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Information Technology Investments and Organizational Performance of the Telecommunications Industry in Ghana

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Abstract: The main objective of this study was to find whether IT investments had any positive effects on organizational performance of Telecoms companies. Another objective was also to come out with a model to explain the dynamics of IT investments covering from the factors that necessitates IT investments to the performance of these investments. The focus was from 2000 to 2006. Mobile subscriber base in Ghana grew from 215928 to 4966797, or by approximately 2300.21% from 2001 to 2006 (calculated from data taken from Ghana's National Communications Authority website www.nca.org.gh). This represents huge IT investments made over the years. As to whether this investment resulted in the performance of these companies or not is what this study tried to unravel. A diagrammatical model was developed as mentioned earlier. At the firm level the results were consistent with the work of Alpar and Kim (1990) who also did not find positive effects of IT investments on performance. Like Strassmann (1985), this study also found no correlation between IT and Return on Investment (ROI) at the firm level. At the industry level however, there were positive effects. This piece of work is purposely meant for all managers, IT professionals, and engineers who take decisions in organizations, government institutions, as well as educational institutions pertaining to Information Technology investments. It will help them make informed decisions, and also to maximize the performance of IT investments once they are made.

Key words: Information, investments, mobile, organizational, performance, telecommunications

INTRODUCTION

The mobile Telecommunications Industry has entered an era of total competition worldwide. In Ghana, the story is not different. It is one of the fastest growing industries in Ghana over the past few years. There are already five active competitors in the industry, namely, Mobile Telecommunications Network (MTN), Tigo, Ghana Telecommunications Company Limited (now Vodafone Ghana), EXPRESSO, and AIRTEL with GLOBACOM yet to do a formal launch. One area of intense competition in the industry is in the acquisition of current and state of the art Information Technology (IT) equipment and software. The IT elements found in the operational setup of a mobile telecom company are the hardware: Global Systems for Mobile Communications (GSM) and Universal Mobile Telecommunications Systems (UMTS) equipment, terminals (or computers: laptops and desktops), and software: operating system, application software, programming languages that run on or run these equipment. These elements are combined for the automatic acquisition, storage, manipulation (including transformation), management, movement, control, display, switching, interchange, transmission or reception of data. These are huge IT investments for any mobile operator, and more especially, if the operator wants to have full nationwide coverage.

These huge and inevitable IT investments must surely result in organizational performance for any operator to remain in business. In the telecommunications industry in Ghana, little has been done in terms of research in this area of IT investments and its impact on organizational performance. One main reason for this is the fact that the industry is still young. There are many studies in this area of research for especially industries apart from the mobile telecommunications industry world wide.

A study (Datamation, 1984, 1985, 1986) revealed that the average information technology expenditure in 1983 was 8% of revenues for high performing companies. The same study revealed that the average firm allocated approximately 2% of revenues to IT (Diebold Group Inc., 1984). Another survey (Carter, 1984) found that

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Management Information Systems (MIS) expenditure on average accounted for 1.44% of revenues. Unfortunately, much of this investment is made not having any clue in real returns. There is little actual evidence that investments in IT are economically advisable. Discussions such as the one reported above show clearly the dilemma many managers face. IT is inevitable to their businesses but they have few guidelines for determining the adequate level of investment in it.

In general, the impact of IT or Organizational Performance can be measured in different ways, using productivity, efficiency, profitability, market value, competitive advantage, and so on, and although authors have come to some consensus about IT's positive impact on some variables(e.g., productivity), there is much less agreement about its impact on others (e.g., profitability) (Alpar and Kim, 1990). The purpose of this study was to establish the relationship between IT investments and performance using appropriate variables in the mobile telecommunications industry in Ghana. A model of the relationship between IT investment and organizational performance was also formulated. The model is presented and questions posed for investigating this important relationship more closely.

The general research problem is: What is the impact of the level of investment in IT on firm performance? This is a very complex issue, as IT investment is only one of the many variables which affect firm performance (Cron and Sobol, 1983; Ginzberg, 1981). The crux of the problem is whether investment in IT really makes a difference.

This problem generates the following series of related questions:

- Is there a significant, unique effect of investment in IT on the performance of mobile telecom companies?
- What is the nature of the relationship between the level of investment in IT and the performance of mobile telecom companies? Does increasing investment lead to increased performance?
- Is the relationship between levels of IT investment and firm performance dependent on the mobile telecom industry in which these firms operate?
- Is there a threshold investment that firms in the mobile telecom industry must make to survive?
- Does the strategic reason for investing in IT make a difference? What effect does the objective for investment have on firm performance?
- Do the other variables that affect performance dominate the effects of the level of IT investments?
- Is it possible to predict the effect of a particular level of IT investment on performance for a given firm in the mobile telecom industry?
- What is the appropriate definition of performance?

The study was not meant to answer all the above questions, but to a greater extent it tried to explain the relationship between IT investment and firm performance in the mobile telecom industry in Ghana. The following questions were also posed before the model was developed:

- How do the mobile telecom companies within the industry define and conceptualize IT?
- How do these companies measure and track or otherwise manage their investments in IT?
- How do these companies infer or calculate return on IT investment?
- What is the drive for IT investment? At what level in the organization does this drive originate? Is it top-down, i.e. driven by corporate strategy at the highest level; or is it bottom-up, i.e. driven by operational requirements?

The hypothesis of the study was therefore stated as follows:

> IT investments result in the performance of the mobile telecom industry in Ghana or there is a positive relationship between IT investments and performance of the mobile telecom industry in Ghana.

MATERIALS AND METHODS

The study was conducted in Accra, Ghana with all the Telecom companies for the industry level and one selected company (name given as company M) for the firm level. The year this was done was 2008, but the years 2000 to 2006 were taken into consideration. Little has been done in terms of research in this area; the reason being the difficulty in the acquisition of consistent data and also the confusion of whether Mobile telecoms equipment could be considered as IT elements or not. Some researchers limit IT to only computers and software. This can only be true for industries which employ only computers as IT elements in their operations. For a mobile telecom industry, the scope of IT embodies all equipment that has something to do with data, voice and image.

Already known and tested methodologies that researchers have used over the years to conduct studies in this area of research were employed. Most of the works have been done in the manufacturing and service sectors.

The mobile telecom industry is part of the service sector; hence methodologies employed by researchers for the service sector were employed in this study. The principal objective was to understand the relationship between IT investments as the independent variable and performance of the mobile telecom industry in Ghana, the

dependent variable. Secondary data was therefore critical to the success of the study.

From the inception of the idea by management of a mobile telecom company to invest in IT to the time that these investments will yield tangible and measurable results, a whole lot of dynamics go into it. These dynamics were fished out by employing primary data collection methods such as interviews, observation, focus group interviews, and so on. A diagrammatical model was then produced out of the gathered information to present for the analysis of the mobile telecom industry in relation to IT investments as input and performance as output. From the quantitative point of view, there are a number of ways of measuring performance. This study focused only on productivity and profitability. Yearly financial statements of the four mobile telecom companies (MTN, TIGO, ONETOUCH and KASAPA) were gathered spanning the years 2000 to 2006 for the firm and industry analysis. Two sets of mathematical models were employed, one for productivity and the other for profitability. These models are all consistent with work that has been done already both at the firm level, most significantly Brynjolfsson and Hitt (1996) and Lehr and Lichtenberg (1999).

