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JOURNAL OF APPLIED QUANTITATIVE METHODS

Quantitative Methods Inquires

Vol. 11
No. 2
Summer
2016

ISSN 1842–4562

JAQM Editorial Board

JAQM Advisory Board

JOURNAL OF APPLIED QUANTITATIVE METHODS

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PUBLIC SERVICE MOTIVATION AND EMPLOYEE OUTCOMES IN THE ITALIAN PUBLIC SECTOR: TESTING THE MEDIATING EFFECT OF PERSON-ORGANIZATION FIT

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Abstract

This article examines the relationship between Public Service Motivation and the following outcomes, Job Satisfaction, Organizational Commitment, Individual Performance and Quit Intention, essential outcomes in the life of any organization though in my work it is the school which is focused upon. Using a sample of 296 public teachers in the Italian public sector, a mediation model is outlined and tested empirically using Partial Least Squares-Path Modeling. Our results show that Public Service Motivation positively affects the congruence between employees' values and organizational mission, known as "Person Organization-fit", which in turn has significant positive associations with Job Satisfaction, Organizational Commitment, Individual Performance, but negative associations with Quit Intentions. All of these outcomes improve the performance in public and private organizations. In general, our findings suggest that if public managers want to improve the organizational performance and avoid their employees to quit the organization they belong to, then they must favor more in general Public Service Motivation, but more specifically the achievement of the above mentioned congruence.

Key words: Public Service Motivation, Person Organization fit, Italy

Introduction

Public Service Motivation (PSM) is 'an individual's orientation to delivering service to people with the purpose of doing good for others and society' (Hondeghem and Perry, 2009, p. 6). Many scholars have tried to study in depth the relationship between Public Service Motivation and employee outcomes, such as Job Satisfaction , Organizational Commitment and Performance (Cerase and Farinella 2009; Taylor 2008, 2011; Andersen et al. 2014). However, the process through which Public Service Motivation affects employee attitudes needs more attention. As far as we know to date, researchers like Bright (2007, 2008), Wright and Pandey (2008), Kim (2012) have concentrated their attention exclusively on the Person-Organization fit process (P-O fit), that is on the role of the shared values on which the fit is based; while researchers like Andersen et al.(2013a, 2013b) and Jensen et al.(2015) have focused their attention on another process, i.e. a specific orientation which public employees have toward the individual user of the public service (Andersen et al., 2013a, 2013b; Jensen et al., 2015), briefly called 'user orientation'.

In this study we have examined four different classes of employee attitudinal outcomes, i.e. Job Satisfaction, Organizational Commitment, Individual Performance and Quit Intention. More precisely we have related Public Service Motivation to them and also studied the relationships between P-O fit and these outcomes.

Our choice of the employee outcomes was triggered by one mainly consideration. As public organizations are under pressure in order to improve the efficiency and effectiveness of services, it's necessary to detect the factors that are associated with them as they could improve public service delivery and thus organizational performance.

In particular, our study is focused on an employee attitudinal outcome, i.e. intention to quit, which is the strongest indicator of actual turnover (Griffeth, Hom, and Gaertner 2000). This not only provides a link to the incipient Public Service Motivation process literature with its emphasis on other attitudes (Job Satisfaction and Organizational Commitment) but it also broadens both the boundaries of Public Service Motivation literature itself by examining a rarely considered attitude, i.e. the intention to quit (Bright 2008, Gould-Williams et al.2013, Mostafa, 2013) and contributes to the substantial body of P-O fit literature.

The article is structured as follows. First, we discuss the relationship between Public Service Motivation and its outcomes, then we examine the relationship between Public Service Motivation and P-O fit so as to provide a description of the process through which Public Service Motivation affects employee outcomes. Thereafter we provide an overview of the direct links between Public Service Motivation, P-O fit, and employee outcomes. The final section of our review highlights how P-O fit mediates the relationship between Public Service Motivation and employee outcomes. Following a description of the data and methodology, we test the study's hypotheses using Partial Least Squares- path Modeling (PLS-PM) with the software R. The final section presents our findings and discusses their implications for both theory and practice.

Theoretical Framework

PSM and its Outcomes

Many scholars have tried to understand and better define PSM (Perry and Wise, 1990, 368; Vandenabeele (2007, 547). Gould-Williams (2013, 599) synthesized it as "a value or attitude that motivates individuals to engage in behaviors that benefit society". Furthermore individuals with greater PSM are more satisfied with their public sector jobs, are committed to the organization they belong to and show better performance (Pandey and Stazyk, 2008; Perry and Wise, 1990; Andersen et al., 2014).

Job satisfaction is a "pleasurable or positive emotional state resulting from the appraisal of one's job or job experiences" (Locke 1976, 1304). Job satisfaction is important because it is positively correlated with motivation, job involvement, organizational citizenship behavior, organizational commitment, life satisfaction, mental health, and job performance and negatively related with absenteeism, turnover, and perceived stress (Judge et al. 2001). Many studies support the direct relationship between PSM and Job Satisfaction (Taylor 2008; Vandenabeele 2009; Kim, 2011). Therefore, we can expect Public Service Motivation to be directly and positively related to job satisfaction, as stated in the following hypothesis:

Hypothesis 1: *Public Service Motivation has a direct effect on Job Satisfaction. The higher the level of an individual's Public Service Motivation, the higher the level of Job Satisfaction.*

Organizational commitment is defined as "a psychological state that (a) characterizes the employee's relationship with the organization, and (b) has implications for the decision to continue or discontinue membership in the organization" (Meyer, Allen, and Smith 1993, 539). PSM has been theoretically and positively related to Organizational Commitment (Perry and Wise 1990; Crewson 1997; Pandey and Stazyk, 2008; Vandenabeele 2009; Kim 2011). On the basis of these studies, we formulated the following hypothesis:

Hypothesis 2: *Public Service Motivation has a direct effect on Organizational Commitment. The higher the level of an individual's Public Service Motivation, the higher the level of Organizational Commitment.*

Many researchers have tried to support the positive PSM -Performance relationship, both in terms of individual and organizational performance. In the study of Alonso & Lewis (2001) there is mixed evidence on whether PSM positively affected grades and performance ratings; in that of Brewer and Selden (2000) Public Service Motivation is a modestly important predictor of organizational performance. Andersen et al. (2014) investigated the association between PSM and the individual performance of Danish teachers using an objective outcome measure (the students' academic performance in their final examinations) and found that PSM is positively associated with examination marks, that is PSM may be relevant for performance improvement. Van Loon, N. M. (2015) provides a robustness test by analyzing the relationship between PSM and overall performance, also in its various dimensions (output, efficiency, service outcome, responsiveness, and resilience). Choi (2015) conducted a structural analyses of meta-analytic correlations with regard to PSM and its outcomes such as Job Satisfaction, Organizational Commitment and Individual Performance. He verified that PSM has positive and direct significant impacts on Job Satisfaction and Organizational Commitment. Therefore, public employees with higher PSM would be more satisfied with their jobs and committed to their organizations. On the other hand, PSM has small but direct effects on performance as well as indirect effects on performance through the mediating effect of Job Satisfaction and Organizational Commitment (Vandenabeele 2009). Therefore we can formulate the two following hypotheses:

Hypothesis 3: *Public Service Motivation has a direct effect on Performance. The higher the level of an individual's Public Service Motivation, the higher the level of Performance.*

Hypothesis 4: *Public Service Motivation has an indirect effect on Performance, through Job Satisfaction.*

Hypothesis 5: *Public Service Motivation has an indirect effect on Performance, through Organizational Commitment.*

Person-Organization fit (P-O fit) and Public Service Motivation (PSM)

P-O fit comes into play "when employees believe that their values match the organization's values and the values of other employees in the organization" (Cable and De-

Rue 2002, 876) or better it indicates the compatibility between individuals and organizational characteristics with regard to values, goals, and climate (Choi, 2015, 5). Furthermore individuals with greater P-O fit are also more satisfied with their public sector jobs, are committed to the organization they belong to (Bright, 2007; Kristof-Brown et al., 2005) as it happens when they are public service motivated.

If PSM and P-O fit lead to and favor the same outcomes, then trying to connect the former with the latter becomes challenger. Yet few scholars have welcomed this challenge. Wright (2008) found that the relationship between employee PSM and Job Satisfaction is not direct but "mediated by the extent to which the employee perceives that his or her values are congruent with those of the public sector organization", or better by P-O fit.

Bright (2007, 2008) and Wright and Pandey (2008) argue that PSM has no significant direct impact on individual performance and work attitudes when P-O fit is mediated in the PSM -performance relationship. Pandey, Wright, and Moynihan (2008) found that PSM increases Organizational Commitment when its influence on employee perceptions of an organization's mission valence occurs. Therefore we can formulate the following hypothesis:

Hypothesis 6: *Public Service Motivation has an indirect, positive effect on P-O fit.*
Hypothesis 7: *Public Service Motivation has an indirect, positive effect on Job Satisfaction through its influence on P-O fit.*

Bright (2008) argued that public employees with high levels of PSM are significantly more congruent with their organizations when compared with their counterparts with lower levels of PSM. According to Kim (2012,833) when public employees with high levels of PSM believe that their values match an organization's values, they develop a sense of attachment to the organization and are willing to give something of themselves in order to contribute to the organization's well-being. In other words, these employees could be more committed to their organization. This allows us to formulate two more hypotheses:

Hypothesis 8: *Public Service Motivation has an indirect, positive effect on Organizational through its influence on P-O fit.*
Hypothesis 9: *Public Service Motivation has an indirect, positive effect on Performance through its influence on P-O fit.*

Intention to Quit, P-O Fit and PSM

Ajzen and Fishbein (1980) and Igbaria and Greenhaus (1992) maintained that intentions are the most immediate determinants of actual behaviour, so intentions to quit are a good predictor of actual turnover. It is reasonable believe that not all turnover intention leads to actual turnover. As a matter of fact, in order to actually quit a job at least it is necessary an alternate employment, which is not always easy to achieve. According to Chang, Wang, and Huang (2013) turnover intention has a negative effect on organizational effectiveness because those employees with unrealized intentions to quit the organization are likely to use other types of withdrawal behavior. Moreover Hanisch (2002) underlined that Quit Intentions are usually associated with negative employee behaviors such as absenteeism, tardiness, and unauthorized breaks, which in turn may negatively affect the quality of public service delivery.

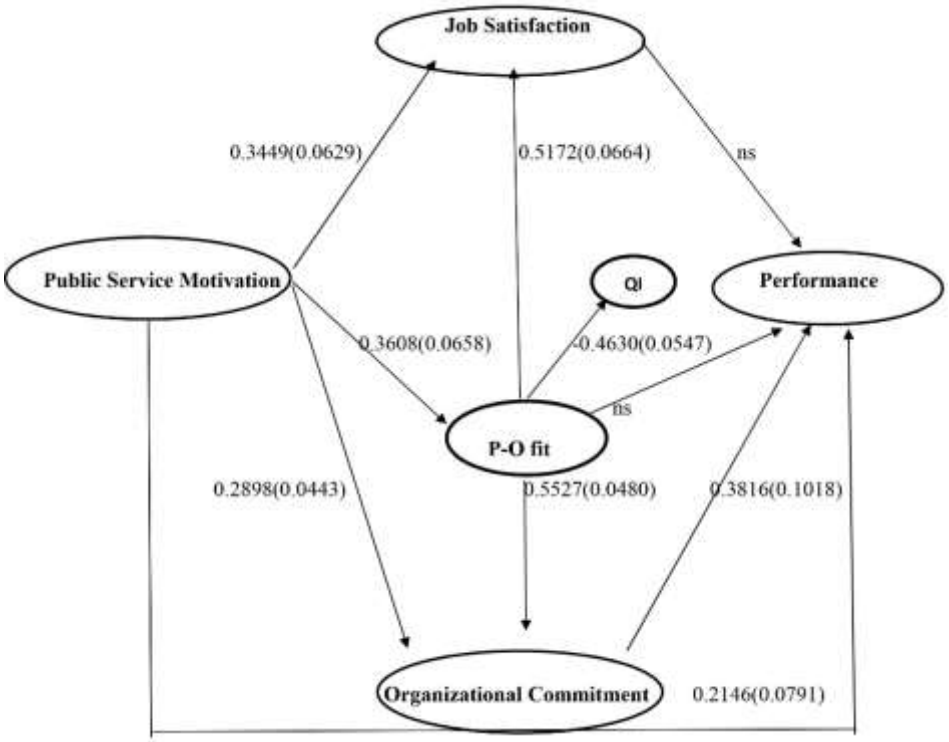
On the other hand, we argue that if organizational values are congruent with employees' values, then employees will be less likely to quit. There is evidence in support of these propositions. For instance, the study of Verquer, Beehr, and Wagner (2003) underlined that P-O fit is an important antecedent of quit intentions, but also of Job Satisfaction and Organizational Commitment. Narayanan and Sekar (2009) reported that P-O fit negatively influences the quit intentions of Indian teachers. Liu, Liu, and Hu (2010) found similar results in the Chinese public employees. Therefore, on the basis of the empirical evidence and our arguments presented above, we hypothesize the following:

Hypothesis 10: *Public Service Motivation has an indirect effect on intention to quit through its influence on P-O fit.*

Hypothesis 11: *PO-fit will negatively affect employees' intention to quit.*

Stimulated by the mentioned researches and their results, this study elaborates the relationship between PSM and its outcomes (i.e., Performance, Intention to Quit, Job Satisfaction and Organizational Commitment) by using the following conceptual model (see Fig.1). However, summarizing the purpose of this article, we want to investigate whether PSM or P-O fit is an antecedent of the attitudes to work of 296 public teachers in Italy. We can achieve this result by testing hypotheses on (1) whether PSM directly influences work attitudes (Job Satisfaction, Organizational Commitment, Performance), or (2) whether P-O fit mediates the relationship between PSM and work attitudes (JS, OC, P, QI) or, (3) whether both hypotheses are true.

Figure 1. Conceptual Model



In brackets Standard Error.

Method

In this study we employ a systematic and rigorous quantitative approach to reviewing empirical findings. The statistical analysis, infact, applied Partial Least Squares Path Modeling (PLS-PM) in R, that is a statistical approach for modeling complex multivariable relationships among manifest and latent variables (Fox 2006). This approach allows us to test all the relationship in the models simultaneously.

In the analysis the internal evaluation method used is the reflexive method, with the exception of the Job Satisfaction block for which we used the formative method. Such choice was adopted to remedy the fact that unidimentionality has not been reached by Job Satisfaction variable. As a matter of fact its Cronbach Alpha index and the Dillon and Goldensyein Rho index aren't at least equal to 0.7.

We have also evaluated the outer weights, the loadings and the paths coefficients, as well as the residuals. We have also calculated the indexes to measure the predictive capacity of the model: the communality index, the R-squared of each structural relationship, the redundance index, and GoF (Goodnes of Fit index). Finally we carried out the bootstrap validation to check the significance of the links among the variables. All the work has been done using standardized data. Data don't meet the assumptions of the parametric test, especially the assumption about normally distributed data.

Data and sample

The survey took place from September to December 2015 through a structured questionnaire.

The sample consisted of 296 employees of Italian public schools. Table 1 shows the demographic characteristics of the respondents, in terms of age and gender.

Table 1. Distribution of sample by age group and sex (%)

Respondents	Male 21.63%	Female 78.37%	Total 100%
Age			
≤ 30	0.00%	0.67%	0.67%
31-40	1.01%	10.47%	11.48%
41-50	6.08%	31.75%	37.83%
51-60	9.12%	30.74%	39.86%
> 60	5.40%	4.72%	10.12%

Thus this sample is composed by more female than male and more than 50% of respondents are 50 or over. It reflects the profile of the European teacher published by Eurostat (the statistical office of the European Union) on the occasion of the World Teachers' Day on 5 October 2015. Eurostat highlighted that in all EU Member States, the teachers' staff was predominantly female. Female teachers were largely over-represented in the early education stages (Italy, 95,8%). Furthemore in Italy more than half of the teaching staff had reached the age of 50 and over in all education levels (Report Eurostat 2015).

Measurement

Several survey items were used to construct the study variables and then the questionnaire. The questionnaire asks respondents to rate their agreement with the items about

the detected variables making from 1 (highly agree) to 5 (highly disagree). In order to measure PSM we used Perry's (1996) 40-item and 6-dimension scale.

To assure equivalence of the measures in the Italian and the English versions, all the scales used in this study were translated into Italian and then translated back into English. As regards Perry's scale items we have positively reworded the negative items in positive ones. For instance we have reworded "politics is a dirty thing" in "politics is a noble thing". Infact Coursey and Pandey (2007) noticed that, in the original formulated items, the terms ''politics'' and ''politicians''induce negative reactions and tap political distrust. For instance we have reworded "politics is a dirty thing" in "politics is a noble thing".

All items associated with the measures are shown in the Appendix A.

Results

Table 2 shows the results of the PLS-PM method. All Cronbach's alphas (or Dillon and Goldenstein Rho indexes) are greater than Nunnally's (1978) suggested level of 0.7. In the analysis the internal evaluation method used is the reflexive method, with the exception of the Job Satisfaction block for which we used the formative method. Such choice was adopted to remedy the fact that unidimentionality has not been reached by Job Satisfaction variable. As a matter of fact its Cronbach Alpha index and the Dillon and Goldenstein Rho index aren't at least equal to 0.7.

Table 2. Blocks Unidimensionality

	Type.measure	MVs	C.alpha	DG.rho	eig.1st	eig.2nd
psm	Reflective	16	0.867	0.890	5.53	1.689
po	Reflective	4	0.447	0.754	2.64	0.767
js	Formative	3	0.000	0.000	2.19	0.529
oc	Reflective	5	0.400	0.669	2.44	1.029
qi	Reflective	3	0.918	0.948	2.58	0.299
srp	Reflective	4	0.811	0.879	2.61	0.796

psm: Public Service Motivation, js: Job Satisfaction; oc: Organizational Commitment; po:P-O fit; QI:Quit Intention; srp: individual Performance.

Table 3 shows the loadings of all items on their factors. They are in a range between .522 and .961. Although some items of PSM have reached low values (<0.5), we preferred not do delete them as they are significant in our analysis.

Table 3. Outer Model

	weights	std.loads	communal	redundan
psm				
SJ3	0.0643	0.423	0.179	0.0000
CD1	0.1410	0.607	0.368	0.0000
APM1	0.0532	0.441	0.195	0.0000
APM2	0.0734	0.324	0.105	0.0000
APM3	0.0474	0.410	0.168	0.0000
CPI1	0.1048	0.518	0.269	0.0000
CPI5	0.1117	0.615	0.378	0.0000
SS1	0.1054	0.617	0.381	0.0000
SS2	0.1434	0.599	0.358	0.0000
SS3	0.0948	0.601	0.361	0.0000
SS5	0.1500	0.773	0.597	0.0000
SS6	0.1089	0.667	0.446	0.0000

SS7	0.1408	0.766	0.587	0.0000
SS8	0.1315	0.783	0.613	0.0000
C1	0.0900	0.483	0.233	0.0000
C5	0.0908	0.515	0.266	0.0000
po				
PO1	0.2700	0.780	0.608	0.0792
PO2	-0.2902	-0.634	0.402	0.0523
PO3	0.3429	0.891	0.794	0.1034
PO4	0.3304	0.907	0.823	0.1071
js				
OC1	0.3955	0.824	0.680	0.3501
OC2	0.2767	0.858	0.736	0.3791
OC3	0.5053	0.864	0.747	0.3846
oc				
OC4	0.3037	0.710	0.503	0.2542
OC5	0.3568	0.786	0.617	0.3117
JS1	0.2768	0.698	0.487	0.2460
JS2	-0.1995	-0.552	0.305	0.1541
JS3	0.2802	0.717	0.514	0.2595
qi				
QI1	0.3346	0.907	0.823	0.1765
QI2	0.3794	0.961	0.923	0.1979
QI3	0.3637	0.913	0.833	0.1786
srp				
SR1	0.3814	0.874	0.763	0.1383
SR2	0.3496	0.901	0.812	0.1471
SR3	0.3378	0.894	0.800	0.1450
SR4	0.1069	0.466	0.217	0.0393

All average variance extracted (AVE) scores are above 0.5 (see Table 4), only PSM has a smaller value.

Table 4. Summary Inner Model

	LV. Type	Measure	MVs	R.square	Av.Commu	Av.Redun	AVE
psm	Exogen	Rflct	16	0.000	0.344	0.0000	0.344
po	Endogen	Rflct	4	0.130	0.657	0.0855	0.657
js	Endogen	Frmtv	3	0.515	0.721	0.3713	0.000
oc	Endogen	Rflct	5	0.505	0.485	0.2451	0.485
qi	Endogen	Rflct	3	0.214	0.860	0.1843	0.860
srp	Endogen	Rflct	4	0.181	0.648	0.1174	0.648

psm: Public Service Motivation, js: Job Satisfaction;oc: Organizational Commitment; po:P-O fit; QI:Quit Intention;srp: individual Performance.

The observable variables (represented by the items) of the model are actual expressions of the latent ones (PSM and its outcomes) to which they are linked as the correlations for the related latents are greater in all blocks in comparison to the correlations with the other latent variables (see Table 5) .

Table 5. Correlations between Manifest Variables and Latent Variables

	psm	js	oc	po	qi	srp
psm						
SJ3	0.423	0.0717	0.1673	0.1393	-0.0921	0.2411
CD1	0.607	0.3405	0.3871	0.3944	-0.2290	0.1676
APM1	0.441	0.0923	0.1770	0.1221	0.0163	0.0925
APM2	0.324	0.1609	0.2419	0.1575	0.0040	0.1113

APM3	0.410	-0.0005	0.1801	0.0928	-0.0063	0.1588
CPI1	0.518	0.1613	0.2805	0.2551	-0.0900	0.2904
CPI5	0.615	0.1665	0.2996	0.2927	-0.1214	0.2851
SS1	0.617	0.2486	0.2996	0.2410	-0.0963	0.1949
SS2	0.599	0.2576	0.3898	0.3850	-0.1555	0.2960
SS3	0.601	0.1643	0.3072	0.2667	-0.0920	0.1063
SS5	0.773	0.3080	0.4496	0.4029	-0.2064	0.2010
SS6	0.667	0.2266	0.3234	0.2931	-0.1740	0.1468
SS7	0.766	0.2996	0.3992	0.3583	-0.1572	0.2428
SS8	0.783	0.2553	0.3899	0.3544	-0.1974	0.1980
C1	0.483	0.1896	0.2296	0.2589	-0.1181	0.1541
C5	0.515	0.1488	0.2219	0.2659	-0.1524	0.2104
po						
PO1	0.234	0.7800	0.5226	0.4908	-0.2159	0.1058
PO2	-0.240	-0.6341	-0.3731	-0.4807	0.5687	-0.1129
PO3	0.363	0.8914	0.5866	0.5898	-0.3468	0.2051
PO4	0.313	0.9073	0.5785	0.5539	-0.3655	0.1963
js						
OC1	0.385	0.5779	0.8244	0.5729	-0.3185	0.1997
OC2	0.398	0.5984	0.8578	0.6532	-0.3951	0.2166
OC3	0.533	0.4898	0.8640	0.6538	-0.3363	0.2657
oc						
OC4	0.454	0.4292	0.5934	0.7095	-0.3744	0.2817
OC5	0.413	0.6033	0.6846	0.7856	-0.3497	0.2784
JS1	0.311	0.3990	0.4463	0.6979	-0.4120	0.3241
JS2	-0.206	-0.3430	-0.2616	-0.5523	0.4852	-0.1661
JS3	0.275	0.4739	0.4906	0.7167	-0.3760	0.2567
qi						
QI1	-0.206	-0.3991	-0.3450	-0.4623	0.9074	-0.1064
QI2	-0.226	-0.4526	-0.4096	-0.5412	0.9608	-0.1281
QI3	-0.190	-0.4338	-0.3696	-0.5352	0.9127	-0.1242
srp						
SR1	0.322	0.2519	0.3162	0.3928	-0.1678	0.8735
SR2	0.303	0.1302	0.1945	0.3156	-0.0991	0.9009
SR3	0.278	0.1689	0.2488	0.3339	-0.1354	0.8943
SR4	0.111	-0.0202	0.0055	0.0627	0.1401	0.4656

Table 6 shows the correlations among all latent variables which are all positively correlated among each other, only Quit Intention is negatively related. We particularly signal higher values in the correlations between P-O fit and Organizational Commitment, between P-O fit and Job Satisfaction.

Table 6. Correlations between Latent Variables

	psm	po	js	oc	qi	srp
psm	1.000	0.361	0.531	0.489	-0.224	0.334
po	0.361	1.000	0.642	0.657	-0.463	0.197
js	0.531	0.642	1.000	0.738	-0.405	0.273
oc	0.489	0.657	0.738	1.000	-0.555	0.380
qi	-0.224	-0.463	-0.405	-0.555	1.000	-0.129
srp	0.334	0.197	0.273	0.380	-0.129	1.000

psm: Public Service Motivation, js: Job Satisfaction;oc: Organizational Commitment; po:P-O fit; QI:Quit Intention;srp: individual Performance.

They are all positively correlated among each other. Only Quit Intention is negatively correlated.

The structural model in PLS is assessed by examining the path coefficients and R2 values, after a bootstrap validation, through many replications.Table 7 shows the Bootstrap validation in terms of loadings.

Table 7. Bootstrap Validation

Loadings	Original	Mean.Boot	Std.Error	perc.025	perc.975
SJ3	0.423	0.421	0.07303	0.297	0.587
CD1	0.607	0.600	0.05129	0.505	0.693
APM1	0.441	0.430	0.06269	0.302	0.537
APM2	0.324	0.329	0.06922	0.212	0.476
APM3	0.410	0.405	0.05968	0.297	0.516
CPI1	0.518	0.519	0.07297	0.365	0.641
CPI5	0.615	0.606	0.05399	0.507	0.701
SS1	0.617	0.618	0.04493	0.535	0.702
SS2	0.599	0.601	0.04396	0.522	0.678
SS3	0.601	0.592	0.06944	0.459	0.696
SS5	0.773	0.771	0.02647	0.718	0.819
SS6	0.667	0.667	0.04060	0.580	0.732
SS7	0.766	0.768	0.03222	0.710	0.828
SS8	0.783	0.780	0.03341	0.708	0.832
C1	0.483	0.472	0.06541	0.326	0.581
C5	0.515	0.520	0.07191	0.407	0.660
PO1	0.780	0.778	0.03624	0.705	0.848
PO2	-0.634	-0.636	0.05091	-0.728	-0.547
PO3	0.891	0.890	0.01682	0.850	0.916
PO4	0.907	0.907	0.01596	0.867	0.931
OC1	0.824	0.822	0.04882	0.731	0.908
OC2	0.858	0.860	0.04102	0.766	0.937
OC3	0.864	0.854	0.04532	0.770	0.927
OC4	0.709	0.711	0.03999	0.634	0.779
OC5	0.786	0.784	0.02716	0.729	0.830
JS1	0.698	0.696	0.06155	0.561	0.782
JS2	-0.552	-0.554	0.05578	-0.659	-0.446
JS3	0.717	0.709	0.05789	0.585	0.804
QI1	0.907	0.905	0.01762	0.861	0.929
QI2	0.961	0.961	0.00579	0.949	0.969
QI3	0.913	0.913	0.01331	0.890	0.935
SR1	0.873	0.869	0.02317	0.815	0.908
SR2	0.901	0.894	0.02367	0.842	0.930
SR3	0.894	0.884	0.03632	0.800	0.937
SR4	0.466	0.465	0.09001	0.276	0.624

This validation is the standard method for testing the significance of PLS path modeling results, thus it was applied to assess the statistical significance of path coefficients (Davison and Hinkley 1997). In this model, regarding the R2 values of the all considered casual relationships, the R2 value of the relationship between PSM and P-O fit is equal to 0.1301; that of the relationships among Job Satisfaction, PSM and P-O fit is equal to 0.5152; that of the relationship is equal to 0.5051; that of the relationship between Quit Intention and P-O fit is equal to 0.2144; that of the relationship among Performance, PSM, P-O fit, Organizational Commitment and Job Satisfaction is equal to 0.1813.

