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Information-Communication Technologies as Management Tool: Case of Slovenia

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Abstract: This paper presents study at national level, which aims to test the influence of information and communication technologies (ICT) on financial (FP) and non-financial performance (NFP) at empirical level. In order to do so, structural equation modeling (SEM) methodology is utilised. Results show statistically significant positive and strong influence of ICT on FP and even stronger statistically significant positive correlation between FP and NFP. ICT did not demonstrate positive impact on NFP. Findings are interpreted from managerial perspective.

JEL Classification: L96

Key words: organisational performance, stakeholders, balanced scorecard, structural equation modeling

Introduction

Modern organisations operate in highly turbulent environment. One could even say that the only constant in such an environment is the change itself. Authors believe that information-communication technologies could play important role in change management. In the new, knowledge-based economy, it is vital for business management to understand relationship between information and communication technologies and organisational performance in order to manage organisational change. This is why a conceptual model related to those issues would be developed and empirically tested in this paper. In order to do so most common taxonomies of information and communication technologies, as well as traditional and modern (Stakeholder theory and Balanced Scorecard) approaches to organisational

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performance measurement are presented. Relationships among formerly introduced constructs are also investigated: influence of information and communication technologies on financial performance, influence of information and communication technologies on nonfinancial performance and (non)-existence of empirical basis for correlation between financial and nonfinancial performance is examined.

This study is structured into five main parts. First, model is conceptualised by presenting main constructs, relationships among them, setting hypotheses and operatinalising constructs of concern. Second, in model specification phase, parameters for estimation are set and hypothesised path diagram constructed. Third, in model identification phase, we deal with question of degrees of freedom and consider whether do we have enough data to estimate desired number of parameters. Fourth, data analysis begins by parameter estimation. In this context, utilised sample is described and hypotheses tested. Fifth, model fit at global, structural and measurement level is assessed. Finally, implications of our findings from managerial standing point are discussed. Article is concluded with presentation of limitations and provision of some future research proposals.

Model Conceptualisation

In the first phase of our research a conceptual model to test relationships among information and communication technologies, financial and nonfinancial performance is developed. This is a two-step process – in the first phase structural submodel and in the second, measurement submodel is conceptualised.

Structural Submodel Conceptualisation

In order to develop a sound model, first, structural framework must be developed. This phase consists of two steps: presentation of constructs and examination of possible relationships among them. Three constructs of our interest will be Information and Communication Technologies (ICT), Financial Performance (FP) and Nonfinancial Performance (NFP). ICT have become a major facilitator of business activities in the modern world (Tapscott in Caston, 1993; Mandel, 1994; Gill, 1996) and are beside that also main catalyst of fundamental changes in structure, operation and management of organisations (Dertouzos, 1997). One of the most often used taxonomies for ICT for business is the one that differentiates among software, hardware and telecommunications (Turban et al., 2001, 2001a; Beynon-Davies, 2002).

How can we evaluate organisational performance? Rejc (2002) claims that this task cannot be performed correctly without consideration of organisational goals. Modern business environment demands multi-goal orientation. Profit theory (Cyert and March, 1963) is no more valid measure of organisational performance and so are not other approaches that are concerned only with interests of shareholders (owners) of a company. Modern business environment is characterised with increased importance and strength of customers, employees and society in general. It has become quite obvious that within an assessment of a modern company performance, all stakeholders need to be taken into account. This is the main idea of Freeman's Stakeholder theory (1984, 1994). We need to remember that already behavioural theory of a company (Cyert and March, 1963) recognised company as a coalition of individuals or groups of individuals such as management, employees, customers, owners, government etc. Stemming from this origins, financial performance (FP) along with non-financial performance (NFP) must be assessed in order to evaluate overall organisational performance of a modern company. According to Rejc (2002) there are two main reasons for such a requirement. First, in every single business, there are several interest groups involved and each one of them has their particular goals and expectations from the company. They will remain in the coalition only if their goals will be satisfied in sufficient manner. Second, strategic business areas are not necessarily financial in their nature. Several approaches to non-financial indicators selection exist, of which the most established and widely spread is Balanced Scorecard – BSC (Kaplan and Norton, 1992, 1993, 1996, 1996a).