Productivity models: For the productivity model, the non-ratio, Cobb-Douglas and ratio functions were employed to see whether there exist at all a relationship between some selected inputs of production, convertible to monitory terms, in the line of investments which IT is part and the output which is an indication of the result or outcome of all that was put in as inputs.

Six dependent financial performance measures were calculated from the secondary data:

- Earnings before interest and taxes (EBIT), return on assets (ROA),
- Return on equity (ROE),
- Net Profit (NP),
- Return on investments (ROI),
- Net Profit Margin (NPM).

The mathematical models are as follows:

The non-ratio, Cobb- Douglas function: Log Performance index(x) = log a +b log Total Assets (TA) +c log Total Revenue (TR) +d log Network Equipment Investments (NEI).

x = EBIT and NP were used for the analysis.
Log a is a constant whilst b, c, and d are all coefficients.

The inputs to the above model can be varied or changed to see how a number of them (for example, Current Assets-CA, and Noncurrent Assets-NCA) relate with the output. In view of this, the above model could be varied by introducing CA and NCA in place of TA to see how they also relate with the output as in the following:

- Log Performance index(x) = log a +b log Current Assets (CA) +c log Total Revenue (TR) +d log Network Equipment Investments (NEI)
- Log Performance index(x) = log a +b log Noncurrent Assets (NCA) +c log Total Revenue (TR) +d log Network Equipment Investments (NEI)

We therefore have three mathematical productivity models in all.For the Ratio model, we have:

- Performance index(x) = a +b IT as percent of Revenue (ITPR) + c Capital Intensity (CI) +d Debt to Assets Ratio (DAR).

Here, x = ROE, NPM, ROI, and ROA were used respectively for the analysis, making four equations in all.

Profitability models: For the profitability model, the financial measures, ROA, ROI, ROE, NPM, NP and EBIT already provided are used as dependent variable against a number of independent variables which are all estimations of IT investments. The set of mathematical models for the profitability measure are as follows:

- ROA = a+ b ITPR
- ROE = c+ d ITPR
- EBIT = e+ f TITS
- NPM = g+ h ITPR
- ROI = i + j ITPR
- EBIT = k + l TA
- NP = m + n TA
- EBIT = p + q NEI
- NP = r + s NEI
- NP = t + u TITS
- NP = v + w CA
- EBIT = x + y CA
- EBIT = z + a_1 NCA
- NP = b_1+ c_1NCA

a, c, e, g, i, k, m, p, r, t, v, x, z, and b_1 are constants whilst b, d, f, h, j, l, n, q, s, u, w, y, a_1, and c_1 are coefficients. TITS not yet defined is Total IT spending. NEI is defined as Network Equipment Investments which gives an indication of IT hardware investments. Again, regression analysis was employed to determine the relationships between these variables. This led to the testing of the stated hypothesis, which then set the stage for effective analysis and discussion.

On the Organizational or firm level, the analysis was performed for one of the four mobile telecom companies using the span of years, 2000 to 2006 and the same models and procedure used for the industry level analysis.

The Industry level analysis was then compared with firm level analysis in the end to see the similarities and differences in conclusions relating to IT investments and performance in the mobile telecom sector in Ghana.

Definitions of variables used in the mathematical models:

Current Assets (CA): A balance sheetaccountthat represents the value of all assets that arereasonably expectedto be converted into cash within one year in the normal course of business. Current assetsinclude cash, accounts receivable, inventory, marketable securities, prepaid expenses and other liquidassets that can be readily converted to cash. Current assets are important to businesses because they are the assets that areused to fund day-to-day operations and pay ongoing expenses. Typical current assets of a mobile telecom company are inventories, national trade debtors, international trade debtors, bank and cash balances and so on.

Noncurrent Assets (NCA): Noncurrent assets are assets which are not easily convertible to cash or not expected to become cash within the next year.
Examples include fixed assets such as mobile telecom switches, servers, hubs and so on, leasehold improvements, and intangible assets such as a brand, franchise, trademark, or patent.

Total Assets (TA): The sum of current and noncurrent assets.

Total liabilities (TL):
A combination of NONCURRENT Liabilities (ncl) and current liabilities (cl): NCL are liabilities that are due to be repaid after more than one year. This is inclusive of bonds and long-term loans. It can also be looked as financing used to purchase or improve assets such as plant, facilities, large equipment and real estate. CL are liabilities that are due to be paid within one year. These include short term debts, accounts payable and accrued liabilities.

Total Revenue (TR): The total amount of money (cash, account receivables or credit) received by a business in a specified period before any deductions for costs, raw materials, taxation, and so on.

Return on Assets (ROA): An indicator of how profitable a company is relative to its total assets.ROA gives an ideaas to how efficientmanagement isat using its assets to generate earnings.Calculated by dividing a company's annual earnings by its total assets, ROA is displayed as a percentage. ROA = Net Profit/Total Assets.

Net Profit (NP): In business, it is what remains after subtracting all the costs (namely, business, depreciation, interest, and taxes) from a company's revenues. Net income is sometimes called the bottom line. Also called earnings or net profit. Basically, Net Profit = EBIT-Taxes

Earnings Before Interest and Taxes (EBIT): An indicator of a company's profitability, calculated as revenueminus expenses, excluding tax and interest. EBIT is also referred to as "operating earnings", "operating profit" and "operating income",as you can re-arrange the formula to be calculated as follows: EBIT = Revenue-Operating Expenses. In other words, EBIT is all profits taking into account interest payments and income taxes.

Net Profit Margin (NPM): Net Profit Margin tells you exactly how the managers and operations of a business are performing. Net Profit Margin compares the net income of a firm with total revenue achieved. The formula for Net Profit Margin is: NPM = Net Profit/Revenue.

Return on Equity (ROE): A measure of a corporation's profitability that reveals how much profit a company generates with the money shareholders have invested.Calculated as: Net Profit/Shareholder's Equity.

Return on investment (ROI): In simple terms, it is the return on invested capital or the profit from an investment as a percentage of the investment outlay. In our context, using the financial statements, ROI = Operating Income or EBIT/ Book value of Assets or Shareholder's Equity. Book value of Assets = Assets-Liabilities (In other words, if you wanted to close the doors of the company, how much would be left after you settled all the outstanding obligations and sold off all the assets). Other parameters are defined below:

- ITPR = (IT Spending/Revenue)*100
- Debt to Asset Ratio(DAR) = Total Liabilities/Total Assets

Capital Intensity (CI): Measure of a firm's efficiency in deployment of its assets, computed as a ratio of the total value of assets to sales revenue generated over a given period. Capital intensity indicates how much money is invested to produce one dollar of sales revenue.

Formula: Total assets/Total revenue. It is also known as the Asset Turnover Ratio.

RESULTS AND DISCUSSION

Diagrammatical model: The whole process of IT investments in the mobile Telecommunications industry in Ghana based on general interviews, focus group interviews and personal observation depicted clearly the following sequence of events:

- Activities that precede the Investments
- The Investments
- The conversion abilities or effectiveness
- Time gap between the Investments and the yields of the Investments
- The yields of the Investments

This sequence of events is discussed briefly.

