# STRUCTURAL EQUATION MODELLING OF PRODUCTIVITY ENHANCEMENT

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## Abstract

**Productivity has often been cited as a key factor in industrial performance, and actions to increase it are said to improve profitability and the wage earning capacity of employees. Improving productivity is seen as a key issue for survival and success in the long term. This paper focuses on examining key factors of productivity enhancement, and investigating the causal relationships among those key factors to better understand and plan for productivity improvement. The results prove 5 key productivity factors, including 'leadership', 'strategic quality planning', 'people', 'data and information', and 'process management', leading to a conceptual model. 'Leadership' is found to be the main driver to productivity enhancement. The strong commitment of a leader is thus crucial in improving productivity. 'Leadership' strongly influences 'strategic quality planning' and 'process management', and indirectly influences 'people' through 'data and information' and 'strategic quality planning'. 'People' also plays a key role in the success of productivity enhancement. Additionally, there are direct and indirect relationships between 'data and information' and 'people' and between 'data and information' and 'process management', respectively.**

**Keywords: Exploratory factor analysis, productivity enhancement, structural equation modelling**

## Introduction

### Productivity

Productivity is one of the most common measures of an organization's competitiveness. It has often been cited as a key factor in industrial performance, and actions to increase it are said to improve profitability and the wage earning capacity of employees (Cosmetatos and Eilon, 1983). The concept of productivity, generally defined as the relation between output and input, has been available for over 2 centuries and applied in many different circumstances on various levels of aggregation in the economic system (Jorgenson and Griliches, 1967). However, there is no common agreement over the understanding and definition

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of the productivity concept. Some of productivity's definitions are as follows:

- Productivity is the ratio of output to input for a specific production situation. Rising productivity implies either more output is produced with the same amount of inputs, or that fewer inputs are required to produce the same level of output (Rogers, 1998; Russell and Taylor, 2009).
- Productivity is the belief in human progress. It is a state of mind which aims at perpetual improvement. It is a ceaseless effort to apply new technology and new methods for the welfare and happiness of mankind. It is the training of the minds and the development of attitudes of the people as a whole which determines whether the nation will realize high productivity and an affluent life or low productivity and poverty (Asian Productivity Organization, 2006).
- Productivity is a measure of the amount of output per unit of input. For example, productivity in the auto industry might be measured by the number of hours of labour used per automobile produced (Heizer and Render, 2008; Investopedia, 2008).
- Productivity is a process of continuous improvement in the production/supply of quality output/service through efficient, effective use of inputs, with emphasis on teamwork for the betterment of all (Trade Unionists, 2008).
- Productivity is an attitude that seeks the continuous improvement of what exists. It is a conviction that one can do better today than yesterday, and that tomorrow will be better than today. Furthermore, it requires constant efforts to adapt economic activities to ever-changing conditions, and the application of new theories and new methods. It is a firm belief in the progress of humanity (European Productivity Agency, 2008).
- Productivity is the amount of work (in terms of goods produced or services rendered) produced during a period of time (usually per hour). Productivity analyses technical processes and engineering relationships such as, how much of an output that can be produced in a specified period of time (Knowledgerush, 2008).

From the above definitions, this research study defines productivity as "the ratio of outputs to inputs, and that, to improve this ratio, continuous improvement must be performed in the organizations". It is argued that productivity is one of the basic variables governing economic production activities, perhaps the most important one (Kilic and Okumus, 2005). Improving productivity is seen as a key issue for survival and success in the long term. To enhance productivity, the organization may either consider reducing inputs while keeping outputs constant, or increasing outputs while keeping inputs constant (Kilic and Okumus, 2005). In an economic sense, inputs are labour, capital, and management, which are integrated into a production system (Heizer and Render, 2008). Outputs, on the other hand, are goods and services (Heizer and Render, 2008). Measurement of productivity is an excellent way to evaluate a country's ability to provide an improving standard of living for its people. Only through increases in productivity can the standard of living improve.

## Productivity in Thai Food Industry

Recently, productivity has received growing attention, both in the manufacturing and service industries. Herron and Braiden (2006), for example, developed a model, based on a wide range of manufacturing efficiency improvements such as just-in-time and lean manufacturing tools, to direct and generate productivity improvement in a group of manufacturing companies. Kilic and Okumus (2005) investigated the factors influencing productivity in hotels in Northern Cyprus and found that factors such staff recruitment, staff training, meeting guest expectations, and service quality are the main factors in improving productivity. NPC (2003) attempted to establish networking and identify benchmarks and best practices through different industries, such as the textile industry, chemical industry, and food industry, in order to improve productivity and waste management. It was found that factors such as information technology, innovation, and training help improve productivity, and thus enhance the company's competitiveness.

Attention has also been paid to improving productivity in the food industry in Thailand, as food is considered one of the important economic sectors, constituting 14 percent of the country's total exports, and generating employment for 20 million people (Thailand Board of Investment, 2005). For example, Betagro Group, one of the biggest food manufacturing companies in Thailand adopted a number of quality management tools, such as Six Sigma and Kaizen, in planning for a productivity improvement program (Thailand Productivity Institute, 2006). By implementing such a program, the company can reduce waste and rework, minimize the work-in-process inventory, lessen transportation costs, and eliminate idle time, thus increasing productivity (Thailand Productivity Institute, 2006).

