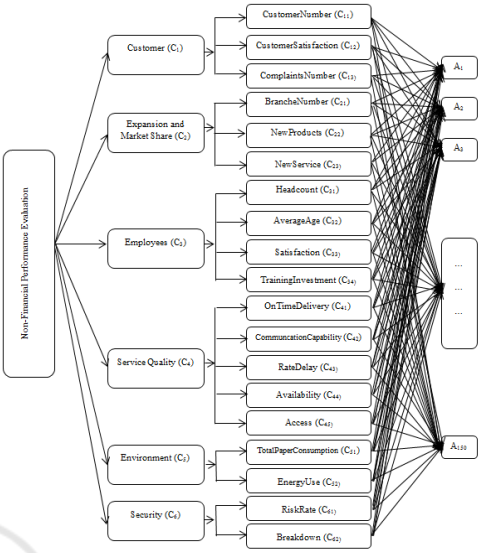

Figure 2: Hierarchical Structure

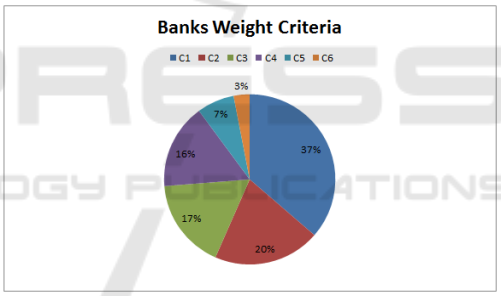

Figure 3: Banks Weight Criteria

Table 2: Decision Matrix of 50 Banks

	C_1			C_2			C_3				C_4					C_5		C_6	
N	1	2	3	1	2	3	1	2	3	4	1	2	3	4	5	1	2	1	2
1	A	AB	D	A	AA	D	B	AA	E	G	C	AC	D	I	L	B	AA	GA	HB
2	A	AC	D	A	AA	D	B	AB	F	G	D	AB	D	I	L	B	AB	GA	HB
3	B	AC	D	B	AB	D	A	AA	F	G	D	AB	D	I	L	B	AB	FA	HB
4	C	AC	D	C	AB	D	B	AA	E	G	D	AB	D	I	J	B	AB	GA	HB
5	B	AC	E	B	AB	E	C	AA	E	G	D	AC	D	H	L	A	AB	EA	IB
6	A	AC	D	C	AA	D	A	AB	E	H	D	AB	D	I	K	B	AA	GA	HB
7	B	AC	D	B	AA	E	A	AB	E	G	D	AB	D	I	L	B	AA	GA	HB
8	A	AB	E	B	AA	D	B	AB	E	G	D	AB	D	I	J	B	AA	FA	HB
9	A	AB	E	B	AA	E	A	AB	E	G	D	AC	D	H	L	C	AA	FA	HB
10	D	AB	E	C	AC	F	C	AB	F	G	D	AC	E	I	L	C	AC	FA	IB
11	B	AC	D	B	AC	F	B	AB	F	G	C	AB	D	I	J	B	AA	GA	HB
12	B	AC	D	B	AA	E	B	AB	F	G	C	AB	D	I	L	A	AA	GA	HB
13	C	AB	D	A	AA	D	A	AB	F	H	C	AB	D	H	K	B	AB	GA	IB
14	C	AB	E	C	AB	D	A	AB	F	G	D	AC	D	H	K	B	AB	EA	HB
15	C	AB	E	C	AB	D	A	AB	E	G	D	AA	D	I	L	B	AB	GA	JB
16	A	AB	E	C	AB	D	C	AB	F	G	D	AB	E	I	J	C	AB	GA	HB
17	C	AB	E	B	AB	E	B	AB	E	G	D	AB	D	I	L	C	AA	GA	IB
18	B	AB	D	B	AA	E	B	AB	E	G	D	AC	D	H	L	C	AA	GA	HB
19	C	AC	D	B	AB	E	C	AB	F	H	C	AC	D	H	K	C	AA	GA	HB
20	C	AB	F	C	AC	E	B	AB	F	G	C	AC	D	H	K	B	AA	GA	HB
21	C	AB	D	A	AA	E	B	AB	E	G	C	AC	D	I	K	B	AB	GA	HB
22	C	AC	E	B	AA	D	B	AB	F	G	D	AC	E	I	L	B	AB	FA	IB
23	B	AB	D	C	AB	D	A	AB	E	G	D	AB	D	I	L	C	AB	FA	HB
24	B	AC	D	B	AA	F	B	AB	F	G	D	AB	D	H	J	B	AB	GA	HB
25	A	AB	E	A	AC	D	A	AB	F	G	D	AB	D	H	L	B	AB	GA	HB
26	A	AB	E	B	AB	E	C	AB	E	H	C	AB	D	I	K	A	AA	GA	IB
27	A	AB	E	C	AB	D	B	AB	E	G	C	AA	D	I	K	C	AA	GA	HB
28	A	AB	E	B	AB	D	B	AB	E	G	C	AB	D	I	L	C	AC	GA	HB
29	B	AC	E	B	AA	D	B	AB	F	G	C	AB	E	I	J	C	AA	EA	JB
30	C	AC	D	C	AB	E	B	AB	E	G	D	AC	D	H	L	B	AB	GA	HB
31	A	AC	D	A	AA	E	B	AB	E	H	C	AC	D	H	L	B	AB	GA	HB
32	B	AC	D	B	AC	E	C	AB	E	G	D	AC	D	I	K	A	AB	GA	HB
33	B	AC	D	C	AA	D	B	AB	E	G	C	AC	D	I	K	B	AB	GA	IB
34	B	AB	F	B	AA	D	B	AB	E	G	D	AC	E	H	K	C	AA	GA	HB
35	C	AB	D	B	AB	F	A	AB	E	G	C	AC	D	H	L	B	AA	GA	HB
36	C	AC	E	C	AB	D	A	AB	F	G	D	AC	D	H	L	B	AB	EA	HB
37	A	AB	F	A	AB	E	A	AB	E	G	C	AB	D	H	L	A	AB	GA	HB
38	A	AC	E	A	AC	E	A	AB	E	H	D	AB	D	I	L	B	AB	FA	HB
39	A	AB	E	B	AB	F	B	AB	F	G	D	AB	E	I	L	C	AA	GA	IB
40	A	AC	E	C	AB	D	C	AB	E	G	D	AB	D	I	J	B	AB	GA	HB
41	B	AB	E	B	AB	E	B	AB	F	G	C	AC	D	I	L	B	AB	GA	HB
42	B	AC	E	B	AB	E	B	AB	E	G	C	AC	D	I	L	A	AB	EA	HB
43	C	AC	F	B	AA	F	A	AB	E	G	C	AC	E	H	L	B	AA	GA	JB
44	C	AC	F	C	AA	D	B	AB	F	G	C	AC	D	H	L	C	AB	GA	HB
45	A	AB	D	C	AC	D	B	AB	E	H	C	AC	D	H	L	B	AA	FA	HB
46	A	AB	E	B	AB	E	C	AB	F	G	D	AB	D	I	K	B	AB	FA	IB
47	B	AB	E	A	AB	F	B	AB	F	G	C	AB	E	I	K	B	AA	FA	HB
48	B	AC	E	B	AC	D	B	AB	E	G	C	AC	D	I	K	B	AA	GA	HB
49	A	AB	D	C	AA	E	B	AB	E	G	D	AC	D	I	L	B	AB	GA	HB
50	A	AB	D	B	AA	D	B	AB	E	G	D	AC	D	I	L	C	AA	GA	HB