Activities that precede the investments: This is where the question "why the need for IT investments?" is asked and answered. This question is normally asked and answered by management, representing a top down impetus which is mostly fuelled by strategy in the direction of gaining competitive advantage over competitors through IT. Employees on the other hand, through reports, departmental meetings, and organized forums and so on do also push for IT investments which may not necessarily be strategically oriented but are sometimes fuelled from genuine concerns pertaining to their work. This is generally known as bottom up impetus.

In this era of IT, customers are very sophisticated and will always want to associate with a mobile company which displays sophistication in terms of IT. This was gathered when most mobile users were interviewed. Customers therefore cannot be left out as a force in the determination of IT investments in a mobile telecommunications company. Feedback from customers reveals these concerns, and any serious mobile telecom company that wants to stay in competition in Ghana will surely not push these concerns under the carpet.

Another form of impetus is pressure from vendors and suppliers. Vendors and suppliers in their quest to make more profits and stay in business always come out with new levels of IT equipment developments and software patches, upgrades and updates which they eventually force on the companies they are supplying. This makes management of these companies at the receiving end sometimes make unplanned IT investments. The vendors and suppliers do it in such a way that there is virtually nothing that these companies can do to resist.

One of the ways they use to achieve this is to declare that they do not provide support and spare parts for the supposedly old IT equipment.

Investments in IT in the mobile telecommunications industry is also largely influenced by the fast pace of development in the IT world or global trends in the development of IT. Software that is very useful today may lose its usefulness tomorrow and this may necessitate new investments in IT. Management may not be ready for IT investments, but for the fact that if they do not do it, the company may be left behind in the industry because all the other companies within the industry are going in for higher levels of IT equipment and software, they are forced to invest in IT to keep with the pace at which the industry is moving in terms of technological developments.

These points are not exhaustive but from the interviews, the above are the main points worth discussing in this write up. In general, the impetus may be internally or externally fuelled.

Internal, representing management and employees, that is emerging from the company itself and external, representing customers, vendors or suppliers and global trends or fast pace of development in the IT world and so on, that is coming from outside the company.

The investments: IT investments in a typical mobile telecommunications industry are all hardware and software that have something to do with voice traffic, data and image. The basis for the various forms of impetus towards IT investments in a mobile telecommunications company discussed in the preceding section should be at least one of the following:

- To change its products and services to attract more customers and gain competitive advantage over its competitors in the long term measured using say Revenue Growth Rates: STRATEGIC ORIENTED IT.
- To support management control and tactical planning such as acquisition of resources, structuring of work and personnel management in the medium term. This has more to do with IT that is purposely meant for all supporting activities as far as mobile telecommunications is concerned. This is usually measured using Return on Assets (ROA): SUPPORT OPERATIONS ORIENTED IT.
- To support the main operations of the industry, namely switching, transmission and customer access in the short term usually measured using say Return on Investment (ROI): CORE OPERATIONS ORIENTED IT.

Conversion abilities or effectiveness: This is the most important part of the model. It is like the transfer function of a control system. If this part is not managed well, all the IT investments can go down the drain without any gains to the company. Mobile companies that have high conversion abilities realize the gains of the IT investments even earlier than stipulated time. Again, various interviews revealed that there are a number of forces that determine this conversion effectiveness; five are captured in this model and they are as follows:

Top level input or top management commitment to IT: Beyond the general approval and "signing of the check", top management commitment is a demonstration of the belief that the IT systems, and/or software tools would be successful. This alone gets all the employees on board and

they also prepare themselves to use the systems and the software tools. This is particularly true in small mobile telecom firms where top management is more visible to all employees. If the employees get to know that even management is not committed to it, the probability that they will adopt the same behavior is very high which can ultimately result in less gains as far as performance of the IT investments is concerned.

Previous firm experience with IT: This is a vital factor in conversion effectiveness. Mobile firms with more experience with IT systems and software tools will tend to be aware of the potential pitfalls and have realistic expectations of what IT can and cannot achieve.

User satisfaction with IT systems and software tools: Unsatisfied users can cause IT investments to become a waste. The solution to this is a complete and thorough requirement analysis in the firm before purchases are made.

Power and politics in the organization: Markus (1983) and Markus and Pfeffer (1983) found out that Power and politics have been recognized as significant determinants of IT design and implementation. In other words, power and politics play a major role in IT design and implementation.

Markus also demonstrated that as a result of political negotiations during system design and development, rational management objectives for systems are not always translated into system design features. Shrivastava and rant (1985), working on models for strategic decision making processes, posited and tested a political expediency model of decision making for computer purchases. More stable mobile telecom firms are expected to experience more conversion effectiveness than mobile telecom firms with politically turbulent internal environments. Individuals or groups and even management will act in their own interests, and if the firm is perceived as a politically charged environment this will reduce the likelihood of a uniform commitment to the use of the IT equipment and software. This reduction is posited to lead to less productive outputs from the investments in IT.

Culture of the firm regarding IT: The caliber of people the company employs, the way the company goes about its processes and procedures, its outsourcing of computing work policy within the company over the years, and so on carves a culture for itself. These can produce for a long time employees who fear anything in the name of computer or employees who are really conversant with IT. The first form of employees will always resist IT investments and IT usage contributing to poor conversion effectiveness but the latter form of employees will always embrace IT investments and innovations contributing to good conversion effectiveness.

Time gap between the investments and the yields of the investments: There is always a time gap between investments and the yields of the investments. The time gap depends so much on the type of investment and the conversion effectiveness. To reduce the time gap, the conversion effectiveness in particular should be worked at very well. Generally, and all things being equal, short term investments should take one year to produce gains or yields. Medium to long term should take three to five years. There are however, other factors that affect the time gap. Some of them are:

- The size of the company
- The IT competency of the staff
- Monitoring and evaluation by management
- Sense of urgency from top management

In a typical mobile telecom company, the time gap is not too much. Gains are realized quickly because most of the employees are IT oriented and there is the general understanding that without IT the industry cannot survive. This makes everyone working in the industry; right from the top to the ordinary worker takes IT seriously. In fact, for a mobile company to survive the competition in the industry IT must be taken seriously by its management; and this is common knowledge in the industry.

The yields of the investments: The yields of IT investments in the mobile telecommunications can be viewed from different directions namely:

Profitability: Measured in ROA ,ROI, ROE, NP, NPM, and EBIT in this write up.

Productivity: Non-ratio, Cobb-Douglas and Ratio functions employed to do the analysis in this write up.

Market: Not employed in the mathematical analysis.Intermediate results: Not employed in the mathematical analysis, and

Consumer welfare: Also not employed in the mathematical analysis.

The diagrammatical model showing all that have been discussed above is shown in Fig. 1 in the appendix.