After defining constructs involved, next logical step in the process is to examine relationships among them and set hypotheses to be tested afterward in the study. Influence of ICT on FP and NFP, and (non)-existence of correlation between FP and NFP is examined. Work of Dewan and Kraemer (1998) and Navarette and Pick (2002) can lead us to assertion that influence of ICT on FP is positive. However, significant body of research was devoted to (so called) productivity paradox, which is based on notion that ICT investment do not result in increased performance gains and can be even considered as counterproductive. Empirical confirmation of this phenomenon is largely country — and observed unit-dependant. Four streams of research based on observed units evolved through time: business, industry, national and international level. Results are mixed, however, the most relevant study in our context would be the one of Dimovski and Škerlavaj (2003, 2003a) that analysed influence of hardware, software, telecommunications and knowledge investments on value added per industry for Slovenia in period from period 1996-2000. Results showed a statistically significant and positive influence of hardware and telecommunication investments on value added. Those two independent variables formed nearly 75% of total ICT investments in Slovenia in given period of time, so hypothesis 1 (Table 1) can be set. What is also important in this context, is the discovery that modern empirical studies tend to demonstrate positive impact of ICT on FP, while this was not necessarily true for older ones. This can lead us to think that productivity paradox is a dynamic phenomenon and that it could be inverse image of a learning curve! There is a lack of quantitative support for thesis that ICT would have positive impact on NFP. Nevertheless, some support can be found in qualitative work of Rau (2003), that demonstrates positive effects of ICT on NFP through adoption of BSC and CIO Dashboard Performance Management Programme. On this ground hypothesis 2 was set. Regarding relationship between financial and nonfinancial performance, empirical literature is not as vast as we would like it to be. Interestingly however, Chakravarthy (1986) found no statistically significant relationship between FP and NFP. On the basis of this working hypothesis in Table 1, using structural equation modeling technique, sets will be tested later.

Table 1.: Hypotheses

#	Hypothesis	Source
H1	Information and communication technologies (ICT) have positive impact of financial performance (FP).	• Dewan and Kraemer, 1998. • Dimovski and Škerlavaj, 2003, 2003a. • Navarette and Pick, 2002.
H2	Information and communication technologies (ICT) have positive impact of nonfinancial performance (NFP).	• Rau, 2003.
H3	There is no correlation between FP and NFP.	• Chakravarthy, 1986.

Measurement Submodel Conceptualisation

ICT construct will have 3 measurement variables: Hardware (HW), Software (SW) and Telecommunication equipment (TCM). When reporting on HW, respondents were asked about portion of employees with access to personal computer or workstations and portion of employees with possibility to use mobile computers and palms. Frequency of groupware, enterprise resource planning systems (ERP), database management systems (DBMS), intranet, e-forums and web page usage were used to measure SW. Value of indicator TCM was aggregated on basis of 4 items asking about portion of employees with access to Internet, mobile phones at work, speed of Internet access and frequency of videoconference usage.

Financial performance (FP) was measured using two one-item measurement variables: Return on assets (ROA) and Value added per employee (VAEMP) in last three years, relative to industry average, using bipolar scale. These results reflect business performance from owners' point of view. We are well aware of all the problems related to ROA (e.g. 'creative accountancy'). That is why indicator Value added per employee was introduced as well. Same approach will be used for nonfinancial performance (NFP) to capture perspectives of other stakeholders in a firm as a coalition of interests. Three one-item measurement variables utilised are stability of relationships with suppliers (SUPPLY), net fluctuation of employees (EMPLOY) and customer complaints (BUYER). In Table 2 operationalisation of all three latent variables (constructs) is obtainable.