The above illustrations demonstrate that productivity is one of the most vital factors affecting a manufacturing company's competitiveness. However, researchers argue that productivity is often regarded as second rank, and neglected or ignored by those who influence the production process (Tangen, 2002). A major reason for this could be that there is no standard tool for assessing and measuring productivity. Increasing productivity requires that attention be paid to using and manipulating numerous factors, which is often a challenging task (Poetscheke, 1995). Moreover, neither the interactions among key factors influencing productivity, nor the consequences of productivity initiatives being undertaken is focused. This research study, therefore, aims at examining key factors of productivity enhancement. The Statistical Package for Social Sciences (SPSS) program version 15.0 is used to ensure data consistency, and to allow the results to be meaningfully interpreted. A number of data screening and preliminary analyses, including the normality test, the outliers test, and the reliability test, are performed. The screened data will then be further analysed using more complex analyses, including the exploratory factor analysis and structural equation modelling, to investigate the causal relationships among key productivity factors, so that the companies are able to better understand as well as plan for productivity enhancement.

## Productivity Attributes

Productivity is considered as one of the basic variables governing economic production activities (Tangen, 2002). At the same time, productivity is also seen as one of the most vital factors affecting a manufacturing company's competitiveness. According to Tangen (2002), the organization can either consider one of the followings to increase productivity levels:

- Increase output and input, but the increase in input is proportionally less than the increase in output
- Increase output while keeping input constant
- Increase output while reducing input
- Keep output constant while decreasing input
- Decrease output and input but the decrease in input is proportionally more than the decrease in output

There are a number of attributes that can be used to represent productivity. These attributes are carefully selected, with reference to the frequency of citations in recent manufacturing-related, including the food industry, literature. Each attribute is described in detail below.

1. *Financial incentive*: Millea and Fuess (2005) claimed that money can be used to motivate workers, which in turn, tends to increase productivity.

2. *Training: According* to Black and Lynch (1996) and Hoffman and Mehra (1999), a successful organization always ensures that its staff is properly trained, so that they can carry out various activities effectively.

3. *Work pressure*: High work pressures are caused by distress, unworkable schedule times, and workforce instability (high turnover) (Siu *et al.*, 2004). These, in turn, lead

to decreased productivity (Black and Lynch, 1996).

4. *Personal recognition*: Productivity improvement requires highly committed and motivated employees. Personal recognition, through trust support, acknowledgement, and empowerment, is the key to attaining commitment (Allender, 1984). Workers with good records should be recognized and rewarded (Marsidi, 2009).

5. *Workers' attitude*: Beck (2009) stated that an important key to high productivity and effective leadership is to have and maintain a positive attitude. A negative attitude leads to absenteeism, high turnover, unnecessary conflicts, and many other counter-productive problems (Marsidi, 2009).

6. *Teamwork*: Very strong teamwork is a tool to improve management and organizational productivity (Asian Productivity Organization, 2007). The world-class organizations see the need to embrace teams and teamwork for competitive advantage and productivity improvement.

7. *Knowledge background*: Kilic and Okumus (2005) stated that the knowledge background of the employees affects their working performance. Employees with a lack of knowledge show signs of problems in productivity programs (Barocci and Wever, 1982).

8. *Workers' experience*: Lubbe (2000) claimed that productivity can be enhanced by using experienced, professional workers. Kilic and Okumus (2005) agreed that workers with higher experience perform better in the job.

9. *Workers' recruitment*: Asian Productivity Organization (2007) stated that the manager's role of hiring and offering a position can affect the productivity and profitability of the entire enterprise.

10. *Leader's support*: Job satisfaction, productivity and organizational commitment are affected by leadership behaviours (Loke, 2001). Lack of management support leads to poor productivity (Savery, 1998).

11. *Job allocation*: Bell (1988) stated that people should be assigned to the tasks for which they are best suited. Proper job allocations in work schedules help an organization reduce its total labour cost, enhance the flexibility of its operations, and improve worker productivity (Peter *et al.*, 2007).

12. *Feedback*: Pritchard (1995) concluded that feedback plays a major role in creating the productivity improvement. Productivity in an organization, where feedback is given, is higher than that in organizations where no feedback is given.

13. *Safe workplace*: According to Thailand Productivity Institute (2008b) and Sales Creators (2009), good housekeeping and orderly plant operations create a pleasant working environment, which, in turn, leads to increased productivity.

14. *Supervision*: According to Bell (1988), poor supervision should be avoided in order to reduce the possibility of decreased workers' motivation, high turnover, and lowered productivity.

15. *Equipment effectiveness*: Good maintenance programs help in reducing the idle time, increasing the machine effectiveness, and perhaps enhancing the productivity (Thailand Productivity Institute, 2008c).

16. *Inventory management*: According to Thailand Productivity Institute (2008a), the storage cost can be reduced with good inventory documentations (e.g. daily check sheets, storage plan, and products records).

17. *Performance appraisal*: According to Dessler (2005) and Thailand Productivity Institute (2008b), performance appraisal should be employed to motivate workers.

18. *Job description*: Clear job description assists new employees in performing tasks correctly and effectively (Thailand Productivity Institute, 2008b).

19. *Operational audit*: Batra *et al.* (2009) identified that operational audit is an effective way for enhancing the productivity and minimizing energy consumption. It has been observed and proven that production levels can be improved and energy consumption can be reduced through the audit.

20. *Information technology investment*: Swierczek and Shrestha (2003) noted that

productivity improvement can be achieved through information technology use, as it increases outputs and decreases costs. It also increases the organization's competitiveness through differentiation and customer service improvement, reduced costs, better risk avoidance, and maintaining the stability of the customer base and market share.

21. *Service quality*: An organization strives to achieve better service quality in order to satisfy its customers (Haynes and Duvall, 1992).

22. *Customer satisfaction*: Lubbe (2000) proposed that service productivity can be increased by becoming more effective (by increased customer satisfaction) or more efficient (less resource use to deliver service).