The relative impact of both PSM and the P-O fit on outcomes are assessed by examining their path coefficients (see Table 8). All the path coefficients are positive, with the exception of the one related to P-O fit and Quit Intention.

Overall, the proposed structural model provided a Goodness-of-fit (Gof) index, which measures the goodness of the model as a whole, equal to 0.3976

Table 8. Paths

	Original	Mean.Boot	Std.Error	perc.025	perc.975
psm->po	0.3608	0.3670	0.0658	0.2298	0.477
psm->js	0.3449	0.3516	0.0629	0.2419	0.468
psm->oc	0.2898	0.2940	0.0443	0.1972	0.370
psm->srp	0.2146	0.2172	0.0791	0.0739	0.380
po->js	0.5172	0.5119	0.0664	0.3876	0.629
po->oc	0.5527	0.5548	0.0480	0.4670	0.647
po->qi	-0.4630	-0.4604	0.0547	-0.5412	-0.376
po->srp	-0.0904	-0.1006	0.1015	-0.2856	0.084
js->srp	-0.0643	-0.0497	0.0966	-0.2315	0.131
oc->srp	0.3816	0.3673	0.1018	0.1910	0.537

psm: Public Service Motivation, js: Job Satisfaction; oc: Organizational Commitment; po:P-O fit; QI:Quit Intention; srp: individual Performance.

The range built with bootstrap percentiles that doesn't contain zero means that the relationship between the variables is significant.

Summarizing, the range built with bootstrap percentiles that doesn't contain zero means that the relationship between the variables is significant. According to the individual paths (see Table 7), PSM had a positive and significant association with Job Satisfaction, Organizational Commitment and P-O fit, suggesting that the fit of employees with their organizations, their job satisfaction and their commitment to the organization is strengthened as individual levels of PSM increase. Moreover, P-O fit in turn had a significant positive association with Job Satisfaction and Organizational Commitment and a significant negative association with quit intention. Together, this indicates that P-O fit acts as a mediator between PSM and employee outcomes, consistent with our process view. Contrary to expectations and hypothesis 4 and 9, the indirect path from PSM to Performance through P-O fit and Job Satisfaction is not supported by the data used in this study, while the Hypotheses 1,2,3,5,6,7,8,10 and 11 are supported. We will return to this result in our discussion section.

Discussion and conclusion

This research study is a contribution to the vastly and worldly studied processes which link PSM to Performance, and more specifically those processes which more significantly link PSM to employee outcomes, such as Job Satisfaction, Organizational Commitment, P-O fit, and Quit Intention. To that purpose we created a Conceptual Model that see these four variables as a sort of mediators between PSM and Performance to find out how they interact and to what extent one is more significant in respect to the others when contributing to better performance.

First and foremost our findings show the secondary role of P-O fit which doesn't operate (i) as a direct linking variable connecting PSM to the individual employee's performance so that we can state that PSM has a *direct* effect on Performance, and (ii) also operates as a mediator between PSM and Organizational Commitment in the sense that it bears heavily on some employee outcomes so that these can significantly influence performance.

We can easily imagine the reasons of the crucial role of P-O fit, which, in a nut-shell, lie in its own definition, i.e. the congruence between an organization's values and the values of its employees. Such values keep organization and employees strictly linked to each other providing the positive influence on performance studied by Barnard (1938) and avoiding disadvantages such as the cost of employees' turnover studied by Dess and Shaw (2001), and tacit or explicit export of the organization's know-how through departing employees studied by Cascio (1999).

The mediating role of the P-O fit variable does not mean that there is no direct effect of PSM on outcomes. Our Conceptual Model does show this more in general, because motivated employees are aware of the fact that their employment provides them with a good opportunity to "do good for others and for society", but we also know that employees with greater PSM are expected to be more satisfied with their jobs, and committed to their organization. Moreover, when we come to analyze the *indirect* effect of PSM, our data say it affects performance but mainly through the individual-level attitude, i.e. Organizational Commitment. Our conclusions then are as follows:

(i)The importance of the interplay of the various variables which have their bearing upon the final result of the PSM-Performance process. Our data demonstrate that all the ones taken into consideration contribute to the value of Performance and cannot be excluded from the process itself. To be extremely examplative, if something goes wrong in one of the variables, it may result in an employee's quitting the organization thus starting a domino effect;
(ii)The pivotal role of P-O fit on the employee outcomes which in turn work towards better performance. This role highlights the relationship between the organization and the individual employee. On this relationship we will base our discussion hereafter outlined.

The high compatibility and convergence between the objectives and values of an organization and those of its employees turns out to become a satisfaction-dissatisfaction relationship. It is then clear that the management must contribute to create an environment where employees are satisfied with their work and role and mainly committed within the organization they belong to.

It's necessary to investigate the factors which are likely to affect the Organizational Commitment among public teachers. Factors affecting the Organizational Commitment may include rewards, support from supervisor, promotion opportunities, favorable conditions of the job, including relationship among workers. These factors refer to the organizational context or environment in which the employee work. In order to remove the factors which doesn't lead an employee to an organizational commitment, a careful objective analysis on the workers is necessary. Substantially this analysis aims at identifying the sources of commitment which can jeopardize the employee outcomes of the process which poses correct PSM as the starting point for successful performance.

This study has a few limitations in this study. One limitation pertains to cross sectional data. This type of data doesn't allow us to compare results different times. Moreover our results revealed *R*2 values not excessively high. It means among other things that PSM is a significant predictor of P-O fit, but not the most important predictor. Thus, there are other drivers which lead to and could increase the congruence between employees and their or-

ganizations and many human resource management (HRM) practices could be tested by public administration scholars to evaluate this congruence and to reinforce the employees' identification with the organization's culture/values.

Further Research

Future researches need to better explore the P-O fit process. Furthemore it would be interesting to study if PSM directly influences Turnover intention. To date , as far as we know there is only one study (Shim et al., 2015).

References

1. Ajzen, Icek, and Martin Fishbein, **"Understanding attitudes and predicting social behaviour."** Prentice-Hall, Englewood Cliffs, NJ, 1980.
2. Alonso, Pablo, and Lewis, Gregory B., **"Public service motivation and job performance evidence from the federal sector."** The American Review of Public Administration 31(4), 2001, 363-380.
3. Andersen, Lotte Bøgh, and Kjeldsen, Anne Mette, **"Public Service Motivation, User Orientation, and Job Satisfaction: A Question of Employment Sector?."** International Public Management Journal, 16(2) 2013a, 252-274.
4. Andersen, Lotte Bøgh, Pallesen, Thomas and Salomonsen, Heidi Houlberg, **"Doing good for others and/or for society? The relationships between public service motivation, user orientation and university grading."** Scandinavian Journal of Public Administration, 17(3), 2013b, 23-44.
5. Andersen, Lotte Bøgh, Eskil Heinesen, and Lene Holm Pedersen, **"How does public service motivation among teachers affect student performance in schools?"** Journal of Public Administration Research and Theory, 24(3), 2014 651-671.
6. Brewer, Gene A., and Selden, Sally Coleman, **"Why elephants gallop: Assessing and predicting organizational performance in federal agencies."** Journal of public administration research and theory, 10(4), 2000, 685-712.
7. Bright, Leonard, **"Does public service motivation really make a difference on the job satisfaction and turnover intentions of public employees?."** The American Review of Public Administration, 38(2), 2008, 149-166.
8. Bright, Leonard, **"Does person-organization fit mediate the relationship between public service motivation and the job performance of public employees?."** Review of public personnel administration, 27(4), 2007, 361-379.
9. Cable, Daniel M., and D. Scott DeRue, **"The Convergent and Discriminant Validity of Subjective Fit Perceptions"**. Journal of Applied Psychology, 87(5), 2002, 875–84.
10. Cascio, W.F., **Costing Human Resources**, 4th ed. Southwestern College Publishing, Dallas, TX, 1999.
11. Cerase, Francesco Paolo, & Farinella, Domenico, **"Public Service Motivation How Does it Relate to Management Reforms and Changes in the Working Situation of Public Organizations? A Case Study of the Italian Revenue Agency"**. Public Policy and Administration, 24(3), 2009, 281-308.
12. Chang, Wan-Jing April, Yung-Shui Wang, and Tung-Chun Huang, **"Work design-related antecedents of turnover intention: A multilevel approach."** Human Resource Management 52.(1), 2013, 1-26.
13. Choi, Seungjin, **"Mediating Effects of Job Satisfaction and Organizational Commitment on the Relationship between Public Service Motivation and Performance: A Meta-Analysis",** 2015, Available at SSRN 2605709.

14. Coursey, David H., and Sanjay K. Pandey, **"Public service motivation measurement: Testing an abridged version of Perry's proposed scale"**. Administration & Society, 39, 2007, 547–68.
15. Crewson, Philip E., **"Public-Service Motivation: Building Empirical Evidence of Incidence and Effect".** Journal of Public Administration Research and Theory 7(4), 1997, 499–518.
16. Davison, Anthony Christopher, and David Victor Hinkley, **Bootstrap methods and their application**. Vol. 1. Cambridge university press, 1997.
17. Dess, G.G., Shaw, J.D., **Voluntary turnover, social capital, and organizational performance**. Acad. Manage. Rev. 26, 2001, 446–457.
18. Gould-Williams, Julian S., Ahmed Mohammed Sayed Mostafa, and Paul Bottomley, **"Public service motivation and employee outcomes in the Egyptian public sector: Testing the mediating effect of person-organization fit".** Journal of Public Administration Research and Theory, 2013, mut053
19. Griffeth, Rodger W., Peter W. Hom, and Stefan Gaertner, **"A meta-analysis of antecedents and correlates of employee turnover: Update, moderator tests, and research implications for the next millennium"**. Journal of Management 26 (3), 2000, 463–88.
20. Hanisch, Kathy A., **The timing of thinking about quitting: The effect on job attitudes and behaviors.** In Meni Koslowsky and MosheKrausz (Eds.), Voluntary employee withdrawal and inattendance, New York: Kluwer Academic / Plenum Publishers, 2002, pp.193-211.
21. Hondeghem, A. & Perry, J. L., **EGPA symposium on public service motivation and performance: Introduction.** International Review of Administrative Sciences 75, 2009, 5-9
22. Igbaria, Magid, and Jeffrey H. Greenhaus, **"Determinants of MIS employees' turnover intentions: a structural equation model."** Communications of the ACM, 35(2), 1992, 34-49.
23. Jensen, Ulrich Thy, & Andersen, Lotte Bogh, **"Public service motivation, User Orientation, and prescription behaviour: doing good for society or for the individual user?"** Public Administration, 2015.
24. Judge, Timothy A., et al., **"The job satisfaction–job performance relationship: A qualitative and quantitative review."** Psychological bulletin, 127 (3), 2001, 376-407.
25. Kim, Sangmook, **"Testing a Revised Measurement of Public Service Motivation: Reflective versus Formative Specification"**. Journal of Public Administration Research and Theory 21(3), 2011, 521–46.
26. Kim, Sangmook, **"Does Person-Organization Fit Matter in the Public-Sector? Testing the Mediating Effect of Person-Organization Fit in the Relationship between Public Service Motivation and Work Attitudes."** Public Administration Review, 72 (6), 2012, 830-840.
27. Kristof-Brown, Amy L., Ryan D. Zimmerman, and Erin C. Johnson, **" Consequences of Individuals' Fit at Work: A Meta-Analysis of Person-Job, Person-Organization, Person-Group, and Person-Supervisor Fit"**. Personnel Psychology, 58(2), 2005, 281–342.
28. Liu, Bangcheng, Jianxin Liu, and Jin Hu, **"Person-organization fit, job satisfaction, and turnover intention: An empirical study in the Chinese public sector."** Social Behavior and Personality: an international journal, 38 (5), 2010, 615-625.
29. Locke, Edwin, A., **The nature and cause of job satisfaction.** In Handbook of industrial and organizational psychology, ed. M. D. Dunnette, 1976, 1297–1343. Chicago: Rand McNally
30. Meyer, John P., Natalie J. Allen, and Catherine A. Smith., **"Commitment to Organizations and Occupations: Extensions and Test of a Three-Component Conceptualization"**. Journal of Applied Psychology, 78(4), 1993, 538–51.
31. Mostafa, Ahmed Mohammed Sayed, **"The relationship between high performance HR practices and employee attitudes: the mediating role of public service motivation and person-organization fit"**, Diss. Cardiff University, 2013.

32. Muchinsky, P. M., and Monahan, C. J., **"What is person-environment congruence? Supplementary versus complementary models of fit"**. Journal of Vocational behaviour, 31(3), 1987, 268-277.
33. Narayanan, S. Sathya, and P. C. Sekar. "**A person-organisation fit study of college work culture and its impact on behavioural intentions of teachers.**" Asia Pacific Management Review 14.2, 2009, 121-136.
34. Nunnally, J.C., & Bernstein, I.H. **Psychometrictheory** (3rd ed.).NewYork, NY: McGraw-Hill, 1994.
35. O'Reilly, Charles A., Jennifer Chatman, and David F. Caldwell, **"People and organizational culture: A profile comparison approach to assessing person-organization fit".** Academy of Management Journal 34 (3), 1991, 487–516.
36. Pandey, Sanjay K., Bradley E. Wright, and Donald P. Moynihan, **"Public Service Motivation and Interpersonal Citizenship Behavior in Public Organizations: Testing a Preliminary Model"**. International Public Management Journal 11(1), 2008, 89–108.
37. Pandey, Sanjay K., and Edmund C. Stazyk, **Antecedents and Correlates of Public Service Motivation. In Motivation in Public Management**, edited by James L. Perry and Annie Hondeghem, Oxford, UK: Oxford University Press, 2008, pp.101-17.
38. Perry, James L., and Lois Recascino Wise, "**The motivational bases of public service.**" Public administration review, 1990, 367-373.
39. Shim, Dong Chul, Hyun Hee Park, and Tae Ho Eom, "**Street-level bureaucrats' turnover intention: does public service motivation matter?**" International Review of Administrative Sciences, 2015.
40. Taylor, Jeannette, **"Organizational Influences, Public Service Motivation and Work Outcomes: An Australian Study".** International Public Management Journal, 11(1), 2008, 67–88.
41. Taylor, Jeannette, and Jonathan H. Westover, "**Job satisfaction in the public service: The effects of public service motivation, workplace attributes and work relations.**" Public Management Review, 13(5), 2011, 731-751.
42. Van Loon, Nina Mari, **"Is Public Service Motivation Related to Overall and Dimensional Work-Unit Performance as Indicated by Supervisors?"**. International Public Management Journal, 2015.
43. Vandenabeele, Wouter, "**Toward a public administration theory of public service motivation: An institutional approach.**" Public management review, 9 (4), 2007, 545-556.
44. Vandenabeele, Wouter, "**The mediating effect of job satisfaction and organizational commitment on self-reported performance: more robust evidence of the PSM—performance relationship.**" International review of administrative sciences, 75 (1), 2009, 11-34.
45. Verquer, Michelle L., Terry A. Beehr, and Stephen H. Wagner, "**A meta-analysis of relations between person–organization fit and work attitudes.**" Journal of Vocational Behavior, 63(3), 2003, 473-489.
46. Wright, Bradley E., and Sanjay K. Pandey, **"Public Service Motivation and the Assumption of Person-Organization Fit: Testing the Mediating Effect of Value Congruence"**. Administration & Society, 40(5), 2008, 502–21.
47. **Report Eurostat**, 2015, http://ec.europa.eu/eurostat/documents/2995521/7017572/3-02102015-BP-EN.pdf/5a7b5406-4a0d-445b-8fa3-3558a8495020.

Appendix A

Measurement of study variables.
The source of items is given in brackets.
Job Satisfaction (Moynihan & Pandey, 2007)
All in all, I am satisfied with my job
In general, I don't like my job
In general, I like working here

Organizational Commitment (Benkhoff, 1997)
I would not leave my organization right now because I have a sense of obligation to the people in it
I am willing to put in a great deal of effort beyond that what is normally expected in order to help this organization to be successful
I am proud to tell others that I am part of this organization
I find that my values and the organization's values are very similar
In my school, I feel I am part of a family
Self-reported Performance (Vandenabeele,2009).
In my opinion, I contribute to the success of the organization
I think I am performing well within this organization
I think I am a good employee
On average, I work harder than my colleagues

Public Service Motivation (Perry, 1996)
I believe that there are many public causes worth championing.
I am willing to go great lengths to fulfill my obligations to my country.
Politics is a noble word.
I'm very interested in giving and taking of public policy making.
I care much for politicians.
It isn't hard for me to get intensely interested in what is going on in my community
I consider public service my civic duty
Making a difference in society means more to me than personal achievements.
I believe in putting duty before self.
Doing well financially is definitely more important to me than doing good deeds. (Reversed)
Serving citizens would give me a good feeling even if no one paid me for it.
I feel people should give back to society more than they get from it.
I am one of those rare people who would risk personal loss to help someone else.
I am prepared to make enormous sacrifices for the good of society.
I am often moved by the plight of the underprivileged
There are a lot of public programs that I wholeheartedly support

Self-reported Performance/Individual Performance (Vandenabeele,2009).
In my opinion, I contribute to the success of the organization
I think I am performing well within this organization
I think I am a good employee
On average, I work harder than my colleagues

Person-Organization fit (Kim 2012**)**
The things that I value in life are very similar to the things that my organization values.
My personal values match my organization's values and culture.
My organization's values and culture provide a good fit with the things that I value in life.

JOURNAL OF APPLIED QUANTITATIVE METHODS

Quantitative Methods Inquires

DETERMINATION OF PARAMETERS IN CHEMICAL AND BIOCHEMICAL NON-LINEAR MODELS USING SIMULATED DATA WITH GAUSSIAN NOISE PERTURBATION

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Abstract

The Michaelis-Menten kinetics is a well-known model in biochemistry, widely used in enzyme-substrate interaction (Nelson and Cox, 2008). The same mathematical formula is called Langmuir equation (Masel, 1996) when is used to model generic adsorption of chemical species, and finally, an empirical equation of this form is applied to microbial growth and it is called J. Monod kinetics (Martinez-Luaces, 2008).

A typical problem in chemistry and/or biochemistry consists in determining the parameters of these equations from experimental data. In order to solve this problem, several methods were proposed, Lineweaver-Burk, Hanes-Woolf, Hofstee, Scatchard and Cornish-Bowden-Eisenthal are the most important ones (Nelson and Cox, 2008).

In this paper, all these methods are analysed and compared in terms of exactitude and precision. For this purpose, simulated data were generated and perturbed using Gaussian noise with different amplitudes. The same methodology was used in a previous work (Martinez-Luaces, 2009).

Absolute and relative errors of the different methods are compared, and taking into account the results, general conclusions about their robustness are obtained. This is particularly important in order to choose the best method when the relation between trend and noise tends to increase.

Keywords: *Chemical and biochemical models, Data simulation, Gaussian noise.*

Introduction

The non-linear mathematical formula $y = \frac{a\,x}{x+b}$ (Eq. 1) is widely used in chemistry and biochemistry for different purposes. For instance, the Michaelis-Menten kinetics is a

well-known model in biochemistry of the form $v_0 = \frac{v_{\max}[S]}{K_m + [S]}$ (Eq. 2) where v_0 and $v_{\max}$ are the initial and the maximum velocity of the enzymatic reaction, $[S]$ is the substrate concentration and k_m is a constant (called Michaelis constant), which depends on the enzymatic reaction considered (Nelson and Cox, 2008).

Irving Langmuir, a Nobel Prize winner in chemistry, developed an equation that relates the coverage or adsorption of molecules on a solid surface to gas pressure or concentration of a medium above the solid surface at fixed temperature (Masel, 1996). The equation is $\theta = \frac{\alpha P}{1 + \alpha P}$ (Eq. 3), where θ is the fractional coverage of the surface, P is the gas pressure (or concentration in the case of liquids) and α is a constant. A very simple algebraic manipulation gives $\theta = \frac{P}{\frac{1}{\alpha} + P}$ (Eq. 4) which is just a particular case of (Eq. 1).

The last example is a mathematical model for the growth of microorganisms proposed by Jacques Monod in 1949. The mathematical formula is $\mu = \frac{\mu_{\max} S}{K_S + S}$ (Eq. 5) where μ is the specific growth rate of microorganisms and $\mu_{\max}$ represents its maximum value, S is the concentration of the limiting substrate for growth and, K_S is called the "half-velocity constant" (Martinez-Luaces, 2008 and Martinez-Luaces, 2009) since it corresponds to the value of S when $\frac{\mu}{\mu_{\max}} = \frac{1}{2}$ as well as the constant K_m in (Eq. 2).

The Monod equation has the same form as the Michaelis-Menten equation, but it was developed empirically whereas the Michaelis-Menten model is based on theoretical considerations.

A typical problem that arises in the treatment of data corresponding to these equations is the parameters determination since all of them are non-linear models. In order to solve this problem, several methods were proposed to linearize these equations, Lineweaver-Burk, Hanes-Woolf, Eadie-Hofstee, Scatchard, and Eisenthal and Cornish-Bowden are the most important ones.

In this paper, all these methods will be compared in terms of exactitude and precision, using simulated data perturbed with Gaussian noise with different amplitudes. The details of this procedure will be described in the following section.

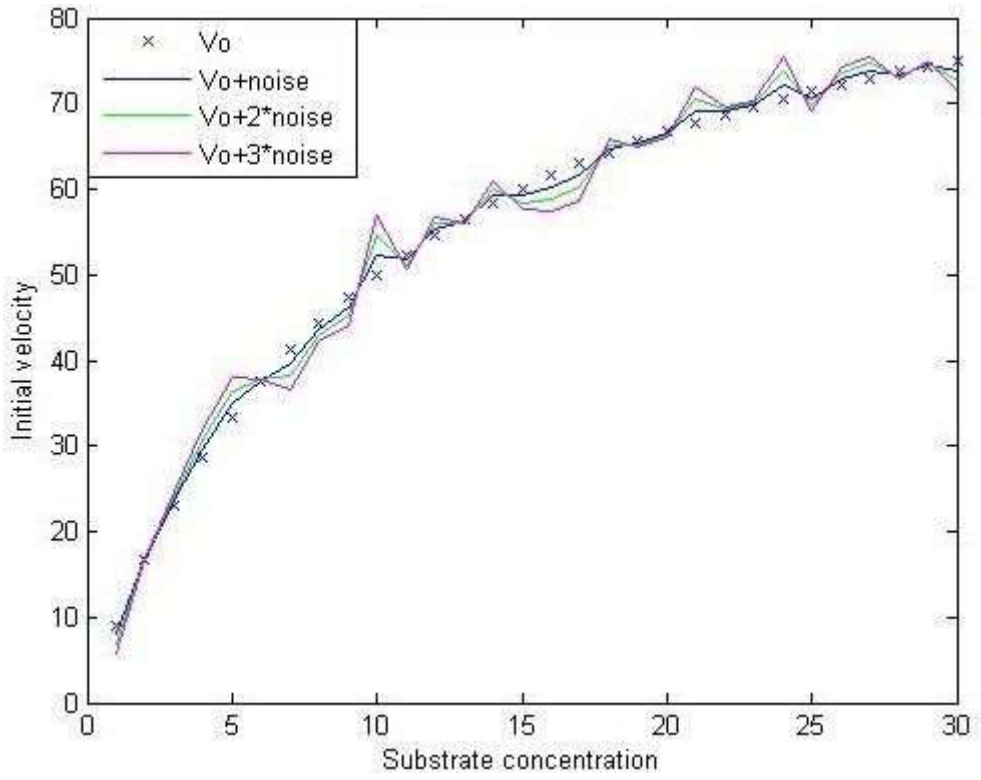
Data Simulation

Since equations (2), (3) and (4) represent the same mathematical model (Eq 1), we choose one of them (the Michaelis-Menten equation) to show the methodology to be followed, so the parameters will be K_M and $V_{\max}$ and variables will be [S] and v_0. For simplicity the notation in this paper will be K_M, V_M, S and V_0, respectively.

Different enzymes have different K_M values. They typically range from 10^{-1} to $10^{-7}M$, so $K_M = 10$ can be considered as a typical value depending on the units employed (for example $10\ mM = 10^{-2}M$ or even $10\ \mu M = 10^{-5}M$ are both possible values, although they are very different). On the other hand V_M, the maximum velocity depends on a constant named K_{Cat}, and $[E_t]$ the total enzyme concentration, like in $V_M = K_{Cat}[E_t]$ (Eq. 6). The constant $K_{C\,a}$ can vary between $0.5\left(s^{-1}\right)$ and $40000000\ \left(s^{-1}\right)$ so, once again, it is difficult to propose a "typical value" for V_M. Thus, we decided to consider $V_M = 100$ which may be taken as a typical value if units are $\mu M/\min$.

Then, a Gaussian noise with different amplitudes was superimposed to the theoretical data obtained from (Eq 2) with $V_M = 100$, $K_M = 10$ and S varying from 0 to 30. The graphics in Figure 1 show the simulated curves with the Gaussian noise multiplied by 2, 3 and 4.

Figure 1. Initial velocity vs Substrate concentration. Simulated curves.



These simulated data will take the place of the real experimental data and they will be used to determine the parameters K_M and V_M ,which real values are known, so the different methods could be compared in terms of exactitude and precision.

A similar methodology was followed in a previous paper (Martinez-Luaces et al., 2006) for Electrochemical Noise studies. More recently, in a mathematical modelling paper (Martinez-Luaces, 2015) this methodology was utilized for educational purposes.

Methods for obtaining the parameters in Michaelis-Menten equation

Several methods were proposed for linearizing the Michaelis-Menten equation. Perhaps the simplest one is the Lineweaver-Burk (or double reciprocal plot), which is a graphical representation of $\frac{1}{V_0}$ vs. $\frac{1}{S}$ (Nelson and Cox, 2008). It is easy to observe that the reciprocal of (Eq 2) gives $\frac{1}{V_0} = \frac{K_M}{V_M}\frac{1}{S} + \frac{1}{V_M}$ (Eq.7) so, the $x-$ intercept of the graph represents $-\frac{1}{K_M}$ and the $y-$ intercept is equivalent to the inverse of V_M . An alternative way is to obtain the coefficients of a linear regression (i.e. $\frac{K_M}{V_M}$ and $\frac{1}{V_M}$) and finally get the K_M and V_M .

The obtained results are summarized in Table 1, with the corresponding absolute and relative errors.

Table 1. Absolute and relative errors for the Lineweaver-Burk method

Noise	Lineweaver-Burk Method					
	Km	Vm	Absolute error Km*	Absolute error Vm*	Relative error Km*	Relative error Vm*
Amplitud Noise 1	12.5936237	112.8575325	2.5936	12.8575	0.2594	0.1286
Amplitud Noise 2	17.1811787	135.3073339	7.1812	35.3073	0.7181	0.3531
Amplitud Noise 3	27.4897736	185.3756073	17.4898	85.3756	1.7490	0.8538

A second methodology was posed by Hanes and Woolf. These researchers proposed to plot $\frac{S}{V_0}$ against S , since a rearrangement of (Eq. 1) gives $\frac{S}{V_0} = \frac{S}{V_M} + \frac{K_M}{V_M}$ (Eq. 8). Once again, a linear regression gives the coefficients $\frac{1}{V_M}$ and $\frac{K_M}{V_M}$ and lastly they can be used straightforward to obtain V_M and K_M .

