A Business Analysis White Paper

Strategic Feedback and Enterprise Process Performance Using Correlation for Impact Analysis

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The ultimate measure of enterprise performance is in the financial measures that management sets for the enterprise. Understanding what performance variables impact the financial performance and how those variables impact each other, is not a simple task. Determining the degree to which they impact the performance and what execution processes are behind the performance issue requires in-depth analysis.

The point of this paper is to illustrate how measures of process performance impact strategic performance indicators (KPIs) and how to identify these impact relationships. In this paper, seven core steps are provided to assess enterprise performance using impact assessment. Some examples are provided to illustrate the steps with possible deliverables as an analyst might go through them.

Correlation and related quantitative techniques are used to provide a different and unique perspective for understanding the implications of process and sub-process measurement on strategic performance.

Method, measures and tools are used to achieve a cost effective improvement in the way strategic feedback of enterprise performance is managed. To do this rapidly, you first need to understand how variables interact in the enterprise you are analyzing. This is the qualitative step that is used to define the variables and how they relate to each other. The second step is to provide some sort of quantitative tracking of the variables to provide feedback to the management as to the attainment of the strategic objectives. The quantitative technique used to assess attainment of objectives is correlation. The linkage between the correlated values that track from the detail process level to the strategic level financial performance is called a correlation chain.

Any business analyst that deals with enterprise performance management including business intelligence, process analysis and enterprise analysis should be familiar with and use these techniques. The method of correlation analysis (and related regression techniques) can be used to identify those processes that are *contributing to the change* in performance. This provides the enterprise with a focus for identifying poor process (or workflow) performers and fixing them or

identifying potential best practices. But how do you do this? You need to identify the dominant process chain that relates to the performance indicators of interest.

A Typical Example of Enterprise Performance Measures

Let's start with a simple general example. We know that Profits = Revenue – Costs (ignoring the detail and the financial accounting for the moment). We also can see some obvious things such as, if costs go up and revenue remains the same that profits will diminish. What is not so obvious is that if costs go up and profits go up what is happening? This requires a bit more thought and analysis of how the variables interact.

Look at the Profit Analysis chart (Figure 1) that shows the line graphs of profit, cost and revenue. This is what you would normally see in many performance management reports. There are several interesting relationships in this simple chart. There is a time when profit exceeds costs, there are times (periods) when profits are decreasing and revenues are going up (costs are increasing faster) and times when profits track directly with revenue and costs. It is not easy to see the relationship between these variables in this chart. Nor would it be easy to just view the raw data in a table. However, if we just stretch a bit and try using correlation we see some interesting things.

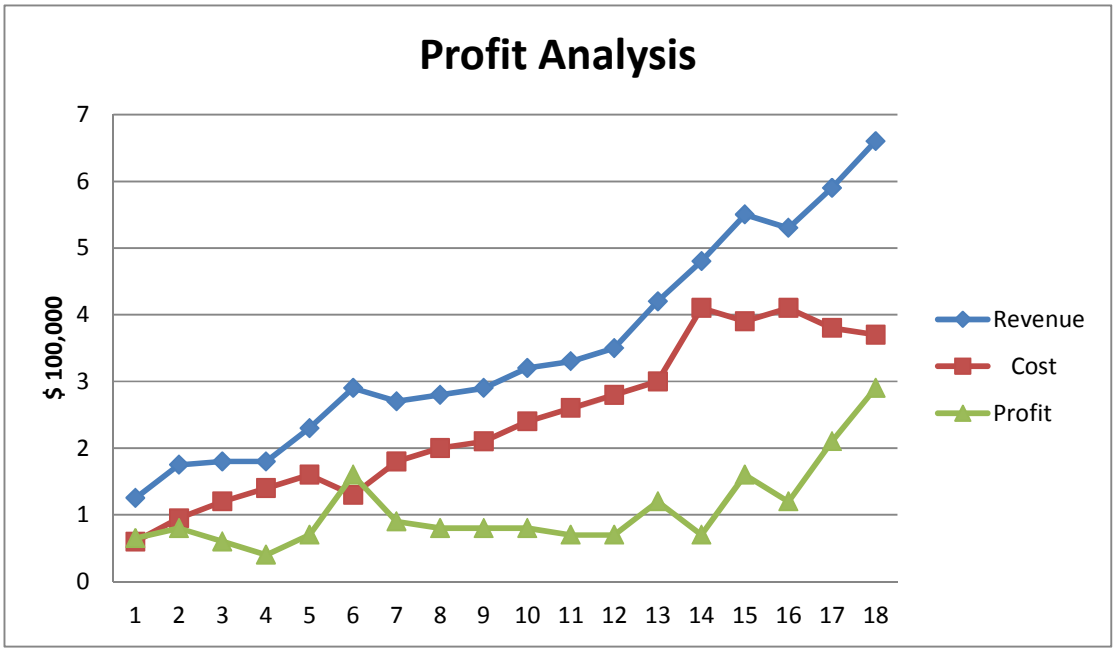

Figure 1

The first step in performance management after identifying relevant variables is to track the variables that we think relate to the measure or measures of interest. In this case for the chart

above, it is profits. Profit, cost and revenue exhibit some degree of correlation in that they will move together if they are truly related in some way. To use this tracking data for estimation and projection, we also need to look at the slope of a line fit to the correlated data - the regression line. This will give some indication of the relationship. For example, if the line is 45 degrees (slope of 1) then the costs and profits move exactly together, either positively or negatively. Each increment move in costs has a matching increment in profits and only looking at a correlation factor may hide what is going on. Also, just looking at profits or costs by themselves may hide what is going on. However, if the slope is greater than 1, then one variable is increasing more than the other. The converse is true if the slope is less than 1. This could be a case of costs squeezing profits or fixed costs diminishing across increased revenue.