Table 2.: Specification of Constructs (latent variables, their indicators, number of measurement items and their sources)

Latent variables (constructs)	Measurement variables (indicators) and number of items aggregated into each	Sources
Information and communication technologies (ICT)	• Hardware (HW) – 2 items • Software (SW) – 6 • Telecommunication equipment (TCM) – 4	• Andersen in Segars, 2001. • Beynon-Davies, 2002. • Turban et al, 2001.
Financial organisational performance (FP) – perspective of owners	• Return on assets (ROA) – 1 • Value added per employee (VAEMP) - 1	• Rejc, 2002. • Freeman, 1984, 1994: Stakeholder theory. • Kaplan and Norton, 1992, 1993, 1996, 1996a: Balanced scorecard. • Chakravarthy, 1986.
Nonfinancial organisational performance (NFP) – perspective of other stakeholders	• Stability of relationships with suppliers • (SUPPLY) – 1 • Net fluctuation of employees (EMPLOY) – 1 • Customer complaints (BUYER) - 1	

Model Specification and Identification

In the model specification phase nature and number of parameters to be estimated is determined. This was done using LISREL (SIMPLIS) syntax. Next phase in the process is model identification, where we check whether do we have enough information to estimate desired number of parameters (Diamantopoulos and Siguaw, 2000). Model can be non-identified (too few observed variables to estimate all parameters), identified (here we can have problem with model testing) or over-identified, which is a desired situation. Necessary, (although not sufficient) prerequisite for model identification, can be tested using following formula:

$$t < s/2$$

where t represents number of parameters to be tested (in our case 19) and s number of variances and covariance among indicators. Latter can be computed as

$$s = (p+q)*(p+q+1)$$

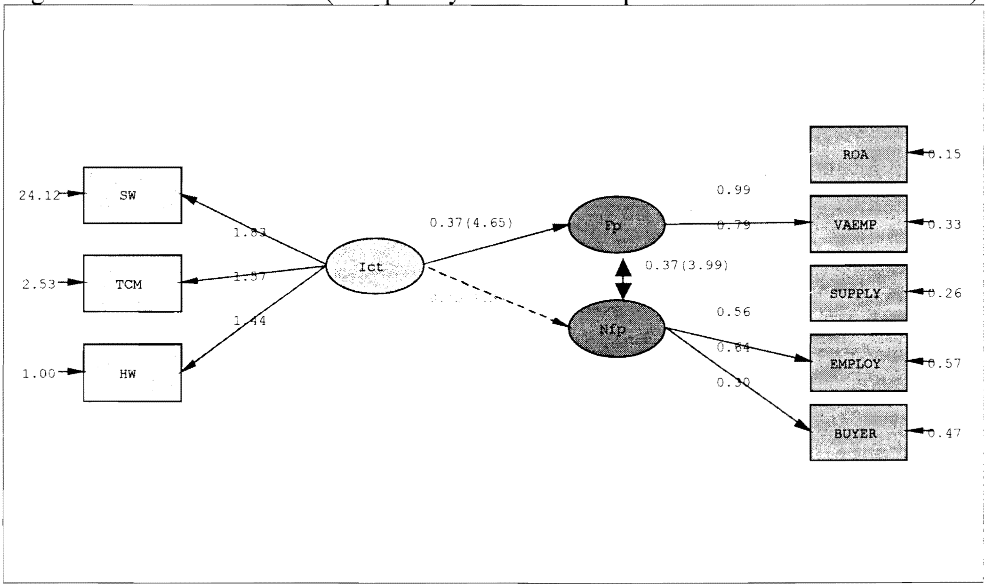
where p stands for number of indicators to measure exogenous latent variables (in our case 3) and q number of indicators for endogenous constructs (in our case 5). This means that $s/2$ equals 36, so our model can be regarded as over-identified. We have to bear in mind however, that this is only a necessary and not sufficient condition for model identification. Fortunately, according to Diamantopoulos and Siguaw (2002), LISREL itself provides sufficient control mechanisms to warn about problems with identification.

Perameter Estimation

Next phase in the process is parameter value estimation using LISREL (SIMPLIS) tool for structural equation modeling. Prior to data analysis, sample and data collection process are briefly presented. Based on model conceptualisation, a measurement instrument – questionnaire was developed and sent in June 2003 to CEO's or board members of all Slovenian companies with more than 100 employees, which accounted for 867 companies. In first 3 weeks 234 completed questionnaires were returned, out of which 14 were excluded due to missing values. Response rate was 25.4%, which can be considered as success in Slovenian context (using our primary data collection technique). We aimed at CEO's and board members due to necessity to have a strategic and interdisciplinary perspective on whole company. We have to be aware, though, that some degree of discrepancy between desired and actual structure of respondents will be always present. In our case, we managed to 'capture' successfully 67.3% respondents, while 21.8% did not reveal their identity and only 10.9% completed questionnaires failed to reach at least functional manager level. Based on average number of employees criterion, in year 2002, 51.4% of the companies had between 100 and 249 employees, followed by 24.6% of the companies with 250 to 499 employed persons, 11.8% had 500-999 and 12.2% of the companies had 1000 and more employees. This can be regarded as an appropriate representation of a structure of Slovenian medium and large businesses.