The results of this method can be observed in Table 2

Table 2. Results corresponding to Hanes-Woolf method

Noise	Hanes-Woolf Method					
	Km	Vm	Absolute error Km*	Absolute error Vm*	Relative error Km*	Relative error Vm*
Amplitud Noise 1	10.1840993	100.685067	0.1841	0.6851	0.0184	0.0069
Amplitud Noise 2	10.4974793	101.751327	0.4975	1.7513	0.0497	0.0175
Amplitud Noise 3	11.0019191	103.400162	1.0019	3.4002	0.1002	0.0340

A third method is due to Eadie and Hofstee. They inverted (Eq. 2) and multiplied by V_M obtaining $\frac{V_M}{V_0} = \frac{K_M + S}{S}$ (Eq. 9) and a rearrange gives $V_M = \frac{K_M V_0}{S} + V_0$ (Eq. 10) or $V_0 = -K_M \frac{V_0}{S} + V_M$ (Eq. 11).

A plot of V_0 against $\frac{V_0}{S}$ will yield V_M as the $y-$intercept and $-K_M$ as the slope of the straight line. Alternatively, a linear regression will give coefficients $-K_M$ and V_M from where the parameters are easily obtained as it is showed in Table 3 with the corresponding absolute and relative errors.

Table 3. Parameters and errors corresponding to Eadie-Hofstee method

Noise	Eadie and Hofstee Method					
	Km	Vm	Absolute error Km*	Absolute error Vm*	Relative error Km*	Relative error Vm*
Amplitud Noise 1	10.16691318	100.637843	0.1669	0.6378	0.0167	0.0064
Amplitud Noise 2	9.911745044	99.38537855	0.0883	0.6146	0.0088	0.0061
Amplitud Noise 3	9.231519446	96.2503578	0.7685	3.7496	0.0768	0.0375

The Scatchard plot can be obtained from (Eq 11), that can be multiplied by $-\frac{1}{K_M}$ to give: $-\frac{1}{K_M} V_0 = \frac{V_0}{S} - \frac{V_M}{K_M}$ (Eq. 12) or $\frac{V_0}{S} = -\frac{1}{K_M} V_0 + \frac{V_M}{K_M}$ (Eq. 13). Once again, a linear regression will give a slope $-\frac{1}{K_M}$ and a $y-$intercept $\frac{V_M}{K_M}$.

As in other methods K_M and V_M can be reached from these coefficients and compared with the theoretical values $K_M = 10$ and $V_M = 100$. Table 4 shows the results.

Table 4. Results corresponding to Scatchard method

Noise	Scatchard Method					
	Km	Vm	Absolute error Km*	Absolute error Vm*	Relative error Km*	Relative error Vm*
Amplitud Noise 1	10.4434129	101.877116	0.4434	1.8771	0.0443	0.0188
Amplitud Noise 2	11.0831493	104.616199	1.0831	4.6162	0.1083	0.0462
Amplitud Noise 3	11.9679929	108.424515	1.9680	8.4245	0.1968	0.0842

The final methodology to be discussed here is the Eisenthal and Cornish-Bowden direct linear plot. In this original approach (Eq. 4) is rearranged to give $\frac{V_M}{V_0} - \frac{K_M}{S} = 1$ (Eq. 14) so if V_M is plotted against K_M a straight line is obtained and the $x-$intercept is $-S$ while the $y-$intercept is V_0.

Then, for each observation (S,V_0) a straight line is obtained. Theoretically all these lines will intersect at a common point, whose co-ordinates (K_M,V_M) provide the values of the parameters. When the observations are subject to error there will be $\binom{n}{2}=\frac{1}{2}n(n-1)$ (Eq. 15) intersections.

Each intersection provides an estimate of K_M and an estimate of V_M, then the corresponding medians will give the best estimate for K_M and V_M, respectively. The results of this procedure are given in Table 5.

Table 5. Results and errors corresponding to Cornish-Bowden and Eisenthal method

Noise	Cornish-Bowden & Eisenthal Method					
	Km	Vm	Absolute error Km*	Absolute error Vm*	Relative error Km*	Relative error Vm*
Amplitud Noise 1	10.0167	100.3243	0.0167	0.3243	0.0017	0.0032
Amplitud Noise 2	9.8727	99.7177	0.1273	0.2823	0.0127	0.0028
Amplitud Noise 3	9.6059	98.5973	0.3941	1.4027	0.0394	0.0140

Results

The results of five different methods were showed in Tables 1-5 in the previous section. In order to compare all these results, Table 6 shows the minimum absolute and relative errors in K_M and V_M and which methodology was the best in each case, depending on the noise amplitude.

Table 6. Comparison of the results for the different methods

Noise	Min. abs. error Km	Min. abs. error Vm	Min. rel. error Km	Min. rel. error Vm	Min. abs. Error Method Km	Min. abs. Error Method Vm	Min. rel. Error Method Km	Min. rel. Error Method Vm
Amplitud Noise 1	0.0167	0.3243	0.0017	0.0032	CBE	CBE	CBE	CBE
Amplitud Noise 2	0.0883	0.2823	0.0088	0.0028	H	CBE	H	CBE
Amplitud Noise 3	0.3941	1.4027	0.0394	0.0140	CBE	CBE	CBE	CBE

The method due to Eisenthal and Cornish-Bowden was the best one in all cases, except when the Gaussian noise had double amplitude and K_M is the considered parameter. In this last case, Eadie and Hofstee's method obtained the minimum absolute and relative error in the parameter K_M, but not in V_M where once again Eisenthal and Cornish-Bowden gave the best estimate.

This last method does not seem to be as simple as the others and the number of intersections grows quadratically – since $\binom{n}{2}=\frac{1}{2}n(n-1)=O(n^2)$ – demanding more computation time than other simpler methodologies. On the other hand, it gives the best results in all the cases except one, for both parameters V_M and K_M.

Conclusions

In the previous sections several data for initial velocity and substrate concentration were simulated. For this purpose, typical values of the parameters K_M and V_M were proposed and the theoretical values obtained were perturbed with Gaussian noise of different amplitudes. These simulated values were used to check five different linearization methods for the Michaelis-Menten equation. The best results were obtained by the methodology proposed by Eisenthal and Cornish-Bowden.

This result can be explained because the original data (S,V_0) are not transformed like in other methods where reciprocal quantities, product, etc., are performed before plotting the data, diminishing the possibility of errors propagation. Moreover, taking medians of the intersection points co-ordinates may give more robustness to this method, since medians are not sensible to extreme values (Janke and Tinsley, 2005). The same situation happens with outliers, because the mean can be completely upset by a single outlier, while the sample median is little affected for these values that are absolutely different in relation to the majority of the sample.

Another aspect that must be considered is that several methods with a poor performance like Lineweaver-Burk may be useful for other purposes. For instance, Lineweaver-Burk's plots allow the researcher to know if there is an inhibitor and if it is competitive or uncompetitive (Nelson and Cox, 2008). This possibility was analyzed in detail in a paper written by Dixon (1953).

A different approach was proposed 20 years later by A. Cornish-Bowden who provided a simple way of determining the inhibition constant of an uncompetitive, mixed or non-competitive inhibitor (Cornish-Bowden, 1974).

Taking into account the previous comments, the errors (relative and absolute) of the different methods are an important aspect to be considered, but not the unique one, particularly if inhibition is taking place. As a consequence, the final election of the methodology to be used will depend on the objectives of the research project.

References

1. Cornish-Bowden, A., **A simple graphical method for determining the inhibition constants of mixed, uncompetitive and non-competitive inhibitors**, Biochemical Journal, Volume 137, No. 1, 1974, pp. 143-144.
2. Dixon, M., **The determination of enzyme inhibitor constants**, Biochemical Journal, Vol. 55, No. 1, 1953, pp. 170-171.
3. Janke, S. J. and Tinsley, F. **Introduction to Linear Models and Statistical Inference**. New York: John Wiley and Sons. 2005
4. Martinez-Luaces, M., Martinez-Luaces, V. & Ohanian, M., **Trend-removal with Neural Networks: data simulation, preprocessing and different training algorithms applied to Electrochemical Noise studies**, WSEAS Transactions on information science and applications. Vol. 3, Issue 4, 2006, pp. 810-817.
5. Martinez-Luaces, V., **Sistemas E.D.O. lineales y no lineales: aplicación a un problema de Bioingeniería**, in Cuadrado, G. (ed.) "Educación Matemática en Carreras de Ingeniería", Mendoza, Argentina: FRM-UTN, 2008.

6. Martinez-Luaces, V., **Aplicaciones y Modelado: Ecuaciones Diferenciales Ordinarias, Transformación de Laplace, Ecuaciones en Derivadas Parciales**, Ed. ISC-Delta, Montevideo, Uruguay. 2009.
7. Martinez-Luaces, V., **Mathematical models for Chemistry and Biochemistry service courses**. Proceedings of the ninth Congress of the European Society for Research in Mathematics Education, Prague: CERME, 2015, pp. 904-909
8. Masel, R., **Principles of adsorption and reaction on solid surfaces**, Wiley Interscience, New York. 1996.
9. Nelson, D.L. and Cox, M.M., **Lehninger principles of biochemistry**, 5th Edition, W.H. Freeman & Company, New York. 2008

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CHILDREN'S SCIENTIFIC KNOWLEDGE IN MOROCCO: A GENDER APPROACH ANALYSIS TIMSS'S SCORES DECOMPOSITION

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Abstract

This work is one of works trying to understand, and to assess the differences of children educational achievement by genre. In fact, this work tries to find answers of two sequential questions: can we accept the hypothesis, often allowed, which stipulates that boys are more performing than girls in science subjects? If yes, how to analyze a possible difference in terms of its determinants? In this regard, we'll try to explain the achievement differences between boys and girls in the 4th year of primary using TIMSS-2011's database. The applied methodology is the decomposition developed by Oaxaca and Blinder (1973), and generalized by Neumark (1988) and Oaxaca and Ransom (1988, 1994). Even if our results confirm that the girls are more performants than boys, the performance of the educational system and Moroccan is still very mediocre in general.

Keywords: *Achievement, education, gender gap, Morocco, TIMSS*

Introduction

The establishment of an educational system able to integrate children is indispensable to the development of the national scientific and technological productivity, and therefore to the socio-economic development. Then, thinking about the scientific knowledge, and performance, among young children is necessary to understand the mechanisms of basic knowledge transmission and to elaborate a better scientific policy.

In many developing countries, including Morocco, the insufficiency in term of enrolment is present in all regions, particularly within the country side. Illiteracy touches an important number of individuals. Even worse, no social development means can be realized without investing in the population, particularly through knowledge diffusion, extending possibilities and choices, and eliminating barriers separating citizens from their goals[1].

From this viewpoint, Morocco has claimed, since the end of 1990, the implementation of a societal project of sustainable development, centered on the human capital, and the reconciliation between the imperative of economic competitiveness and the requirement of the social equity and the democratic participation in a context characterized by a sustainability of resources (the initiative was, and is still, supported by the highest political authority

of the country: "the king MOHAMED VI"). This awareness of the need of the education system development, added to voluntarily to make of the children learning a lever of the socio-economic development, pushed the Moroccan authorities to deploy considerable efforts which results caused an undeniable advances in terms of access (enrolment rates)[2].

In spite of this quantitative aspect, the problem of educational achievement evaluation by gender has retained the attention for several decades. It was primarily a problem of girls' poor performance. Now, the problem is become a problem of boys'meager performance. Even if there is no visible difference between girls and boys in regard to the intelligence and the general skills, the discrepancy of the educational path of girls and boys in matters of math and science achievement is remarkable, especially within the countries of the MENA region (TIMSS 2011 : Trends in International Mathematics and Science Study).[3]

This work is one of works trying to understand, and to assess the differences of children educational achievement by genre. In fact, this work tries to find answers of two sequential questions: can we accept the hypothesis, often allowed, which stipulates that boys are more performing than girls in science subjects? If yes, how to analyze a possible difference in terms of its determinants? In this regard, we'll try to explain the achievement differences between boys and girls in the 4th year of primary using TIMSS-2011's database. The applied methodology is the decomposition developed by Oaxaca and Blinder (1973), and generalized by Neumark (1988) and Oaxaca and Ransom (1988, 1994).

For the Moroccan context, this work presents a double interest:

- On the methodological level: this contribution is, to our knowledge, one of the first applications of the micro-econometric approach in Morocco ;
- On the analytical level: the results of this work come to supplement the rare evaluation works (A. Ibourk; 2012 and 2013), and to guide the public actions and measures which aim to improvethe performance and the quality of the school system, particularly the science subject teaching and learning in primary.

This paper is structured as follow:

The first section overflew the literature review concerning the children school achievement by gender. The second section presents a brief overview of the TIMSS-2011's database. Then, we expose the used methodology, and we analyze the variances in order to identify the differences between girls and boys according to the type of school, the community and the region. Finally, we are trying to explain these differences. A final section concludes.

The gender-gap in mathematics and science subjects: literature review

The present literature review exposes some of publications dealing with gender gaps in matter of educational achievement and development, particularly scientific achievements at the primary.

Questions concerning school achievement's gender-gap have always captivated great interest among researchers, policy makers, and all educational system stakeholders in

general (Arnot et al, 2003). Some authors (Lajoie, 2004), argue that researches carried out - among girls and boys- over the past few years show some similarity in terms of intellectual abilities. Others, based on the brain development researches, claim that female babies acquire an extensive vocabulary more quickly than boys, and then they succeed easily in certain subjects (Duru-Bellat, 2004; Lemery, 2007; Fize, 2003).

Additionally, there are some other variables, rather than those correlated to personal skills, that explain the variability and the amplitude of the gender gaps in school achievements. The comprehension of the mechanisms of interaction between those variables is very appalling since we know that primary school achievements influence the overall educational pathway, particularly the future completions in the scientific subjects. The following paragraphs suggest and describe some variables that can impactthe school achievement's gender gap.

1. The effect of the nursery school

The first years of human development constitute a criticalstage of the scientific skills development. Skills and competencies that are acquired during this period influence significantly the children school achievements at the primary school and beyond it (McWayne, Green, &Fantuzzo, 2009) and (Klibanoff & al, 2006) this is why encouraging young children to learn is something much more valuable than giving them the ability to read fairy story. More and more evidences demonstrate that the mathematics and the sciences achievements, in the pre-school cycle,are significantly determining regarding the future achievements. From this viewpoint, Duncan & al. (2007) discovered that the skills acquired in primary and nursery school in mathematics -based on a six longitudinal studies' analysis- were very indicatingvis-à-vis the later achievements in this science. Additionally, recent longitudinal studies show that the calculation skills developed in thenursery school are very revealing of the future children's performances in the primary school (Aunola, Leskinen, Lerkkanen, &Nurmi, 2004 ; Desoete &Grégoire, 2007 ; Jordan, Kaplan, Locuniak, &Ramineni, 2007). "In general,children develop strong and deep knowledge in mathematics and science during their early development", said Ginsburg, Lee, and Boyd (2008).

2. The effect of the parents' involvement: home based school support, books' provision, media and hardwareaccessibility

A large number of researchesaffirmthat the parent support, in the school and at home, has a positive impact on the achievement of their children (X. Fan & Chen, 2001; Jeynes, 2003, 2005; Nye, Tuner, & Schwartz, 2007; Seneschal, 2006). In spite of the significant number of research focused on literacy, there now more and more studies concerningchildren'smathematics and science achievement. Those researches demonstrated that the various aspects of the parent involvement at home (for example, the expectations of the parents, the parent-child communication, encouragement regarding mathematics and science learning, and the educational media provision: office, computer, books...) are highly correlated to the improvement of the mathematics and science achievements in primary school (X. Fan & Chen, 2001; Fantuzzo, King, and Heller, 1992; becomes & al, 1983; Jeynes, 2003, 2005; Nye & al, 2007). Grolnick, Ryan &Deci (1991) have hand out the hypothesis supposing that theparents involvement influences mainly the children attributes and behavior, these laterimpactthe children'sschool achievements in mathematics and science. Similarly, the hypothetical framework provided by Hoover-Dempsey and Sandler (1995, 1997) suggested

that the parents involvement increases the children intrinsic motivation vis-à-vis science and mathematics learning, and also improve the children self-regulation and self-efficacy, and therefore improve the school achievements.

3. The effect of the parents' literacy

"The cultural capital consideration is most often done by taking into account the parents' education" (Murat, 2009). In effect, the parents'education level, particularly the mother's one, is one of the most decisive factors of the child skills development; the father's one has more influence on the child school achievements (Morin Justine, 2012). [4]

4. The effect school

Bressoux (1995) showed that the family is not the only variable that influences the child's schoolachievements.He advanced that the school's climate is highly preponderant in term of achievement level. Thus, Grisay (1997) emphasizes that the intrinsic characteristics of the institutions staff can influence their performance. According to this theory, the child's results depend on the type of school attended. In effect, François and Poupeau (2008) have asserted that schools are subjectedto their social, economic, technological, cultural and political environment.However, they focused on the analysis of the spatial localization and its weight on the gender gap in school achievement.

5. Teacher's effect

According to this approach, the academic performance of students depends on their teachers; that is to say their level of competence, their professional experience, and their teaching methods (Bressoux et al, 2007). Other studies have shown that girls achieve their mathematics' tests better than boys when the examiner is a woman (Pedersen, 1968), and even when the examiner committee is mixt (Hoffman, 1961), while the committee expect better results for boys (Feldman-Summers, 1974).

The methodology will try to explain the interconnection between the variablespresented in the literature above and the gender gap in mathematics and science achievement if it exists. Before this, we'll present the TIMSS-2011's survey in the following section.

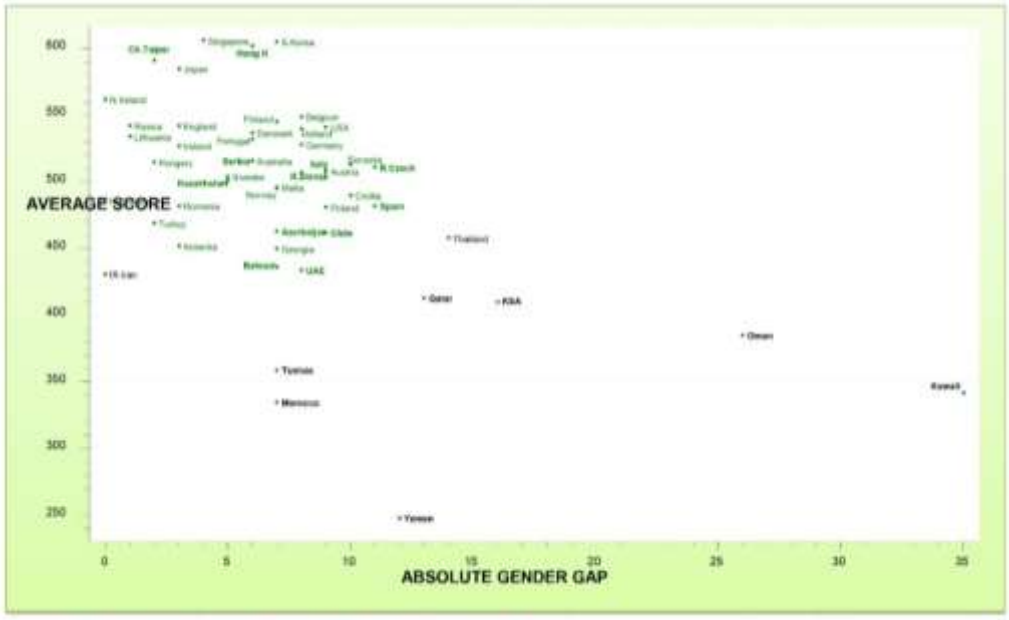
Mathematics and science studies: performance and gender gaps among the participating countries (TIMSS-2011)

Trends in International Mathematics and Science Study –TIMSS- aresome kind of international assessments of the students' mathematical and scientific knowledge across the world. TIMSS is an international survey which aimed to assess "the ability to understand and to use the forms of mathematical and scientific skills". It targets the students of the 4th year having more than 9.5 yearsin average during the tests. The study carried out in 2011 shows that most of the participating countries have recorded "good" average scores either in mathematics thanscience: 30 countries have an average score higher than 500 in science, and 27 countries in mathematics. All the participating countries belonging to the MENA regionhave less than 500 points in average score in both mathematics and science. South Korea and Singapore occupied the two first rows in mathematics and science, while Yemen and Morocco occupied the two last positions.

In addition, the gender gaps don't exceed 10 points -for 37 countries- of absolute difference in science; this difference is 42 in mathematics. This significant number of coun-

tries, having a gender gap of 10 points or less, confirmed that girls and boys achievements in mathematical and scientific knowledge -basic and algebraic calculation knowledge- are comparable (Armstrong, 1981). Girls' superiority is found only among MENA; the gaps in the other regions, and/or countries, are somewhat not significant and the scores may be comparable (see TIMSS-2011 report). Indeed, most salient gaps were discovered within the MENA region countries (in mathematics: Oman(26), Kuwait[5] (35); in science: Bahrain (23), Tunisia (25) Qatar (26) Yemen (27) Oman (34) KSA (48) Kuwait (53)).

The figures below give an overview of the results obtained by the participating countries as well as the relationship between these results and the gender gaps:



Source: author's calculation on the basis of the TIMSS-2011's survey (Stata12)

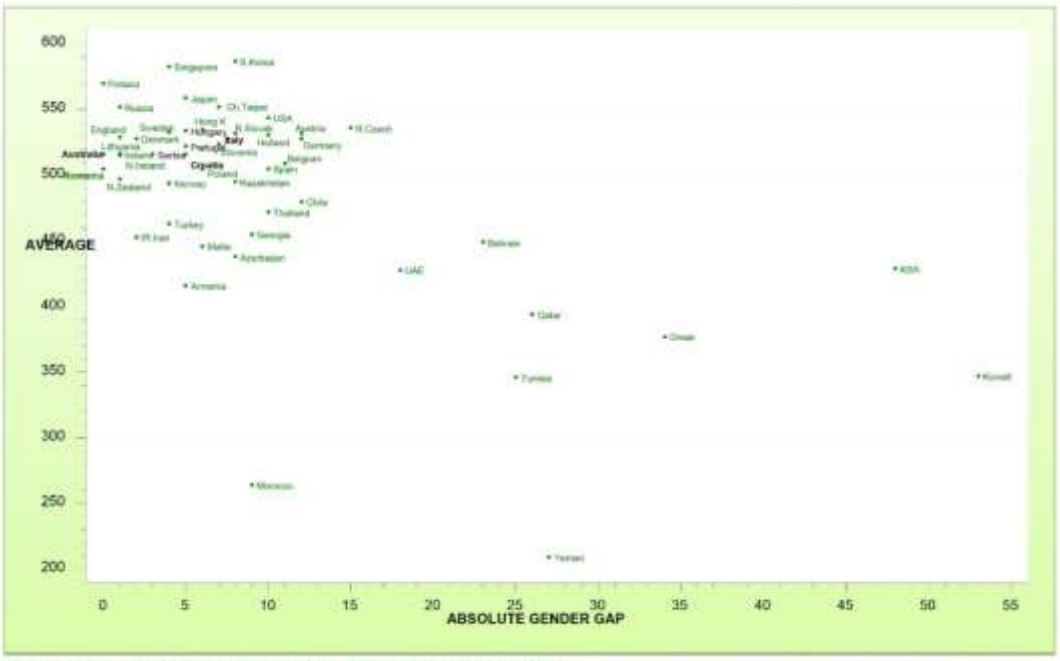
Figure 1. Relation between the scores in mathematics and the gender gap

Either in mathematics or science, most of the MENA region's countrieshave a highproportion -a model- of students unable to attain thenormal level of knowledge acquisition. In fact, none of the region countries have been able to achieve an average score equal or greater than 500 points.This fact explains partially the scientific and economic[6] gaps between the region countries and the other participating countries. On the other hand, in this era where the economy of knowledge is a particularly necessaryfor development, it's crucial to develop the intangible assets, the human capital, and generallyall activity related to education, science, research and innovation...

Nowadays, countries are continuallylooking for positioning themselveswithin the globalized knowledge economy. Only countries that are building a comprehensive strategy based on anintegrated vision, where public policies aim the qualification of the man, can conserve their socio-economic viability.

Each period of the human development brings with it new skillsdemands, new challenges and new opportunities for personal growth. Along the human lifecycle, the primary school presents a crucialperiodfull of new challenges concerning the acquisition of the basic tools for learning, and in term of personal skillsdevelopment. Then, achievements in science and mathematics influence significantly the human development level of a country. As a final

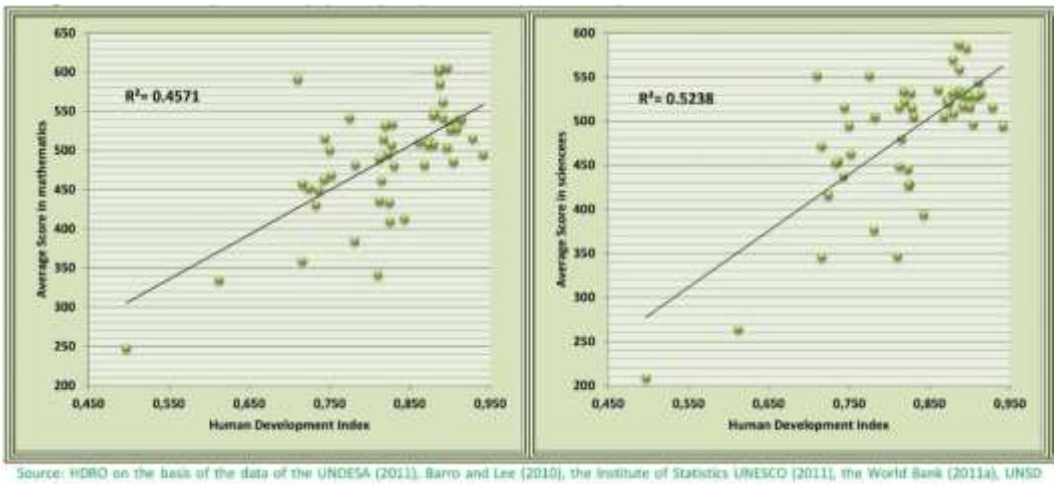
point, we can approvethat the development of the children's scientific knowledge is an essential ingredient for the human development: more the children capitalize scientific knowledge; the more the country may be developed.



Source: author's calculation on the basis of the TIMSS-2011's survey (Stata12)

Figure 2. Relation between the scores in science and the gender gaps

Aware of this causality, the impossibility of realizing an economic and social development without having a population that decrypts, filtrates, and uses the extensive-knowledge; Morocco have to conceive and implementsome actions in orderto promote and improve the quality of the primary education. With this in mind, any approach that isn't taking into account the differentiation between boys and girls -in their successes and their failures- would make a little effective positive change (Brown, 2006; Francis & Skelton, 2005; Martens Lingard, Martino, Mills & Bahr, 2002; Martino &Kehler, 2007).



Source: HDRO on the basis of the data of the UNDESA (2011), Barro and Lee (2010), the Institute of Statistics UNESCO (2011), the World Bank (2011a), UNSD (2011) and the IMF (2011).

Figure 3. The relationship between the playback capability of children and human development

Gender gaps in mathematics and science: micro econometrics analysis

1. Methodology: methods and formulas

The counterfactual decomposition technique popularized by Blinder and Oaxaca (1973) is widely used to study mean outcome differences between groups. This document uses the technique in order to explain the gender gap in science and mathematics' achievements in Morocco (students issued from the 4th year primary).

Before analyzing the gender gap in reading regarding certain factors, this subsection aims to give an overview of the Blinder-Oaxaca decomposition.