Wouldn't it be great if we could use one of these factors to track another? To do that, we need to know which factors relate best to each other. The simple quantitative technique for this is to use correlation. Here is how you might interpret the data using that idea. Understanding that the greater the correlation value, the more the time series track with each other. Let's look at a few correlation values. More will be explained later.

1. Cost and Profit = .525 This is a moderate correlation and most people will focus on cost control as a means of profit generation. While it works, it does not appear to be as good a predictor as Revenue.
2. Revenue and Profit = .783 A better correlation and one that is the most interesting as profits are the bottom line.
3. Revenue and Cost = .941 A very good correlation but does not tell us about the bottom line of profits.

After looking at these values, it may appear that generating revenue would do the most for profits. Of course this was pretty simple and it may be easier to control costs than generate revenue but it gets you to insight quickly.

The Core Steps of Enterprise Performance Management

First, the relationship is established between the strategic measures (e.g. financial) and processes down to the detail level. This is *the qualitative stage* and is done using assumptions that are derived through senior management interviews, past experience, observations, best practices and judgments by those that execute the processes. Values are then gathered for performance, *the quantitative stage* that can be used in a correlation. The values can be business measures or process performance values such as cycle time, wait time, cost, error rate, process cycle efficiency or transport time. Using process measures may provide a stronger cause and effect than pure business measures because process measures and the enablers of the process can be well known. All the factors for the business measure may not be known.

The factors (measures) that drive enterprise financial performance management are linked in some type of structure, usually a tree structure from general to more specific measures.

The point of performance analysis is to drill down the linked correlation factors until you get to a direct process business measure as opposed to internal process performance measures like cycle time and efficiency, etc.

The external measures that relate to the business, such as number of complaints handled per unit time, customer satisfaction with complaint handling and the number of complaints arriving per unit time, are more important as these relate directly to the execution processes of the enterprise.

To identify the linkage between factors you need an approach that makes them explicit. There is a basic enterprise performance management approach to determining the factors needed based on the strategies of the enterprise, the related Key Performance Indicator (KPIs) and the strategic feedback that is quantitative. Here are the core steps of that approach:

1. Create driver diagrams of each KPI that show the variables that impact that KPI
2. Drive the diagram down in detail until you reach the process level (a driver diagram)
3. Track the measures and calculate the correlation between each measure and its parent
4. Identify any parallel or same level correlations (to simplify the analysis)
5. Interpret the correlation values and line fit parameters
6. Draw conclusions from the results
7. Validate the measures structure at least once a year as it may change to reflect changes in KPIs and strategic intent

The driver diagram captures performance measures

In this paper the balanced scorecard idea is used. The four basic branches coming out of the center (Enterprise Performance Management) are associated with the four basic scorecards. Any set of measures (viewed as a scorecard) can be used and organized around any domain of interest for performance management. For example, some enterprises choose to use a scorecard for technology along with the four basic scorecards of the balanced scorecard idea. Other enterprises develop scorecards for major functions of the business such as customer relations or supply chain management or risk measurement.

A simple starter '***Driver Diagram''*** using the balanced scorecard idea with 4 scorecards might look like this:

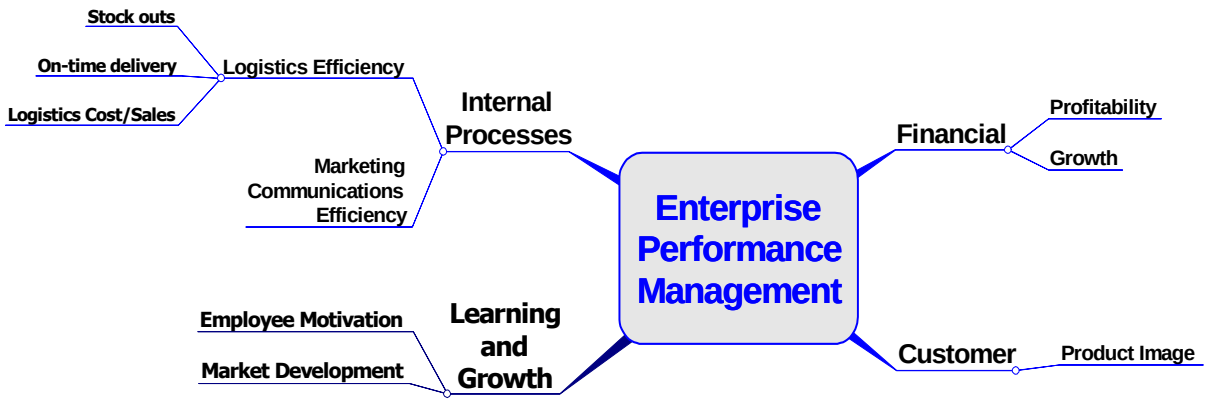

Figure 2

The Enterprise Performance Management dependency diagram shown in Figure 2 can be converted to a strategy map for a balanced scorecard implementation or any other scorecard type implementation used for performance management. An example of the conversion is shown in Figure 3 using the QPR Scorecard[1] Software. Once the key performance indicators are developed, they are decomposed down to their basic or feeder measures. That is, decompose the measures that compose the KPIs down to the lowest level.

In this paper, we are driving down the internal processes scorecard. The measures are driven down each path of the internal processes structure until you hit basic logistics efficiency. In a real situation, there would be many more measures used. Each measure has some strength of relationship with its parent. If we were to look at the processes that make up the logistics efficiency, we would see a process for on time delivery, an inventory process for stock outs, and a process for controlling logistics costs. The goal is to identify if any of these processes are contributing to poor logistics performance and therefore to poor internal process performance (at the enterprise KPI level) and finally to the overall impact on the related scorecards especially the financial scorecard. In order to relate these sets of measures and assess their strength of relationship, we need to know something about correlation and business decision making.

Correlation links measures that move together

Business decisions can be simplified and made a bit more accurate with the use of correlation between two sets of aligned variables. The basis of impact analysis using ideas of strategy maps, process measures performance, business measures performance and correlation is verifying that the assumed dependence indicated by management in a mind map type of diagram is in fact what we can show through statistical correlation of actual data.