Having gathered and prepared data for further analysis, parameter estimation phase (using Maximum likelihood - ML method) follows. In this phase, hypotheses set in conceptualisation phase are tested. Several methods can be used for this purpose, ML is the most often used and has an advantage of being statistically efficient. At the same time it is specification-error sensitive method, because it demands only complete data and does not allow for missing values. All methods will, however, lead to similar parameter estimates under the assumption that sample is large enough and that the model is correct (Jöreskog and Sörbrom, 1993). Based on path diagram (Figure 1), which demonstrates completely standardised parameter values and their t-values (in brackets) our three hypotheses were tested. Information and communication technologies construct (ICT) proved to have strong statistically significant positive impact on financial performance (FP) but not on nonfinancial performance (NFP). This means that hypothesis 1 proved to have support in data gathered, while we have to reject hypothesis 2. At the same time, correlation between FP and NFP proved to be statistically significant and positive. Not surprisingly, hypothesis 3 must be rejected and does not support Chakravarthy's (1986) findings.

Figure 1.: Research Model (completely standardised parameter values and t-values)



Model Fit Assessment

Parameter estimation is followed by model fit assessment at global level, at level of structural submodel and at level of measurement submodel. By model fit, we mean degree to which hypothesised model is consistent with data at hand. We deal with degree to which implicit matrix of covariance (based on hypothesised model) and sample covariance matrix (which is based on data) fit (Bollen, 1989).

Table 3.: Fit Indices

Fit indices	Model value	Reference value (condition)	Global model fit?
χ^2(level of significance p)	32.622 (0.0126)	$p \geq 0.05$	No
RMSEA	0.0629	< 0.100	Yes (Acceptable)
AIC	69.715	< AIC saturated model < AIC independent model	Yes Yes
CAIC	153.194	< CAIC saturated model < CAIC independent model	Yes Yes
Standardised RMR	0.0525	< 0.05	Limit value
GFI	0.965	≥ 0.90	Yes
AGFI	0.926	≥ 0.90	Yes
PGFI	0.456	≥ 0.50	No

Aim of global fit assessment is to determine degree to which model, as a whole is consistent with gathered empirical data. Through years, numerous global fit indices have been developed. However, none of them is superior to others. Different authors favour various measures, that is why Diamantopoulos and Siguaw (2000) recommend using several measures and at the same time provide reference values for every one of them (Table 3). The most traditional value is χ^2 statistics where we test hypothesis that implicit covariance matrix equals sample covariance matrix. Our goal is not to reject this hypothesis. In our case hypothesis must be rejected (at 5% level of significance). χ^2 statistics is the only global fit index that could mislead us to conclusion that our model is not entirely acceptable. At the same time, all other indices lead to conclusion that model is appropriate representation of reality. Root means square error of approximation (RMSEA) is the most wide spread measure of global fit and in our case points to acceptable fitness of the model. Akaike information criteria (AIC) and Consistent Akaike information criteria (CAIC) of the model need to be compared against AIC and CAIC for saturated and independent model, where smaller values represent better fit. That is also the case in our model. Standardised root mean square residual (Standardised RMR) is fit index calculated from standardised residuals (differences between elements of sample and implicit covariance matrix). Goodness-of-fit (GFI) index, Adjusted goodness-of-fit (AGFI) index and Parsimony goodness-of-fit (PGFI) index are absolute fit indices which directly assess how well do covariance based on parameter estimates reproduce sample covariance (Gebring and Anderson, 1993). All of the indices described above lead to conclusion that our model can be regarded as appropriate approximation of reality.