23. *Two-way communication*: Relgolook (2009) stated that effective communication has become the order of the day for any individual or a business entity. Hoffman and Mehra (1999) highlighted that 2-way communication should be encouraged in the organization, as poor communication can lead to productivity failures.

24. *Top management commitment*: Hoffman and Mehra (1999) stated that lack of top management commitment and involvement is the major obstacle in successfully implementing a productivity improvement project.

25. *Advertisement and marketing*: According to Kilic and Okumus (2005), good advertising and sales support plan have a positive influence on productivity.

26. *Total quality management*: The use of total quality management in the organization helps in increasing productivity (Thailand Productivity Institute, 2008b).

27. *Benchmarking system*: According to Hussain (2008), a benchmarking system should be encouraged in order to improve productivity.

## Questionnaire Survey and Data Collection

The above 27 productivity-related attributes are used in the questionnaire survey development. A written questionnaire is self-administered, and can be sent through the traditional mail system or by email. It is important that a mail survey be clearly written and self-explanatory because no one will be available to answer questions regarding the survey, once it has been mailed out. Questionnaire surveys have several advantages, for example, they generally have less sampling bias (a tendency for one group to be overrepresented in a sample) than personal interviews. They also allow the researcher to collect data on more sensitive information. Participants, who may be unwilling to discuss personal information with someone face-to-face, may be willing to answer such questions in a written survey. This method is usually less expensive and can cover a large geographical area. Further, the participants can take as much time as they need to answer the questions without feeling the pressure of someone waiting for the answers. However, the major problems concern the low response rate, and the misinterpretation of the questions (McBurney, 1994).

The questionnaire survey comprises 3 parts. The first part is devoted to gathering demographical information about the respondents and their respective organizations (such as position, name of the organization, years of experience, and job title) to ensure that the respondents have the appropriate backgrounds. It is useful in identifying discrepancies in the received responses. The second part covers 27 statements to operationally define productivity enhancement. Each statement is designed to elicit the respondents' opinions on the different attributes in the context of productivity enhancement using a 5-point Likert scale, with point 1 representing 'strongly disagree' and point 5 representing 'strongly agree'. This approach enables the evaluation of the organization's perception of, and commitment towards, each construct to be carried out. Lastly, the third part asks for suggestions. An example of a questionnaire survey is illustrated in Appendix 1.

The intention of this research was to study the food industry sector in Thailand. Medium to large organizations, with staff of 100 or more, located in Bangkok and nearby provinces were selected for the sampling. Targeted respondents were both management and working positions to gain diverse opinions on productivity improvement. Four hundred and sixty eight questionnaires were distributed, with 372 responses representing a response rate of 79.49%. From the returned responses, 17 questionnaires were deemed unusable, due to data incompleteness, and were subsequently dropped from the data set. As a result, 355 usable questionnaires provide data for the analyses.

Among the respondents, 56.06% are workers, while 43.94% are in management positions, including managers, head officers, and directors/owners. Apart from that, more than 50% of the respondents have more than 5 years working experience both in the present organization and in the Thai food industry. This indicates the reasonably high work experience rate of the respondents.

**Data Screening and Preliminary Analyses**

After the data is collected, a number of data examination techniques, ranging from the simple process of visual inspection of graphical displays to statistical methods are conducted. Thus, statistical methods of the handling of missing data, the normality test, the outliers test, and the reliability test needed to be performed to increase confidence in the data. Each statistical method is described in detail below.

**Test of Normality**

The screening of continuous variables for normality is an important early step in almost every multivariate analysis (Tabachnick and Fidell, 2007). Although the normality of the variables is not always required for an analysis, the solution is usually more appropriate if the variables are all normally distributed. For this reason, the normality of the variables is assessed by either statistical or graphical methods.

Two important components of normality are skewness and kurtosis (Tabachnick and Fidell, 2007). Skewness relates to the symmetry of the distribution; a skewed variable is a variable whose mean is not in the centre of the distribution. Kurtosis, on the other hand, relates to the peakedness of a distribution; a distribution is either too peaked (with short, thick tails), or too flat (with long, thin tails). When a distribution is normal, the values of skewness and kurtosis are zero (Pallant, 2005). If there is a positive skewness, there is a pileup of cases to the left, and the right tail is too long; with negative skewness, the result is reversed. Kurtosis values above zero indicate a distribution that is too peaked, while kurtosis values below zero are reversed. Non-normal kurtosis produces an underestimate of the variance of a variable. According to Curran et al. (1996), the values of skewness $< \pm 2$ and kurtosis $< \pm 7$ are considered acceptable.

The 355 data are performed with the normality test, and the results demonstrate the normal distribution, with all the skewness and kurtosis values in the limited ranges. This, thus increases confidence in the data collected.

**Outliers Test**

An outlier is a case with such an extreme value on one variable (a univariate outlier), or such a strange combination of scores on two or more variables (multivariate outlier), that distorts the statistical results (Tabachnick and Fidell, 2007). There are many ways to test for outliers, such as the use of the 5% trimmed mean, the use of standardized scores (z-scores), and the use of boxplots (Pallant, 2005; Tabachnick and Fidell, 2007). In this study, the mean, the 5% trimmed mean, and the z-score tests are used to detect outliers.

The 5% trimmed mean is a mean calculated from the cases in which 5% of the top and the bottom of the cases are removed (Pallant, 2005). According to Pallant (2005), the big difference ($> 0.2$) between a mean and its 5% trimmed mean may indicate a problem with an outlier. The results show that the mean differences ($\Delta$mean) of all 27 attributes are small, providing support for the absence of outliers.