[1] QPR Software Plc. (2010, March 29). *QPR ScoreCard 8.* Retrieved March 29, 2010 from www.qpr.com/performance-management.html.

The idea is to find two variables that track together and use one to predict or modify another. Statistical correlation by itself *does not mean cause and effect* but simply that two variables track with each other and might reveal a dependency that is at least statistical and possibly real. If the business objects that have the numerical values of the correlation are related to each other such as in a process hierarchy or a process network flow, then there may be some degree of cause and effect. Analyzing the children (sub-processes of a process) which are part of the hierarchical structure (a tree structure) for correlation with a (process) parent may point to a process that has a strong effect on the parent. In fact, if a Driver Diagram (as previously shown) is used, then the tree structure of measures as they relate to business performance is a start on cause and effect analysis.

For example, stock outs as used in the following example are impacted by supply/demand forecasting and actual types of conditions while process cycle time is process cycle time regardless of demand or supply. In fact, if you have a stock out, the process cycle time will most likely improve as you are not executing the full cycle but aborting when the stock out is detected.

Process improvement opportunities can be identified by analyzing the correlation between processes in the process architecture and doing some simple 'what if' analysis to see if changes in one factor will improve another factor. The method is simple:

Implementing the correlation concept

In this example, we will use a scorecard for a fictitious manufacturing company called Dentorex (provided as part of the QPR[2] product set). While this example is manufacturing based, the correlation concept works in any enterprise (for profit, non-profit, government, educational and so on) as long as you define the measures dependencies (down to through process levels) first and verify with actual process performance results.

The mind map developed to show the measures dependencies (through interviews, observations, workshops and other techniques) like the one above (Figure 2) is converted to a strategy map. The set of strategy maps that result from using a tool (such as QPR Scorecard) would look like the graphic in Figure 3. Adding actual process performance data for a set of time periods such as monthly for one year or one and a half years would provide the basis for correlations providing feedback for the strategic initiatives. These data items are also used for the basic monthly briefing book type reporting expected from any performance management systems.

[2] QPR Software Plc. (2010, March 29). *QPR ProcessGuide 8.* Retrieved March 29, 2010 from www.qpr.com/process-management.html.

There are a number of correlation chains in this simple diagram. Also, some of the chains pass through common points like Product Image. In this view of the business (the business model from a performance perspective), the core or key driver of Profitability and Growth is Product Image. It is clear in the real world; this view will differ from company to company.

We see in Figure 3 above that the quantitative correlation values for the core strategic initiatives are provided on the relationship arrows between measures. The first thing we can see is the correlation chain from both profitability and growth down to logistics efficiency.

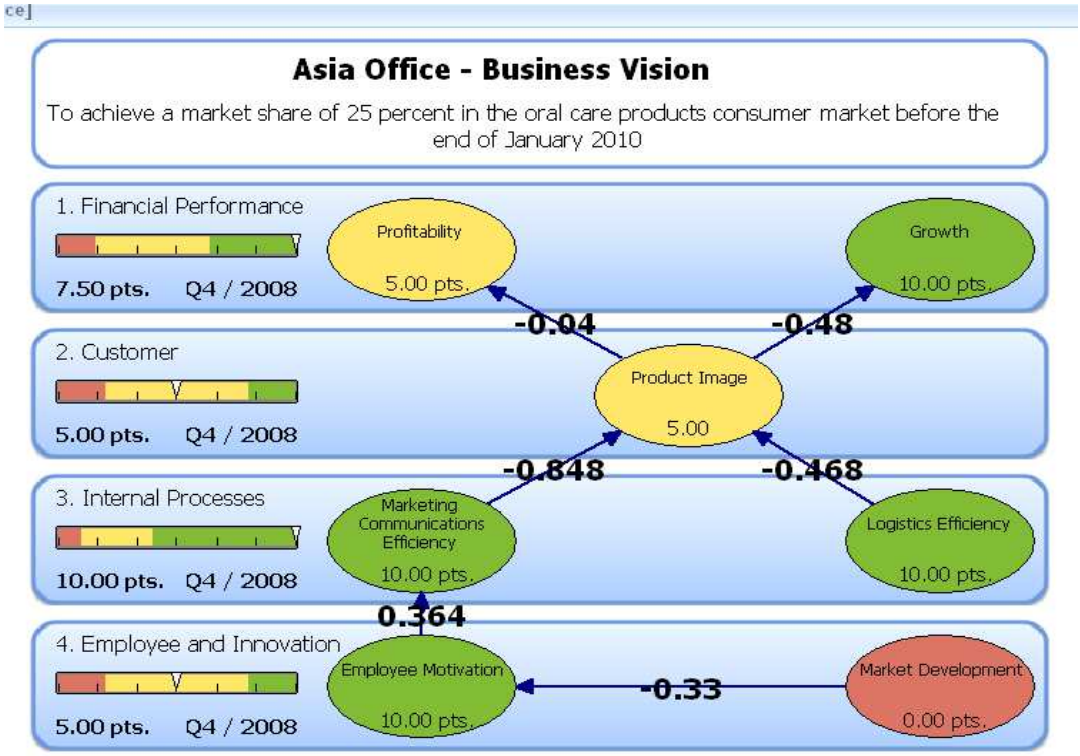

Figure 3

The longest correlation chain is:

1. **Logistics Efficiency** → **Product Image**
2. **Product Image** → **Growth**
3. **Marketing Communications Efficiency** → **Product Image**
4. **Employee Motivation** → **Marketing Communications Efficiency**
5. **Market Development** → **Employee Motivation**

The first thing to do is understand the direction of the correlations in the chain and their impact. How you would read through the chain to determine the impact is as follows starting at the bottom:

1. If Market development goes up,
   Then Employee Motivation goes down (negative correlation)
2. If Employee Motivation goes up,
   Then Marketing Communication Efficiency goes up (positive correlation)
3. If Marketing Communication Efficiency goes up,
   Then Product Image goes down and (negative correlation)
4. If Product Image goes down
   Then Growth goes up (negative correlation)

The conclusion is that to improve Growth and Profitability, your Market Development should decrease. Perhaps there should be more management review of this set of relationships to see how to improve the correlations, that is, make them positive where they should be and negative where they should be. This may imply one of three situations:

1. The initial mind map of the relationship is wrong. The mind map should be fixed before going any further because the management defines the cause and effect. So, at this point you go back to the mind map and review the relationships.
2. The second situation is that the correlations are statistically pointing to a true cause and effect relationship and management misses it. In this case, management needs to understand what the real values are telling them.
3. The data may be incorrect and needs to be reviewed by the process management people.