Given are two groups A and B (girls and boys), an outcome variable Y, and a set of explanatory variables $X_1 : X_n$. The question is to know how much of the mean outcome difference:

$$R = E(Y_A) - E(Y_B) \quad (1)$$

Where $E(Y)$ refers to the expected value of the outcome variable, and is accounted for by group differences in the predictors, based on the following linear model:

$$Y_g = X'_g \beta_g + \varepsilon_g, \qquad E(\varepsilon_g) = 0, \qquad g \in \{A, B\} \quad (2)$$

Where X is a vector containing the predictors and a constant, the β vector contains the slope parameters and the intercept, and ε_g represents the error. The mean outcome difference can be groups in Y can be expressed as following:

$$R = E(Y_A) - E(Y_B) = E(X_A)'\beta_A - E(X_B)'\beta_B \quad (3)$$

In order to identify the contribution of group differences in predictors to the overall outcome difference, equation (3) can be rearranged as follows (see Winsborough and Dickinson, 1971; Jones and Kelley, 1984; Daymont and Andrisani 1984):

$$R = [E(X_A) - E(X_B)]'\beta_B + E(X_B)'(\beta_A - \beta_B) + [E(X_A) - E(X_B)]'(\beta_A - \beta_B) \quad (4)$$

This is a "three-fold" decomposition, that is, the outcome difference is divided into three parts:

$$R = E + I + C$$

- The first part amounts to the part of the differential that is due to group differences in the predictors (the "endowments effect"):

$$E = [E(X_A) - E(X_B)]'\beta_B$$

- The second component measures the contribution of differences in the coefficients (including differences in the intercept):

$$I = E(X_B)'(\beta_A - \beta_B)$$

- The third summand is an interaction term accounting for the fact that differences in endowments and coefficients exist simultaneously between the two groups:

$$C = [E(X_A) - E(X_B)]'(\beta_A - \beta_B)$$

The decomposition (4) is formulated from the viewpoint of the group B. Of course, the difference can be expressed in a similar manner from the viewpoint of the group A, which gives the following decomposition:

$$R = [E(X_A) - E(X_B)]'\beta_A + E(X_A)'(\beta_A - \beta_B) + [E(X_A) - E(X_B)]'(\beta_A - \beta_B) \quad (5)$$

The estimation of the components of the decompositions (4) and (5) is straightforward. Let $\hat{\beta}_A$ and $\hat{\beta}_B$ be the least squares estimates for β_A et β_B, obtained separately from the two group-specific samples. Furthermore, use the group means $\overline{X}_A$ et $\overline{X}_B$ as estimates for $E(X_A)$ and $E(X_B)$. Based on these estimates the decompositions (4) and (5) are computed as:

$$\hat{R} = \overline{Y}_A - \overline{Y}_B = (\overline{X}_A - \overline{X}_B)'\hat{\beta}_B + \overline{X}'_B(\hat{\beta}_A - \hat{\beta}_B) + (\overline{X}_A - \overline{X}_B)'(\hat{\beta}_A - \hat{\beta}_B) \quad (6)$$

and

$$\hat{R} = \overline{Y}_A - \overline{Y}_B = (\overline{X}_A - \overline{X}_B)'\hat{\beta}_A + \overline{X}'_A(\hat{\beta}_A - \hat{\beta}_B) + (\overline{X}_A - \overline{X}_B)'(\hat{\beta}_A - \hat{\beta}_B) \quad (7)$$

So far, these methods of decomposition have mainly been applied in the context of linear regression models. However, in many cases, the explanation of themean outcome differences requires non-linear estimation. So, the OLS estimates become inconsistent.

If one is interested in the marginal effects of a latent censored outcome variable Y, the strategy would be to use the Tobit estimator in the standard Blinder-Oaxaca decomposition in equations (4) and (5). However, the conventional decomposition method leads to erroneous predictions of the components of the decomposition equation if we aim at analyzing the observable corner solution outcome variable. In this case, an alternative decomposition method must be applied (see Bauer and Sinning, 2006).[7]

2. The data

This work useindividual data, obtained from the TIMSS-2011's survey, concerning 5893 students issuedfrom the 4th year of primary and belonging to 273 schools. Girls represent 47% of our sample while 53 % are boys. 67% of these students are urban and 33% are rural. By type of school, 11.2 per cent of the pupils attend private schools, 13.4% satellite schools, 15.8 per cent central schools, and 59.6 per cent are issued from autonomous schools.

3. The variables

The variable to explain is the score obtained during the TIMSS tests. The average score of our sample is 335.37 in mathematics and 266.26 in science (Table1). The average gender-gap's score is almost 8% points in math and 11 in science. The following graphs show the densities of scores recorded in mathematics and science.

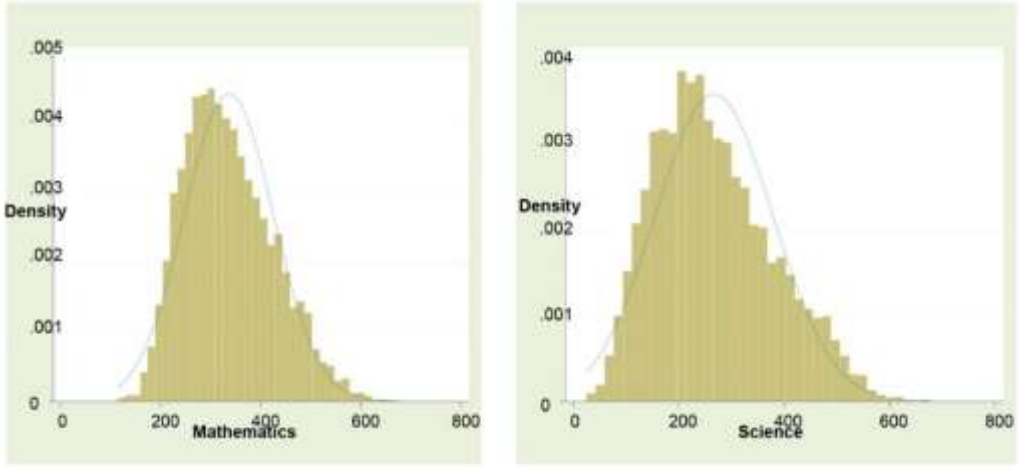


Figure 4. Density of the in mathematics and science scores
Source: author's calculation on the basis of the TIMSS-2011's survey (Stata12)

Seven variables are used –in the decomposition- in order to assess the Moroccan students' achievements. The student'sage, support at home, the lengthof the nursery schoolperiod(variable scale), the type of school, the sex and the age of the instructor, educational material possession, and the educational level of the mother. [89]

Finally, the characteristics of the school, and its localization, will enable us to understand the mechanism of interaction between the school environment and the gender-gaps in mathematics and science achievements. For this, we use an ANOVA analysis in order to identify the key period features of the influence exercisedby the cited characteristics on the gender-gaps in mathematics and science achievements.

4. The differences of average scores of girls and boys: results of the ANOVA analysis

The findings indicate that girlsalways have a higher, and significantly different, average scores than boys (at the level of mathematics or/and science, localities, and type of school). The satellite schools record the most significant gender gap with 18 points of difference in mathematics and 20 points in science. The private and central schools are the only forms of school where there are no significant gender gaps.In addition, the most interesting-scores are recorded at private schools (in mathematics or science).

Table 1. Gender-gapsin the average score according to the type of school, and the locality

Mathematics		Average	SD	T-stat	Proba	SCIENCE		Average	SD	T-stat	Proba
TYPE OF SCHOOL											
SATILLETE SCHOOL	Boys	307.3090	89.0130	8.334	.004	SATILLETE SCHOOL	Boys	226.6423	105.4140	7.361	.007
	GIRLS	325.1246	97.7436				GIRLS	246.5138	116.2493		
	Total	315.6723	93.5955				Total	235.9706	111.0150		
AUTONOMOUS SCHOOL	Boys	321.3482	78.7393	11.770	.001	AUTONOMOUS SCHOOL	Boys	251.2137	102.5046	12.378	.000
	GIRLS	329.7003	74.6075				GIRLS	262.4615	99.0518		
	Total	325.2334	76.9483				Total	256.4458	101.0565		
CENTRAL SCHOOL	Boys	318.7512	97.8384	.208	NS	CENTRAL SCHOOL	Boys	245.2876	116.9680	.659	NS
	GIRLS	321.4047	91.2453				GIRLS	250.9718	110.7492		
	Total	320.0044	94.7467				Total	247.9723	114.0508		
PRIVATE	Boys	440.8003	72.5811	1.978	NS	PRIVATE	Boys	366.0744	95.0098	.504	NS
	GIRLS	433.5757	66.6737				GIRLS	361.3188	86.4943		
	Total	437.2223	69.7644				Total	363.7192	90.8618		
MIDDLE OF RESIDENCE											
URBAN	Boys	340.8144	88.97016	7.080	.000	URBAN	Boys	273.9485	112.12735	7.115	.000
	GIRLS	347.6430	82.49499				GIRLS	282.6743	106.00344		
	Total	344.0290	86.04073				Total	278.0563	109.36189		
RURAL	Boys	312.9515	92.15545	7.827	.000	RURAL	Boys	235.2538	110.99868	11.237	.000
	GIRLS	323.9332	93.47302				GIRLS	251.1660	113.73630		
	Total	318.1020	92.91684				Total	242.7169	112.54636		
TOTAL SAMPLE	Boys	331.4980	90.98956	14.360	.000	TOTAL SAMPLE	Boys	261.0105	113.23738	16.817	.000
	GIRLS	339.7523	87.00940				GIRLS	272.1882	109.63045		
	Total	335.3790	89.22889				Total	266.2660	111.67665		

Source: author's calculation on the basis of the TIMSS-2011's survey (SPSS)

The analysis by locality demonstrated that urban children have the best attitude toward mathematics and sciences with respectively 344.02 and 278.05 points, whilerural children capitalized more inferior scores with 318.10 in mathematics, and 242.71 in sciences. This fact is may be due to the schools'proximity, the important number of educational constructs, and the availability of the learning materials-in number and in quality- for the first group of children; whereas the second group is the most vulnerable relating to the benefits mentioned above. To finish, we mention that the average score of the satellite schools'students reflects the fact that these students are facing serious difficulties in terms of scientific learning.

The following table gives more details concerning the reality of children'sscientific knowledge capitalization and its gender gaps in Morocco.

5. The Oaxaca and Blinder decomposition : findings

Table 2 presents the results of the decomposition of the natural logarithm scores'gaps in mathematics, and science. The method proposed by Oaxaca and BLINDER allows decomposing the scores gender's gaps in three components. The firstpart corresponds to the differential assigned to the individual characteristics of each group.The second part reflects the impact of the explanatory variables on the scores' differential. Finally, the third component matches with the simultaneous effect of groups' characteristics and variablesheterogeneity between groups.

First of all, we notice that the total scores' differential is significant in mathematics and science. The findings show that there isa gender gap of 3.1 per cent in mathematics and 6% in science –for the benefit of girls-; thisdifference is distributed as follow:

- Differences in term of the characteristics make girls more performants than boys by 0.85% in math, and 1.94% in science;
- An additional gap of 1.82% in math, and 3.51% in science, is the result of the difference of the effects caused by the explanatory variables in each model;
- The interaction between differences in terms of characteristics and explanatory variables' effects explains 0.5 % of the gender gap[10] in mathematics and science achievements.

Detailed results of the decomposition allowed us distinguishing the non-significant variables from the significant ones (partially significant or/and globally significant).

A. Non-significant variables

Some variablesaren'tsignificantly determining the level of the gender gap. There are fivenon-significant variables:the size of the class, the teacher gender, the teacher experience, the attendance of a private school, and the education level of the mother.

Table 2. Decomposition Oaxaca and BLINDER differential of scores (Stata12)

Variables	Mathematics				Science			
	Overall	Endowments	Coefficients	Interaction	Overall	Endowments	Coefficients	Interaction
Commune		-0.000574	0.0112*	-0.000817		-0.000684	0.0235**	-0.00171
		(0.000388)	(0.00671)	(0.000599)		(0.000673)	(0.0115)	(0.00111)
Office		-0.000582	-0.0148**	0.00101*		-0.00148*	-0.0393***	0.00270**
		(0.000396)	(0.00645)	(0.000606)		(0.000812)	(0.0111)	(0.00134)
Internet		3.86e-05	-0.0113**	-0.00144*		0.000257	-0.0188**	-0.00238*
		(0.000503)	(0.00535)	(0.000799)		(0.000862)	(0.00920)	(0.00136)
Age of the student		-0.00428***	-0.113	-0.00287		-0.0115***	-0.105	-0.00266
		(0.00139)	(0.0689)	(0.00177)		(0.00255)	(0.118)	(0.00302)
Size		1.48e-05	0.0218	-3.38e-06		2.06e-05	0.0320	-4.97e-06
		(0.000611)	(0.0286)	(0.000140)		(0.000851)	(0.0492)	(0.000205)
Teacher gender		-8.50e-05	0.00714	-4.11e-05		-0.000135	0.0117	-6.71e-05
		(0.000361)	(0.00703)	(0.000179)		(0.000573)	(0.0121)	(0.000293)
Teacher experience		0.000182	-0.0205	-0.000198		0.000374	-0.0270	-0.000262
		(0.000243)	(0.0164)	(0.000284)		(0.000482)	(0.0283)	(0.000414)
Satellite		1.78e-05	-0.00464*	0.000182		0.000104	-0.00851*	0.000335
		(8.05e-05)	(0.00271)	(0.000332)		(0.000220)	(0.00467)	(0.000606)
Private		-0.00268	0.00491	-0.000414		-0.00381	0.00761	-0.000642
		(0.00216)	(0.00306)	(0.000430)		(0.00307)	(0.00527)	(0.000680)
Mather education		5.30e-05	0.00222	3.90e-05		8.32e-05	4.27e-05	7.49e-07
		(0.000147)	(0.00371)	(0.000121)		(0.000233)	(0.00639)	(0.000112)
Support		-0.000798	-0.00333	-0.000521		-0.00264**	-0.000880	-0.000137
		(0.000661)	(0.00584)	(0.000917)		(0.00121)	(0.0100)	(0.00157)
Group_1	5.771***				5.470***			
	(0.00496)				(0.00844)			
Group_2	5.883***				5.538***			
	(0.00490)				(0.00828)			
Difference	-0.0317***				-0.0594***			
	(0.00697)				(0.0118)			
Endowments	-0.00848***				-0.0156***			
	(0.00309)				(0.00502)			
Coefficients	-0.0182***				-0.0351***			
	(0.00654)				(0.0113)			
Interaction	-0.00506**				-0.00483			
	(0.00231)				(0.00400)			
Constant			0.102				0.0894	
			(0.0787)				(0.135)	

Stata 12 ; (...)SD; *** p<0.01, ** p<0.05, * p<0.1

B. Significant Factors

At the end of our study on the gender-gap-kind in mathematics and science achievements–for thefourth class of primary-, it is appropriate to makesome comments.The detailed analysis of the decomposition gives six variables that aresignificantly influencing the scores' gendergaps. Except"support at home" that has a partial impact (effect on science's gender gaps), the other five variables (possession of a computer, possession of an office, possession of the internet, the student'sage, and the attendance of asatellite school) influence both gendergaps in science and mathematics:

- When the girls'age exceeds the boys one by one year, the girls'average score surpassesthe boys one by 0.4 % in math and 1.15% in science;
- Every one point increasing of the home support index,forgirls,–the same index is unchanging for boys-generates0.26% more out-achieving in science in the profit of girls. This observation allows us to propose the implementation of a national campaign, for example, that encourages parent to support their children at homein order to guarantee the improvement of the scientific achievements and the gender parity in matter of scientific knowledge;
- The learning's material possession (a desk, computer, or internet) is significantly affecting the gender-gap. Indeed, the possession of a computer tends to reduce the gap in math, and in science, in favor of boys; while the possession of the internet, and/or of a desk, benefits more to girls. Beyond this fact, the learning via internet-TIC in general-provides an effective solution to the physical and geographical obstacles confronted by certain children. However, this solution needs the development of a greater autonomy (children must learn with no teacher orientation).
- Finally, frequenting satellite schools is significantly extending the gender gap (in math and science) in favor of girls, thus rejecting the hypothesis that girls are more vulnerable to satellite schools compared to boys.

Conclusion

The previous developments deal with the question of the educational discrimination. This question has been at the heart of the public debate since at the end of the 1990's. Even if our results confirm that the girls are more performants than boys, the performance of the educational system and Moroccan is still very mediocre in general. This is why it is essential to deploy more efforts in several areas, to conduct studies on the causes of the current situation, and to imply every man, who think, in the development of the necessary medication.

The medication process success is with no doubt dependent on the behavior'schange of all stakeholders. This change depends essentiallyon some factors related to the middle of residence (which affects the type of school attended), the learning material's availability (office, computer, books etc…), the parentsupport, the generalization of the nursery school frequentation, and the continuous updating of the educational pedagogy.

To the issues cited above, it is necessary to supplement other factors which fall within the framework of a double logic of development:

- The development of a new project based on the development of psychosocial skills;
- The development of a system of monitoring/evaluation of children'spsychosocial skills and support for children's personal projects (especially for children who have salientproblems).

References

1. Aletha C. H, Amy Claessens, Chantelle J. Dowsett, Crista Called, Greg J. Duncan, Holly Sexton, Jeanne Brooks-Gunn , Katherine Magnuson, Kathryn Duckworth, Leon Feinstein, Linda S. Pagani, Mimi Engel, Pamela Klebanov: **"School Readiness and Later Achievement"**. 2007
2. Arnot, M. and Gary Dillabough, J., **"Challenging Democracy: international perspectives on gender, education and citizenship"**. London: RoutledgeFalmer, 2003
3. Aunola, K., Leskinen, E. , Lerkkanen, M. K. , &Nurmi, J. E., **"Developmental dynamics of math performance from preschool to grade 2 "**. Journal of Educational Psychology, 96, 2004, 699-713.
4. Blinder, A. **"Wage Discrimination: Reduced Form and Structural Estimates"**. The Journal of Human Resources, 8 (4), 1973, pp. 436-455.
5. Bressoux, P., **The effects of the school context on the acquisitions of pupils: effect-school and effects-classes in reading**. French Review of Sociology , 36 (2), 1995, 273-294.
6. Brown, L., **"Dropout, failure rates linked to language".** Toronto Star, 2006, June 23, A01 Retrieved on July 28, 2007.
7. Desoete, A., & Gre'history, J., **"Numerical competence in young children and in children with mathematics learning disabilities".** Learning and Individual Differences, 16, 2006, 351-367.
8. Fan, X. & Chen, M., **"Parental involvement and students' academic achievement: A meta-analysis".** Educational Psychology Review, 13, 2001, 27-61. doi:10.1023 /A:1009048817385
9. Fantuzzo, J. W. , King, J. A. , & Heller, L. R., **"Effects of reciprocal peer tutoring on mathematics and school adjustment: A component analysis"**. Journal of Educational Psychology, 84, 1992, 331-339. doi:10.1037 / 0022-0663.84.3.331
10. Feldman-Summers S., **"The effects of sex on powers of causality".** Journal of Personality and Social Psychology. 30 (6), 1974, 846-55.
11. Francis, B. & Skelton, C., **"Reassessing gender and achievement: Questioning contemporary key debates"**. Abingdon, UK: Routledge, 2005
12. Gerin-Lajoie, D, **"The impact of the assessment of educational outcomes among students of minorities"** in C. Lessard and P. Meirieu (reds) the obligation of results in education. Quebec: The Presses of the Laval University, 2004, p. 167178.
13. Ginsburg, H. P., Lee, J. S., & Boyd, J. S., **"Mathematics education for young children: What it is and how to promote it"**. Social Policy Report of the Society for Research in Child Development, 22, 2008, 3-22

14. Becomes, E. M., Weinstein, T. , & Walberg, H. J., **"School-based home instruction and learning: A quantitative synthesis"**. Journal of Educational Research, 76 (6), 1983, 351-360.
15. Grisay, A. **Evolution of acquired cognitive and socio-emotional needs of students during the years of college**. Paris: Ministry of National Education, 1997.
16. Grolnick, W. S., Ryan, R. M., &Deci, E. L**., "Inner resources for school achievement: Motivational mediators of children's perceptions of their parents".** Journal of Educational Psychology, 83, 1991, 508-517. doi:10.1037 / 0022-0663.83.4.508
17. Hoffman L. R. and Maier N. R. F. , **"Social factors influencing problem solving in women"**, 1961.
18. Hoover-Dempsey , K. V. , & Sandler, H. M., **"Parental involvement in children's education: Why does it make a difference?"** Teachers College Record, 97 (2), 1995, 310-331.
19. Hoover-Dempsey, K. V. , & Sandler, H. M., "**Why do parents become involved in their children's education?"** Review of Educational Research, 67, 1997, 3-42. doi:10.2307 /1170618
20. Ibourk H.A.S., **"Determinants of Educational Achievement in Morocco: A Micro-Econometric Analysis Applied to the PIRLS Study'**, Regional and Sectoral Economic Studies vol 13. 2. 2013
21. Ibourk H.A.S., **"Determinants of Educational Achievement inmorocco: A Micro-Econometric Analysis Applied to the TIMSS Study'**, International Education Studies, Vo 6. 2, No. 12, 2013
22. Ibourk H.A.S., **"Young Graduate Cooperatives in Morocco: Achievements and Problems".** Creative Education: Scientific Research Publishing, USA, 2012. Vol. 3, Special Issue, 1043-1052 ,PDOI:10.4236 /obligatory2012.326157
23. Ibourk H.A.S., **"The educational expectations of poor families in Morocco, an empirical investigation"**, International Review of education of Sevres no. 62, April 2013, France
24. Jeynes, W. H., **A meta-analysis: "The effects of parental involvement on minority children's academic achievement"**. Education and Urban Society, 35 (2), 2003, 202-218.
25. Jeynes, W. H., **"A meta-analysis of the relationship of parental involvement to urban elementary school student academic achievement".** Urban Education, 40, 2005, 237-269. doi:10.1177 /0042085905274540
26. Jones, F. L. , and J. Kelley, **"Decomposing Differences Between Groups. A Cautionary Note on Measuring Discrimination"**. Sociological Methods and Research 12, 1984, 323-343.
27. Jordan, N. C. , Kaplan, D. , Locuniak, M. N. , &Ramineni, C., **"Predicting first-grade math achievement from developmental number sense trajectories"**. Disabilities Research and Practice, 22, 2007, 36-46.
28. Klibanoff, R. & coll. **"Preschool children's mathematical knowledge: The effect of teacher "math talk"**, Developmental Psychology, vol. 42, 1, 2006, 59-69
29. Lemery, J. -G., **"The reading and the boys"**. Montreal: Les Editions of the Cheneliã¨re, 2007.

30. Leroy, N., Bressoux, P., Sarrazin, P., &Trouilloud, D., **Impact of teachers' implicit theories and perceived pressures on the establishment of an autonomy supportive climate.** European Journal of Psychology of Education, 22 (4), 2007, 529-545.
31. Martens Lingard, B., Martino, W., Mills, M., & Bahr, M., **"Addressing the educational needs of boys".** Canberra: Department of Education, Science and Training, 2002, Retrieved on June 18, 2007.
32. Duru-Bellat, M. **"The social segregation at school: facts and effects",** 2004
33. Martino, W. & Kehler, M., **"Male teachers and the 'boy problem: Year outcome of recuperative masculinity politics"**. McGill Journal of Education, 41 (2), 2006, 113-131.
34. McWayne, C. Green, L., &Fantuzzo, J., **"A variable- and person-oriented investigation of preschool competencies and Head Start children's transition to kindergarten and first grade"**. Applied Developmental Science, 13, 2009, 1-15.
35. Michel Fize**, "The traps of the mixed school"**, 2004
36. Morin Justine, **Memory: "The involvement of parents in the education of their child(s) in the elementary school: differences according to social environment?"**, framed by Billouet Pierre. University of Nantes, University Teacher Training Institute, 2012. Site-web of Nantes
37. Murat Fabrice, **"The school delay as a function of parental care: the influence of parents' skills"**. Economies and statistics, no. 424-425, 2009, p. 103-124.
38. Neumark, D**., "Employers Discriminatory Behavior and the estimation of Wage Discrimination"**, Journal of Human Resources, 23, 1988, 279-295.
39. Nye, C., Turner, H. , & Schwartz, J., **"Approaches to parent involvement for improving the academic performance of elementary school age children in grades K-6".** London, England: Tea Collaboration, 2007. Retrieved from http:// campbellcollaboration.org/doc-pdf/nye_pi_review.pdf
40. Oaxaca, R., **"Male-Female Wage differentials in Urban Labor Markets".** International Economic Review, 14 (3), 1973, pp. 693-709.
41. Oaxaca, R. L., and M. Ransom, **"Searching for the Effect of Unionism"on the wages of Union and third Workers"**. Journal of Labor Research, 9, 1988, 139-148.
42. Pedersen, D.M., Shinedling, M. M. & Found Guilty, D. L., **"Effects of sex of examine and subject on children's quantitative performance test"**. Journal of Personality and Social Psychology. 1968, 10 (3), 1968, 251-4.
43. Poupeau F., Francois J. -C., **The meaning of the placement**. Residential Segregation and school segregation, Paris, 2008, reasons to act, 229 p.
44. Seneschal, M., **"Testing the home literacy model: Parent involvement in kindergarten is differentially related to grade 4 reading comprehension, Dr. Papert, spelling, and reading for pleasure"**. Scientific Studies of Reading, 10, 2006, 59-87. doi:10.1207 /s1532799xssr1001_4

[1] The rate of illiteracy has reached 38.45 per cent for the population aged 10 years and over, and 43% for the aged 15 and more, said Mr. Birou at a press conference devoted to the presentation of the results of "the national survey on illiteracy, the non-enrolment and the enrolment rates in Morocco" 2007. According to the latest figures of the

HCP relating to 2009, the rate of illiteracy is 39.7 %. The ministry of finance, him, given for 2010 a rate of 30% only.

[2] According to the report "An Assessment of the progress made in Africa in the achievement of the Millennium development goals, 2011 ", Morocco is 5 to 10 percent of the target of 95% in net enrolment rate in primary

[3] Ina V. S. Mullis, Michael O. Martin, Pierre Foy, and Alka Arora: "TIMSS 2011: International Results in Mathematics".

[4] Morin Justine. Memory: "The involvement of parents in the education of their child(s) in the elementary school of differences according to social environment? ". Framed by Billouet Pierre in 2012.

[5] The values between parentheses denote the absolute differences of the scores achieved by girls and boys.

[6] Except for the group of countries of the Gulf OPEC members, and importers of human resources, according to the global index of the knowledge economy IKE-2013.

[7] Bauer and Sinning: "An Extension of the Blinder-Oaxaca Decomposition to Non-Linear Models", Oct-2006.

[8] 0 =No support; 1 =one or two times per month; 2 =a o two times per week; 3 =all days.

[9] 0 =Not enrolled in pre-school; 1 =one year or less; 2= between 1 and2 years; 3 =2 years ; 4= between 2 and 3 years; 5= 3years and more.

[10] 1.85 =(0.002/0.108) * 100

CSR AND PROFITABILITY IN ROMANIAN IT SMES

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Abstract

A growing number of European small and medium IT promotes social responsibility strategies as a result of social pressure, environmental and economic crises. These businesses seek to influence decisions of the parties that interact: employees, shareholders, investors, customers, the public and non-governmental organizations. In this respect, companies are investing in their future and it is expected that a voluntary commitment that we make to help increase firm profitability. The European Union attaches great importance of corporate social responsibility it can contribute significantly to the strategic objective set in Horizon 2020 EU the most competitive and dynamic knowledge-based economy with a high level of employment and social cohesion work. This paper is a study of the CSR practices of 121 small-size companies drawn from IT sector in Romania. The empirical analysis shows a high level of incidence of CSR in these SMEs, particularly on the factors that translate into management benefits. Thus, the practice of CSR is seen to both correlate and contribute to the management efforts of the SMEs.

Keywords: *corporate social responsibility, SMEs, IT*

Introduction

Although the Corporate Social Responsibility (CSR) movement has grown in recent years, there is a simmering debate if CSR is a necessity for business. It is often said that business is the wealth-creating body of society. Hence, its prime role is to produce the goods and services that people need in their daily lives. Friedman (1970) wrote a famous article for The New York Times whose title summed up its main point: "The social responsibility of business is to increase its profits." He argued that most often the principle of social responsibility is usually a way to justify an otherwise irresponsible action.