To further detect outliers, a standardized score (z-score) test is performed. According to Tabachnick and Fidell (2007), the cases with z-scores that exceed ± 3.29, at $p < 0.01$, two-tailed test, are the potential outliers. The results show that there are 63 z-scores exceeding ± 3.29, in which most are from questionnaire survey number '98', '198', and '248'. As a result, these three cases are deleted from the data file, leading to a total of 352 data retained for further analyses.

## Exploratory Factor Analysis

In this research study, 2 statistical analyses are performed, including the exploratory factor analysis (EFA) and the structural equation modelling (SEM). The exploratory factor analysis (EFA) method is often used in the early stages of data analysis to gather information about interrelationships among a set of variables. According to Seo *et al.* (2004), the EFA is a precursor to the SEM. When conducting an EFA, three main steps are followed: 1) the assessment of the suitability of the data; 2) the factor extraction; and 3) the factor rotation (Pallant, 2005). The details of each step are described below.

### Assessment of the Suitability of the Data for the Analysis

Two main issues facilitate the determination of whether a particular data set is suitable for factor analysis. The first issue is the sample size. Tabachnick and Fidell (2007) noted that it is comforting to have at least 300 cases for factor analysis. However, they conceded that a smaller sample size (e.g. 150 cases) should be sufficient, if the solutions have several high loading marker variables (above 0.80). Pallant (2005), on the other hand, recommended that five cases for each item are adequate in most cases. Coakes and Steed (2003) took a stance in between, arguing that a sample of 100 cases is acceptable, with a sample of 200 or more cases being preferable. A total of (usable) 352 cases (with case numbers '98', '198', and '248' deleted) are considered acceptable for the analysis in this study.

The second issue concerns the strength of the inter-correlations among the items. Bartlett's test of sphericity and the Kaiser-Meyer-Olkin (KMO) test are normally applied to assess the factorability of the data (Pallant, 2005). Bartlett's test of sphericity should be significant ($p < 0.05$) for factor analysis to be considered appropriate, while the KMO index should range from zero to one, with 0.6 suggested as the minimum value for a good factor analysis (Tabachnick and Fidell, 2007). In this study, Bartlett's test of sphericity is significant ($p = 0.00$), with the KMO index being 0.87 (higher than a minimum of 0.60), thus indicating that the data is suitable for factor analysis.

### Factor Extraction

Factor extraction, the second step in conducting the EFA, involves determining the smallest number of factors that can be used to best represent the interrelations among the set of variables (Tabachnick and Fidell, 2007). There are a variety of approaches that can be used to extract (or identify) the number of underlying factors. Some of the most commonly available extraction techniques are principal components, principal axis factoring, and general least square (Pallant, 2005).

According to Coakes and Steed (2003), the most frequently used techniques are principal components and principal axis factoring. Principal components analysis is, however, normally used when the researcher is interested in discovering which variables in the set form coherent subsets that are relatively independent of one another. Variables that are correlated with one another but largely independent of other subsets of variables are combined into factors (Tabachnick and Fidell, 2007). For this reason, the principal components method is chosen for the analysis.

### Factor Rotation and Interpretation

After the extraction, factor rotation is ordinarily used to present the pattern of loadings in a manner that is easy to interpret.

Numerous methods of factor rotation are available, but the most commonly used is 'varimax' (Coakes and Steed, 2003; Pallant, 2005). Varimax is a variance maximizing procedure. The goal of varimax rotation is to maximize the variance of factor loadings by making high loadings higher, and low loadings lower, for each factor (Tabachnick and Fidell, 2007). The varimax method is used for the factor analysis in this study.

In summary, the principal component method, together with the varimax rotation method, are used to examine the dimensionality of the 27 attributes of productivity enhancement, and to achieve better interpretation of the factor loadings. Due to the sample size (352 data set), a cut-off factor loading of 0.40 is used to screen out the attributes that are weak indicators of the constructs, as suggested by Hair *et al*. (1998). The first run leads to dropping of the 'feedback' attribute as it fails to make the cut-off loading. Consequently, performing the next factor analysis extracts the remaining 26 attributes into 5 factors, accounting for 52.04% of the total variance, as shown in Table 1.

Factor 1 is accounted for by 10 items, measuring mainly process management. For example, Thailand Productivity Institute (2008b) mentioned that good housekeeping and orderly plant operations create a pleasant working environment. They also suggested that the storage costs can be reduced with good inventory documentations (e.g. daily check sheets, storage plan, and products records). Pupat (2009), on the other hand, stated that a clear job description, with a clear outline of duties and responsibilities, helps in reducing the rework process, and making the screening process as direct and focused as possible. Peter *et al*. (2007) also concluded that proper job allocations in work schedules help an organization reduce its total labour cost, enhance the flexibility of its operations, and improve worker productivity. As a result, Factor 1 is called the *'process management'* (PRO) factor. Factor 2 is explained by 5 items, initially measuring leadership. Blazey (2008), for example, explained that leaders should demonstrate a strong commitment to improving productivity by focusing more on customer satisfaction. This can be achieved through, for instance, leaders developing an effective system to understand customer requirements, strengthening loyalty and customer relationships, and resolving customer problems immediately. This factor is, therefore, named the *'leadership'* (LEA) factor.

Factor 3 is accounted for by 3 items, measuring strategic quality planning; as stated in Thailand Productivity Institute (2008b) and Hussain (2008) an effective quality plan and benchmarking system help increase productivity. This factor is, therefore, labelled the *'strategic quality planning'* (STR) factor. Factor 4 is explained by 5 items, initially measuring people, and, therefore, called the *'people'* (PEO) factor. This is confirmed by Allender (1984) who mentioned that productivity improvement requires highly committed and motivated employees. Trust, support, acknowledgement, and empowerment are the keys to workers' commitment. Lastly, Factor 5 is represented by 3 items, measuring mainly workers' data and information, and is hence called the *'data and information'* (DAT) factor.