Firm level analysis: From the mobile telecommunications companies in Ghana, one was chosen for this analysis. I will from this point onwards refer to this company as Company M. As stated in the

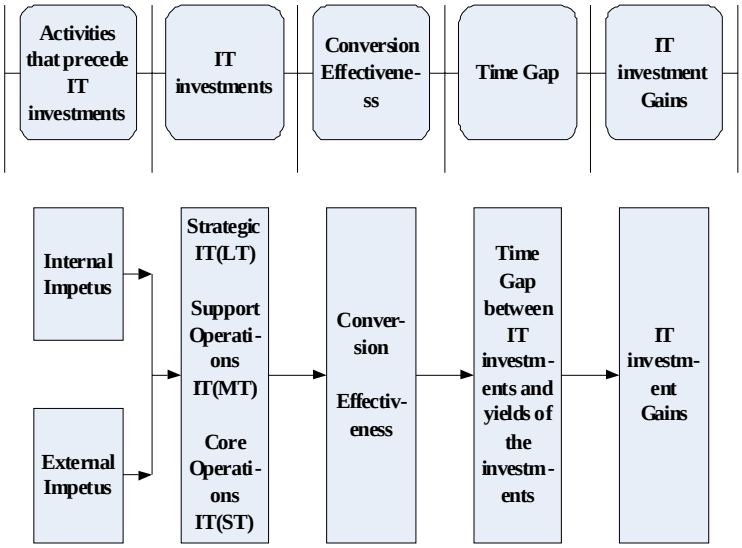

Fig. 1: Diagrammatical model of the dynamics of IT investments
1. Internal Impetus is made up of bottom up (employees) and bottom down (management)
2. External Impetus is made up of customers, global trends, and vendors and suppliers
3. LT-Long Term, MT-Medium Term, ST-Short Term
4. Conversion Effectiveness: Components are Top management commitment, previous firm experience with IT, User satisfaction with IT systems and tools, Power and politics of the firm, and culture of the firm regarding IT
5. Time Gap between IT investments and yields of the investments: components are size of firm, staff IT competence, monitoring and evaluation, and sense of urgency
6. IT investment gains: These are market, profitability, productivity, consumer welfare, and intermediate results

Table 1: Firm level profitability summary

No.	Profitability measure (y)	IT measure(x)	ρ	t stat form output	P-value form output	F stat form output	Over all significance
1	ROA	ITPR	0.58	1.61	0.168	2.6	Not significant
2	ROE	ITPR	0.35	0.84	0.438	0.71	Not significant
3	EBIT	TITS	- 0.85	3.56	0.016	12.67	Significant
4	NPM	ITPR	0.5	1.299	0.251	1.687	Not significant
5	ROI	ITPR	- 0.203	0.464	0.662	0.215	Not significant
6	EBIT	TA	0.817	3.17	0.025	10.061	Significant
7	NP	TA	0.27	0.626	0.559	0.392	Not significant
8	EBIT	NEI	0.635	1.84	0.126	3.374	Not significant
9	NP	NEI	- 0.085	0.1911	0.856	0.0365	Not significant
10	NP	TITS	- 0.341	0.812	0.454	0.659	Not significant
11	NP	CA	0.55	1.472	0.2	2.167	Not significant
12	EBIT	CA	0.87	3.96	0.011	15.672	Significant
13	EBIT	NCA	0.791	2.89	0.034	8.341	Significant
14	NP	NCA	0.202	0.461	0.664	0.212	Not significant

Standard p-value is 0.05, t stat from tables is 2.571, and F stat from tables is 6.61 were not shown on the table because they hold for all the cases, that is all the fourteen cases. ρ (rho) is the correlation coefficient in the table

Table 2: Firm level non-ratio Cobb Douglas productivity summary

No.	output: Performance measure(logy)	Inputs (log xi)	R^2	Significance F	F stat form output	P- value of significant parameter
1	EBIT	TA,TR,NE L		0.967	0.0102	29.10.0187
2	EBIT	TR,NE L,CA	0.949	0.0195	18.45	0.032
3	EBIT	TR,NE I,NCA	0.972	0.008	34.37	0.0154

Standard Significance F is 0.05 and F stat from tables is 9.28. The significant parameter for all the three cases is TR and all the models are significant for the overall significance.

methodology, data from yearly financial statements of Company M spanning from year 2000 to 2006 was gathered. Regression analysis was used to transform the data into meaningful information which were analyzed. Sets of mathematical models were postulated for both profitability and productivity. Table 1 shows the

Table 3: Firm level ratio Cobb Douglas productivity summary

No.	Output :Performance measure (y)	Input (xi)	R^2	Significance F	F stat Form Output	Over all Significance
1	ROE	ITPR,CI,DAR	0.544	0.444	1.19	Not significant
2	NPM	ITPR,CI,DAR	0.425	0.595	0.74	Not significant
3	ROI	ITPR,CI,DAR	0.917	0.039	11.08	Significant
4	ROA	ITPR,CI,DAR	0.383	0.647	0.622	Not significant

Standard Significance F is 0.05 and F stat from tables is 9.28. DAR is the only significant parameter in relation number 3, that is, between ROI and ITPR, CI, and DAR. The p-value of DAR is 0.013

summary of the regression of the set of profitability models; Table 2 shows the summary of the regression of the set of non-ratio Cobb Douglas productivity models, and Table 3 the summary of the regression of the set of ratio Cobb Douglas productivity models. I analyzed these models based on the following precedence:

- Firstly, to find fitting models from the set of models representing profitability and productivity using statistical inference.
- Secondly, to use these fitting models to test the stated hypothesis: that is "IT investments result in the performance of mobile telecom companies in Ghana"
- Thirdly, to make conclusive statements inferring from the relationships of the parameters or variables of the fitting models.

We look at the outcomes of the regression of the profitability and productivity models respectively.

Profitability model analysis at the firm level: Refer to Table 1 at the appendix for the following analysis.

Figures which represent monies are all in New Ghana Cedis. Ratio figures are in percentages. Monies representing gains to company M were assigned positively. Assets and Revenue fall into this category. Monies representing loses to company M were assigned negatively. Liabilities and all forms of spending fall into this category. Profits were assigned positively whereas loses negatively.

With the single regression analysis as is the case of the profitability models, 95% confidence level or 5% significance level was employed. Degree of freedom (df) is given as (n-2).

For this analysis, n = 7, that is, yearly data from year 2000 to year 2006. This implies df = 7-2 = 5. Assuming a general model to represent the profitability models as $Y = a + \beta_1 X$, we set our t test hypothesis for the significance of the coefficient as follows:

H_o: $\beta_1 = 0$
H_1: $\beta_1 \neq 0$

Where β_1 is the coefficient of X: We compare t* from the computer output with t from the tables. If t* > t, we reject H_o and say that β_1 is significantly different from zero and hence the parameter X is significant. Using the p value to test the significance of the parameter X, for 5% significance level, we reject H_o if p value of β_1 from the computer output is <0.05 and say that the parameter X is significant.

For the F test of overall significance or validity of the regression model, we set the hypothesis as follows:

H_o: $\beta_1 = 0$
H_1: $\beta_1 \neq 0$

Where β_1 is the coefficient of X: We compare F* from the computer output with F from the tables. Here, we have v_1 = numerator = k and v_2 = denominator = n-k-1, where k = 1 = number of independent variables. This implies F from the table is given as $F_{v1, v2}$ which is the same as $F_{1, 5.}$ If F* > F, we reject H_o and conclude that the model does have some validity.