More recently, Henderson (2001), emphasizing the anti CSR arguments, states that in an open and competitive environment business further the general interest: "… by responding to the demands of their customers, by keeping down costs and prices, and through timely and well-judged innovation. Not only does such an environment make for better enterprise performance, but at the same time […] it opens up opportunities for ordinary people including the poorest: prosperity and economic freedom go together". He further adds that

responsible behaviour need not translate into endorsing the current doctrine of CSR; however businesses should act responsibly, and should be seen to do so. Elbing (1970) points out that CSR has been approached as "value of business" and has been discussed academically in universities, pragmatically by businesspeople, politically by public representatives, and approached philosophically, theologically and even aesthetically. From all these discussions, Elbing (1970) states that two distinct positions of CSR emerge:

a. The singular perspective- i.e., to maximize the economic profits of the firm for its owners.
b. The other perspective- that the businessman has a social responsibility more important than profit maximization.

While defining the social responsibility framework, Walton (1967) states, "their common denominator is a rejection of enforceable obligations as the only criteria of a corporation's responsibility to society." He further adds, "there are costly corporate responsibilities to society that do not necessarily contribute to long-term profitability of the enterprise." However, he does conclude that there is an abundance of literature advocating a different viewpoint to the classical economic theory or economic framework that considers that businessmen do have a social responsibility, a responsibility other than making money for themselves and their stockholders.

Bowen (1953), similar to Elbing (1970), had recognized two basic principles that relate to the current arguments on social responsibility. The first principle builds on the notion that business is for society and hence would necessarily need to be governed by rules. The second principle attempts to direct attention to the role of business as a moral agent of the society it is within. Although this position is not given due attention by Friedman (1962), his forceful argument against CSR stirred the academic community and paved the way to explore the role of business in society.

In the present, CSR is quite often seen as the business way of pursuing sustainable development and attaining the "triple bottom line": planet, people, and profits. The triple bottom line is essentially a measure beyond the economic value a business adds, which includes social value of business. This means giving equal consideration to economic and social goals and commitments, and allocating sufficient resources to research that supports these commitments.

Holme and Watts (2000) use the following definition: "CSR is the continuing commitment by business to behave ethically and contribute to economic development while improving the quality of life of the workforce and their families as well as of the local community and society at large."

However, the most common understanding of CSR comes from the definition used by the World Bank which states the commitment of business is to contribute to sustainable economic development along with employees, their families, the local community and society at large and to improve their lives in ways that are good for its business and for development. This definition seems most comprehensive, as it provides clarity on the business role of CSR. This is because business cannot be seen in isolation, as the primary factors that make up a business are its employees and the society in which the business functions.

From the above, we notice that the strong arguments and mixed point of view on the social responsibility of business people and the value issue of business cover a very wide

spectrum. Further, the basic premise for such arguments is based on the fact that it has not been possible to determine the impact on the financial performance of organizations adopting good CSR behaviour (Nicolescu O. et al, 2009).

CSR, SMEs and profitability

The 1970s laid much emphasis on finding a correlation between CSR and profitability. This may perhaps have been due to the fact that the proponents of CSR were outnumbered by the ones who believed that business had only one moral duty, i.e., to make profits. Hence, empirical evidence was the only answer to ensure the acceptance of the belief that socially responsible behaviour is good for business. Numerous research studies (McWilliams and Siegel, 2000) and exhaustive literature search (Aupperle, et al., 1985) have been undertaken, with no clear evidence of a positive correlation between CSR and profitability.

Since the 1970s, a number of CSR models have been developed. The most popular and well-cited are the three-dimensional model (Carroll, 1979); the synthesis model (Wartick and Cochran, 1985); the stakeholder model (Clarkson, 1995); and the integrative model (Wood, 1991), all of which provide a description of activities related to social responsibility. Each model has attempted to explore the varied dimensions of CSR and measure the nature and extent of social responsibility in an organization. It is observed that none of the above models are 'stand-alone' answers for measuring social performance in an organization. Further, assessment of CSR activities in an organization involves identifying the activities based on the different stakeholders as Clarkson (1995) notes, "at any point of time one or more stakeholders may be of importance to an organization and hence factors of influence would vary from time to time."

Despite the lack of any empirical evidence of a direct or a visible correlation between CSR and the economic performance of an organization, it has been accepted and acknowledged that CSR (Piercy and Lane, 2009) does impact on the policy and behaviour of companies throughout the world. However, not much attention has been devoted to the link between CSR and management. If one were to expand the focus of profitability in an organization, it would include elements that contribute to long-term financial success, such as reputation, brand value, employee loyalty, strong and long-lasting relationships with stakeholders, etc. (Ceptureanu SI et al, 2015b).

In other words, the CSR activities present benefits at two levels: one for the company as stated above, the other for the society, as many of the CSR initiatives are operative in and around the vicinity of the business. Hence, the community around it is likely to benefit as a result. The impact of these CSR initiatives on customers and other stakeholders is a key to performance improvement in a company.

Although the correlation between CSR and profitability is yet unproven, there have been some efforts to study the links between CSR and management. In fact, there is a growing interest among management practitioners and CSR advocates to develop a framework that could integrate CSR and management.

Vives and Peinado-Vara (2003) found that there is a business case for CSR; in other words, that responsibility generates economic returns highlighting those cases that have brought about both improvements in the competitiveness of firms, whilst, at the same time, improving their relations with stakeholders: customers, suppliers, human resources and communities (Ceptureanu SI, 2015a). The deliberations exhibited the positive impact that

CSR has within the firm, how it can lead to improved competitiveness, and, therefore, profitability.

The concept of "corporate iceberg", which essentially denotes the increasing risks of the intangibles that surround an organization as against the tangible financial profits, goes to the extent of cautioning companies of the potential threat to their reputation and social license to operate if they fail to address ecological and social responsibilities (Willard, 2002).

The present era of globalization has moved the spotlight from bigger companies to small and medium enterprises (SMEs). However, the vulnerability of the small firm (SMEs) changes with the environment, and its survival depends to a large extent on how it interacts (Ceptureanu EG, 2015a). Here, the environment denotes a larger frame and includes not merely raw material demand and supply, but also the human and financial resource and its governance mechanism within and outside the enterprise (d'Ambiose and Muldowney, 1998). The increase in globalization and the direct supply chain relationship is clearly affecting SMEs globally (Popa I et al, 2009; Ceptureanu SI, 2015b). This includes business ethics, workplace practices and labour issues, company values, health and safety considerations, etc. Furthermore, the effect of globalization is also impacting the production processes and trade and providing opportunities for innovation and technology development.

As mentioned earlier, market forces are driving the need for organizations to address CSR in a credible manner and motivating companies to change their behaviour and use CSR as a strategic instrument (Ceptureanu EG, 2015b).

Conventional thinking has led us to believe that larger companies have been the primary drivers of CSR. However, this does not mean that CSR is irrelevant to or not practiced by SMEs. Some of the academic work discussed earlier and the CSR models (Carroll, 1979; Wartick and Cochran, 1985; Wood, 1991; Clarkson, 1995) were predominantly for large organizations. The Clarkson (1995) study did include some small firms, but they did not provide any details of the outcome of his study on small firms.

Ironically, there is very little known on the CSR practices in SMEs in comparison to the vast amount of articles and dialogues available for large organizations. Most of the academic literature on CSR originates from Western countries; hence, the question arises whether CSR is a standardized concept across different cultures. Not much research is available on the cultural difference in understanding the notion of CSR. Since there is a distinct cultural scheme and changes from region to region, it is but common that social behaviour cannot be assumed to be uniform. Pedersen and Huniche (2006), in a study on CSR in the African context using Carroll's model, noticed that the 'critical priorities' of CSR in Africa are likely to different from that of a classic case in a developed country. Similarly, the meaning of CSR would differ in SMEs as against a large company and is also likely to differ among SMEs across regions.

A unique feature in SMEs is that they are largely ownership based or in cases where they are partnership based, they would be among family friends or distant relatives (Ceptureanu SI et al, 2015a). In this context, Jenkins (2006) observes that SMEs tend to have a personalized style of management. Given the multi-relationship the owner observes in his day-to-day management, it is perceived that the stakeholder relationships for an SME may be more informal, trusting and characterized by intuitive and personal engagement (Ceptureanu EG et al., 2014). Fuller and Tian (2006) also state that SMEs undergo their business largely on a personal level, and it acts as a catalyst for socially responsible behaviour. They

further note that due to the strong association with immediate stakeholders, such as employees, customers, suppliers and their local community, their involvement is more direct and informal (Ceptureanu EG et al, 2012). Unlike large corporations, SMEs have fewer numbers of stakeholders in aggregate terms to intermingle with, and hence are able to maintain a certain code of conduct characteristic of the neighbourhood or region. The rapid development of legislation and international standardization has had a far-reaching impact, particularly on developing country SMEs (Ceptureanu SI, 2014).

The research method

The heterogeneous and highly fragmented nature of the SME segment makes the availability of information regarding SMEs and their practices extremely limited. Hence, the given data set from the responses received through the award application made a good case to explore the incidence of CSR in SMEs along the same lines as the earlier study undertaken in the IT sector. The original application received for the awards included both objective (options for responses) and subjective (statements from the applicants) types of questions. However, for the purpose of this study, only the objective type questions were considered. The data provided descriptive statistics regarding the SMEs and their CSR activities, which helped in collating the results and further empirically testing them.

Hence, a similar empirical testing as that of the IT sector (Ceptureanu EG, 2015c) was considered, help in strengthening the basis of using the statistical inference method to explore the incidence of CSR in SMEs. As mentioned earlier, only 45% of the applications were being considered for the award evaluation due to incomplete forms. For the purpose of this study, the responses were once again reviewed and the section that each applicant was unable to complete was recorded. It was observed that incomplete applications were predominantly the narrative section of the questionnaire. Hence, for the purpose of our empirical observation, we had 121 applicants that had responded to the entire "objective" section of the questionnaire. This number was sufficient for empirically testing the applications.

The aim here was to assess the incidence of CSR in SMEs as per the IT sector study. The choice for repeating the statistical analysis on this entirely new sample was primarily to test the efficacy of this statistical method. Hence, the data collected from the application forms were statistically analysed using the method of statistical inference. We assume that the respondents' awareness level would be higher. Hence, during this analysis, the P-value was set on a higher scale, i.e., test of $p = 0.6$ vs $p > 0.6$ against the P-value of $p = 0.5$ vs $p > 0.5$ taken for the IT sector study. The reason for doing this was to account for the respondents' basic knowledge of CSR as against the respondents of the IT sector study. It follows that the designated null hypothesis (H0), that the proportion of indicative factors of social responsibility is at least 60%. In other words, if 60% responded in favour of CSR practices, then the existence of CSR among the sample would be considered. The alternative hypothesis (H1) is that the proportion is less than 60%.

The questionnaire typically had multiple choices that included "yes", "no", "in part" and "not applicable" responses. The results of the empirical testing are given in Table 1. The survey questionnaire primarily was broken down to four factors and can be depicted as: (a) market policy, (b) workplace policy, (c) company values and (d) social and community policies. In some it also included some prominent sub-factors.

While undertaking the statistical analysis, all those who responded as "not applicable" were removed and were not included in the total number of responses = "N". Those who responded "in part" were included as a positive response = "X".

It may be noted that, in this study, the sample was heterogeneous, as the respondents comprised different sectors of industry. Market policy, workplace policy and company values scored well (see Table 2). However, the social and community policy did not show an incidence of CSR. The results of the survey analysis subsequent to the "proportion test" showed an overall incidence of CSR.

In reviewing the questions in this section, the results point to the fact that SMEs are not comfortable with social and community issues. Hence, this provides room for reflection on how to increase the community/enterprise interactions to enable the enterprise to draw benefit. It can be further suggested that perhaps the enterprise do not feel or have the financial resources to take up activities such as the capacity building of community, etc. All the other four factors- market policy, workplace practices and company values- exhibit high incidence of CSR.

However, when it comes to sub-factors, the position gets altered within the factor (Table 3). For instance, regarding the 'workplace practices' factor, a sub-factor- provision of good work balance- does not exhibit an incidence of CSR. It seems that facilities such as recreation room, stress management, etc. are not issues for an enterprise that is constantly struggling to make ends meet.

For the sub-factors of "company values", it is observed that the SMEs score a "No" on the sub-factor on "providing training and having clear guidelines". The sub-category on "labour standards", however, exhibits an incidence of CSR. Here, one could conclude that the incidence of CSR is perhaps due to the pressure exerted by the supply chain and due to regulation. However, the survey shows a poor score on "health" practices. Clearly, health issues of the unit employee are not important and the SMEs do not perceive providing health benefits as something that will accrue benefit for them in return. Another factor is that many SMEs have contract labour and, hence, are not obliged to provide benefits that are given to full-time employees.

Examining the last factor, "community and social issue", the response did not show an incidence of CSR. Further, the sub-factor on developmental activity also does not show an incidence of CSR. The question on philanthropy practices did not receive any attention. This result appears to be different from the usual responses that one gets from SMEs in Romania. SMEs are known for their charitable practices and do so often discreetly. The negative response to this can be attributed to the cultural norms of the country, which is not to share their philanthropy behaviour or activities.

This analysis clearly shows that an SMEs, whichever sector it be in, has a strong inclination in getting factors, such as market policy, workplace policy, company values and labour standards. Further, they ensure that these factors are adhered to within the norms of government regulations.

However, factors, such as training and capacity, social issues and community issues do not appear high on their agenda. This stems from the fact that, and as proved earlier in the IT sector (Ceptureanu SI, 2015c) enterprises do not attempt to engage in any socially responsible behaviour unless they are able to perceive an immediate gain from the engagement for their respective businesses.

Table 1. Empirical survey of CSR Factors

Questions	Yes	N	Sample P	Exact p value	0.05 level of Significance
Market policy	116	121	0.93	0	Yes
Environment friendliness of products	121	121	1	0	Yes
Ensure honesty and quality in all its contracts, dealings and advertising	121	121	1	0	Yes
Provide clear and accurate information and labelling about products and services, including its after-sales obligations	121	121	1	0	Yes
Timely payment of suppliers' invoices?	121	121	1	0	Yes
Effective feedback process	121	121	1	0	Yes
Register and resolve complaints from customers, suppliers and business partners	121	121	1	0	Yes
Work with other companies in your supply chain or other organizations to address issues raised by responsible entrepreneurship	107	121	0.89	0.001	Yes
Workplace practices	108	121	0.9	0.001	Yes
Encourage employees to develop real skills and long-term careers	121	121	1	0	Yes
Steps are taken against all forms of discrimination, both in the workplace and at the time of recruitment	116	121	0.96	0	Yes
Frequency of team meetings to discuss operational/occupation health and safety issues?	93	121	0.77	0.029	Yes
Suitable arrangements for health, safety and welfare that provide sufficient protection for your employees?	112	121	0.93	0	Yes
Provision of a good work-life balance that includes:	61	121	0.5	0.861	No
a. Recreation room	27	121	0.23	1	No
b. Stress management	56	121	0.47	0.927	No
c. Annual get together	88	121	0.73	0.063	No
d. Other	61	121	0.5	0.859	No
Company values	121	121	**1**	**0**	**Yes**
Have you clearly defined your enterprise's values and rules of conduct?	117	121	0.97	0	Yes
Do you communicate your enterprise's values to customers, business partners, suppliers and other interested parties?	121	121	1	0	Yes
Are your customers aware of your enterprise's values and rules of conduct?	121	121	1	0	Yes
Are your employees aware of your enterprise's values and rules of conduct?	121	121	1	0	Yes
Do you provide training to your employees on:	76.23	121	0.63	0.348	No
a. Skill performance enhancement?	100.4	121	0.83	0.004	Yes
b. Career Development?	68.97	121	0.57	0.639	No
c. Work Culture/ethics?	88.33	121	0.73	0.066	No
d. Other	44.77	121	0.37	0.989	No
Labour standards	96.8	121	0.8	0.009	Yes
Payment of minimum wages	112.5	121	0.93	0	Yes
Equal remuneration for equal work	100.4	121	0.83	0.004	Yes
Freedom of association	93	121	0.77	0.027	Yes
Elimination of forced or compulsory labour	76	121	0.63	0.352	No
Elimination of discrimination in respect of employment and occupation	97	121	0.8	0.008	Yes
Abolition of child labour	109	121	0.9	0	Yes
Clear guidelines on	81	121	0.67	0.221	No
a. Recruitment	105	121	0.87	0.001	Yes
b. Termination	93	121	0.77	0.027	Yes
c. Career advancement	85	121	0.7	0.128	No
d. Performance appraisal	109	121	0.9	0	Yes
Faced or dealt with any labour disputes in the past three years?	9	121	0.07	1	No
Health policy	52	121	0.43	0.24	No
Health insurance	40	121	0.33	0.11	No

Provident funds	48	121	0.4	0.22	No
Other	63	121	0.52	0.28	No
Social and community policies	72	121	0.59	0.36	No
Offer training opportunities to local community?	108	121	0.89	0.74	Yes
Open dialogue with the local community	73	121	0.6	0.19	No
Strategies adopted to undertake developmental activities	52	121	0.43	0.18	No
Philanthropic initiatives	71	121	0.59	0.39	No
Community investments/social investments	52	121	0.43	0.25	No
Public- private partnership	21	121	0.18	0.04	No
Imparting skills to local community	65	121	0.54	0.32	No
Allowing use of its resources	52	121	0.43	0.19	No
Encourage employees to participate in community activities	61	121	0.5	0.24	No

Table 2. Empirical Summary of the Prime Factors

Questions	Yes	N	Sample P	Exact p- value	Incidence of 0.05 level of significance
Market policy	116	121	0.96	0	Yes
Workplace practices	108	121	0.90	0.001	Yes
Company values	121	121	1	0	Yes
Social and community policies	75	121	0.59	0.36	No

Table 3. Empirical summary with the Sub-factors

Questions	Yes	N	Sample P	Exact p-value	Incidence at 0.05 level of significance
Market policy	**116**	**121**	**0.96**	**0**	**Yes**
Workplace practices	**108**	**121**	**0.90**	**0.001**	**Yes**
Provision of a good work-life balance	61	121	0.5	0.861	No
Company values	**121**	**121**	**1**	**0**	**Yes**
Do you provide training to your employees on?	76.23	121	0.63	0.348	No
Labour standards	96.8	121	0.8	0.009	Yes
Clear guidelines on	81	121	0.67	0.221	No
Health policy	52	121	0.43	0.24	No
Social and community policies	**75**	**121**	**0.59**	**0.36**	**No**
Strategies adopted to undertake developmental activities	52	121	0.43	0.18	No

Conclusions

The empirical analysis does showcase CSR practices in SMEs and positive responses have been reported across many factors. This illustrate that the SMEs follow a comprehensive approach combining various areas. However, the concept may still appear to be vague to many SMEs. Further, this paper limits itself to exploring the incidence of CSR in SMEs empirically with a sample size of only 121 enterprises and many not is ideally representative of all SMEs in Romania.

Nevertheless, the response to CSR award denotes that SMEs in Romania are now beginning to see CSR as a one of the many managerial channels and are consciously embedding CSR in their respective business policies, as they realize it to be a managerial instrument with direct benefits to them.

Given the stake SMES have in the national economy, management is one of the critical areas that require focus (Ceptureanu SI et al, 2012). Extensively evaluations of such instruments are required to establish a correlation between CSR and management. SMEs do not have the strategic tools and the means for their business development unlike the large

enterprises. Such analysis will give an empirical base for SMEs to appreciate the significance and to adopt CSR practices.

References

1. Aupperle, K.E, A.B. Carroll, and J.D. Hatfield., **An Empirical Examination of the Relationship Between Corporation Social Responsibility and Profitability**, Academy of Management Journal 28(2), 1985, 446-463.
2. Bowen, H.R., **Social Responsibility of the Businessman**. New York University Press: Harper & Row, 1953.
3. Carroll, A.B., **A Three-dimensional Conceptual Model of Corporate Social Performance**, Academy of Management Review 4(1), 1979, 497-505.
4. Ceptureanu E.G., **Survey regarding resistance to change in Romanian innovative SMEs from IT Sector**, Journal of Applied Quantitative Methods, 10 (1), 2015a, 105-116
5. Ceptureanu E.G., **Reaction to change in Romanian SMEs**, Review of International Comparative Management, 16(1), 2015b, 77-87
6. Ceptureanu E.G., **Research regarding change management tools on EU SMEs**, Business Excellence and Management Review, 5(2), 2015c , 28-32
7. Ceptureanu E.G. and Ceptureanu S.I., **Change management survey on innovative ITC Romanian SMEs**, Quality- Access to success, 16 (144), 2014, 62-65
8. Ceptureanu EG and Ceptureanu SI, **Practice in management and entrepreneurship: some facts from the Bucharest University of Economic Studies**, Review of International Comparative Management, 13(5), 2012, 703-716
9. Ceptureanu S.I., **Knowledge based economy in Romania: comparative approach**, Journal of Applied Quantitative Methods, 9 (4), 2014, 51-61
10. Ceptureanu S.I., **Competitiveness of SMEs**, Business Excellence and Management Review, 5(2), 2015a, 55-67
11. Ceptureanu S.I., **Knowledge management in Romanian young SMEs**, Review of International Comparative Management, 16(1), 2015b, 5-22
12. Ceptureanu S.I. and Ceptureanu E.G., **Knowledge management in Romanian companies**, Quality- Access to success, 16 (145), 2015b, 61-66
13. Ceptureanu S.I. and Ceptureanu EG, **Challenges and barriers of European young entrepreneurs**, Management Research and Practice, Vol. 7 Issue 3 (2015), 2015a, 34-58
14. Ceptureanu SI, **Romanian young SMEs overview. Business environment situation**, Proceedings of the 25th International Business Information Management Association (IBIMA), ISBN: 978-0-9860419-4-5, 7-8 May 2015, Amsterdam, Nederland, 2015c, 1555-1567.
15. Ceptureanu SI, Ceptureanu EG, Tudorache A. and Zgubea F, **Knowledge based economy assessment in Romania**, Economia, Seria Management, 15(1), 2012, 70-87
16. Clarkson, M.B.E., **A Stakeholder Framework for Analyzing and Evaluating Corporate Social Performance**, Academy of Management Review 20(1), 1995, 92-117.
17. d'Amboise, G., and M. Muldowney, **Management Theory for Small Business: Attempts and Requirements**. Academy of Management Review 13(2), 1998, 226-240.
18. Elbing Jr., A.O., **The Value Issue of Business: The Responsibility of the Businessman**, Academy of Management Journal 13(1), 1970, 79-89.
19. Friedman, M., **Capitalism and Freedom**. University of Chicago Press: Chicago, 1962.
20. Friedman, M., **The Social Responsibility of Business is to Increase its Profits**, New York Times Magazine. September 13, 1970
21. Fuller, T., and Y. Tian., **"Social and Symbolic Capital and Responsible Entrepreneurship: An Empirical Investigation of SME Narratives."** Journal of Business Ethics 67(3), 2006, 287-304.
22. Henderson, D., **Misguided Virtue: False Notions of Corporate Social Responsibility**, New Zealand Business Roundtable, June 2001.

23. Holme, R., and P. Watts., **Corporate Social Responsibility: Making Good Business Sense**, World Business Council for Sustainable Development, Conches-Geneva, Switzerland, 2000.
24. Jenkins, H., **Small Business Champions for Corporate Social Responsibility**, Journal of Business Ethics 67(3), 2006, 241-256.
25. McWilliams, A., and D. Siegel, **Corporate Social Responsibility and Financial Performance: Correlation or Misspecification?**, Strategic Management Journal 21(5), 2000, 603-609.
26. Nicolescu O., Nicolescu C., Popa I, Ceptureanu SI, Dobrin C, Ceptureanu EG, **Innovation in Romanian SMEs and its impact on performance**, International Association of Computer Science and Information Technology-Spring Conference, 2009. IACSITSC 2009, 336-339
27. Pedersen, E. R., and M. Huniche (eds.), **Corporate Citizenship in Developing Countries**. Copenhagen Business School Press: Copenhagen, 2006.
28. Piercy, N.F., and N. Lane., **Corporate Social Responsibility: Impacts on Strategic Marketing and Customer Value**, The Marketing Review 9(4), 2009, 335-360.
29. Popa I, Dobrin C, Ceptureanu SI, Ceptureanu EG, **The positive impact on SMEs activity of Romania's integration in the European Union**, 2009 International Association of Computer Science and Information Technology-Spring Conference 2009, IACSITSC 2009, 2009, 340-344
30. Vives, A., and E. Peinado-Vara (eds.), **Corporate Social Responsibility as a Tool of Competitiveness**. Proceedings, Panama City, October 26-28, 2003. Inter-American Development Bank: New York, 2003
31. Walton, C., **Corporate Social Responsibilities**. Wadsworth: Belmont, CA, 1967
32. Wartick, S.L., and P.L. Cochran., **The Evolution of the Corporate Social Performance Model**, Academy of Management Review 10(4), 1985, 758-769.
33. Willard, B. **The Sustainability Advantage.** New Society Publishers, 2002
34. Wood, D.J., **Corporate Social Performance Revisited**, Academy of Management Review 16(4), 1991, 691-718

CRITICAL REVIEW OF VISION FITNESS TESTING WITHIN THE SOUTH AFRICAN DRIVING LICENSE TESTING AND ROAD SAFETY CONTEXT[1]

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Abstract:

In the South African context visual fitness testing prior to issuing a learner's, driving license or authorizing the renewal of a driving license has been legislated since 1998. Of all the medical fitness disqualifiers, visual fitness has been prioritized as perhaps the most important medical condition to be verified through eye-testing procedure at a licensing authority. All other medical conditions are disclosed or declined through a concise declaration by the applicant. This study shows firstly, that the causal factors of certain vehicle accidents are not significantly related to visual fitness. Secondly, considering the substantiated low failure rate through eye-testing at driving license testing centres, the study suggests there is no justification for the current prescribed eye-testing procedure and accompanying operational and capital budget implications without the other relevant eye-testing procedures.

Key words: *Eye-testing, visual acuity, visual field, driving license, driver view field analysis, vehicle accident*

Introduction

The principle of keeping a proper lookout or failing to do so is well imbedded in law within the South African context [1, 2, 3, 4]. In many litigation cases the apportionment of negligence is decided, based on the principle of failure to keep a proper lookout by one or both or more drivers involved in a vehicle accident [1, 2, 3]. The latter legal principle will for many confirm the importance of vision fitness. However, the ability to keep a proper

lookout is not a function of perfect vision versus some degree of vision impairment alone. It will be argued by the authors that a conscious awareness of the principle of keeping a proper lookout which is dependent on visual acuity and visual fields and other as reported in [5], and the skill to timeously foresee road usage risks and finally, competent driving skills in general are overwhelmingly more important factors to be considered in road safety strategies aimed at reducing the road carnage on South African roads.

Readers are reminded of a convincing finding reported in [6] that drivers with visual defects are no more vulnerable to have accidents than those with normal vision. The aforesaid finding is supported in a critical review of the existing literature related to vision, driving competency and accidents. The authors Owsley et al. present a critical review on reported findings found in 211 research papers [7].

In South Africa, compulsory eye-testing to verify visual fitness meeting minimum visual acuity and visual field requirements has been legislated since 1998 [8]. Eye-testing became standardized procedure during the period of converting driving licenses to the credit card format and for obtaining a learner's or driving license or renewal thereof, thereafter. Implementing the legislation with the considered view of government that such tests should be freely available to all citizens necessitated enormous financial investment in amongst others, retraining of examiners for driving licenses, provision of eye-testing equipment throughout the driving license testing centres (DLTC's) countrywide, specialized stationary and other auxiliary services. Cycling all driving license holders through the driving license card conversion process was a rather frustrating process for many citizens. The current driving license renewal process proves to be equally cumbersome and certainly time consuming. Admittedly, an analysis of process flow efficiency and the cost-benefit of eye-testing is not the theme of this research project but, anecdotal evidence suggests that very little value is added to accident reduction, driving skills and road usage behaviour. The latter suggestion motivated this study. The authors are convinced that the millions spent on this singular aspect of driver fitness as a holistic competency should be re-channeled appropriately. Arguably, other important road safety factors come into play. However, accepting that not all can be done simultaneously, the objective of this research is to convince the case that decisive leadership and implementation strategies must be sought to (i) define a more comprehensive (meaningful) eye-test protocol to be performed by professionals rather than the instrumental approach by semi-skilled officials at driving license testing centres; (ii) capacitate driving license testing centres to prevent corrupt and incompetent driver testing, effectively; (iii) operationalize concerted and effective speed law enforcement; (iv) development of a sense of foreseeability of risks amongst road users through amended training curriculum, prior to issuing driving licenses.