To increase confidence in the construct validity, the 5 factors extracted are tested for internal consistency (Cronbach's alpha, $\alpha$). Sharma (1996) stated that the alpha values ranging from 0.6 to 0.7 are regarded as sufficient, and the value higher than 0.7 is regarded as good in reliability testing. The results, shown in Table 2, have alpha values ranging from 0.60 to 0.85, all of which are considered acceptable. This thus increases confidence in the contribution of the 26 attributes to the measurement of their respective constructs.

**Table 1. Five factors extracted from the 26 attributes**

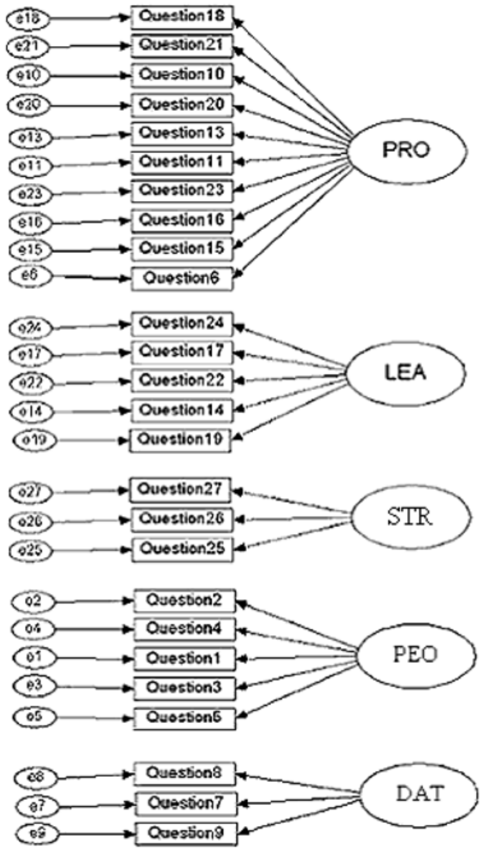
| Attribute no. | Attribute | Factor extracted | | | | |
|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 |
| 18 | Job description | 0.66 | | | | |
| 21 | Service quality | 0.65 | | | | |
| 10 | Leader's support | 0.64 | | | | |
| 20 | Information technology investment | 0.61 | | | | |
| 13 | Safe workplace | 0.60 | | | | |
| 11 | Job allocation | 0.59 | | | | |
| 23 | Two-way communication | 0.59 | | | | |
| 16 | Inventory documentations | 0.59 | | | | |
| 15 | Equipment effectiveness | 0.55 | | | | |
| 6 | Teamwork | 0.45 | | | | |
| 24 | Top management commitment | | 0.67 | | | |
| 17 | Performance appraisal | | 0.63 | | | |
| 22 | Customer satisfaction | | 0.59 | | | |
| 14 | Supervisor | | 0.57 | | | |
| 19 | Operational audit | | 0.49 | | | |
| 27 | Benchmarking system | | | 0.79 | | |
| 26 | Total quality management | | | 0.79 | | |
| 25 | Advertisement and marketing | | | 0.58 | | |
| 2 | Training | | | | 0.71 | |
| 4 | Personal recognition | | | | 0.60 | |
| 1 | Financial incentive | | | | 0.54 | |
| 3 | Work pressure | | | | 0.53 | |
| 5 | Workers' attitude | | | | 0.52 | |
| 8 | Workers' experience | | | | | 0.76 |
| 7 | Workers' recruitment | | | | | 0.64 |
| 9 | Knowledge background | | | | | 0.61 |

*Extraction method: principal component analysis. Rotation method: varimax with Kaiser Normalization. Rotation converged in 14 iterations.*

**Productivity Enhancement Model Development**

The EFA gives rise to a total of 26 attributes grouped to explain 5 latent factors, leading to the so-called conceptual model of productivity enhancement, as shown in Figure 1. The ovals and rectangles, shown in the baseline model, symbolise latent and observed variables, respectively. The former represent the 6 constructs of the baseline model, whereas the latter represent their respective attributes. The arrows connecting the 2 sets of variables indicate the direction of the hypothesized influence. For example, it is hypothesized that 'process management' is manifested by the achievement of its 10 attributes: Questions 18, 21, 10, 20, 13, 11, 23, 16, 15, and 6; the arrows are thus shown originating from 'process management' to each one of the 10 attributes.

By investigating the conceptual model, it is found that its constructs match with the 5 major categories of the Malcolm Baldrige National Quality Award (MBNQA) Framework. The MBNQA Framework is one of the widely used quality models, and is used to promote quality awareness and thus improve the competitiveness of the companies (Pannirselvam and Ferguson, 2001). The framework consists of 7 categories (leadership, information and analysis, strategic quality planning, human resources development and management, management of process quality, quality and operational results, and customer focus and satisfaction) grouped into 4 basic elements




Note:
PRO = processes management, LEA = leadership, STR = strategic quality planning, PEO = people, DAT = data and information

**Figure 1. Conceptual model of productivity enhancement**

**Table 2. Internal consistency of the five productivity factors**

| Factor | Cronbach's Alpha (α) |
|---|---|
| Process management | 0.85 |
| Leadership | 0.69 |
| Strategic quality planning | 0.81 |
| People | 0.67 |
| Data and information | 0.60 |

(driver, system, measures of progress, and goals). Lee and Quazi (2001), however, grouped the 'measurement of progress' and 'goals' elements into 1 single group called 'results', as it is expected that the better implement of the 'driver' and 'system' elements helps achieve better 'results' (see Figure 2).