What would the management expect the correlation directions to be? Here is an example:

1. Market Development goes up and Employee Motivation goes up (positive)
2. Employee Motivation goes up and Marketing Communication Efficiency goes up (again positive)
3. Marketing Communication goes up and Product Image goes up (positive)
4. Product Image goes up and Profits and Growth go up (positive)

So a better result could be achieved if all the correlations in this enterprise performance model are positive.

A brief note is useful regarding correlation chains. If the chain gets very long, you have the same issue with correlation that comes with doing inference analysis (inferencing). Only if the relationships are 100% known and accurate are the chains perfectly valid. When these chains get long and relationships are only 98 or 99% accurate, the linked result gets less reliable. If the

relationship is 98% accurate, a chain of only five links could be only 90% accurate. If the relationship accuracy drops to 95%, then the linked chain is only 77% accurate. This implies that feedback regarding the accuracy and reliability of the model to the real world is very important and necessary to the ultimate success in using link chains.

Looking at the processes that feed logistics efficiency

There are many chains (paths) through the measures tree that pass through the Logistics Efficiency process. Let's review two of those chains, namely:

1. **Logistics Efficiency → Product Image**
2. **Product Image → Profitability**

And

1. **Logistics Efficiency → Product Image**
2. **Product Image → Growth**

There are processes that support Logistics Efficiency and contribute to its performance. So, expand the Logistics Efficiency down to the processes that support it. Make sure that each process has some results over the last 12 to 16 months that can be correlated to Logistics Efficiency. In the Dentorex Scorecard we can look more specifically at the Logistics Efficiency process, expand it and see the correlation values. The correlation chain now includes the basic processes below Logistics Efficiency. The three complete chains eventually displayed now look like this:

Chain 1:

1. **On time delivery → Logistics Efficiency**
2. **Logistics Efficiency → Product Image**
3. **Product Image → Growth**

Chain 2:

1. **Logistics Costs/Sales → Logistics Efficiency**
2. **Logistics Efficiency → Product Image**
3. **Product Image → Growth**

Chain 3:

1. **Stock outs → Logistics Efficiency**
2. **Logistics Efficiency → Product Image**
3. **Product Image → Growth**

So if the following first level reasoning is applied to the correlation chain:

1. On time delivery goes up, then Logistics Efficiency goes up (a reasonable assumption but we need to look at the trend to see the direction of movement)
2. If Logistics Costs/Sales goes up, then Logistics Efficiency goes down (a reasonable assumption and the data confirms this relationship but we need to look at the trend)
3. If Stock outs goes up, Logistics Efficiency goes down (another reasonable assumption the data confirms but again we need to look at the trend)

There is a net effect of these on Logistics Efficiency depending on the strength of the correlations. The strongest correlation is with stock outs so that should be reviewed first.

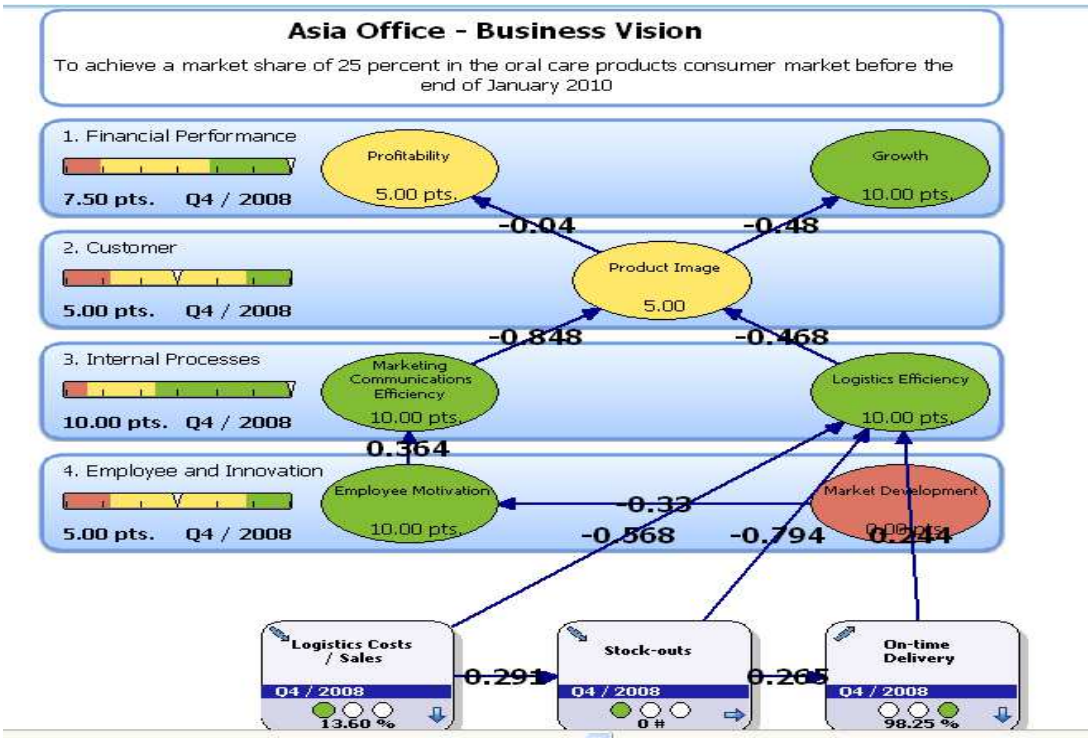

Figure 4

You can also do a correlation with any pair of values such as between stock outs and on time delivery. This is useful if you want to search for high correlations between the feeder processes to see if you can reduce the number of variable you need to track. There is no automatic calculation and ranking of correlations, meaning you have to decide on which correlation between the feeder variables is most useful. This is shown above as correlations between Stock outs and on time delivery and stock outs and logistics costs/sales ratio. Both of these are somewhat weak correlations. Regressions are not shown here but are described in the appendix

along with some interpretation. Regressions are important since they explain the degree of change (magnitude and direction) of the relationship of one performance variable with another.