It is worth noting that t test and F test for a single regression model as in this particular case provide the same conclusion. The following relation is always true for a single regression model: $(t^*)^2 = F^*$.

From Table 1 it is clear that the models which have some validity and which can be relied on for this analysis are the models involving EBIT as dependent variable and TITS, TA, CA, and NCA each as independent variable. The rest do not have any validity, implying that they cannot be relied on for proper analysis. EBIT and TITS have a strong negative correlation. This shows that the more company M spends on IT, the more EBIT is affected negatively. In other words as spending goes up, profit before tax goes down. EBIT and TA, EBIT and CA, and EBIT and NCA however have strong positive correlation. IT equipment and software form a majority portion of these assets. This means that company M is able to translate its assets into profits before tax. EBIT and CA have the highest correlation coefficient of 0.87 and hence the best fit model for the profitability model.

It is interesting to know that even though EBIT and NEI did not present a significant model, there is averagely some correlation between them. The correlation coefficient between them is 0.635. This shows that real network equipment investments also somehow contribute positively to profits before tax in company M. This can however not be relied on so much for decision making because the model is not significant.

It is worth noting that EBIT compared to NP is not a good measure of profitability. This is because NP is what

the company can categorically say belongs to the company and for that matter goes into its coffers. EBIT is not a true picture of the profitability of a company.

From Table 1 it is clear that models involving NP and NEI and NP and TITS (total IT spending) all have negative correlation coefficients of -0.085 and -0.341 respectively, implying that Network Equipment Investments as well as IT spending do not have positive effects on real profit. NP and CA, TA, and NCA each however has positive relations but not anything to depend or rely on since the correlation coefficients of 0.55, 0.27, and 0.202 respectively are not good enough, far below 1. The models too are not significant.

Other strong profitability measures like ROA, ROE, and NPM all follow the same trend, that is, they do not have any strong positive relations with the IT measure ITPR. ROA versus ITPR model out of this group (the ratio profitability measures) has the strongest relation because it has the highest correlation coefficient of 0.58. This shows that on the average, the more company M spends on IT out of its revenue in securing assets, the more it makes returns on those assets. This again cannot be relied on so much since the model is not significant and hence not fit to be used to make a case. ROI versus ITPR presents a very weak negative relationship. The model is not significant and hence does not represent any true relationship.

In conclusion I will say that for firm level studies, IT investments in the form of Assets(CA, NCA, TA, NEI) and IT spending(TITS) do not result in net profitability (profit after tax). Percentage of IT spending to Revenue (ITPR) also does not generate any commensurable returns in terms of ROA, ROI, ROE and NPN. However, the Assets of M result in profitability (profit before tax) of company M.

Productivity model analysis at the firm level: As indicated earlier, we have for this study ratio Cobb Douglas model and non-ratio Cobb Douglas model. There are sets of models for each, and we again find which models are best fit models. Using a general model $Y_i = \beta_o+\beta_1X_1+\beta_2X_2+\beta_3X_3$ as is the case of this study for the ratio Cobb Douglas productivity model and $\log Y_i = \log \beta_o+\beta_1\log X_1+\beta_2\log X_2 +\beta_3\log X_3$ for the non-ratio Cobb Douglas productivity model, we test for the individual parameter significance using the parameter's p value or by employing the t test. If the parameter's p value is less than 0.05, we say it is significant, otherwise it is not. Using the t test, if the parameter's t* from the computer output is greater than t from the tables; we say that the parameter is significant, otherwise it is not. The overall significance of the model is set starting with the hypothesis as follows:

H_o: $\beta_1 = \beta_2 = \beta_3 = 0$
H_1: At least one $\beta_i \neq 0$

For the overall significance of the model, at least one of the coefficients must be different from zero. That is to say that at least one of the parameters should be linearly related to Y. Also, using the F test, if $F^* > F_{V1, V2}$; where $v_1 = k = 3$ = number of independent variables, $v_2 = n-k-1$ and n = 7, that is yearly data from 2000 to 2006, we say that the model does have some validity. $F_{V1, V2}$ is read from tables and F^* is the computer output. Significance F (p value of overall significance) can also be used to test the overall significance. If the significance F from the computer output is less than 0.05, then we reject the null hypothesis and say that at least one of the coefficients is different from zero, and for that matter the model is significant.

Table 2 shows the summary of the regression of the non-ratio Cobb Douglas productivity models and Table 3 the summary of the regression of the ratio Cobb Douglas productivity models.

With the coefficient of determination (R^2), the higher it is (the nearer it is to 1), the better the fit of the line and the higher the percentage of the variation in the dependent variable explained by the independent variables or the regression equation as a whole. We look at the outcomes of the regression of the non-ratio and ratio Cobb Douglas models closely below. Parameters with one or more negative entries are excluded from the non-ratio Cobb Douglas model since we cannot have logarithms of negative numbers for this analysis.

Non-ratio Cobb Douglas productivity model analysis at the firm level: Refer to Table 2 at the appendix for this analysis.

There is fit between the dependent variable and the independent variables for all the three models. There is fit between log EBIT as output and log TA, log TR, and log NEI as inputs.

The R square is 0.967. This is almost 1, meaning the model is very significant and hence can be used for forecasting. The same applies to models 2 and 3. In each case log TR relates with log EBIT positively. This means that log EBIT has a direct and strong relation with log TR which in real life is very true. Comparing the models, the most fitting model is model 3. It is only with this model that EBIT relates positively with a measure of the firm's asset, NEI. EBIT relates with all the measures of the firm's assets (NCA, TA, NEI, and CA) negatively in models 1 and 2. Even in model 3, EBIT relates with NCA negatively.

Because company M made loses in a particular year within the years 2000 to 2006, log NP as dependent variable could not be used for this particular analysis because of the logarithm of a negative number which though can be found, is in a form of a complex number and cannot be used for this analysis. Again, since EBIT does not represent the true status of company M in terms of profitability, the three fitting models cannot be relied

on so much for management decision. EBIT most of the time is favorable but can result in loses for the company after deduction of tax and interest. We can therefore infer that there is no fit between net profit as output of production and company M's assets and revenue as inputs of production. Hence in terms of net profit, it does not only take the assets of a company to generate it and it will be very wrong for management to think otherwise.

Ratio Cobb Douglas productivity model analysis at the firm level: Refer to Table 3 at the appendix for this analysis.

Out of the four models, fit is found for only model 3. ROE, NPM, and ROA as output each with ITPR, CI, and DAR as inputs (that is models 1, 2, and 4) did not produce any fit. Though model 3 is a fitting model, it cannot be relied on so much since ROI is a measure based on EBIT which is not a good measure of profitability compared to NP. ROA, NPM, and ROE which are based on NP did not give any fit with ITPR, CI, and DAR. This goes again to show that in terms of net profit and all ratios relating directly to net profit, there is no relationship between them and the firm's IT spending and also the firm's assets which are predominantly IT equipment and software.