The 5 productivity factors achieved from the EFA can be matched with the 5 categories of the MBNQA Framework within the 'driver' and 'system' elements i.e. the 'leadership' factor matches with the 'leadership' category, the 'data and information' factor matches with the 'information and analysis' category, the 'strategic quality planning' factor matches with the 'strategic planning' category, the 'people' factor matches with the 'human resources development and management' category, and the 'process management' factor matches with the 'process management' category. As stated earlier, the implementation of the 'driver' and 'system' elements helps achieve better 'results', thus, the focus of this study is on the improvement of the 5 key factors in order to achieve higher productivity.

## Structural Equation Modelling

Theoretically, SEM comprises 2 types of models: measurement and structural models. The former is concerned with how well the observed variables measure the latent factors, addressing their reliability and validity. The latter is concerned with modelling the relationships between the latent factors, by describing the amount of explained and unexplained variance, which is akin to the system of simultaneous regression models (Wong and Cheung, 2005).

### Measurement Model

Testing the structural model would have been meaningless until it was established as a good measurement model. In this study, a confirmatory factor analysis is undertaken to establish confidence in the measurement model. According to Byrne (2001), the measurement model should be assessed by 4 methods, including the feasibility of parameter estimates, the appropriateness of standard errors, the statistical significance of parameter estimates, and the model fit as a whole (using goodness of fit, GOF, indices).

The most widely used GOF indices are he chi square to the degrees of freedom ($\chi^2$DF), the root mean square error of approx imation (RMSEA), the comparative fit index (CFI), the incremental fit index (IFI), and the Tucker-Lewis index (TLI) (Byrne, 2001; Garson, 2006; Tabachnick and Fidell, 2007).

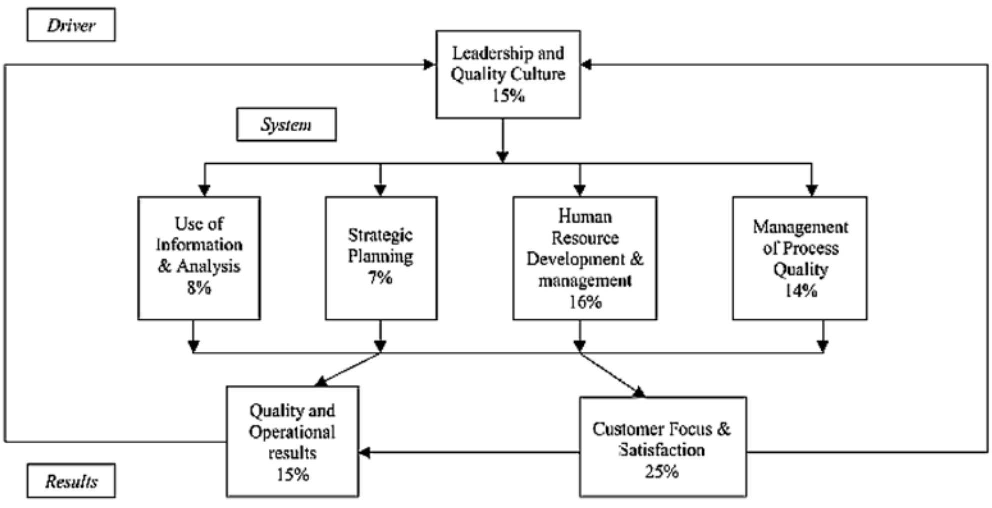
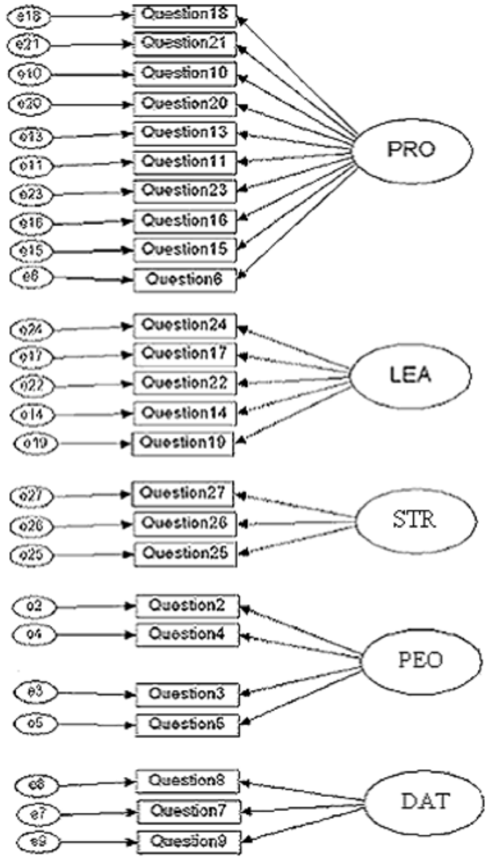



**Figure 2. Seven categories of the MBNQA Framework (Lee and Quazi, 2001)**

Normally, the value of $\chi^2$/DF less than 2 represents the model as a good fit; however, the value of less than 3 is acceptable (Garson, 2006). The value of RMSEA up to 0.05 indicates a good model fit, with a value up to 0.10 indicating a reasonable error of approximation (Tabachnick and Fidell, 2007). Kline (2005) suggested that the CFI, IFI, and TLI values should be at least 0.90 to indicate a model fit. Garson (2006), however, used the cut-off value of 0.80 as the criterion.

The basic productivity model is tested with SEM, and the GOF indices reveal a need to modify the model in order to improve the model fit (see Table 3). According to Kline (2005), there are potentially 2 possible options involved in the process of model refinement. The first option is to eliminate the links or 'paths' with very low correlations. This option is found not to be applicable to the conceptual model due to the high correlations of all paths. The second option is to remove the observed variables shown by the computed modification indices as having multicollinearity (e.g. the observed variables/their error variances that correlated to more than 2 other observed variables/error variances). As a result, the 'financial incentive' attribute shows signs of high multicollinearity, and thus is removed, leading to the best-fit measurement model with the best GOF indices, as shown in Table 3 and Figure 3, respectively. Table 3 highlights the significant improvement of the GOF indices' values compared to those obtained for the conceptual model.