Business models and the business:

The issue with any modeling approach is that there is a difference between the model and the real world. In this case, we talk about statistical dependency accuracy and dependability which in turn depends on whether the real world is following the same path. A good example is the recent failure of mortgage backed securities models due to a lack of validity and model confirmation. The real world changed and no one rechecked the models.

There are two types of measures that are of interest to the manager and senior executive of any enterprise. You can analyze by driving down or by building up from the detailed or base process measures. These two approaches are described below. In both cases you set up the correlations, test them for validity (do they fit with the management understanding of the relationship), use the model structure for a while to manage the business performance and see how well it works. This is done by the usual method of watching indicators and drilling down when a variance sets off a warning signal. Validate the model periodically even if all indicators look OK. There are three considerations when looking at performance factors.

Consideration 1: Internal process performance factors

The first type of process correlation measure is that which is related to the internal performance of the process. It is the most detailed or base level used in process analysis and is a direct link to the operation of the enterprise. Here is a brief method for eliciting the measures and acting on them. The method assumes you are gathering these measures and can correlate them with their parent process or at least with the business factors.

1. Identify the low correlation factors using the typical process performance factors such as:
    a. Cycle time
    b. Wait time
    c. Transport time
    d. Error rate (quality)
    e. Cost
    f. Process cycle efficiency
    g. Throughput
2. See if a change in the process performance will improve the parent process
3. Make process changes in the factor that is most sensitive
4. Verify the changes had the desired impact
5. Recheck the measure and relationship periodically

Consideration II: External or business performance factors

The business performance factors are those that are external to the process. The method is similar to the above but now you are focused on the external process measures that relate to actual business performance.

1. Identify the low correlation factors using the business measures for the process. For example, in the logistics efficiency they are:
    a. Stock outs
    b. Logistics costs/sales
    c. On time delivery
2. Make adjustments in the data values and project potential performance (a simulation for example)
3. If the numbers work, then drill down to locate the contributing processes and adjust the base process performance.
4. Add factors that may be outside of the enterprise, such as supply and demand measures:
    a. Include product demand and inventory as part of supply chain.
    b. These would be factored in to get a more accurate picture of performance. The expected impact of these two might be:
        i. If demand goes up, logistics efficiency might go down
        ii. If supply goes up, logistics efficiency may go up also
    c. These hypotheses must be tested with real data before decisions are used to manage the business.

Developing the structure of business measures is an iterative effort as part of overall enterprise performance management. Even after the structure is developed, it must be validated periodically as the business conditions could change.

Consideration III: The correlation analysis itself

For the math weary let's distinguish between three ideas: scatter plot, correlation, and regression[3] before we interpret any results.

Scatter plot

A scatter plot displays the form, direction, and strength of the relationship between two variables. Straight-line (linear) relationships are particularly important because a straight line is a simple pattern that is quite common.

[3] Moore, David S., McCabe, George P. (2003). *Introduction to the Practice of Statistics* (4th Ed.) (pp.164-168). New York: W.H. Freeman and Company.

Correlation:

Correlation is a measure of the direction and strength of the linear (straight-line) relationship between two quantitative variables (x and y). If a scatter plot shows a linear relationship, we would like to summarize this overall pattern by drawing a line on the scatter plot. So, correlation is used to express the power of one variable (x) to predict another (y). So in correlation you get a bunch of dots in some sort of cluster. Correlation can have a value between -1 and +1. A value of 1 means perfect prediction that is, given a variable (x); you can precisely predict another variable (y) on a straight-line (linear manner).

Note: In the correlation and regression examples shown in this paper, you can clearly change the model values and therefore the results by just selecting different time series periods. You might choose the most recent 12 months or the most recent 24 months. Choosing a short time period like the previous 12 months emphasizes the most recent performance results. If you look at a series of time periods such as 12, 18, 24 and 30 months, you can determine if the correlation is getting stronger (larger) or weaker (smaller) over time and needs interpretation. It could be that the variables are truly drifting apart and different feeder variable(s) need to be identified.

Regression:

Regression is a straight line that describes how a response variable (y) changes as an explanatory variable (x) changes. We often use a regression line to predict the value of (y) for a given value of (x). Regression, unlike correlation, requires that we have an explanatory variable and a response variable.

Other Considerations:

As part of doing this type of analysis, you should be aware of the impact of other factors. An example is the effect of hidden variables. A hidden variable is one that was not identified originally in the initial analysis but influences one of the variables you are looking at. Basically it means the original measures tree is incomplete and you are not getting a true picture.

Another consideration deals with making sure the cause and effect condition is real, that is, has business meaning not just statistical meaning. An association that is due to causation is best established by a ‘what if’ experiment that changes the explanatory variable while controlling other influences on the response. The ‘what if’ scenario should help establish if the variable is or is not tracking and if it should be included in the performance model. In the absence of experimental evidence, be cautious in accepting claims of causation. Good evidence of causation requires a strong business association that appears consistently in many studies, a clear explanation for the alleged causal link, and careful examination for any possible hidden variables.