Mathematical Analysis of Two Types of Intersection Accidents

The visual fitness standards for obtaining or holding a learner's or driving license are prescribed in Regulation 102 of the National Road Traffic Act, (Act 93 of 1996), [8]. The standards provide for two clusters of driving licenses i.e. code A1, A, B or EB (motorbikes and light motor vehicles) and code C1, C, EC1 or EC (heavy motor vehicles). Regulation 102 of the Act prescribes as follow:

(i) Code A1, A, B or EB a Snellen rating of minimum visual acuity of 6/10 for each eye and; a minimum visual field of 70 degrees temporal for each eye, or where visual field

of one eye is less than 70 degrees a minimum total horizontal visual field of at least 115 degrees. In all standards with or without refractive correction applies.

(ii) Code C1, C, EC1 or EC a Snellen rating of minimum visual acuity of 6/9 for each eye and; a minimum visual field of 70 degrees temporal for each eye. In all standards with or without refractive correction applies.

In the South African context approximately 40% of all accidents occur in, at or close to an inter-section [9]. This compares well with worldwide statistics [9, 10, 11, 12]. In 2001 the British Columbia Police reported these accidents constitute 44,1% of all accident types [11]. For this reason two of the typical causal scenarios resulting in intersection accidents will be analyzed to show that both the eagle eyed and the blind or a combination thereof is of absolute zero assistance to prevent an accident from occurring. Note that the mathematical analysis can be applied to numerous other intersection related accident scenarios as well as head-to-rear and multiple vehicle highway accidents. The purpose of the analysis is to introduce the reader to the concept of driver view field analysis to gain some understanding to what extent visual acuity and visual field can or cannot assist in the prevention of accidents.

Restricted Vision Line Angled Across Intersection

Figure 1 illustrates a common situation found at one or more corners of an intersection when building construction is in process. Legislation in respect of construction site safety typically requires the erection of safety fencing on the edge of pedestrian walks and on occasion, right on the road-edge.

Common practice is to utilize corrugated sheets which completely obstruct visual line diagonally across the intersection up to a critical point. We refer to such fencing as solid fencing. Figure 1 depicts a vehicle modeled as a point travelling at speed $v_1 > 0\ ms^{-1}$ following a line of travel parallel along the street hence, parallel to along the street hence, parallel to the solid fencing. The perpendicular separating distance between the line of travel and the solid fence is given by $\ell_1 \geq 0$.

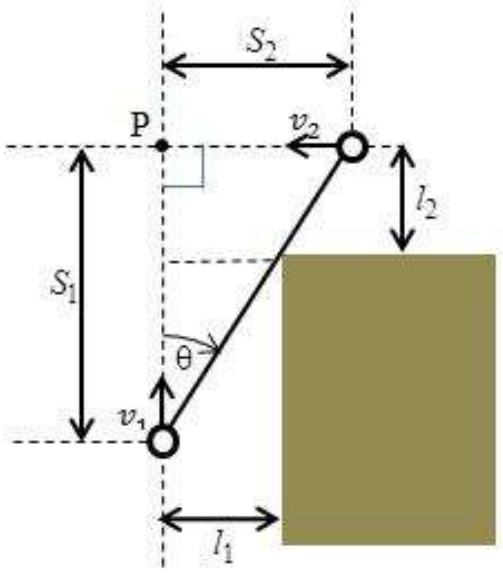

Figure 1.

Similarly, a second vehicle travelling perpendicular to the direction of travel of the first, at speed $v_2 > 0\ ms^{-1}$ and separated by distance $\ell_2 \geq 0$ from its corresponding solid fence applies.

Let both drivers be ignorant to the risk of the situation and assume both will drive through the intersection either just hoping for the best or, that they solely depend on eye sight to timeously alert them of eminent danger to which they must react.

The critical positions both vehicles must reach respectively to open the earliest opportunity for a direct line of sight (angled "across") are indicated in figure 1. Clearly after the respective vehicles travelled distances S_1 and S_2 an accident might occur. The occurrence is guaranteed (completely inevitable) if the travelling time to cover S_1 and S_2 by the respective vehicles are equal. It simply means that both vehicles have reached the same point P at exactly the same time, $t > 0$. In physics such occurrence is called a collision.

We have that:

$$tan\theta = \frac{\ell_1}{S_1 - \ell_2} = \frac{v_2 t}{v_1 t},$$

$$\therefore S_1 - \ell_2 = \frac{v_1 \ell_1 . t}{v_2 . t},$$

$$\therefore S_1 = \frac{v_1 \ell_1 + v_2 \ell_2}{v_2},$$

$$\therefore v_1 t = \frac{v_1 \ell_1 + v_2 \ell_2}{v_2},$$

$$\therefore t = \frac{v_1 \ell_1 + v_2 \ell_2}{v_1 v_2}.$$

Hence, what is fact is that the time from the moment the direct line of sight opens up to reaching the point of collision is a function of only the respective speeds and the separating distances from the respective solid fences. Because a driver can only control his/her travelling speed and not the speed of the other driver, an accident is inevitable if time t (constant for both drivers) is such that $t \leq t_0$, $t_0 > 0$ the accepted average human reaction time. No degree of good or poor vision fitness can mitigate this inevitable situation. Neither can vision impairment contribute causally to the accident as a physical science event. In fact, in litigation the principle of keeping a proper lookout or the failure to do so cannot objectively be applied. Only intuitive appreciation of the danger posed by the visual obstruction followed by the foreseeability of an accident and subsequent reduction in speed, which is not a function of visual parameters, to allow at least $t > t_0$ can possibly prevent an accident. The reason why travelling time exceeding human reaction time is not necessary sufficient to prevent an accident is because, if motion time (now including evasive action such as braking or swerving) remains equal for both vehicles to reach a common point, a collision occurs. It will only be that the point of impact, the nature of impact and the respective speeds at which

impact occur, differ. Furthermore, a vehicle is not a true point but a dimensional structure hence the time at which the collision might occur is at $t' \in [t-\delta, t+\delta]$.

From the above model it is easy to see that visual obstruction can be temporary and in motion itself. For example passing a bus or an articulated vehicle serves as a temporary visual obstruction for a finite time measure. However, when the direct line of sight reopens the situation can be eminent danger despite the best or the worst vision fitness of the driver(s). Another very practical scenario is the tragic accidents resulting from a driver approaching a stationary bus from which commuters exit. If the driver does not foresee the possibility that a pedestrian can unexpectedly dash from "behind" the bus the analysis above applies. This is the reason why drivers are made aware to take extra precaution when approaching a stationary school bus. Young children cannot comprehend the danger and the principle should be explained to learner drivers. The authors are not aware of a curriculum explaining this principle

The 'Can Stop-Can Run'; 'Cannot Stop-Cannot Run' Dilemma

The third author presented most of this section during the 3rd International Conference on Accident Investigation, Reconstruction, Interpretation and the Law, during October 1999 [10]. Assume a driver travels at a constant speed $v > 0\ ms^{-1}$ along a road approaching an intersection with an across width of $\ell \geq 0$ meters. Assume that at distance $D \geq 0$ meters from the stop line the traffic lights switch to amber. The driver may after reaction time $\gamma > 0$ lapsed either run through the intersection safely if the distance ($D + \ell$) meters can be covered before the traffic lights switch to red or, stop safely if the vehicle stops within ($D - v\gamma$) meters. Figure 2 depicts the scenario.

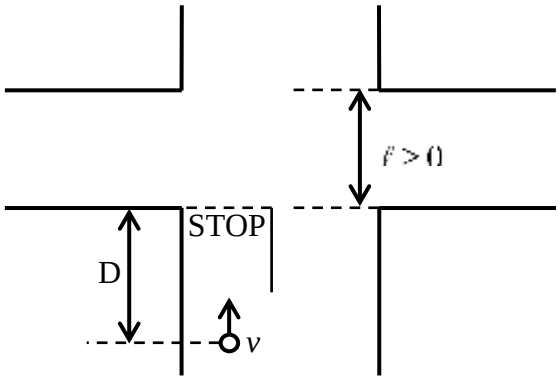

Figure 2.

A conservative assumption would be to consider running through without further acceleration. Therefore, to run safely through the intersection the inequality $vT \geq D + \ell, T > 0$ seconds denotes the amber time. The minimum stopping distance utilizes full the friction coefficient say, μ. The minimum stopping distance corresponds to:

$$S = v\gamma + \frac{v^2}{2g\mu} \text{ meters, } g = gravitational\ acceleration.$$

For safe stopping hence, outside the boundaries of the intersection either the inequality:

$$S = v\gamma + \frac{v^2}{2g\mu} \le D \ ,$$

or the inequality:

$$S = v\gamma + \frac{v^2}{2g\mu} + \ell \le D + \ell$$

must be satisfied. A potentially dangerous situation arises if, $v\gamma + \frac{v^2}{2g\mu} + \ell > vT$.

In fact, if $v\gamma + \frac{v^2}{2g\mu} + \ell > D + \ell > vT$, the driver can neither run through safely nor stop safely. This situation is the real dilemma. This dilemma occurs when:

$$v < (T-\gamma)g\mu - \sqrt{g^2\mu^2(\gamma - T)^2 - 2g\mu\ell} \ \textbf{or}$$

$$v > (T-\gamma)g\mu + \sqrt{g^2\mu^2(\gamma - T)^2 - 2g\mu\ell} \ .$$

Most drivers have experienced this unpleasant situation where, after harsh braking the vehicle skids to a standstill somewhere within the intersection. The vehicle must then either be reversed to a safe position or cross traffic must allow the driver to clear the intersection. A safe situation prevails if:

$$v\gamma + \frac{v^2}{2g\mu} + \ell \le vT.$$

If $D + \ell \ge vT$, the driver can and must stop. Attempting to run is a risk. If $D + \ell \le v\gamma + \frac{v^2}{2g\mu} + \ell$, the driver can and must run. Attempting to stop is a risk. If, $D + \ell \le v\gamma + \frac{v^2}{2g\mu} + \ell \le vT$, the driver can do either, safely.

Since stopping distance is a quadratic function of speed, whilst running distance is a linear function of speed, there are critical speeds at which stopping distance exceeds running distance and a hazardous situation may arise. It is not uncommon for drivers to occasionally find themselves in a critical position where, even with added acceleration late running is required to clear an intersection. The analysis shows undoubtedly that vision fitness or lack thereof alone cannot be a critical causal or preventative factor in accidents resulting from these dilemmas. These dilemmas require good vision with the skill of good judgment to mitigate. Some of the dilemmas are so critical per se that they present an inevitable consequence.

In [4] a total of 5471 crashes for the period June 2005 to December 2007 were analyzed in well-defined detail. It was found that measured against the categories performance/non-performance errors and decision/recognition errors, these errors by drivers were the critical pre-crash factors in 92,9 % of the crashes.

Analysis of Historical Eye-Testing Data

Since this was purely a desk-top research project there is no ethical conflict with the Helsinki Declaration. Note that the data is stratified such that it is not personalized. Hence, the data *per se* and the analysis thereof fully comply with the Protection of Personal Information Act, (Act 4 of 2013) of the Republic of South Africa [13]. Historical data of 3200 applicants for renewal of their driving licenses were randomly selected through stratified sampling as follows:

(i) In the Gauteng Province the driving license testing centres (DLTC's) within the City of Tshwane (CoT) were selected. The following stratified sampling applied. Rayton DLTC: 400 applicants randomly selected over the period January to March 2014; Bronkhorstspruit DLTC: 400 applicants randomly selected over the period May to July 2015; Waltloo DLTC: 800 applicants randomly selected over the periods January to March 2015 and August to October 2015; Akasia DLTC: 800 applicants randomly selected over the period May to September 2015; Centurion DLTC: 800 applicants randomly selected over the period November 2015 to February 2016. Accumulatively over the said periods an estimated 20 000 applicants renewed their driving licenses. The sample is of formidable size and the data inputs are binary in nature. This implies that ratio analysis is all that is required to derive extremely reliable results.

(ii) Age of applicant was approximated to the age reached in 2016. The formula used is: 2016 - 19$\langle x_1, x_2 \rangle$, $\langle x_1, x_2 \rangle$ are the first two digits of the applicant's South African Identity Number.

The age ranges were: R-1 = [18-25] years; R-2 = [26-35] years; R-3 = [36-45] years; R-4 = [46-55] years; R-5 = [56-65] years; R-6 = [66-75] years; R-7 = [76-85] years.

(iii) Driving license codes were categorized as: Cat-1 = {Code A1/A only}; Cat-2 = {Code B or EB only}; Cat-3 = {Code B or EB and A1/A}; Cat-4 = {highest Code C1 with (A1/A optional)}; Cat-5 = {highest Code C with (A1/A optional)}; Cat-6 = {highest Code EC with (A1/A optional)}.

(iv)The first eye-test event i.e. (a) eye-test failed; (b) eye-test passed; (c) optometrist or ophthalmologist (oculist) certificate presented on application date. Important to note is that amongst those who failed the eye-test, a subsequent pass after visiting an optometrist for a second and final result, was not captured. It implies that the fail ratio represents an upper bound (worst case in respect of eye-test pass rate).

Clearly a variation in calendar periods from which the samples were randomly selected are not of thematic significance. However, the data in respect of gender, driving license code, approximation of age and the eye-test event are of binary truth value and of thematic significance, and therefore data capturing in respect of this data was verified by random recapturing of 800 (25%) of the sample population. A total of 7 errors were detected of which 4 were age errors and 3 were errors in the data population. This implies that the probable error margin is $\frac{x}{3200} \approx \frac{7}{800} \Rightarrow x = 44.8(45)$ errors in the data population. After correcting the detected errors it is probable that a further $\approx$37,8 (38) errors may remain implying an error margin of $\approx$[1,1813 to 1,1875]%: Therefore the data integrity is considered sufficient to proceed with formal data analysis.

Some Important Findings

In this subsection the data for each DLTC will be analyzed individually where-after an accumulative analysis is presented. The authors' proposition is that the DLTC's within the City of Tshwane are most popular throughout the Gauteng Province. Perhaps it is correct to state that the Centurion, Akasia and Waltloo DLTC's are most popular in the country. It is therefore assumed that the study within the jurisdiction of the CoT is representative of the status quo in the Gauteng Province. It is envisaged to further this research through comparative studies throughout all nine provinces of the Republic of South Africa. Similar to the sample size selected for the City of Tshwane, formidable sample size will be selected from a main city in each of the eight other provinces.

Table 1. Centurion DLTC

Age Range	Male	Female	Cat-1	Cat-2	Cat-3	Cat-4	Cat-5	Cat-6	Pass	Cert	Fail
R-1: 107	48	59	6	94	1	6	-	-	105	2	-
R-2: 249	137	112	-	205	12	32	-	4	204	39	6
R-3: 213	114	99	5	142	26	30	-	10	194	19	-
R-4: 116	52	64	2	88	8	4	-	14	92	24	-
R-5: 74	46	28	-	48	8	4	-	14	54	14	6
R-6: 28	4	24	-	28	-	-	-	-	18	10	-
R-7: 13	7	6	-	10	3	-	-	-	9	2	2
Total: 800	408	392	13	615	58	76	-	42	676	110	14

Note that:

(i) Only 1,75% of applicants failed the prescribed visual acuity test.

(ii) Cat-2 (Code B or EB) is the most popular renewal category (76,875%) at the Centurion DLTC.

(iii) Cat-5 (highest Code C with (A1/A optional)) has no representation.

(iv) 89,47% of Cat-4 (Code C1) subsample are in the R-1 to R-3 age range.

(v) We observe noticeable lower renewal numbers (7,125% of sample) from the age 56 years and older.

(vi) Gender renewal ratio Male: Female = 51%: 49%.

Table 2. Rayton DLT

Age Range	Male	Female	Cat-1	Cat-2	Cat-3	Cat-4	Cat-5	Cat-6	Pass	Cert	Fail
R-1: 61	37	24	-	53	-	5	-	3	61	-	-
R-2: 116	87	29	-	81	-	32	-	3	116	-	-
R-3: 69	40	29	-	21	-	43	-	5	69	-	-
R-4: 69	48	21	-	45	-	21	-	3	64	5	-
R-5: 37	29	8	-	26	-	3	-	8	32	5	-
R-6: 27	16	11	-	22	-	-	-	5	22	5	-
R-7: 21	13	8	-	21	-	-	-	-	15	3	3
Total: 400	270	130	-	269	-	104	-	27	379	18	3

Note that:

(i) Only 0,75% of applicants failed the prescribed visual acuity test.

(ii)Cat-2 (Code B or EB) is the most popular renewal category (67,25%) at the Rayton DLTC.

(iii)Cat-5 (highest Code C with (A1/A optional)) has no representation.

(iv)76,92% of Cat-4 (Code C1) subsample are in the R-1 to R-3 age range.

(v)We observe noticeable lower renewal numbers (14,5% of sample) from the age 56 years and older.

(vi) Gender renewal ratio Male: Female = 67,5%: 32,5%.

Table 3. Bronkhorstspruit DLTC

Age Range	Male	Female	Cat-1	Cat-2	Cat-3	Cat-4	Cat-5	Cat-6	Pass	Cert	Fail
R-1: 87	45	42	16	34	2	21	-	14	83	4	-
R-2: 160	110	50	8	28	-	84	-	40	158	2	-
R-3: 82	39	43	6	20	-	44	-	12	76	6	-
R-4: 36	8	28	2	10	-	18	-	6	32	4	-
R-5: 24	14	10	2	10	-	2	-	10	20	4	-
R-6: 9	4	5	-	7	-	-	-	2	5	4	-
R-7: 2	2	-	-	-	-	-	-	2	2	-	-
Total: 400	222	178	34	109	2	169	-	86	376	24	-

Note that:

(i) None (0,00%) of applicants failed the prescribed visual acuity test.

(ii) Cat-4 (Code C1) is the most popular renewal category (42,25%) at the Bronkhorstspruit DLTC.

(iii) Cat-5 (highest Code C with (A1/A optional)) has no representation.

(vi) 88,17% of Cat-4 (Code C1) subsample are in the R-1 to R-3 age range.

(v) We observe noticeable lower renewal numbers (8,75% of sample) from the age 56 years and older.

(vi) Gender renewal ratio Male: Female = 56,00%: 44,00%.

Table 4. Waltloo DLTC

Age Range	Male	Female	Cat-1	Cat-2	Cat-3	Cat-4	Cat-5	Cat-6	Pass	Cert	Fail
R-1: 91	63	28	1	54	24	8	-	4	72	16	3
R-2: 312	224	88	8	100	60	116	7	21	280	32	-
R-3: 165	120	45	8	68	16	33	12	28	133	30	2
R-4: 100	68	32	-	24	13	16	24	23	68	29	3
R-5: 76	69	7	-	31	-	13	-	32	68	7	1
R-6: 44	28	16	-	4	11	7	6	16	23	21	-
R-7: 12	12	-	-	4	-	-	8	-	12	-	-
Total: 800	534	266	17	285	124	193	57	124	656	135	9

Note that:

(i) Only 1,125% of applicants failed the prescribed visual acuity test.

(ii) Cat-2 (Code B or EB) is the most popular renewal category (35,625%) at the Waltloo DLTC.

(iii) 81,35% of Cat-4 (Code C1) subsample are in the R-1 to R-3 age range.

(iv) We observe noticeable lower renewal numbers (16,5% of sample) from the age 56 years and older.

(v) Gender renewal ratio Male: Female = 66,75%: 33,25%.

Table 5. Akasia DLTC

Age Range	Male	Female	Cat-1	Cat-2	Cat-3	Cat-4	Cat-5	Cat-6	Pass	Cert	Fail
R-1: 47	31	16	-	32	-	15	-	-	43	4	-
R-2: 208	100	108	2	124	21	61	-	-	197	9	2
R-3: 209	128	81	-	101	40	68	-	-	191	17	1
R-4: 140	80	60	-	48	44	27	1	20	120	20	-
R-5: 133	75	58	4	85	28	4	4	8	83	49	1
R-6: 39	22	17	-	19	8	4	8	-	27	10	2
R-7: 24	16	8	-	20	4	-	-	-	8	16	-
Total: 800	452	348	6	429	145	179	13	28	669	125	6

Note that:

(i) Only 0,75% of applicants failed the prescribed visual acuity test.

(ii) Cat-2 (Code B or EB) is the most popular renewal category (53,625%) at the Akasia DLTC.

(iii) Cat-5 (highest Code C with (A1/A optional)) has some presence (1,5%).

(iv) 80,45% of Cat-4 (Code C1) subsample are in the R-1 to R-3 age range.

(v) We observe noticeable lower renewal numbers (24,5% of sample) from the age 56 years and older.

(vi) Gender renewal ratio Male: Female = 56,5%: 43,5%.

Table 6. Accumulative Data Table

Age Range	Male	Female	Cat-1	Cat-2	Cat-3	Cat-4	Cat-5	Cat-6	Pass	Cert	Fail
R-1: 393	224	169	23	267	27	55	-	21	364	26	3
R-2: 1045	658	387	18	538	93	325	7	68	955	82	8
R-3: 738	441	297	19	352	82	222	12	55	663	72	3
R-4: 461	256	205	4	215	65	86	25	66	376	82	3
R-5: 344	233	111	6	200	36	26	4	72	257	79	8
R-6: 147	74	73	-	80	19	11	14	23	95	50	2
R-7: 72	50	22	-	55	7	-	8	2	46	21	5
Total: 3200	1886	1314	71	1707	329	721	70	307	2756	412	32

In summary note that:

(i) Most likely less than 1% of applicants finally fail the prescribed visual acuity test. The reason for this conclusion is because the data did not reflect those who failed an eye-test at a DLTC on first event and passed the eye-test at an optometrist as second event.

(ii) Cat-2 (Code B or EB) is the most popular renewal category (53,34%) overall.

(iii) Cat-5 (highest Code C with (A1/A optional)) is close to redundant as a heavy vehicle driving license category.

(iv) 83,495% of Cat-4 (Code C1) subsample are in the R-1 to R-3 age range.

(v) We observe noticeable lower renewal numbers (11,16% of sample) from the age 56 years and older.

(vi) Gender renewal ratio in the City of Tshwane Male: Female = 58,94%: 41,06%.

(vii) The Rayton DLTC shows distinct male applicant preference.

(viii) Bronkhorstspruit DLTC shows a perhaps questionable, 0% eye test failure rate.

Synopsis of Vehicle Population and Driving License Holders in South Africa

The most reliable source of the vehicle population in the South African context is e-NaTIS. The most recent published statistics to date (29 February 2016) confirms that Code B or EB is the minimum driving license requirement for 89,83% of registered motor vehicles (GVM 3500 kg). A further 6,05% comprises of motorcycles, quadru-cycles, tricycles and other self-propelled light vehicles. All other vehicles (GVM > 3500 kg) hence, < 4,1% require at least a Code C1 or higher driving license code.

The same statistics release indicates the following numbers per driving license code in Gauteng Province: Code A1 = 44706; Code A = 173290; Code B = 961450; Code EB = 1 313283; Code C1 = 1 116164; Code C = 4519; Code EC1 = 227126; Code EC = 294892. Clearly the 26,99% Code C1 driving license holders are disproportionate to the intended vehicle population (< 4.1%).

Conclusion and Further Research

The researchers are in agreement that vision fitness is of importance. However, research indicates the cognitive interpretation of visual stimuli is of greater importance. Legislation sets standards for visual acuity and visual field but ignores more important visual performance factors such as color vision, stereopsis (depth perception) and contrast sensitivity. In a recently published study by Boadi-Kusi et al. [5] it was concluded convincingly that comprehensive eye examination by appropriate professionals to detect conditions such as refractive errors, binocular vision anomalies and monocular blindness, is far more important than simply testing visual acuity as is currently the case.

The data analysis strongly suggests, almost in the absolute sense, that the current eye-testing protocol in the South African context is obsolete and it adds little value to driver fitness as a holistic concept. It is doubtful whether the current eye-tests have any deterministic relation as a meaningful causal factor in the catastrophic rate of serious/fatal/pedestrian accidents in South Africa. In practical terms it is required from license holders to spend long hours in service queues and in many instances it requires a revisit. Since the economic impact of the time wasted has not been assessed it offers scope for further research. Anecdotal evidence (complaints and public debate forums) suggests that for many drivers the waste of time is unaffordable. It is suggested that this is the single most important procedure preventing the elegant solution of on-line driving license card renewals. It is further suggested that if the current eye-test standards and protocol be sustained, that the acceptance of an optometrist certificate be promoted to minimise the number of those queuing for eye-tests at a DLTC.

A noticeable imbalance in the ratio of Code C1 license holders versus the vehicle population requiring that driving license code is observed. This observation raises the mysterious question for which a plausible answer should be researched. Why is it that so many decision makers and DLTC's claim the existence of a high demand for Code C1 driving license testing for a vehicle category < 4,1% of the vehicle population? Secondly, is there any correlation between the increasing number of Code C1 driving license holders and the carnage on South African roads? The respected digital research company, Pondering Panda, released a survey in May 2013 in which it reliably reported that corrupt driving license testing is rife in South Africa. In particular, Cat-4 is of interest because anecdotal evidence suggests strongly that Code C1 driving testing is the most corrupt driving testing code in the South African context.

With the observation that Code C is practically a redundant driving license category, it comes to mind that the deletion of Code C1 and C together with a prerequisite of compulsory Code B or EB with a minimum number of years driving experience prior to graduating to Code EC1 or EC could be a feasible intervention in reducing heavy vehicle accidents. The aforesaid is based on the well-known principle of induction skilling through repetition as stated in an ancient Latin proverb, '*Repetitio mater studiorum est*'. Hence, the proposal is based on the principle that developing comprehensive driving skills and the required cognitive skills while restricted to driving a light motor vehicle is likely to be, a safer option than developing same while driving heavy vehicles or an articulated tractor with interlinked trailers. An immediate intuitive challenge will be the resistance from the many existing driving schools specialising only in Code C1 instruction and testing. Perhaps, within the South Afri-

can context, we have an example of an undesirable driving license category that cannot be corrected due to the anticipated civil unrest which might follow.

References

1. Coetzee versus Road Accident Fund (38098/2-12) [2014], ZAGPPHC 551, (8 August 2014).
2. Jacobs versus Road Accident Fund (A402/2008) [2011], ZAGPPHC 121, (13 June 2011).
3. Mmeti versus Road Accident Fund (2038/2008) [2011], ZANWHC 82, (3 February 2011).
4. B. Walston-Dunham, **Introduction to Law**, Fith Edition, Delmar, Cengage Learning.
5. S.B. Boadi-Kusi, S. Kyei, F.A. Asare, A. Owusu-Ansah, A. Awuah, C. Darko-Takyi, **Visual Function among Commercial Vehicle Drivers in the Central Region of Ghana**, Journal of Optometry, 9,2016, 54-63.
6. G.T.W. Cashell, **Visual Function in Relation to Road Accidents**, Injury: The British Journal of Accident Surgery, 2(1), July 1970, 8-10.
7. C. Owsley and G. McGwin Jr, Vision and Driving, **Vision Research**, 50(23), 2010, 2348-2361
8. National Road Traffic Act, (Act 93 of 1996), Republic of South Africa.
9. National Motor Vehicle Crash Causation Survey, NHTSA, Report to Congress, U.S. Department of Transport, (July 2008).
10. J. Kok, **On Traffic Light Controlled Intersection Accidents**, The 3rd International Conference on Accident Investigation, Reconstruction, Interpretation and the Law, Pretoria, South Africa, October 1999.
11. S.J. Laing, **A Study of Age Differences in Accident Rates at Intersections in British Columbia**, M.A. Thesis (Gerontology), Simon Fraser University, August 2003.
12. N.S.S.R. Murthy and R. Srinivasa Rao, **Development of model for road accidents based on intersection parameters using regression models**, International Journal of Scientific and Research Publications, 5(1), January 2015.
13. Protection of Personal Information Act, (Act 4 of 2013), Republic of South Africa

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[1] **Competing Interests:** The authors declare that they have no competing interests.
Author's Contribution: All the authors contributed significantly in writing this paper. The authors read and approved the final manuscript.