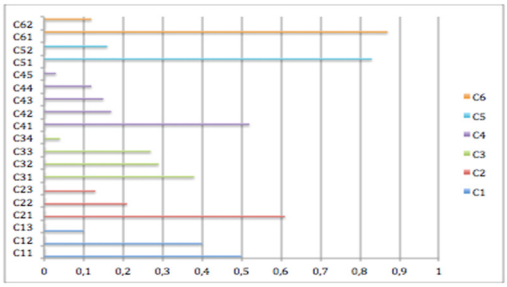

Figure 4: Sub-Criteria Weight

In this section, we evaluate the non-financial bank's performance based on the decision matrix (Table 2) and the weight's sub-criteria (Figure 4) using in order Eq (4) (5) (6) (7) (8) (9)(10) to obtain the rank of each alternative (bank).

Subsequently, we studied the correlation between the two variables (IS investment and non-financial performance). In general way, firms invest on IS to achieve better competitive advantages through reducing costs. Given the number of alternative, ten banks were selected based on the results of the non-financial performance evaluation (the first three, the four averages and the last three).

The financial sector is considered as the biggest investor in the IS. The figure below (Figure 5) shows the results of the IS investment percentage compared to the bank's turnover. It can be concluded that more than 80% of financial firms invest between 21 and 60% of their turnover in information systems; which is a huge investment given the large turnover of banks.

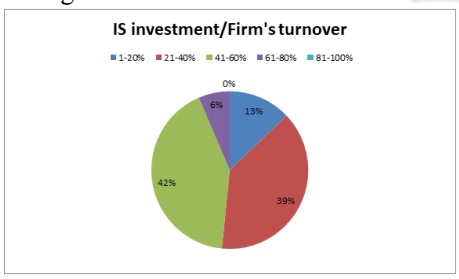

Figure 5: Bank's Investment Percentage

The curve shows the ranking of the bank's non-financial performance according to the IS investment (Figure 6), we find that the impact of IS investment does not always ensure the performance of the company, as shown concretely the example of the B_3 bank which is ranked third performance rating but in return invests only a percentage between 1-20%. Unlike the B_9 bank which invests 61-80% of its turnover but is ranked among the last three banks in terms of performance. These two contradictory examples lead us to believe that there are other factors that influence the relationship between IS investment and non-financial bank performance.

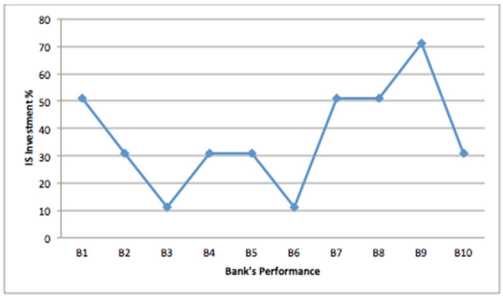

Figure 6: Impact of IS investment on Banks Performance

6 CONCLUSIONS

Evaluating the non-financial bank performance is crucial for the competitors and managers. Customer, expansion and market share, employee service quality, environment and security affect this type of performance. The use of several criteria and sub-criteria for bank evaluation makes the process of evaluating and ranking bank more difficult. In this study, we present a framework using the analytic hierarchy process (AHP) with TOPSIS method for evaluating the non-financial banking performance and supporting bank selection decision. The weights of different criteria and sub-criteria are calculated using the AHP method, and for ranking banks, one of the most popular MCDM namely TOPSIS has been used. Furthermore, this paper investigates the correlation between IS investment and non-financial bank's performance; more than 80% of bank's invest between 21 and 60% of their turnover in information system which is a huge investment unfortunately those investments are not rewarded by the improved bank performance, since we have bank who invest heavily in IS and are ranked at last among the others on term of non-financial performance. In the future, we will work in other sector to discover the way to evaluating their performance and ranking companies of the studied sector.

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