When assessing measurement submodel fit, we focus on relationships between latent variables and their indicators (measurement, observed variables). Goal is to determine reliability and validity of measurement variables used to represent constructs of interest. Validity measures degree to which indicator actually measures what it was supposed to measure, while reliability deals with consistency of measurement (Tabachnick and Fidell, 2001). Data for construct validity measurement can be obtained from LAMBDA-X and LAMBDA-Y matrices for nonstandardised parameter estimates. All absolute t-values are larger than 1.96, meaning that construct validity is achieved in our case. For completely standardised parameter estimates goes that, greater the weight, more valid certain indicator for certain construct measurement is. Absolutely the most valid indicator in our model is Return on assets (ROA). Indicators, where some additional work on operationalisation needs to be done, are Relationships with customers (BUYER) and Software (SW). When reliability is an issue we need to address it in two steps: (1) reliability of individual indicators and (2) construct (composite) validity. Former is measured using R^2 for every single individual indicator and presents part of variance in an indicator explained by its latent variable. In our case, the most reliable indicator for ICT is HW, the most reliable indicator for FP is ROA and the most reliable measure of NFP is SUPPLY. The most valid indicator in the model is ROA, while the least reliable measurement variable is SW. For every single construct, a construct (composite) reliability can be calculated (in LISREL 8.53 still manually) using following formula:

$$\rho_c = \frac{(\sum \lambda_i)^2}{(\sum \lambda_i)^2 + \sum \theta_i}$$

where λ are indicator loading and θ represent variances of indicator errors (whether δ or ε). Data can be obtained from completely standardised solution and it is desired that $\rho > 0.6$ in order to be able to state that certain construct as a whole is valid. In our case $\rho_{ICT} = 0.67$, $\rho_{FP} = 0.86$ and $\rho_{NFP} = 0.63$. Based on these three calculations it can be said, that composite validity for all 3 constructs is fulfilled. Latent variable FP is operationalised the best. This is no surprise, due to objectivity of the indicators involved in construct FP (as opposed to potentially subjective measures included above all in NFP).

Next, we focus on structural part of the model to establish whether hypothesised relationships among latent variables can be supported with data at hand. R^2 for FP equals 0.140 and 0.016 for NFP, which are not the highest values. This is quite a strong indication of very common problem with structural equation modeling in general – namely, omission of some kind of important variables. We would probably manage to explain variance of NFP and FP constructs much better using other exogenous constructs as well (for example organisational learning, organisational culture etc.) This remains challenge for future research and poses important limitation to our model. We are aware that there is still a potential for the improvement of the model, especially in terms of its broadening with e.g. organisational learning, measurable parts of organisational culture as exogenous constructs. We have to bear in mind though, that all modifications in the model need to be based on theory. Only data driven modifications must be avoided in every case.

Managerial Implications

In this section results are evaluated to clarify question of ICT as a management tool. ICT have, without any doubt, played important, if not crucial role, in transfer from industrial society to new economy. In this setting, information and knowledge can be considered as fundamental sources of competitive advantage. Modern companies operate in rapidly changing and turbulent business environment characterised by challenges of globalisation, transformation of organisations, empowered employees and new technologies (to name just few of them). Some important directions for ICT strategic management stem from our research. Thesis on productivity paradox in area of ICT investments (hypothesis 1) needs to be rejected and reconsidered as dynamic process, potentially inverse to organisational learning. This is consistent with findings of recent studies in the field. It is obvious that ICT in Slovenia still present important source of competitive advantage in terms of financial performance. Prudent ICT investments, based on cost-benefit analysis, do pay-off. In future we will need to address question of ICT accompanied with organisational learning and how does this reflect on company performance. Meta-analysing recent studies in field could lead us to think of a productivity paradox as a dynamic process inverse to learning curve. In other words, ICT investments and usage, if accompanied with systematic endeavours to achieve organisational learning of higher level (strategic, generative, double-loop), might lead to better results. And this is an important perspective of a learning organisation.