Summary Interpretation of the correlation factors in the example

1. If stock outs go up, logistic efficiency goes down (strong correlation because it has a relatively high value -.794). You really want to watch/manage stock outs as they seem to have significant correlation. Using continuous improvement of this process is a must.

2. If logistics cost/sales ratio increases (costs going up relative to sales) then efficiency goes down (moderate correlation because its value is about the mid-point on a scale of one (1) -.568). You might look at the logistics cost factors via the feeder processes (what drives logistics costs) in a further drill down to see if any stand out as an opportunity for improvement.

3. If on time delivery goes up then logistics efficiency goes up. (However it is very weak because its value is about 1/4 on a scale of one (1) - .244 so this factor does not seem to correlate much to efficiency). Maybe this should be a stronger factor (more weight for example) in the calculation of logistics efficiency.

   Again here you would drill down if possible to the feeder factors to 'on time delivery'. In this case it may be useful to apply some lead and lag analysis to see if the time series would line up if their time periods are re-aligned. This is done before any process changes are made. You do not want to make changes that will decrease process performance. If there is no alignment by lead and lag analysis, then the goal is to see if there are any feeder processes that can be improved to increase the on time delivery or at least get it to track with the logistics efficiency.

All three of these measures and their related correlation factors make sense. However, as can be seen by adding demand/supply to the measures tree, they may not be a complete representation of the logistics efficiency drivers. Identification of a representative set of drivers can only be done through a workshop type effort with the enterprise that is using the measures. A measures structure is a model of the real world and hence may not perfectly represent what is going on. The point is to get as close as possible and to validate periodically to make sure the measures and their relationships are still useful.

You can also look at the correlation between the factors that feed logistics efficiency to see if any move together. They have very weak correlation meaning that you can't look at them in pairs or assume a multiplier factor or anything like that. They seem to move separately with no one factor being very strong with respect to the other.

There is no expectation that they would track. It is just another possibility for management attention or simplification of performance management by having to watch fewer variables. It is a 'given'. We know that the data is probably made up but at least it looks reasonable.

Conclusions

Examining the correlations provides you with an insight that may challenge your business assumptions. A key part of the analysis effort is the interpretation of the results. An analyst must bridge information collected out of any performance tools used to support strategic as well as operational decision-making. Therefore, the decisions and related alternatives related to strategic objectives and their possible outcomes must also be identified early on.

After the correlation analysis, what is known at this point is that we have identified and verified (validated) that certain Process performance variables in the execution of the business that move with certain other variables. From a business analysis point of view, we know that these variables have a cause and effect relationship. The cause and effect starts with the initial assumptions of the relationships and ends with the actual verification from capturing and correlating real data. If the performance is not satisfactory, then some form of remediation must take place.

What remediation an enterprise takes must be identified early so that reaction is quick when measures are unacceptable. The form of enterprise performance analysis described here helps to simplify and speed up management's assessment and conclusions about enterprise performance. It also brings understanding about the impact process relationships have on performance as seen through KPIs on the overall strategic performance of the enterprise.

Making enterprise performance analysis simpler and having the correct enterprise performance management tools helps to identify, collect, monitor and interpret data about fundamental strategic impact relationships that exist in an enterprise. With tools and methods, the business analyst can evaluate a larger number of factors that impact strategic direction. Not only that, but the analyst can do this in much less time than by other means.

Appendix: A short explanation of regression as used in this paper

Knowing the amount of benefit you get from a change in process performance would be really useful. This is especially true if you are relating the investment needed to achieve that benefit. So knowing and validating the relationship through correlation is one part of the analysis. Estimating the degree of improvement is another. The question to be answered is how much change is there in the dependent variable that happens when we change the independent variable. In the example used in this paper it means; if we change the stock outs, what amount of change can we expect in the logistics efficiency? The degree of improvement can be estimated by looking at the equation of the best fit line and doing a bit of 'What If' analysis with the values.

The examples below show you the correlations and regressions of Logistics Efficiency with the stock outs, logistic cost/sales ratio and on-time delivery. You notice that these graphically show different conditions for the best fit line. In each graph you have the following:

- The correlation factor
- The equation of the line with the slope,
- The intercept plus the square of the correlation coefficient which tells you the proportion of the variation in y (the dependent variable) that is explained by the regression line.

If you use the slope and the R^2 value together you get an estimate of the amount benefit from one unit of change in the independent variable (logistics efficiency) and the proportion of that change that is explained by the line.

In the graphs below, the Logistics Efficiency is the y axis (dependent variable) and the feeders are the x axis (independent variable). In the case of correlation it makes no difference for us which is the dependent variable and which is independent as you will get the same value either way. Also the R squared value is the same since it is based (just the square of the value) on the correlation factor. Of course there are upper limits to how much you can improve something and this has to be kept in mind when considering change.

As you can see from the regression line in the first two graphs, reversing the dependent and independent variables gives a different equation of the line. So always choose the parent process as the y axis (the dependent variable) and the feeder process as the x axis or independent variable.

In the Cost/Sales Impact on Logistics Efficiency graph below Figure 5, the logistics efficiency is correctly used as the dependent variable.