Note:
PRO = processes management, LEA = leadership, STR = strategic quality planning, PEO = people, DAT = data and information

**Figure 3. The best-fit measurement model**

**Table 3. The GOF indices of the basic and the best-fit measurement models**

| GOF index | Recommended level | Conceptual model | Best-Fit measurement Model |
|---|---|---|---|
| $\chi^2$/DF | < 2.00 (Byrne, 2001) | 2.60 | 1.98 |
| RMSEA | ≤ 0.05 (Tabachnick and Fidell, 2007) | 0.07 | 0.05 |
| CFI | > 0.90 (Kline, 2005) | 0.83 | 0.91 |
| IFI | > 0.90 (Garson, 2006) | 0.84 | 0.91 |
| TLI | > 0.90 (Kline, 2005) | 0.81 | 0.90 |

*The Conceptual model is shown in Figure 1, while the best-fit measurement model is shown in Figure 3.*

**Structural Model**

Having established confidence in the measurement model, a structural equation model is developed and tested to examine the direction of the relationships between the 5 constructs, and to improve the overall model fit. Wilson and Collier (2000) introduced the casual relationships of the 5 constructs of the MBNQA Framework, as shown in Figure 4. A number of model runs are, then, carried out in this study to verify these relationships. Any links with very low correlations, or items showing signs of multicollinearity, are deleted. For each run, the GOF indices are computed and compared. According to Clissold (2004), the model with the best fit would prove the directional influences.

The SEM results show that the causal link between 'data and information' and 'strategic quality planning' has a negative covariance. Moreover, the causal relationship between 'data and information' and 'process management' is very weak. These 2 links are, therefore, removed, leading to the fitted structural model (shown in Figure 5), with the best GOF indices (listed in Table 4).

The final productivity model is, then, achieved (Figure 6). It is clear that 'leadership' is the main driver to productivity enhancement, and the strong commitment of the leader is crucial in improving productivity.

As previously mentioned, the value of SEM lies in its ability to depict both direct and indirect effects between the variables. In light of this, the final productivity model appears to indicate that 'leadership' strongly influences 'strategic quality planning' (path coefficient = 0.64) and 'process management' (path coefficient = 0.60). This is supported by Dayan and Bedenetto (2008) who concluded that comments given by and to leaders help encouraging 2-way communication as well as creating better teamwork. Leaders should also motivate the search for new ideas

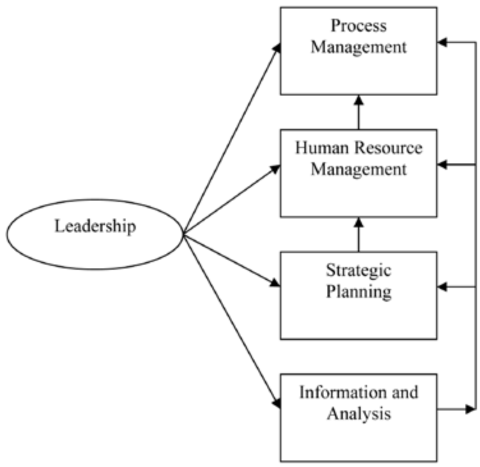



**Figure 4. The causal relationships of the five constructs of the MBNQA Framework (Adapted from Wilson and Collier, 2000)**

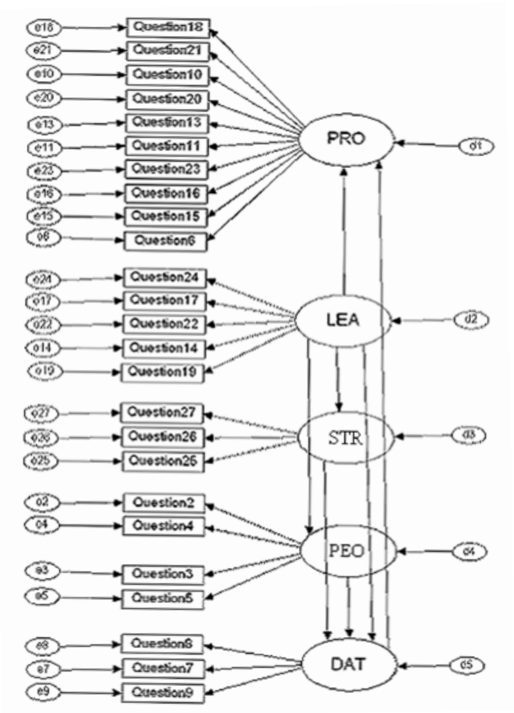
**Table 4. The GOF indices of the best-fit structural model**

| GOF Index | Recommended Level | Best-Fit Measurement Model | Best-fit Structural Model |
|---|---|---|---|
| $\chi^2$/DF | < 2.00 (Byrne, 2001) | 1.98 | 1.87 |
| RMSEA | ≤ 0.10 (Tabachnick and Fidell, 2007) | 0.05 | 0.05 |
| CFI | > 0.90 (Kline, 2005) | 0.91 | 0.92 |
| IFI | > 0.80 (Garson, 2006) | 0.91 | 0.92 |
| TLI | > 0.90 (Kline, 2005) | 0.90 | 0.90 |

*The best-fit measurement model is shown in Figure 3, and the best-fit structural model is shown in Figure 5.*

of productivity enhancement by means of benchmarking, as well as seeking out the best practices for productivity improvement (Hussain, 2008).