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JOURNAL OF APPLIED QUANTITATIVE METHODS

Quantitative Methods Inquires

THERMAL MANIPULATION IN BROILERS AND LAYERS

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Abstract:

Thermal manipulation during incubation has been shown to have positive effects on performance and mortality of broilers in later life. This only holds when chickens are exposed to temperatures in later life they already experienced during the embryonic phase. Hardly known are the effects of thermal manipulation in layer chickens and furthermore the consequences of a mismatch between incubation temperature and later life ambient temperature. In this study, both cold and warm thermal manipulation was investigated in broilers and layers and the effects in later life during high temperatures. During d 7 to 16 of incubation broiler and layers eggs were exposed to an eggshell temperature (EST) of 37.5°C (C), a high EST of 39.5°C for 12 h per d (H), or a low EST of 36.5°C for 12h per d (L). Hatchability was not affected by breed, but was higher in the H treatment (96.3%) than in both other treatments (92.3% on average). Yolk free body mass was higher in C chickens, followed by H and L chickens in both breeds, whereas the opposite was found for the residual yolk. Body weight till 28d of age was hardly affected by incubation temperature treatment, but body temperature was higher in L chickens than in C and H chickens till 14d of rearing in broilers and till 21d in layers. Mortality during rearing was not affected by breed, but was considerable higher in L chickens (6.7%) than in C (1.8%) and H (1.2%) chickens. Based on this study, we concluded that layers act more or less comparable during and after thermal manipulation than broilers. Secondly, a mismatch between incubation temperature and rearing temperature will not only result in higher body temperatures, but also in considerable higher mortality in later life.

Key words: *thermal manipulation, poultry incubation, quantitative methods*

Introduction

Extensive progress in genetic selection of fast growing broiler chickens and high yielding laying hens has resulted in high heat production rates and consequently in a reduced ability to cope with high temperatures (Yahav *et al*., 2004a, b, 2009; Collin *et al*.,

2007). This can lead to poorer post hatch performance, including high mortality (Yahav and Plavnik, 1999), which can have a substantial importance for poultry industry, particularly in (sub)tropical countries (Moraes *et al*., 2003; Collin *et al*., 2005).

A way to prepare chickens to the high environmental temperatures in later life is epigenetic temperature adaptation or thermal manipulation (Minne and Decuypere, 1984; Tzschentke et *al*., 2004; Yahav *et al*., 2009). Instead of maintaining a constant temperature throughout incubation, which has been shown to result in best hatchability and chickens quality in moderate climates (French, 1997; Lourens *et al*., 2005), increasing or decreasing the temperature during certain critical periods of embryo development might stimulate the development of different physiological control systems (Yahav *et al*., 2009). In that way capacity of chickens to cope with heat stress (Yahav *et al*., 2009) or cold stress (Shinder *et al*., 2009, 2011) in later life might be improved.

The direction of the thermal manipulation and expected temperature in later life should match to find positive effects of thermal manipulation has been suggested by (Yalçin *et al*., 2010). In case chickens were programmed to high temperatures in later life, but exposed to normal temperatures (mismatch), body weight gain was lower than in the chickens programmed in the same way, but exposed to high temperatures in later life (match) (Yalçin *et al*., 2010). However, evidence whether this is also true under practical conditions is lacking. Furthermore, it is not clear whether in laying hens, comparable effects will be found than in broilers, because almost all studies to thermal manipulation are performed in broilers. Thermal manipulation could have comparable effects in layers than in broilers, but both this was not proven under practical circumstances and furthermore, effects of match and mismatch between embryonic and later life temperature are also not known in layers (Walstra *et al*., 2010).

The aim of this experiment was to investigate the effects of thermal manipulation in both broilers and layers under practical circumstances and furthermore to investigate effects of match or mismatch between temperature during incubation and in later life on growth performance and body temperature of chickens.

Materials and methods

Experimental Design

The experiment was conducted in the central part of Bangladesh during summer 2010, which means that high temperatures were observed during the experimental period. The experiment was carried out at the facilities of Kazi Farms Group, Dhanmondi, Dhaka, Bangladesh. The experiment consisted of two phases; 1) the incubation phase and 2) the rearing phase. During incubation, broiler and layer eggs were incubated at a control eggshell temperature, a high temperature during 7d to 16d for 12 h per day, or a low temperature during d 7 to 16 for 12 h per day. During rearing, male and female chickens were reared separately till 28d of age.

Eggs, treatments, and incubation

Eggs of a Cobb 500 broiler parent flock, aged 44 wk and a Hyline-Brown layer parent flock, aged 50 wk were used in this experiment. Per parent flock 600 eggs were collected, weighing between 65 and 70 g for the broilers and between 55 and 60 g for the layers. After weighing, eggs were randomly divided over 3 treatments of 200 eggs each.

Treatments were high incubation temperature (H), low incubation temperature (L) and control incubation temperature (C), resulting in six treatment groups (**BH, BL,** and **BC** for broilers and **LH, LL,** and **LC** for layers). The control treatment consisted of an eggshell temperature (**EST**) of 37.5°C (French, 1997; Lourens et al., 2005) throughout incubation. Eggs in the H treatment were incubated at an EST of 39.5°C for 12 h per d from 7d to 16d (Yahav *et al.*, 2009), whereas eggs in the L treatment were incubated at an EST of 36.5°C for 12 h per day from 7d to 16d. The incubation temperature for the other 12 h per d in the H and L treatment was maintained at 37.5°C. Eggs were incubated in a single stage incubator (Ei Fuzzy Computer Incubator, Qingdao Yingyi Electronic Equipment Co. LTD). Eggs of both broilers and layers of each treatment were incubated in the same incubator, meaning that 3 incubators were used. EST was controlled at each experimental day by using an infra-red digital thermometer just after starting the increase or decrease of the EST and also 6 h later. Eggs were turned hourly from the start of incubation till candling at day 18 of incubation.

After candling at 18d, eggs were transferred to a hatcher (Ei Fuzzy Computer Incubator, Qingdao Yingyi Electronic Equipment Co. LTD). After pull out at 21.5d chickens were manually graded and sexed. Color and feather sexing was applied for layers and broilers, respectively. Chickens were graded as 1 (no defects), 2 (not dry, small size, weakness), or 3 (anomalies, blindness, four legs, unabsorbed yolk, brain exposure). All apparently infertile eggs (18d) and unhatched eggs (hatching) were opened to determine true fertility or moment of death. Moment of death was recorded as early (1d to 7d), mid (8d – 14d) and late (15d -21d) using the breakout analysis manuals of Cobb and Hy-line. Fertility was calculated as number of fertile eggs / number of set eggs, whereas hatchability was calculated as number of hatched chickens / number of fertile eggs.

At pulling, per treatment group 7 male and 7 female chickens were decapitated to determine residual yolk (**RY**) weight and yolk free body mass (**YFBM**), where YFBM was calculated as chicken weight – RY.

Rearing

Only grade 1 chickens were used during the rearing period till 28d of age. A total of 443 broiler chickens and 457 layer chickens were reared in one of two sheds at the same location. Within these chickens, 15 male and 15 female chickens per treatment group were tagged to determine BW during rearing. Male and female chickens were housed separately in floor pens containing litter of rice hulls and calcium oxide. All male or female chickens of each treatment were housed in one pen, meaning that in total 12 pens (6 pens per shed) of approximately 75 chickens per pen were used.

Chickens were reared under normal environmental and management conditions as exists in Bangladesh. Chickens had ad libitum access to commercial available feed and water throughout the rearing period. All chickens were vaccinated against Newcastle disease at 3d and Infectious Bursal Disease at 18d of the rearing period. Additionally, layer female chickens were vaccinated against Marek's disease at hatch day.

Measurements

Body weight of the 30 chickens per treatment (15 males and 15 females) was determined at 0, 7, 14, 21, and 28d of rearing on pen basis. Cloacal temperature (**Tb**) of 7 male and 7 female randomly chosen chickens per treatment was determined at the same days as BW. Mortality was recorded on daily basis per treatment group.

Statistical analyses

All data were analyzed with SAS version 9.2 (SAS Institute Inc., Cary, NC) software. Logistic regression model was used to analyze Fertility, hatchability of fertile eggs, and week of embryo mortality. For fertility the model contained only breed as factor, whereas for hatchability and mortality breed, temperature (treatment) and their interaction were included in the model considering Egg as experimental unit.

BW, YFBM, and RY weight at hatch were analyzed by developing Analysis of Variance (ANOVA) model where breed and temperature were used as factors with their interaction considering Chicken as experimental unit. The Bonferonni correction was applied for adjusting multiple comparisons.

Linear Mixed Model was used to analyze BW and Tb during rearing. The model was developed using Breed and temperature as factor with their interaction considering pen as repeated subject. We found that compound symmetry (CS) structure was the best fit, and was used for within-pen variation.

Mortality during rearing was also analyzed by developing Logistic regression model. In this case we also used Breed and Temperature as factor with their interaction considering Chicken as experimental unit. Data were expressed as LSMeans ± SEM and statistically significant was considered at $P \leq 0.05$.

Results

Fertility and hatchability

Average fertility was 83.1% and 90.8% for broiler and layers, respectively ($P<0.001$; Table 1). Hatchability of fertile eggs was not affected by breed (94.5 and 92.8% for broilers and layers, respectively), but was higher at the High incubation temperature than in both other temperatures (96.3 vs. 92.9 vs. 91.7%, for H, C, and L incubation temperature, respectively). Mortality per week was not affected by week or incubation temperature (Table 1).

Table 1. Effect of breed and incubation temperature profile during d 7 -16 of incubation on fertility, hatchability, and weekly mortality.

1. Breed	Broilers			Layers			P-value		
Temperature[1]	H	C	L	H	C	L	breed	temp.	int.
Fertility, %	83.1			90.8			<0.001	-	-
Mortality wk 1, %	1.2	2.5	1.8	1.6	4.1	4.3	0.20	0.32	0.86
Mortality wk2, %	0.6	0.0	0.6	0.0	0.6	0.5	1.00	1.00	1.00
Mortality wk3, %	1.2	4.3	4.2	2.7	2.9	4.9	0.65	0.16	0.50
Hatchability, %	96.9	93.3	93.3	95.7	92.4	90.2	0.29	0.05	0.88

[1] Low (L): EST=36.5°C for 12 h/d; Control (C): EST=37.8°C for 24 h/d; High (H): EST=39.5°C for 12 h/d.

BW, YFBM, and RY at hatch

BW, YFBM, and RY at hatch showed an interaction between breed and incubation (Table 2). For broilers no differences in BW were observed among incubation, but for layers BW of H chickens were lower than of L chickens with C chickens intermediate. YFBM was higher in broiler chickens than in layer chickens, but within each breed the C chickens had higher YFBM than H chickens with the lowest value for L chickens. The RY was on average

higher in broilers than in layers, but within broilers the C chickens had lowest value, followed by H and L chickens. In layers, H and C chickens had the same RY, with a higher value for the L chickens.

Table 2. Effect of breed and incubation temperature profile during 7d -16d of incubation on body weight at hatch (BW), yolk free body mass (YFBM), and residual yolk (RY) (LSmeans)

Breed	Broilers			Layers			SEM	P-value		
Temperature[1]	H	C	L	H	C	L		breed	temp.	int.
BW, g	47.7^{a}	48.4^{a}	49.2^{a}	40.3^{c}	41.2^{bc}	41.6^{b}	0.2	<0.001	<0.001	0.03
YFBM, g	41.6^{b}	42.7^{a}	40.3^{c}	36.1^{e}	37.1^{d}	35.3^{f}	0.1	<0.001	<0.001	<0.001
RY, g	7.1^{b}	5.8^{c}	8.9^{a}	4.2^{d}	4.1^{d}	6.2^{bc}	0.2	<0.001	<0.001	0.007

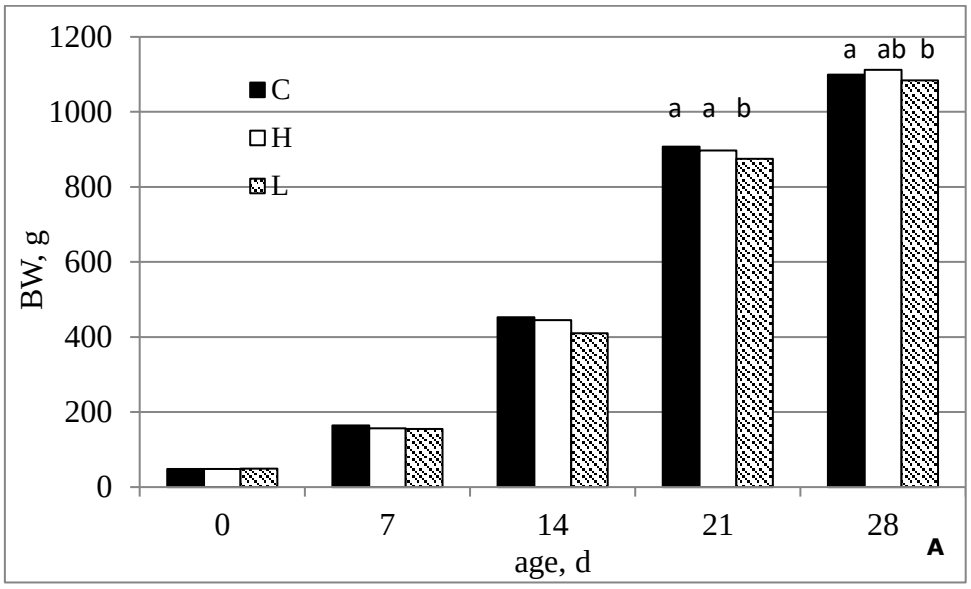
[1]Low (L): EST=36.5°C for 12 h/d; Control (C): EST=37.8°C for 24 h/d; High (H): EST=39.5°C for 12 h/d.

^{a,b} Values within a row, lacking a common superscript differed (P≤0.05).

Rearing

Average ambient daytime temperature during the rearing period was 33.4°C (range 32.1-36.5°C). Daytime shed temperature on chicken level in the same period was on average 35.7°C (range 33.3-37.3°C). Nighttime ambient temperature was not recorded, but was in the specific period between 25 and 30°C.

BW during the rearing phase showed a strong breed by day interaction (P<0.001), with diverging higher values for broilers from hatching onward (Figure 1a, b). Within broilers (P=0.007) and layers (P=0.009) an interaction between temperature and day of rearing was found for BW. In broilers no effect of temperature treatment was found at 1, 7, and 28d. At day 14 BW was lower in L chickens compared to C and H chickens, whereas this difference at day 21 was only significant between C and L chickens. In layers, BW did not differ among treatments at day 1, 7, 14, and 21, but at day 28 H chickens had higher BW than both other treatments. Sex differences were found in broilers from day 21 and from d 14 onward in broilers and layers, respectively, with higher values for males (data not shown).



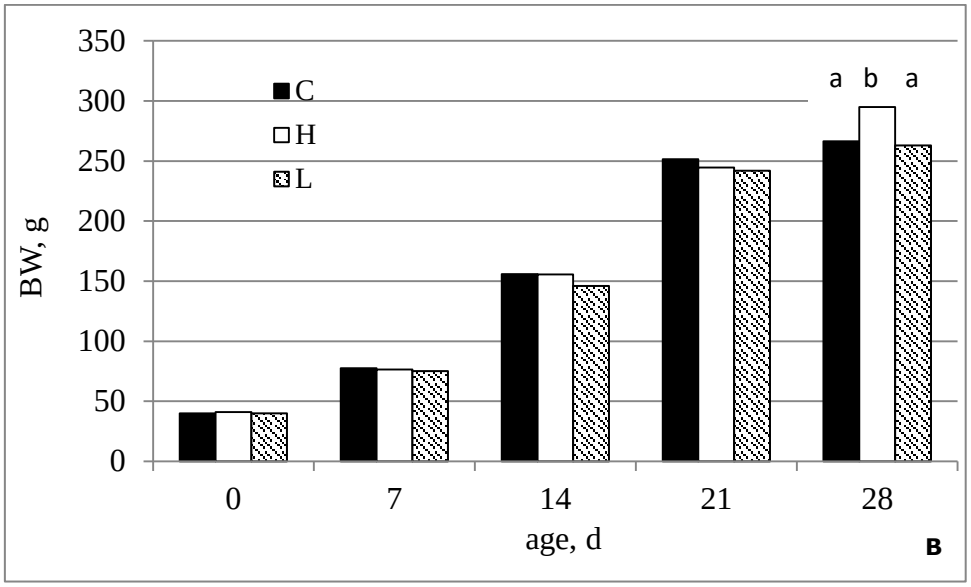
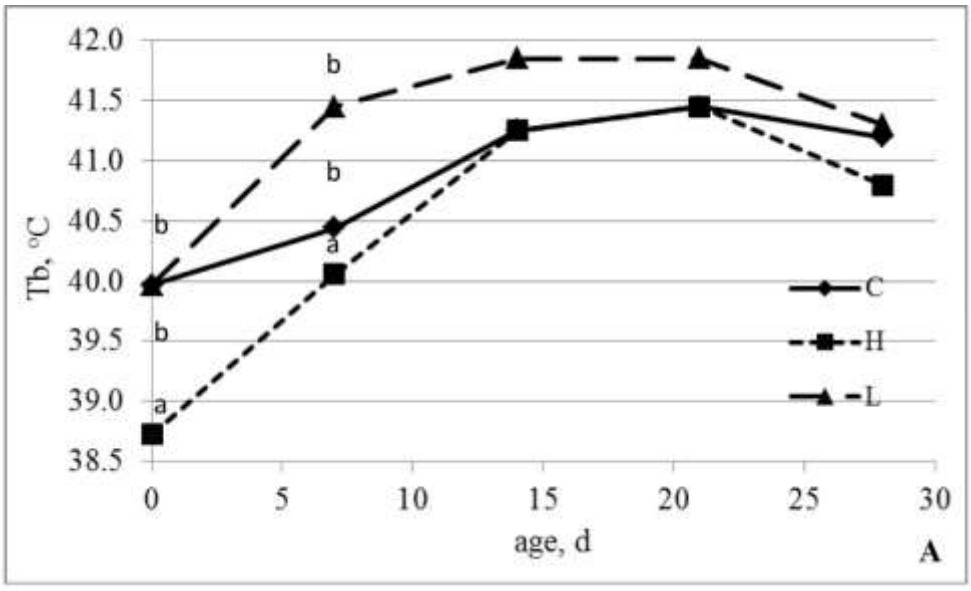


Figure 1. Effects of eggshell temperature (EST) during day 7 to 16 of incubation on BW of broiler (A; overall SEM=4.4) and layer (B; overall SEM=3.5) chickens from 0d – 28d after hatch (LSmeans). Low (L): EST=36.5°C for 12 h/d; Control (C): EST=37.8°C for 24 h/d; High (H): EST=39.5°C for 12 h/d. a,b = values within day and breed lacking a common superscript differ (P≤0.05).

Rectal temperature (Tb) showed a significant interaction between breed, temperature, and day of rearing (P=0.005). No sex effect or interaction with sex was found. Within each breed (broilers: P=0.01; layers: P=0.02) an interaction between temperature and day was found (Figure 2a, b). In broilers, no effect of temperature treatment was found at day 14, 21, and 28, but Tb was lower in H chickens than in C and L chickens at day 0 and 7. In layers, no effect of incubation temperature was found at d 21 and 28, but Tb was higher in L chickens than in C and H chickens at day 0 and 7, whereas at d 14this difference was only significant between C and H chickens.



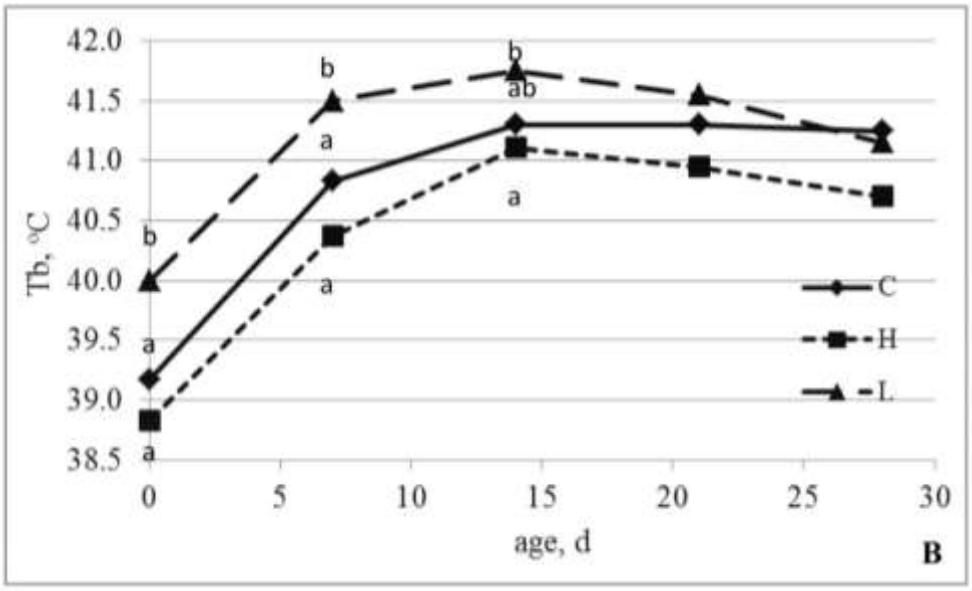


Figure 2. Effects of eggshell temperature (EST) during day 7 to 16 of incubation on body temperature (Tb) of broiler (A; overall SEM=0.22) and layer (B; overall SEM=0.16) chickens from 0d – 28d after hatch (LSmeans). Low (L): EST=36.5°C for 12 h/d; Control (C): EST=37.8°C for 24 h/d; High (H): EST=39.5°C for 12 h/d. a,b = values within day and breed lacking a common superscript differ (P≤0.05).

Mortality during rearing did not shown an interaction between breed and temperature (P=0.88) and was not affected by breed (P=0.23), but was higher in the L chickens than in the C and H chickens (Figure 3).

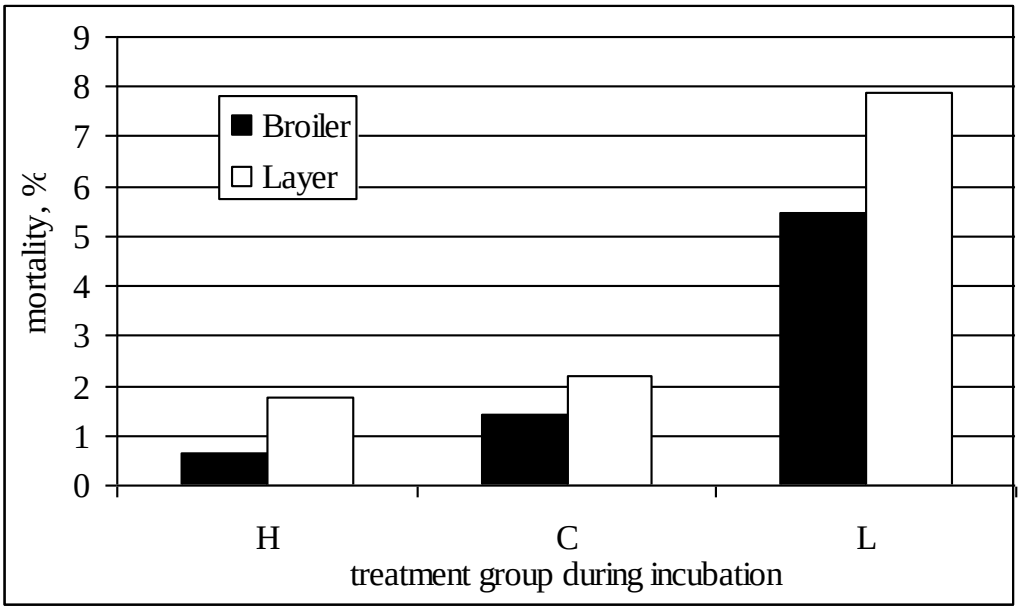


Figure 3. Effects of eggshell temperature (EST) during day 7 to 16 of incubation on mortality of broiler and layer chickens from 0d- 28d after hatch. Low (L): EST=36.5°C for 12 h/d; Control (C): EST=37.8°C for 24 h/d; High (H): EST=39.5°C for 12 h/d.

Discussion

We investigated effects of thermal manipulation during incubation on chicken quality and later life performance. The high incubation temperature treatment was based on the large experiences with thermal manipulation by (Piestun *et al*., 2008a, b; 2009; 2011) in broilers, whereas the low incubation treatment was not based on literature. Cold thermal manipulation as described in literature (Shinder *et al*., 2009, 2011) was performed at 18d and 19d of incubation. Because Piestun et al. (2008a, b) showed that high thermal manipulation was most effective when provided between incubation 7d and 16d, we have chosen also to lower the incubation temperature in that specific period. A decrease of 2 or 3°C in incubation temperature provided at the end of incubation seems to be no problem (Shinder *et al*., 2009, 2011; Willemsen *et al*., 2011), but at day 7, when heat production of embryos is still low (Lourens *et al*., 2006), a decrease of 2°C might lead to negative effects on hatchability and chicken quality. Therefore, we have chosen to lower the incubation temperature with only 1°C compared to the control treatment.

The significant higher hatchability in the H treatment eggs was in accordance with Yahav *et al*. (2004a) and Collin *et al*. (2007), whereas Yahav *et al*., (2004b), Collin *et al*. (2005), Piestun *et al*. (2008a, b, 2011), Walstra *et al*. (2010), and Willemsen *et al*. (2011) did not find an effect and Willemsen et al. (2010) found a negative effect of high thermal manipulation on hatchability. These ambiguous results might be related to differences in used temperature, moment, and duration of thermal manipulation during incubation. At the other hand, it can be speculated that due to epigenetic effects eggs from breeders in hot climates need higher incubation temperatures to obtain maximal hatchability than breeders from more mild climates. However, this seems to conflict with the results from the current study, which showed that eggs receiving the H treatment delivered chickens with higher RY and lower YFBM. A higher RY and lower YFBM seem to reflect a poorer chicken quality (Lourens *et al*., 2005; Molenaar *et al*., 2010; Willemsen *et al*., 2010). Molenaar *et al*. (2011) speculated that the lower YFBM and higher RY after high incubation temperatures, particularly during late incubation are due to the reduce yolk lipid oxidation, which might be due to a lack of oxygen (Moran, 2007; De Oliveira *et al*., 2008).

Thermal manipulation has been shown to improve thermo tolerance (Yahav *et al*., 2004a,b, 2009; Piestun *et al*., 2008a,b, 2011). Results found in the current study confirm these findings with lower Tb in H treated chickens and higher Tb in L treated chickens. Results also showed that effects of thermal manipulation in Tb were strongly comparable in broilers and in layers; whereas effects on Tb in broilers lasted till d 14, effects in layers were still present at d 21.

Besides effects on Tb, thermal manipulation also can improve chicken performance (Halevy *et al*., 2001). In the current experiment hardly any effect was found on BW of the H treatment and only the L treatment showed in broilers a small negative effect on BW. In layers the H treatment had a positive effect on BW only at 28d. That the effects on BW in the current study were small is possibly due to the short rearing period we had.