Firm level analysis versus the stated hypothesis: The hypothesis of the study was stated as follows: "IT investments result in the performance of the mobile telecom industry in Ghana" or "there is a positive relationship between IT investments and performance of the mobile telecom industry in Ghana". From the analysis of the productivity and profitability models so far, it is clear that the hypothesis does not hold at the firm level of the mobile telecom industry in Ghana. IT investments in the mobile set up in the form of acquisition of Assets (CA, NCA, and NEI) and software, and IT spending (TITS) do not necessarily yield net profit. These investments however yield profit before tax which is not a good measure of profitability compared to net profit. At the firm level therefore, the stated hypothesis is disproved. It is worth mentioning that with the productivity models, a clear conclusion cannot be made of the fit between NP and the assets and IT spending of company M due to the fact that log NP could not be included as a dependent variable in the analysis; but we can say categorically that there is fit between EBIT and the assets of company M.

Industry level analysis: For industry level analysis, the same models for profitability and productivity are used. The only difference is that this time around the data used for the analysis is the aggregated data for all the mobile telecom industries in Ghana (only four of them in operation as at 2006: TIGO, MTN, KASAPA, and GHANA TELECOM). Also, yearly data from 2002 to 2006 was employed instead of from 2000 to 2006 used for the firm level analysis. The null and alternate hypothesis set for the profitability and productivity models at the firm level still holds.

For the profitability model, n = 5. This implies degree of freedom (df) = –2 = 5-2=3. Hence t from tables is found using $t_{0.05,\ 3}$ for 5% significance level which is 3.182. If t^* from the computer output is greater than 3.182, we reject the null hypothesis and say that the model is significant. For F test of overall significance, v_1 = numerator = k = 1 = number of independent variables and v_2 = denominator = n-k-1 = 5-1-1 = 3. This implies we find $F_{0.05,\ 1,\ 3}$ from the tables, which is 10.13. If F^* from the computer output is greater than 10.13, we conclude that the model has overall significance and can be used for forecasting.

For both the ratio and non-ratio Cobb Douglas productivity models, we have three independent variables. This implies k = 3. For overall significance, v_1 = numerator = k = 3 = number of independent variables and v_2=denominator = n-k-1 = 5-3-1 = 1. Hence we find $F_{0.05,\ 3,\ 1}$ from the tables, which is 215.7. If F^* from the computer output is greater than 215.7, we reject the null hypothesis and say that at least one of the coefficients of the independent variables is not equal to zero, and hence the model is significant. As indicated earlier, Significance F can also be used to determine the overall significance of the model. If the Significance F of the computer output is less than 0.05, the model is significant.

Profitability model analysis at the industry level: Refer to Table 4 at the appendix for the following analysis.

From Table 4 twelve out of the fourteen models are significant. All of the models too presented very strong positive or negative correlation between the dependent and independent variables. ROI, ROE, NPM, and ROA each had a strong positive relationship with ITPR.

This means that at the industry level, the higher the industry spends from its revenue for IT investments, the more positive results are obtained in terms of ROI, ROE, NPM, and ROA. IT spending (TITS) however have a strong negative correlation with EBIT. This again means that the higher the spending, the lesser the EBIT. This is true in real life situation. Assets of the industry (NCA, TA) from Table 4 have a strong positive correlation with Net profit and EBIT. These assets are predominantly IT equipment. But on the other hand, and surprisingly, CA has strong negative correlation with EBIT and strong positive correlation with Net Profit. This shows that current assets which are convertible to cash within a year have strong positive effects on profits and not EBIT. Even though EBIT and NEI, and NP and NEI have strong positive correlations of 0.844 and 0.747 respectively, the models are not significant and cannot be relied on so much for decision making. NEI is the actual measure of

Table 4: Industry level profitability summary

No	Profitability measure(y)	IT measure(x)	ρ	t stat form output	p-value form output	F stat form output	Overall Significance
1	ROA	ITPR	0.976	7.81	0.0044	60.922	Significant
2	ROE	ITPR	0.95	5.29	0.0132	27.991	Significant
3	EBIT	TITS	- 0.982	8.97	0.0029	80.466	Significant
4	NP	MITPR	0.976	7.71	0.0045	59.48	Significant
5	ROI	ITPR	0.94	4.767	0.0175	22.72	Significant
6	EBIT	TA	0.98	8.486	0.0034	70.02	Significant
7	NP	TA	0.941	4.812	0.0171	23.16	Significant
8	EBIT	NEI	0.844	2.72	0.0723	7.422	Not significant
9	NP	NEI	0.747	1.948	0.147	3.794	Not significant
10	NP	TITS	- 0.955	5.563	0.0115	30.95	Significant
11	NP	CA	0.94	4.783	0.0174	22.88	Significant
12	EBIT	CA	- 0.978	8.18	0.0038	66.93	Significant
13	EBIT	NCA	0.979	8.25	0.0037	68.04	Significant
14	NP	NCA	0.939	4.75	0.0177	22.65	Significant

Standard p-value is 0.05, t stat from tables is 3.182, and F stat from tables is 10.13 were not shown on the table because they hold for all the cases, that is all the fourteen cases. ρ (rho) is the correlation coefficient in the table.

Table 5: Industry level non-ratio Cobb Douglas productivity summary

No.	Output performance measure (logy)	Input (log xi)	R^2	Significance F	F state form output	Overall Significance
1	EBIT	TR,NEI,NCA	0.999	0.0457	258.2	Significant
2	EBIT	TR,NEI,TCA	0.996	0.084	75.43	Not Significant
3	EBIT	TR,NEI,TA	0.999	0.0308	569.9	Significant

Standard Significance F is 0.05 and F stat from tables is 215.7. No parameter in each model was significant

Table 6: Industry level ratio Cobb Douglas productivity summary

No.	Output performance measure (y)	Input (xi)	R^2	Significance F	F state form output	Overall Significance
1	ROE	ITPR, CI, DAR	0.921	0.353	3.887	Not Significant
2	NPM	ITPR, CI, DAR	0.961	0.249	8.29	Not Significant
3	ROI	ITPR, CI, DAR	0.936	0.318	4.897	Not Significant
4	ROA	ITPR, CI, DAR	0.965	0.298	9.07	Not Significant

Standard Significance F is 0.05 and F stat from tables is 215.7. No parameter in each model was significant

IT of concern because it represents all IT equipment investments. NEI is embedded in NCA and NCAembedded in TA. From the analysis so far, it is clear that even though the models NP versus NEI and EBIT versus NEI are not significant, there is enough evidence to prove a strong positive relationship between NP and NEI, and EBIT and NEI.

CA includes software and so for NP and CA to have a strong correlation of 0.94 and also NP to relate to TA and NCA positively with correlation coefficients of 0.941 and 0.939 respectively, it appears sufficient to conclude that at the industry level IT investments result in profitability. This is however not true because the true measure of IT investments (NEI) did not find fit with both NP and EBIT. TA or NCA alone cannot be used to conclude that the IT investments of the industry result in profitability because TA and NCA contain other forms of assets apart from IT equipment and software.

Finally, I will say that on one hand fit was found between ROA, ROI, ROE, and NPM each of which are very good measures of profitability with ITPR, and on the other hand, even though there is a strong positive correlation between EBIT and NP each with NEI, there was no fit found. This only means that at the industry level there is enough proof to conclude that IT investments result in profitability, but cannot be over stretched or relied so much as a strong basis for investing very huge sums of money in IT without critically looking at the other important factors.