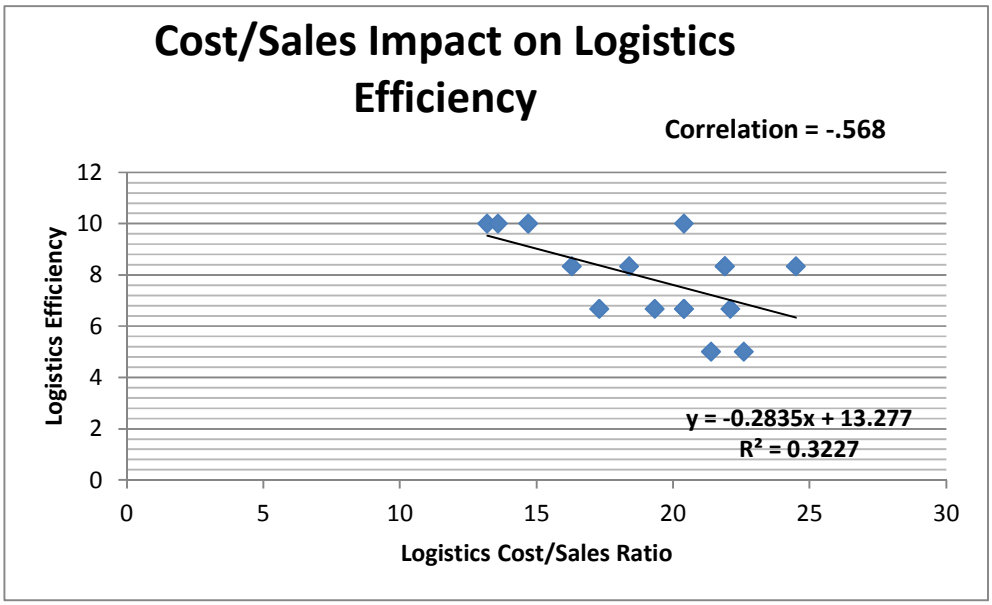

Figure 5

The .568 correlation is mild and if you use the R^2 value (.323), it is even weaker. The slope of the line is negative which means these values move opposite to each other. The .2835 slope value means that, when the X axis moves 1 increment, the Y axis increases by .28. It takes a big change (e.g. 3.52 increments) in the cost/sales ratio to have a one increment change in the logistics efficiency. The leverage value of cost/sales is not very big. So, if you want to improve the logistics efficiency using the cost/sales ratio, you might have more work to do that than using one of the other factors.

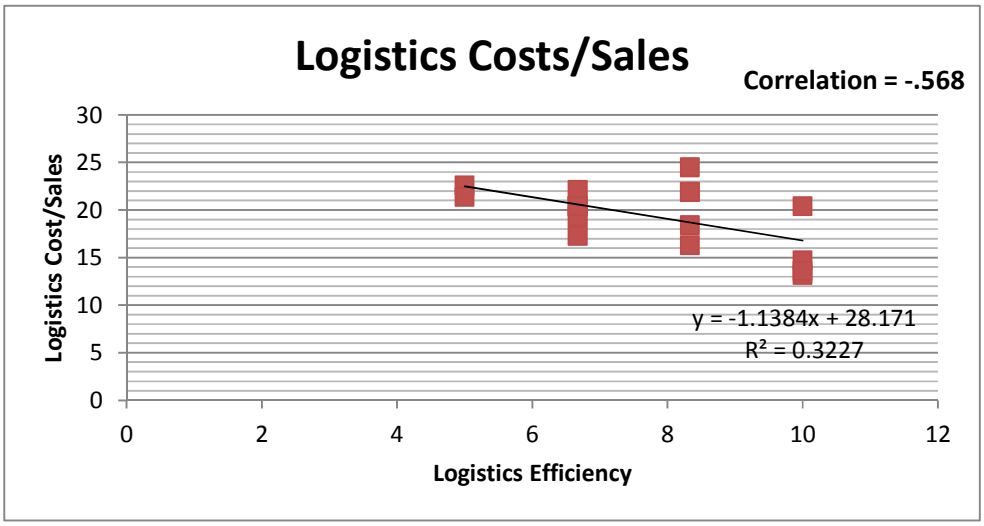

Figure 6

The Logistics Costs/Sales graph in Figure 6 shows the difference in what happens when choosing the dependent variable. In the Cost/Sales Impact on Logistics Efficiency (Figure 5) graph, the parent (Logistics Cost/Sales Ratio) was the dependent variable. In Figure 7, the child (Logistics efficiency) is the dependent variable. If you look a the slope of the line you see a reverse of the last graph, that is, the logistics cost/sales moves 1.14 increments up to each 1 increment move of logistics efficiency which in this case is the independent variable. It means a small decrease change in logistics efficiency will cause a slightly larger change increase change in cost/sales. Of course, this is not practical since in the 'real world' the efficiency does not drive the cost/sales ratio.

The next two graphs show similar understanding of the other two factors that are understood to drive the logistics efficiency. The Stock out Impact on Logistics Efficiency (Figure 7) graph shows for every increment of movement in the stock outs there is a .66 increment movement in logistics efficiency. The interesting insight of this graph is that the correlation is negative meaning that when stock outs go down logistics efficiency goes up (a hoped for expected result from a business perspective) and further that the increment movement is amplified by .66 units. Looking at the equation you can see this:

For x = 5 then y = 6.03

For x = 4 then y = 6.69

So when stock outs go down logistics efficiency goes up. This is twice as good as the cost/sales leverage.

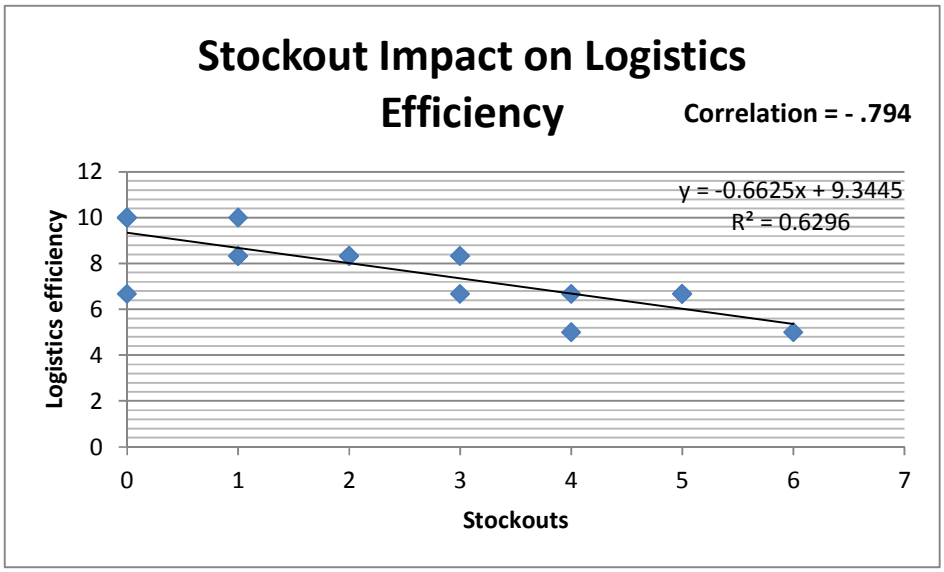

Figure 7

Finally, we come to on time delivery as the third and final factor in determining the logistics efficiency. There is a positive correlation here but it is quite weak.