The current study made clear that L treated chickens exposed to high ambient temperature in later life have difficulties to maintain their BW, showing that a mismatch in experienced and expected temperature can give negative effects on BW as shown by Yalçin *et al*. (2010). This confirm studies in which chickens incubated at a high temperature prefer a higher ambient temperature in later life (Tzschentke and Basta, 2002; Yahav, 2009). Moreover, the mismatch in experienced and expected temperature became evident in the current experiment when mortality rate was taken into account. The H and C treatment had both a

low mortality rate, but the L treatment had a considerable mortality rate, both in broilers and layers. The cause of the higher mortality in L incubated chickens might be related to hypothalamic threshold responses (Yahav, 2009), indicating that L incubated chickens were more sensitive to high ambient temperatures.

We conclude from this experiment firstly that layers act more or less comparable during and after thermal manipulation than broilers. Secondly, a mismatch between incubation temperature and rearing temperature (expected and experienced temperature) will not only result in higher body temperatures, but also in considerable higher mortality during rearing. Both in scientific studies and in practice it seems interesting (or may necessary) to take expected seasonal temperature into account, when incubating both broiler and layers eggs.

References

1. Collin, A., Picard, M. &Yahav, S., **The effect of duration of thermal manipulation during broiler chick embryogenesis on body weight and body temperature of post-hatched chicks.** *Animal Research*, 54, 2005, 105-111.
2. Collin, A., Berri, C., Tesseraud, S., Requena Rodón, F.E., Skiba-Cassy, S., Crochet, S. Duclos, M.J., Rideau, N., Tona, K., Buyse, J., Bruggeman, V. , Decuypere, E., Picard, M. & Yahav, S., **Effects of thermal manipulation during early and late embryogenesis on thermotolerance and breast muscle characteristics in broiler chickens.** *Poultry Science*, 86, 2007, 795-800.
3. De Oliveira, J.E., Uni, Z. & Ferket, P.R., **Important metabolic pathwasys in poultry embryos prior to hatch.** *World's Poultry Science Journal*, 64, 2008, 488-499.
4. French, N.A., **Modelling incubation temperature: The effects of incubator designç embryonic development, and egg size.** *Poultry Science,* 76, 1997, 124-133.
5. Leksrisompong, N., Romero-Sanchez, H., Plumstead, P.W., Brannan, K.E., & Brake, J., **Broiler incubation. 1. Effect of elevated temperature during late incubation on body weight and organs of chicks.** *Poultry Science,* 86, 2007, 2865-2891.
6. Lourens, A., van den Brand, H., Meijerhof, R. & Kemp, B., **Effect of eggshell temperature during incubation on embryo development, hatchability, and posthatch development.** *Poultry Science,* 84, 2005, 914-920.
7. Lourens, A., Molenaar, R., van den Brand, H., Heetkamp, M.J.W., Meijerhof, R. & Kemp, B., **Effect of egg size on heat production and the transition of energy grom egg to hatchling.** *Poultry Science,* 85, 2006, 770-776.
8. Minne, B. & Decuypere, E., **Effect of late prenatal temperatures on some thermoregulatory aspects in young chickens**. *Archive Experimental Veterinary of Medicine,* 38, 1984, 374-383.
9. Molenaar, R., Meijerhof, R., van den Anker, I., Heetkamp, M.J.W., van den Borne, J.J.G.C., Kemp, B. & van den Brand, H., **Effect of eggshell temperature and oxygen concentration on survival rate and nutrient utilization in chicken embryos**. *Poultry Science,* 89, 2010, 2010-2021.
10. Molenaar R., van den Anker, I., Meijerhof, R., Kemp, B. & van den Brand, H., **Effect of eggshell temperature and oxygen concentration during incubation on the developmental and physiological status of broiler hatchlings in the perinatal period.** *Poultry Science,* 90, 2011,1257-1266.
11. Moraes, V.M.B., Malheiros, R.D., Bruggeman, V., Collin, A., Tona, K., van As, P., . Onagbesan, O.M, Buyse, J., Decuypere, E. & Macari, M., **Effect of thermal conditioning during embryonic development on aspects of physiological responses of broilers to heat stress.** *Journal of Thermal Biology*, 28, 2003,133-140.
12. Moran Jr., E.T., **Nutrition of the developing embryo and hatchling**. *Poultry Science,* 86, 2007, 1043-1049.

13. Piestun, Y., Shinder, D., Ruzal, M., Halevy, O., Brake, J. & Yahav, S., **Thermal manipulations during broiler embryogenesis: Effect on the acquisition of thermotolerance.** *Poultry Scienc,* 87, 2008a, 1516-1525.
14. Piestun, Y., Shinder, D., Ruzal, M., Halevy, O. &Yahav, S., **The effect of thermal manipulations during the development of the thyroid and adrenal axes on in-hatch and post-hatch thermoregulation**. *Journal of Thermal Biology*, 33, 2008b, 413-418.
15. Piestun, Y., Halevy, O. & Yahav, S., **Thermal manipulations of broiler embryos-The effect on thermoregulation and development during embryogenesis.** *Poultry Science,* 88, 2009, 2677-88.
16. Piestun, Y., Halevy, O. Shinder, D., Ruzal, M. Druyan, S. & Yahav, S., **Thermal manipulation during broiler embryogenesis improves post-hatch performance under hot conditions.** *Journal of Thermal Biology,* 36, 2011, 469-474.
17. Shinder, D., Ruzal, M., Giloh, M. & Yahav, S., **Effect of repetitive acute cold exposures during the last phase of broiler embryogenesis on cold resistance through the life span.** *Poultry Science,* 88, 2009 636-646.
18. Shinder, D., Ruzal, M., Giloh, M., Druyan, S., Piestun, Y. & Yahav, S., **Improvement of cold resistance and performance of broilers by acute cold exposure during late embryogenesis.** *Poultry Science,* 90, 2011, 633-641.
19. Tzschentke, B. & Basta, D., **Early development of neuronal hypothalamic thermosensitivity in birds: Influence of epigenetic tempearture adaptation**. *Comparative Biochemistry Physiology Part A: Molecular & Integrative. Physiology*, 131, 2002, 825-832.
20. Tzschentke, B., Basta, D., Janke, O. & Maier, I., **Characteristics of early development of body functions and epigenetic adaptation to the environment in poultry: Focused on development of central nervous mechanisms.** *Avian and Poultry Biology Reviews*, 15, 2004, 107-118.
21. Walstra, I., ten Napel, J., Kemp, B. & van den Brand, H. **Temperature manipulation during layer chick embryogenesis.** *Poultry Science,* 89, 2010,1502-1508.
22. Willemsen, H., Kamers, B., Dahlke, F., Han, H., Son, Z., Ansari Pirsaraei, Z., Tona, K., Decuypere, E., & Everaert, N., **High- and low-temperature manipulation during late incubation: Effects on embryonic development, the hatching process, and metabolism in broilers.** *Poultry Science,* 89, 2010, 2678-2690.
23. Willemsen, H., Li, Y., Willems, E. Franssens, L. Wang, Y., Decuypere, E. & Evereart, N., **Intermittent thermal manipulations of broiler embryos during late incubation and their immediate effect on the embryonic development and hatching process**. *Poultry Science,* 90, 2011, 1302-1312.
24. Yahav, S., **Alleviating heat stress in domestic fowl: different strategies**. *World's Poultry Science Journal*, 65, 2009, 719-732.
25. Yahav, S. & Plavnik, I., **Effecst of early-age thermal conditioning and food restriction on performance and thermotolerance of male broiler chickens**. *British Poultry Science*, 40, 1999, 120-126.
26. Yahav, S., Collin, A., Shinder, D. & Picard, M., **Thermal manipulations during broiler chick embryogenesis: Effects of timing and temperature**. *Poultry Science,* 83, 2004a, 1959-1963.
27. Yahav, S., Rath, R.S., & Shinder, D., **The effect of thermal manipulations during embryogenesis of broiler chicks (Gallus domesticus) on hatchability, body weight and thermoregulation after hatch**. *Journal of Thermal Biology*, 29, 2004b, 245-250.
28. Yahav, S., Shinder, D., Ruzal, M., Giloh, M. & Piestun, Y., **Controlling Body Temperature. – The Opportunities for Highly Productive Domestic Fowl**. Chapter-3, Nva Science Publishers, Inc., 2009
29. Yalçin, S., Babacanolu, E., Güler, H.C. & Akşit, M., **Effects of incubation temperature on hatching and carcass performance of broilers.** *World's Poultry Science Journal*, 66, 2010, 87-94.

FINDINGS REGARDING CORPORATE SOCIAL RESPONSIBILITY IN ROMANIAN IT SMES

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Abstract:
CSR has its origins necessity of implementing different from one organization to another, depending on several factors: company size, products, activities, territorial dispersion, suppliers, leadership and reputation etc. However, the common factor is that in a responsible and application of sustainable development strategies go beyond considerations on building a reputation, being directly associated business continuity, employee morale and market expansion. Ideally, CSR policies at the organization operates as a self-regulatory mechanism integrated into the organization's functioning by companies to monitor and ensure compliance with legislation, ethical standards of operation and not least the international standards. Unfortunately, the importance of using CSR in small and medium enterprises continues to be negatively influenced by reporting against multinationals and large companies practices. Consequently, it is common practice that the judge SMEs in terms of strategies, methods and objectives set in companies mentioned above. The results of our research highlights the peculiarities of CSR in small firms, generated by a unique combination of features and their chronic lack of resources allocated for this purpose.

Key words: *small and medium enterprises, entrepreneurship; corporate social responsibility*

Stakeholder, CSR and entrepreneurship

Freeman (1984) defined stakeholders as "any group or individual who can affect or is affected by the achievement of the firm's objectives". In 2002, he suggested that businesses should redistribute benefits and important decision-making power to all stakeholders based on the share they make.

On the other hand, SMEs are "a heterogeneous group of business, ranging from a single artisan working at home and producing handicrafts to sophisticated software-producing companies selling in specialised global niches" (Fischer and Reuber 2005). Westhead and Storey (1996) consider that "theories relating to SMEs must consider the motivations, constraints and uncertainties facing smaller firms and recognise that these differ from those facing large firms". Short-range management perspective, lack of coaching for employees and capital are some of the characteristics commonly seen in SMEs (Nicolescu O et al, 2009; Ceptureanu EG, 2015a; Ceptureanu EG, 2015b). These traits often restrict the organisation's ability to focus on strategic objectives (Jenkins 2006; Spence 2000). Small and

medium companies also tend to have organisational structures and management styles that are different from larger organisations (Ceptureanu SI et al, 2012). The "simple, flexible and highly centralised management structure" (Mintzberg 1979) of SMEs is further "reinforced by the limited number of hierarchical levels" (MacMillan 1975).

There is a lack of consensus regarding SMEs' familiarity and their perception of CSR in the literature (Ceptureanu SI, 2015a; Ceptureanu EG et al, 2012). Gerstenfield and Roberts (2000), Hitchens (2005), Ceptureanu SI (2015b) and Hunt (2000) have identified factors such as lack of knowledge and involvement of entrepreneurs in daily activities affecting their ability to engage in social activities. Curran (2000) and Thompson (1993) found SMEs to have fewer CSR programmes aimed at their local community compared to customers and employees.

Carr (2003) suggests that "responsibility and ethics is a personal ethos that informs the practice of any business". In the case of SMEs, this implies that personal ethos and business behaviour is inseparable (Fuller et al. 2006; Ceptureanu SI et al, 2015a).

It is well established that social interaction with stakeholders shapes responsible behaviour of SMEs more than in large organisations (Fuller et al., 2006; Ceptureanu SI et al, 2012). The extent of CSR participation with different stakeholders thus reflects the influence that they have on the decisions taken by the SME entrepreneurs. Ceptureanu EG (2015c) found that small businesses in Romania prioritise the demands of dominant stakeholders over discretionary stakeholders. Murillo (2006), Popa Ion (2009) and Ceptureanu EG (2014) noted that the most important factor that legitimates participation in social activities is financial objectives and community expectations receive lesser importance. Other specialists (Goffee and Scase 1995; Spence and Rutherfoord 2001) oppose the notion of profit maximisation as the key motivation of small company entrepreneurs, and therefore argue that fulfilling expectations of dominant stakeholders may not be an imperative for SMEs. Finally, Ceptureanu EG (2015c) and Ceptureanu SI (2015a) observed that Romanian SMEs prioritise economic objectives over the needs of community stakeholders.

The research design and findings

A qualitative case-study research methodology was applied to investigate the CSR approaches undertaken by Romanian SMEs. The issue under exploration is a real-life situation where the boundaries between the phenomenon and the body of knowledge are unclear (Yin 2009). This was the case because CSR has been probed by numerous disciplines through the application of various theoretical frameworks, each interpreting the context from their own perspective. This research was conducted in the Bucharest- Ilfov region of Romania. A sequential sampling technique was adopted to ensure all possible interpretations get captured. After 121 interviews, we achieved data saturation and discontinued with the data collection process. Cases were purposively chosen from a wide range of business sizes employing between 1 and 249 employees, and industry sectors including manufacturing, consultancy and services. One in-depth interview for each of the participating organisations was arranged either with the entrepreneurs or the managers who were directly responsible for their respective business' social responsibility. Given that the topic is sensitive and informants may respond in a socially desirable way, interviewers developed a rapport with the interviewees prior to data collection, phrased interview questions to make the participants comfortable irrespective of their participation in CSR, applied multiple tests of validity and relia-

bility, and finally triangulated data with information available from secondary sources such as annual reports, company brochures, media publications, etc. Although the limited number of cases does not represent the entire sector, it enabled collection of rich data revealing some of the most crucial aspects of SME approach to CSR.

Most of the SMEs were not familiar with the term CSR. After it was explained in common language, without demarcating the boundaries of such activities, varying understandings of the concept were put forward, all of which were taken into consideration. Among the four most popular explanations, these being looking after people who support the business, giving back to the community, being a community member and operating the business ethically, the first three reflect a strong philanthropic perception.

Some respondents perceived CSR as creating business reputation, helping community organisations and following social norms. Interestingly, all SMEs believed that they have some social obligations, but none viewed the concept as just an economic or legal responsibility of the business.

The impacts of CSR expenses were mixed. Of the 121 participants, 31% experienced very little impacts, while 21% regarded the impacts as "fairly strong". Another 48% felt a moderate impact, but most of them preferred to manage the costs by limiting their CSR activities instead of disengaging from such practices. 21% included them in the budgeting process, and 11% sponsored activities and charities that matched the company's profile. Only 11% enterprises regarded CSR expenses as an investment with the expectation of long-term business benefits. SMEs did not see any contradiction between the economic objectives and their moral obligations, rather considered CSR as a morally correct behaviour. However, all respondents shared the view that businesses need to remain profitable in order to meet their moral obligations.

CSR decisions in most businesses were independently taken by the entrepreneurs, except for one that had investors and a range of stakeholders involved due to their organisational structure. Although 72% of the participants encouraged staff and/or peers to participate and one accepted suggestions from suppliers, the decision making power was still held by the entrepreneurs. 31% did not allow any stakeholder to participate. Nevertheless, the CSR agenda of the company in which a range of stakeholders collectively took the decisions was not much different from the company where the entrepreneurs were the only participants, both being equally philanthropic. Likewise, companies in which employees participated were also involved in charities and sponsorships, often without any benefit for their staff. This implies that the participation of stakeholders did not influence the CSR decisions and that community remains at the forefront of SME social responsibility.

Another notable aspect was that most entrepreneurs struggled to identify their stakeholders. 10% of participants understood stakeholders as those who own a share in the business, while another 10% said that "we do not have any stakeholders". After the interviewer explained the meaning of stakeholder, nearly half of the respondents reported that there was no influence from their stakeholders. Further probing, however, revealed that their participation in CSR activities was more tuned to the demands of their social expectations. Among those that admitted some kind of influence, the majority referred to discretional stakeholders. Thus, lower salient stakeholders appeared to have a greater impact on CSR decisions.

Nearly all participants identified building business reputation as their primary goal to participate in CSR. SMEs with aims such as fulfilling personal satisfaction and to be seen

as a community member, were greater in number than those having economic objectives such as motivating staff and meeting stakeholder expectations. More importantly, none of the participants undertook social activities exclusively for their definitive or dominant stakeholders. Hence, the most common underlying motivation was to build relationships and networks with community members that improve the business' image and at the same time, increase their personal satisfaction. In other words, economic goals were not the predominant motivation for SMEs to engage in CSR.

Informal discussion with the interviewees further revealed that SMEs had no advanced planning for CSR. They either wanted to continue their ongoing activities or adapt to their stakeholders' expectations. Although the large SMEs appeared to be proactive, they did not have any intention to leverage CSR for the benefit of their business. Like most participants, they saw it as "an opportunity for social involvement".

Interviewees clarified this apparently confusing behaviour by stating that connections with these institutions or associations are instrumental for the purpose of networking and information sharing. Some discussed the increased negotiation power that they gain through these networks to influence stronger stakeholders like governments. Others explained how these associations educated them about the upcoming market trends and introduced the business to markets which they would not otherwise have explored.

Table 1. Empirical Summary of the Prime Factors

Questions	Yes	N	Sample P	Exact p-value	Incidence of 0.05 level of significance
Workplace practices	108	121	0.90	0.001	Yes
Company values	121	121	1	0	Yes
Social and community policies	75	121	0.59	0.36	No

Table 2. Empirical summary with the Sub-factors

Questions	Yes	N	Sample P	Exact p-value	Incidence at 0.05 level of significance
Workplace practices	108	121	0.90	0.001	Yes
Company values	121	121	1	0	Yes
Social and community policies	75	121	0.59	0.36	No

Discussion and conclusion

The concept of CSR continues to be as fluid, as discussed in the literature. Despite a range of understandings put forward, SMEs agree that businesses have obligations beyond economic and legal responsibilities. In fact, SMEs see participation in such activities as an obligation towards the community members who trust them, and an opportunity to show how the business shares the social values.

Although this supports Garriga and Mele's (2004) conclusions, in-depth questions revealed deeper insights into the attitude of SMEs in relation to CSR. For example, SMEs neither denied their business' impact on the society, nor did they see CSR as a cost-disadvantage, an outcome which contradicts the findings of Hitchens et al. (2005) and Gerstenfield and Roberts (2000) respectively. Furthermore, the "morally correct" perception of CSR in itself is indicative of the importance that they give to social relations (see Adler and

Kwon 2002) and formal engagements with a range of stakeholders, instead of fulfilling the economic expectations of dominant stakeholders only (Ceptureanu SI et al, 2015b).

The discrepancy between the stated behaviour of the SME entrepreneurs and the actual behaviour of SMEs questions the validity of intertwined ownership and management (Nooteboom 1994) and the alignment of owner's personal ethos with business behaviour (Fuller and Tian 2006; Spence 2007) in such organisations. It appears that, in the current business environment, a community's influence on SME is strong enough to subside, if not displace, entrepreneurs' personal values and interests. The presence of powerful social governance (Larson 1992; Leifer and White 1986; Ceptureanu SI, 2014) is clearly at loggerheads with the ST approach to business management since SMEs cannot risk overlooking community expectations for immediate profits.

The research findings also indicate that the dominant stakeholders of SMEs have little or no influence on CSR decisions. Community relationships, by way of contrast, appeared to be the most important criterion legitimating SME responsible behaviour and not the financial motives, as claimed by Mankelow (2003) and Murillo and Lozano (2006).

The value for SMEs particularly lie in the fact that researchers, practitioners and policy-makers, who are responsible for advising business strategies and implementing policies, will now have a better understanding of SME behaviour, their challenges, limitations and goals for participating in CSR for researchers, practitioners and policy-makers. Accordingly, SMEs can expect pragmatic solutions and effective policies from them that will not only exert less pressure to participate in CSR activities that do not effectively reduce their survival risks or facilitate the growth of this sector, but also benefit the broader society by bridging the gap between internal business goals and externally set societal aspirations. That said, we suggest further investigation of the research problem in different locations, involving a larger sample size and using different methodologies to validate the research findings. Further research is also required to explore the relative importance of each type of social capital that SMEs accrue through relationships with different stakeholders.

References

1. Adler, P., and Kwon, S. W., **Social capital: Prospects for a new concept**, Academy of Management Review, 27(1), 2002, pp. 17–40.
2. Bolton, J. E., **Report of the committee of enquiry on small firms**, London, 1971
3. Carr, P., **Revisiting the protestant ethic and the spirit of capitalism: Understanding the relationship between ethics and enterprise**. Journal of Business Ethics, 47(1), 2003, pp. 7–16.
4. Ceptureanu E.G., **Survey regarding resistance to change in Romanian innovative SMEs from IT Sector**, Journal of Applied Quantitative Methods, 10 (1), 2015a, pp.105-116
5. Ceptureanu E.G., **Reaction to change in Romanian SMEs**, Review of International Comparative Management, 16(1), 2015b , pp.77-87
6. Ceptureanu E.G., **Research regarding change management tools on EU SMEs**, Business Excellence and Management Review, 5(2), 2015c, pp.28-32
7. Ceptureanu E.G. and Ceptureanu S.I., **Change management survey on innovative ITC Romanian SMEs**, Quality- Access to success, 16 (144), 2014, pp.62-65
8. Ceptureanu EG and Ceptureanu SI, **Practice in management and entrepreneurship: some facts from the Bucharest University of Economic Studies**, Review of International Comparative Management, 13(5), 2012, pp.703-716
9. Ceptureanu S.I., **Knowledge based economy in Romania: comparative approach**, Journal of Applied Quantitative Methods, 9 (4), 2014, pp.51-61

10. Ceptureanu S.I., **Knowledge management in Romanian young SMEs**, Review of International Comparative Management, 16(1), 2015a, pp.5-22
11. Ceptureanu S.I., **Competitiveness of SMEs, Business Excellence and Management Review**, 5(2), 2015b, pp.55-67
12. Ceptureanu SI, Romanian Young SMEs Overview. Business Environment Situation, Proceedings of the 25th International Business Information Management Association (IBIMA), ISBN: 978-0-9860419-4-5, 7-8 May 2015, Amsterdam, Nederlands, pp.1555-1567.
13. Ceptureanu S.I. and Ceptureanu EG, **Challenges and Barriers of European Young Entrepreneurs**, Management Research and Practice, Vol. 7 Issue 3, 2015a, pp. 34-58
14. Ceptureanu S.I. and Ceptureanu E.G., **Knowledge management in Romanian companies**, Quality- Access to success, 16 (145), 2015b, pp.61-66
15. Ceptureanu SI, Ceptureanu EG, Tudorache A. and Zgubea F, **Knowledge based economy assessment in Romania**, Economia, Seria Management, 15(1), 2012, pp.70-87
16. Curran, J., Rutherfoord, R., and Lloyd, S., **Is there a local business community? Explaining the non-participation of small business in local economic development**. Local Economy, 15(3), 2000, pp. 128–143
17. Dean, T., Brown, R., and Bamford, C., **Differences in large and small firm responses in environmental context: Strategic implications from a comparative analysis of business formations**, Strategic Management Journal, 19(8), 1998, pp. 709–728
18. Fischer, E., and Reuber, R., **Industrial clusters and business development services for small and medium enterprises**. In G. Wignaraja (Ed.), Competitive strategy in developing countries: A manual for policy analysis. London: Routledge, 2005, pp. 131-165
19. Freeman, R. E., and Philips, R., **Stakeholder theory: A libertarian defence.** Business Ethics Quarterly, 12(3), 2002, pp. 331–349
20. Freeman, R. E., Harrison, S., Wicks, A., Parmar, B., and Colle, S., **Stakeholder theory: The state of the art.** Cambridge: Cambridge University Press, 2010
21. Freeman, S., **A comprehensive model of the process of small firm internationalisation: A network perspective.** Paper presented at the 18th Annual IMP Conference, Dijon, France, 2002, pp. 1–22
22. Fuller, T., and Tian, Y., **Social and symbolic capital and responsible entrepreneurship: An empirical investigation of SME narratives**. Journal of Business Ethics, 67(3), 2006, pp. 287–304
23. Garriga, E., and Mele, D., **Corporate social responsibility theories: Mapping the territory.** Journal of Business Ethics, 53(1–2), 2004, pp. 51–71
24. Gerstenfield, A., and Roberts, H., **Size matters: Barriers and prospect for environmental management**. In R. Hillary (Ed.), Small and medium-sized enterprises (pp. 106–118). Sheffield: Greenleaf, 2000
25. Goffee, R., and Scase, R., **Corporate realities: The dynamics of large and small organisations**. London: International Thomson Business Press, 1995
26. Hitchens, D., Thankappan, S., Trainor, M., Clausen, J., and Marchi, B., **Environmental performance, competitiveness and management of small businesses in Europe.** Tijdschrift Voor Economische En Sociale Geografie, 96(5), 2005, pp. 541–557
27. Hunt, J., **Environment, information and networks: How does information reach small and medium-sized enterprises.** In R. Hillary (Ed.), Small and medium-sized enterprises and the environment. Sheffield: Greenleaf, 2000, pp. 194–202
28. Jenkins, H., **Small business champions for corporate social responsibility.** Journal of Business Ethics, 67(3), 2006, pp. 241–256
29. Larson, A., **Network dyads in entrepreneurial settings: A study of the governance of exchange relationships**. Administrative Science Quarterly, 37(1), 1992, pp. 76–104
30. Leifer, E. M., and White, H. C., **Wheeling and annealing: Federal and multidivisional Control**. In J. F. Short (Ed.), The social fabric: Dimensions and issues (pp. 223–242). Beverly Hills, CA: Sage Publications, 1986
31. MacMillan, I. C., **Strategy and flexibility in the smaller business.** Long Range Planning, 8(3), 1975, pp. 62–63

32. Mintzberg, H**., The structuring of organisations**. Upper Saddle River, NJ: Prentice Hall, 1979
33. Murillo, D., and Lozano, J. M., **SMEs and CSR: An approach to CSR in their own words**. Journal of Business Ethics, 67(3), 2006, pp. 227–240
34. Nicolescu O., Nicolescu C., Popa I, Ceptureanu SI, Dobrin C, Ceptureanu EG, **"Innovation in Romanian SMEs and its impact on performance"** International Association of Computer Science and Information Technology-Spring Conference, 2009. IACSITSC'09, pp. 336-339
35. Nooteboom, B., **Innovation and diffusion in small firms: Theory and evidence.** Small Business Economics, 6(5), 1994, pp. 327–347
36. Perrini, F., **SMEs and CSR theory: Evidence and implications from an Italian perspective**. Journal of Business Ethics, 67(3), 2006, pp. 305–316
37. Popa I, Dobrin C, Ceptureanu SI, Ceptureanu EG, **The positive impact on SMEs activity of Romania's integration in the European Union**, 2009 International Association of Computer Science and Information Technology-Spring Conference 2009, pp.340-344
38. Putnam, R. D., **Bowling alone: The collapse and revival of American community**. New York: Simon & Schuster, 2000
39. Raymond, L., **Determinants of website implementation in small business,** Internet Research: Electronic Network Applications and Policy, 11(5), 2001, pp. 411–422
40. Spence, L. J., **Practices, priorities and ethics in small firms.** London: Institute of Business Ethics, 2000
41. Spence, L. J., **CSR and small business in a European policy context: The five C's of CSR and small business research agenda**, Business and Society Review, 112(4), 2007, pp. 533–552
42. Spence, L. J., and Rutherfoord, R., **Social responsibility, profit maximisation and the small firm owner-manager**, Small Business and Enterprise Development, 8(2), 2001, pp. 126–139
43. Thompson, J., Smith, H., and Hood, J., **Charitable contributions by small businesses,** Journal of Small Business Management, 31(3), 1993, pp. 35–51
44. Tilley, F., **Small firm environment ethics: How deep do they go?**, Business Ethics: A European Review, 9(1), 2000, pp. 31–41
45. Westhead, P., and Storey, D. J., **Management training and small firm performance: Why is the link so weak?**, International Small Business Journal, 14(4), 1996, pp. 13–24
46. Yin, R. K., **Case study research: Design and methods (4th Ed.).** Thousand Oaks, CA: Sage, 2009