Non-ratio Cobb Douglas productivity model analysis at the industry level: Refer to Table 5 at the appendix for the following analysis.

Fit was found for two out of the three models. Again log NP was not used as dependent variable because NP had negative entries and logarithm of a negative number cannot be used for this analysis. The analysis is therefore done with only log EBIT which does not depict a true measure of performance. In all the three models, log EBIT has a positive relationship with log TR that is, holding all others constant. This is true in real sense. It is also evident that log EBIT has a negative relation with log NCA, log CA and log TA in all the models holding others constant.

With log EBIT and log NEI, one significant model presented a negative relation, and the other two including the insignificant model presented a positive relation holding all other parameters constant. We concentrate now on the significant model which presented a positive relation between log EBIT and log NEI holding all others constant.

This particular model happens to be the most significant with R square 0.999, almost 1 and F stat from

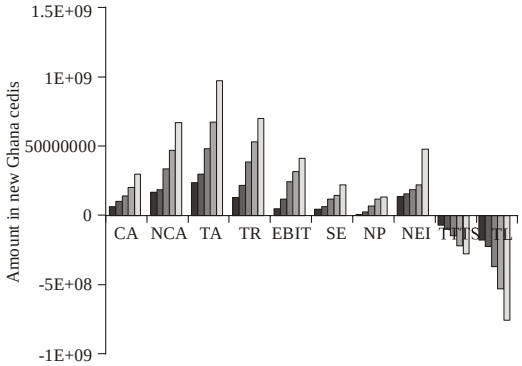

Fig. 2: Bar Chart of Industry data 1 from year 2002 to 2006

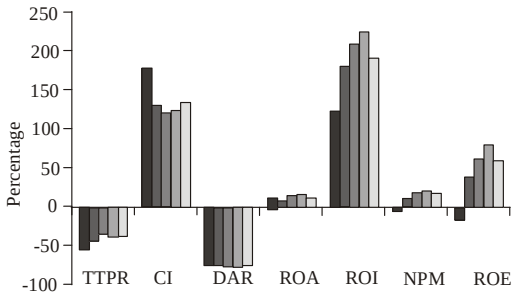

Fig. 3: Bar Chart of Industry data 2 from year 2002 to 2006

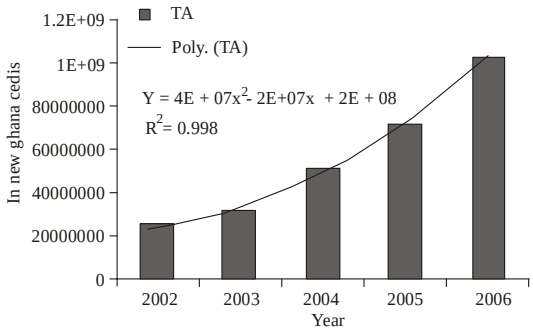

Fig. 4: Industry Total Assets (TA) against year

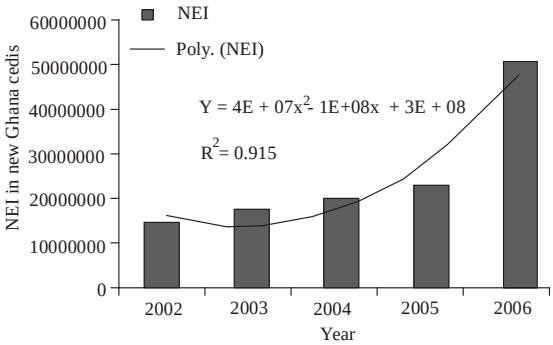

Fig. 5: Industry Network Equipment Investments (NEI) against year

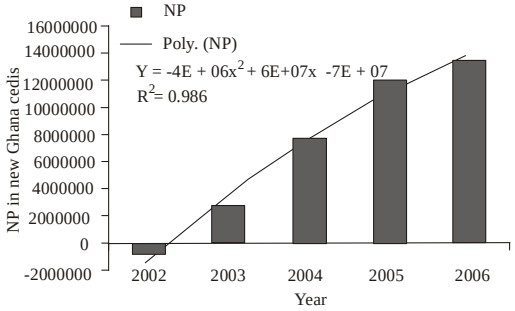

Fig. 6: Industry Net Profit (NP) against year

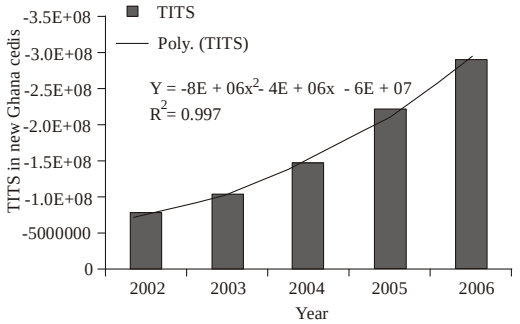

Fig. 7: Industry Total IT Spending (TITS) against year

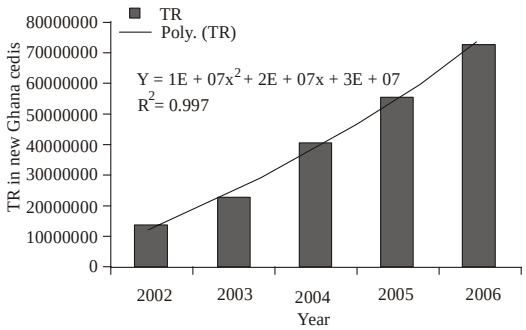

Fig. 8: Industry Total Revenue (TR) against year

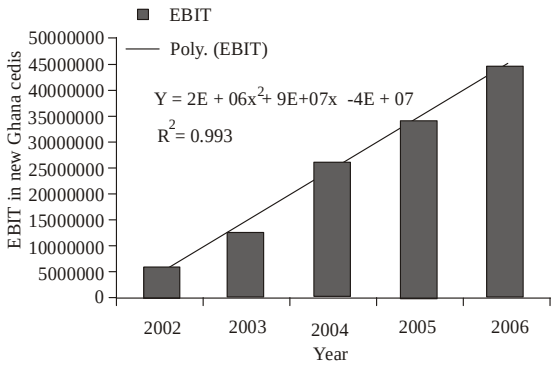

Fig. 9: Industry Earnings before Interest and Tax (EBIT) against year

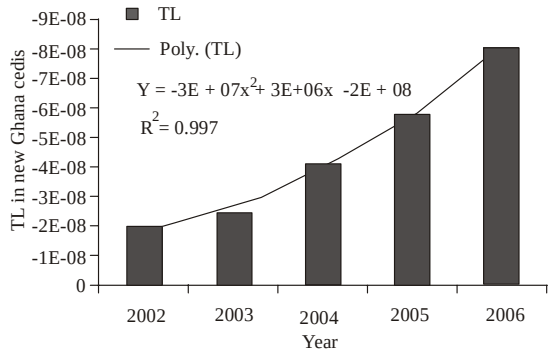

Fig. 10: Industry Total Liabilities (TL) against year

the computer output ($F^* = 569.9$) far greater than F stat from tables (F = 215.7). We therefore conclude that there is fit between performance (log EBIT) and IT investments (log NEI, log TA) and Total revenue. Again since EBIT is not a true measure of the performance of the industry, we do not rely on it so much.