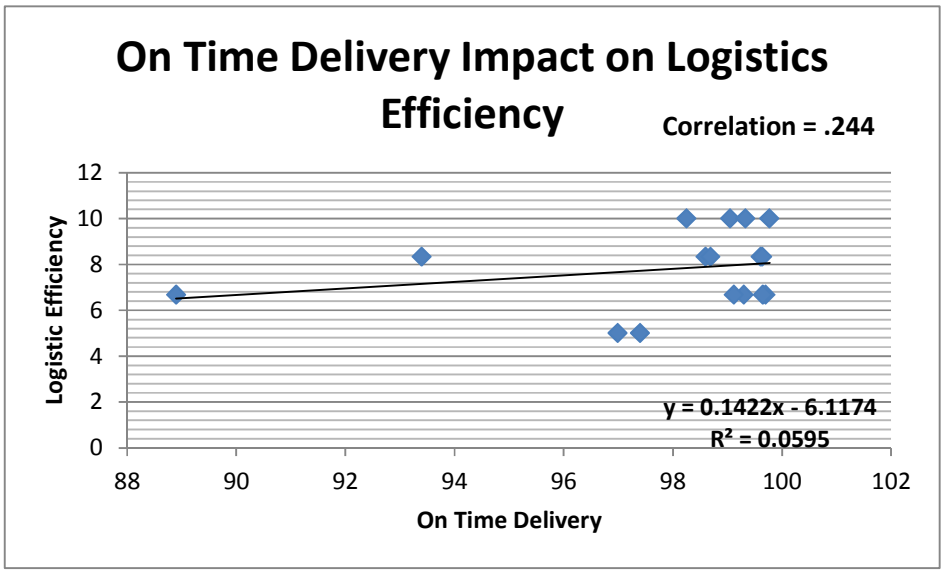

Figure 8

In fact for each 1 point move in the on time delivery (a move of one percentage point), there is only a .142 move in logistics efficiency. And, it may be difficult to improve on time delivery.

Putting this all together we see that the focus of process improvement here might be executed according to the following order:

1. Stock outs
2. Cost/sales
3. On time delivery

The end result is a ranking showing which process is the most likely to contribute the most to improving logistics efficiency. You get the most value from improving the stock outs if possible followed by cost/sales and followed by on time delivery. Of course, at this point you need to look at how much each increment change of improvement costs that gets you the result you want. [Optional sentence] Of course, at this point you need to decide on what result you want and look at how much it will cost you to achieve it (your improvement costs). Further, the cost might be relative implying that all the costs could be high, they might all be low some could be low and other high and so on. So relative means with respect to each other.

A visual way to see your choices can be observed using a 4 – box that relates the degree of change with the cost of change. The box would look like this:

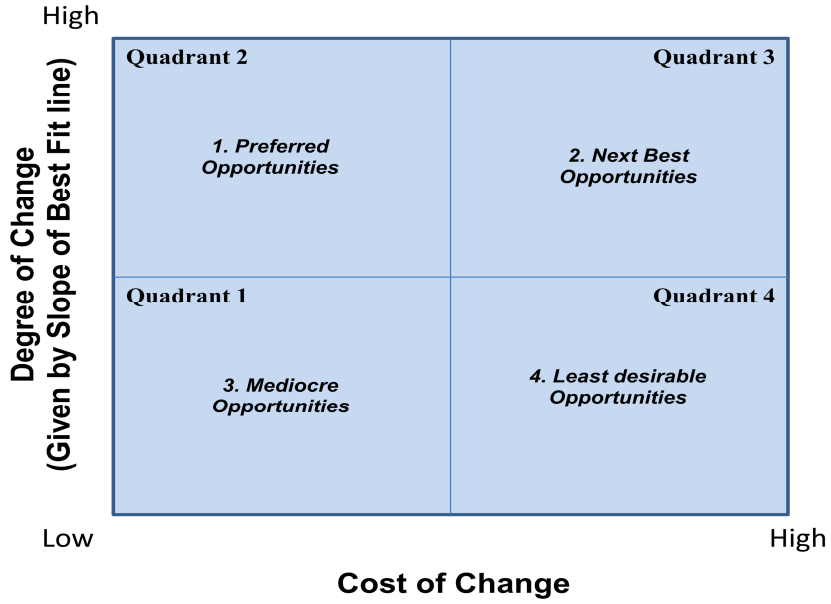

Figure 9

Here is an interpretation of the four quadrants in rank order of opportunity:

1. Clearly the best opportunities are in Quadrant 2 as this represents a large degree of change for a relatively low cost. This is the low hanging fruit.
2. The next best opportunities are in Quadrant 3. Even though the cost of change is relatively high, the change is also high.
3. The next best opportunity is in Quadrant 1. Both change and cost are low so the risk is small and the result probably will not attract much attention. This is a good place to train staff.
4. The final quadrant, Quadrant 4 is the one to stay away from as the cost is high and the change is relatively low.

Any business analyst that deals with enterprise performance management can use this seven step procedure using correlations to provide measures that point to very cost effective business execution performance improvements. Understanding the interpretation of the quantitative values for techniques like regression and correlation is a key skill the analyst uses to see and utilize strategic feedback of enterprise performance in a managed way.