'Leadership', however, bears no statistically significant relationship with 'people' (path coefficient = 0.14). The relatively strong influences 'data and information' and 'strategic quality planning' have on 'people' (path coefficients of 0.36 and 0.22, respectively) suggest that 'leadership' indirectly influences 'people' through these 2 constructs. Swierczek and Shrestha (2003), for example, stated that to improve productivity, leaders should provide workers with adequate resources, including information technology resources. At the same time, the workers should receive proper training on how to use those information technology tools, so that they can carry out various activities effectively (Black and Lynch, 1996; Hoffman and Mehra, 1999). This, in turn, leads to positive attitude, resulting in lower turnover, lower absenteeism, and improved productivity (Marsidi, 2009).




Note:
PRO = processes management, LEA = leadership, STR = strategic quality planning, PEO = people, DAT = data and information

**Figure 5. The best-fit structural model**

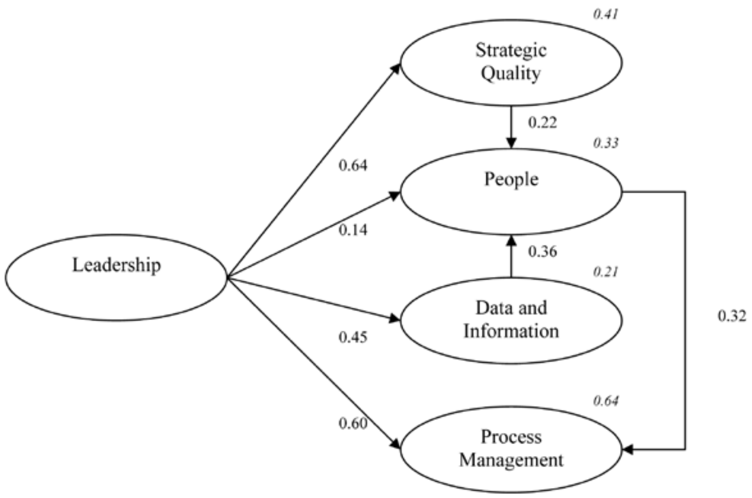
'People' plays a key role in the success of productivity enhancement, as seen by the direct link from 'people' to 'process management'. Productivity improvement requires highly committed and motivated employees. Personal recognition, workers' perceptions of work pressure, workers' empowerment, and workers' attitude towards productivity improvement are important keys in improving productivity (Allender, 1984; Siu *et al.*, 2004; Beck, 2009). Negative attitudes may lead to high errors, lack of team spirit, and low productivity (Umiker, 1998).

The results also show that 'data and information' has no relationship with 'strategic quality planning'. Also, no statistically significant relationship is found between 'data and information' and 'process management', indicating the absence of a direct effect. An indirect effect exists, though, through 'people'. It is worth noting that the variance for 'process management' is 0.64, demonstrating that 64% of the variance associated with this particular factor is accounted for by 'people'. In other words, 'people' explains (or influences) 64% of the variance in 'process management'. For instance, Bell (1988) stated that workers should be assigned to the tasks for which they are best suited, as it helps the organization in, reducing lead time, cost, inventory, and improving labour productivity (Ryurik Management Solutions, 2009). A summary of the direct and indirect path coefficients is shown in Table 5.

## Conclusions

The basic productivity model, as a result of the exploratory factor analysis, is developed based on the MBNQA Framework. The 5 key productivity factors, including 'leadership' 'strategic quality planning', 'people', 'data and information', and 'process management', are tested with the structural equation modeling to empirically validate the causal relationships among them. The results improve the understanding of the interrelationships and determine where the organization should focus in order to achieve higher productivity.

'Leadership' is found to be the main driver to productivity enhancement. The strong commitment of the leader is, thus, crucial in improving productivity. In this study, it is found that 'leadership' strongly influences 'strategic quality planning' and 'process management'. Leaders, therefore, should help to encourage 2-way communication, create good teamwork, motivate the search for new ideas of productivity enhancement by means of benchmarking, and seek out the best practices for productivity improvement. 'Leadership' also indirectly influences 'people' through 'data and information' and 'strategic quality planning'. Leaders should thus provide workers with adequate resources, including information technology resources. At the same time, the workers should receive proper training on how to use those information




Note:
All path coefficients are significant at 0.05 probability level. The italised numbers show variance values R2 (R-square) of the factors.

**Figure 6. The final productivity model**

**Table 5. The direct and indirect path coefficients between the five productivity factors**

| Factor | Correlation Coefficient |
|---|---|
| Strategic quality planning | (0.64*LEA) |
| People | (0.14*LEA)+(0.22*STR)+(0.36*DAT)+(0.14*LEA*STR)+(0.16* LEA* DAT) |
| Data and information | (0.45*LEA) |
| Process management | (0.60*LEA)+(0.32*PEO)+(0.12*DAT*PEO) |

*All path coefficients are significant at 0.05 probability level. PRO = processes management, LEA = leadership, DAT = data and information, STR = strategic quality planning, PEO = people* technology tools, so that they can carry out various activities effectively.

'People' is also found playing a key role in the success of productivity enhancement. Personal recognition, workers' perceptions of work pressure, workers' empowerment, and workers' attitude towards productivity improvement are important keys in improving productivity. Negative attitudes may lead to high errors, lack of team spirit, and low productivity. Additionally, 'data and information' should ease the process implementation performed by workers, as direct and indirect relationships exist between 'data and information' and 'people' and between 'data and information' and 'process management', respectively.

The 5 key productivity factors, as well as their causal relationships, can be used as a guideline for an organization in planning for its productivity enhancement. The results can also be used as an empirical basis for comparison in future research.

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