Ratio Cobb Douglas productivity model analysis at the industry level: In table 6 (at the appendix), all the four models are not significant. This means that there is no fit between any of the following: ROE, NPM, ROI, and ROA with ITPR, CI, and DAR even though the R square for each is very high, all above 0.9. None of the models can be used for decision making.

Industry level analysis versus the stated hypothesis: The industry level analysis discussed above shows that on the average the hypothesis for this study holds for the mobile telecom industry. That is to say that IT investments result in the performance of the industry. It did not come out so clearly, but from the analysis, it suffices to say that there is significant proof to conclude that IT investments result in the performance of the mobile telecommunications industry in Ghana.

Industry trend analysis: Figs. 2 to 10 at the appendix were used for the industry trend analysis.

Figure 2 shows a number of industry measures (each from 2002 to 2006) on the X-axis and the corresponding amount in New Ghana Cedis on the Y-axis. From Fig. 2 it can be deduced that from 2002 to 2005, there was a gradual increase of the industry's network equipment investments (NEI), but sharply shot up in 2006. This shows that in 2006 the industry recorded so much investment in network equipment. This also resulted in commensurable revenue and Earnings before interest and tax. It is worth noting however that total liabilities was also high in 2006, and this explains why even though there was an increase in net profit from 2005 to 2006, it was not so significant. This is further explained from Fig. 3 by the values of return on investment, net profit margin, and return on assets in 2006.

Year 2005 was one particular year the industry realized so much gains from its assets and investments in general. Year 2002 was the bad year for the industry in terms of net profit, return on assets and net profit margin. From 2003 to 2006, the industry saw some level of improvement in terms of profitability, return on investment, and return on assets.

Figures 4 to 10 at the appendix show the estimated forecast models or equations for total assets, network equipment investment, net profit, total IT spending, total revenue, earnings before interest and tax, and total liabilities over time (time series). Among the available models for forecasting: linear, power, exponential, logarithmic, polynomial, and moving average, the polynomial model was used because it presented the most fitting for all the measures above.

The following are the forecasting models and their coefficient of determination (R^2) for the measures above:

- TA against YEAR: $Y = 4E10^7X^2-2E10^7X+2E10^8$, $R^2 = 0.998$
- NEI against YEAR: $Y = 4E10^7X^2-1E10^8X+3E10^8$, $R^2 = 0.915$
- NP against YEAR: $Y =- 4E10^6X^2+6E10^7X-7E10^7$, $R^2 = 0.986$
- TITS against YEAR: $Y = -8E10^6X^2-4E10^6X-6E10^7$, $R^2 = 0.997$
- TR against YEAR: $Y = 1E10^7X^2+9E10^7X+3E10^7$, $R^2 = 0.997$
- EBIT against YEAR: $Y = 2E10^6X^2+9E10^7X-4E10^7$, $R^2 = 0.993$
- TL against YEAR: $Y = -3E10^7X^2+3E10^6X-2E10^8$, $R^2 = 0.997$

We can therefore estimate forecasts for the above measures for say, year 2012. As an example, we can estimate the forecast for total asset (TA) for 2012 as follows:

- TA at 2012 = $4E10^7 (2012)^2-2E10^7 (2012) +2E10^8 = 1.62E10^{14}$.

Similar estimations can be done for all the measures for 2012. These estimations can be used by the ministry of communications, national communications authority, and other stakeholder bodies to plan strategically for the industry.

CONCLUSION

Comparing this study to past studies, we can say that at the firm level the results are in consonance with the work of Alpar and Kim (1990) who also did not find positive effects of IT investments on performance. Like Strassmann (1985), this study also found no correlation between IT and ROI at the firm level. Generally, at the

firm level, there were positive effects of IT in the form of assets (CA, NCA, NEI, and TA) each on performance (EBIT).

Now, as indicated earlier, total assets are a combination of IT equipment, software, and all other forms of assets of the company. This means that using TA alone to do the analysis does not give the true picture of the situation, even though TA is predominantly IT equipment and software for the mobile telecom industry. NEI which is the true measure of IT investments however, has negative effect on net profit, which is also a true measure of profitability. EBIT too does not present itself as a good measure of profitability. For productivity, fit was found between log EBIT and ROI as dependent variables each and a number of parameters (refer to Tables 2 and 3).

At the industry level however, there were positive effects of IT in the form of IT spending as a percent of revenue on ROA, ROI, ROE, and NPM. There were also positive effects of IT in the form of assets on net profit and EBIT. Even though NEI versus NP and NEI versus EBIT did not yield fit models, their correlation coefficients were strong positively. On the productivity front, fit was found between log EBIT as dependent variable and a number of parameters (refer to Tables 5 and 6).

From the analysis so far it is clear that IT investments alone, being in the form of assets or spending do not guarantee performance in the form of profitability and productivity. Other factors play a major role for these investments to translate into the desired profitability and productivity, especially at the firm level. These factors were discussed into details (the diagrammatical model). The most important part of the diagrammatical model worth mentioning here is the "conversion capabilities" portion which shows a number of factors that affect the conversion of IT investments into performance.

It is also important for management of Mobile Telecom Companies to know that there are other benefits of IT investments apart from profitability that are all needed for the businesses' going concern. These are all captured in the diagrammatical model. Most of the IT investments in the mobile telecom sector benefit customers mostly. It is after a time that the mobile company has been able to satisfy the IT needs of the customer that the customer becomes loyal to the company, and it is at this point that the company begins to realize net profits. The situation is very complex; a mobile company will virtually cease to exist if it does not satisfy the IT needs of its customers. At the same time, this study has shown that IT investments do not necessarily yield profits. This is a quandary situation which forces management to use the trading off concept. Profits are bound to come if customers are satisfied and delighted and eventually pledge their loyalty.

In future I recommend the expansion of this study to all the other sectors of the economy to also see the trend in those sectors. I also recommend that the number of years for the yearly financial statements be increased to get a very good picture of the situation on the ground.

Appendix: List of acronyms and abbreviations:

- GSM- Global System for Mobile Communications
- UMTS- Universal Mobile Telecommunications System
- CA- Current Assets
- CI- Capital Intensity
- CL- Current Liabilities
- DAR- Debt to Asset Ratio
- EBIT- Earnings before Interest and Taxes
- ICT- Information and Communication Technology
- IT- Information Technology
- ITPR- IT spending as a percent of Revenue
- MIS- Management Information Systems
- MTN- Mobile Telecommunications Network
- NCA- Non Current Assets. It also represents National
- Communications Authority elsewhere
- NCL- Non Current Liabilities
- NEI- Network Equipment Investments
- NP- Net Profit
- NPM- Net Profit Margin
- ROA- Return on Assets
- ROE- Return on Equity
- ROI- Return ts
- TITS- Total IT on Investment
- TA- Total AsseSpending
- TL- Total Liabilities
- TR- Total Revenue
- SE- Shareholder's Equity

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