Second, ICT proved to have no statistically significant impact of nonfinancial performance (hypothesis 2) developed in order to measure quality of relationships with employees, suppliers and customers. This is very interesting finding bearing in mind immensity of promises that some commercial providers offer when trying to sell various technologies such as customer relationship management (CRM), supply chain management (SCM) and enterprise resource planning (ERP) systems. Absence of a statistically significant relationship might be consequence of the fact that (for vast majority of companies in a small Slovenian economy) those solutions are simply too expensive, knowing how much additional consultant hours need to be added to initial selling price in order to adjust some solution 'from the shelf' to certain organisation and its very specific business model. It is very wrong (and unfortunately not that uncommon as one might think) to demand business model to adapt to information system under disguise of 'best-practice implementation'. Another reason might be associated with problems with integration of information systems within the company and with their environment. It is no surprise to us that financial and non-financial performances do correlate (hypothesis 3). At one hand this means that better financial situation allows company to invest in improved relationships with employees, customers and suppliers. On the other hand, improved relationships with their stakeholders result in financial gains. Without any doubt this poses important guideline for modern managers to invest in quality of relationships with their stakeholders. Reasons for that are obviously not only ethical but also purely economical in their nature.

All our findings should reflect themselves throughout whole modern paradigm of management process. In planning phase management needs to bear in mind goals of all stakeholder groups. Our research demonstrated that, beside ethical, very practical, financial reasons exist to support this notion. From organising perspective, one can say that situational variables of modern business environment demand organisational structure closer to organic type. Organisations, that will be more customer-oriented, that will covet for improvement of relationships with employees and optimisation of supply chain, will perform better. To support learning, cooperation and empowerment of employees are tasks of a modern leader in a learning organisation. One needs to be committed to achieving organisational culture of trust, cooperation and information sharing. This is also place where ICT (e.g. Intranet, virtual communities of employees, etc.) can play crucial role in modern organisations. To be able to perform efficient and effective control in a turbulent environment, characterised with decentralisation of knowledge and constant change, various information systems for control are compulsory.

Conclusion

Main goal of our research was to determine conceptually and empirically, what is the relationship between information-communication technologies and performance (from both financial and nonfinancial perspective). Stemming from these origin three hypotheses arose. Using data for 220 medium-sized and large Slovenian companies with more than 100 employees (gathered with self-administered questionnaire) hypothesis 1 proved to have sufficient support in gathered data. Influence of information and communication technologies as exogenous construct on organisational performance from financial point of view proved to be statistically significant, strong and positive. This is consistent with previous findings of Dewan and Kraemer (1998), Dimovski and Škerlavaj (2003, 2003a) and Navarete and Pick (2002). However, hypotheses 2 and 3 need to be rejected. Impact of information and communication technologies on non-financial organisational performance is not statistically significant. In contrary to Chakravarthy's findings (1986), and not surprisingly, correlation between financial and nonfinancial organisational performance demonstrated itself as statistically significant, strong and positive.

We have to be aware of some limitations, though. First, sample size and context always poses important limitation to every research and so does here. We used sample of all Slovenian companies with more than 100 employees in year 2002. It would be interesting to find out that how does our model perform in some other context, possibly in another country of higher or lower development level. Interesting case would be e.g. Singapore, which achieved high rates of growth investing in ICT and knowledge despite very limited natural resources. Cross-validation would be useful, although it was almost impossible to perform it with data at hand. At the same time it would be interesting to compare it against some competitive model. We have to keep in mind also, that we deal with perceptual measurement, where subjective assessments from respondents lead to danger of measurement errors. Next limitation is cross-sectional nature of research. With introduction of longitudinally and by observing data through time, interesting findings could emerge. We also have to be aware of possibility of missing variables that could statistically significantly influence relationships among elements of the model. Nevertheless, it would be utopically to expect that some model could ideally represent reality, which is far too complex to be investigated to every single detail. Despite that, authors hope and believe, that model represents relatively well balanced relationship between complexity of influence of information and communication technologies on financial and non-financial performance on one hand and simplicity of its formulation in the model on the other.

Directions for future research could be well connected to limitations at hand. There is a need to expand the sample, to introduce time-dimension, to cross-validate the model, to introduce new exogenous or mediating variables in the structural submodel, to introduce new measurement variables in order to improve operationalisation of latent variables etc. We are well aware of the fact that much of the work still remains to be done. Nevertheless, we hope to have demonstrated to academic and business community strategic importance of information and communication technologies and their influence on both financial and nonfinancial performance of modern company in its perpetual change and quest for competitive advantage.

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