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Production lot sizing and optimal numbers of cycles considering rework and reject situations and price dependent demand

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Abstract

The economic production quantity (EPQ) is a widely used inventory model. While most of the researches has been reported to explore the traditional optimal batch quantity in ideal cases, little appears to have been done with rework option In this paper products are classified in the four groups of perfect products, imperfect products, defective but reworkable products, and finally, non-reworkable defective products. The proportion of each type is assumed to be constant and deterministic. The objective of this paper is to determine the lot size and optimal number of cycles with rework and reject situations and price dependent demand in a single-stage system in which rework is done after *N* cycles causing less than the desired quantity of good products in each cycle. The model has been validated with illustrating numerical example and a sensitivity analysis is carried out to study how the optimal number of cycles is affected due to the changes of defective rates and selling price.

1- Introduction

A difficult situation most manufacturing organizations encounter concerns the difficulties associated with production planning and inventory control. Included among the problems to be dealt with are deciding on raw materials lead time and quantity, adopting the proper type of inventory control model, determining storage capacities, and planning for timely and economical delivery of orders. The EOQ model has been commonly used in inventory control systems to determine order quantity. The model has been extended to Economic Production Quantity (EPQ) by considering a constant production rate. In classical models it is assumed that all parameters are fixed and known. Furthermore the production of imperfect or defective products is a natural expectation and it will be more realistic to consider different levels of quality. Also it would be more practicable to consider the demand as selling price dependent, as high selling price generally makes a negative impact on a major part of the customers to buy the product. Therefore, in this paper demand is considered to be inversely related to the selling price.

The classical EPQ model has been in use for a long time. It is a well-established and

widely used technique in inventory management [1]. In recent decades, researchers have tried to determine the optimal batch quantity of imperfect production systems considering different operating conditions. A brief discussion of these works follows:
Gupta and Chakraborty [4] considered the reworking of rejected items. Furthermore they considered recycling from the last stage to the first stage and obtained an economic batch quantity model. Schwaller [11] presented a procedure that extends EOQ model by adding the assumptions that a known proportion of defectives existed in arriving lots and that fixed and variable inspection costs were required in seeking and eliminating the defectives. Hayek and Salameh [5] assumed that all of the defective items produced were repairable and obtained an optimal point for EPQ model under the consideration of reworking of imperfect quality items. Chan et al. [3] provided a framework to integrate lower pricing, rework and reject situations into a single EPQ model. They found that the time factor of when to sell the imperfect items is critical, as this decision would affect the inventory cost and the lot size. Jamal et al. [8] considered a single production system with rework options including two cases of rework process to minimize the total system cost. In the first case, they suppose that the rework executed within the same cycle and the same stage of production. In the second case, the defective items are collected up to N cycles to be then reworked in the next cycle. He assumed that all defective products could be reworked. Ben-Daya et al. [2] assumed integrated inventory inspection models with and without replacement of nonconforming items discovered during inspection. Inspection policies include no inspection, sampling inspection, and 100% inspection. They suggested a solution procedure for determining the operating policies for inventory and inspection consisting of order quantity, sample size, and acceptance number. Hejazi et al [6] developed a model to determine the economic production quantity with reduced pricing, rework and reject situations in a single-stage system in which rework takes place in each cycle after processing to minimize total system costs. Recently Jaber et al. [7] uses the concept of entropy cost to extend the classical EOQ model under the considerations of perfect and imperfect quality products.
In this paper we extend the previous work by Jamal et al [8] under the considerations of four groups of perfect products, imperfect products, defective but reworkable products, and finally, non-reworkable defective products. Furthermore we consider that the demand rate is unit selling price dependent. Hence the objective of this paper is to determine the lot size and optimal number of cycles with rework and reject situations and price dependent demand in a single-stage system in which rework is done after N cycles causing less than the desired quantity of good products in each cycle.
This paper is organized along the following lines: Problem definition, notations and

assumptions used throughout this study are presented in Section 2. In Section 3, the mathematical models are derived in order to minimize the total cost per unit time. The various costs of the inventory system considered here include setup, in- process inventory and finished goods inventory products and penalty cost. In process inventory consist of good quality and defective products. In this section, the optimal solution to the problem is also introduced. Numerical example is provided in Section 4 to show the implementation of the proposed model. Sensitivity analysis is presented in section 5 and In Section 6, some conclusions and recommendations for possible future work are presented.

2- Problem Definition

Consider the classical EPQ model and suppose that a process produces a single product in a batch size of Q. Producing these items takes place at a finite production rate, P units per unit time. Each lot produced contains γ percent of imperfect quality items. The perfect and imperfect products are kept in stock when identified. The lot also contains a percentage of defectives, β, so that these defective products can be reprocessed, or reworked, after N cycles. These products are held in defective products basket. These products are assumed to be of good quality after reprocessing. This is a realistic assumption since the item re-entering a machine will be processed with greater care. Thus, the reworked products will need no inspection. Each lot produced also contains a percentage of defectives, α, so that these units are rejected with an associated cost when identified (See Fig. 1). In other words, a defective product that cannot be reworked is rejected immediately after its work operation completes.

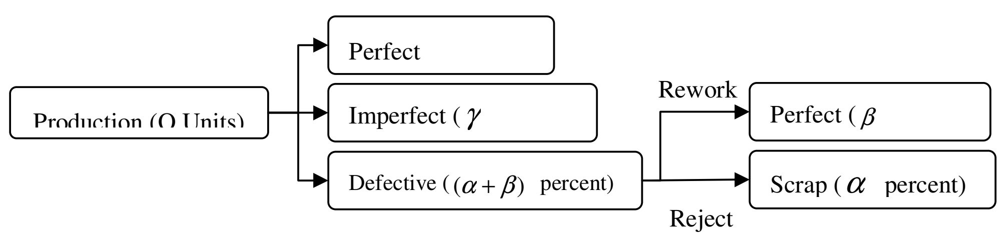

Figure1. A schematic diagram of the model.

Inspection of each product follows immediately after the process is completed. Since inspection operations can normally be carried out concurrently with the manufacturing process and independent of any machine work, the assumption here, as elsewhere, is that no time is taken by the inspection process beyond the manufacturing time. Good quality products transfer to warehouse.

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The main objective of the present study is to minimize the total system cost of the inventory system. Below are the notations used and assumptions made:

2.1. Notations

k_s	Setup cost ($/year)
k_w	Unit in-process holding cost ($/unit/year)
k_p	Unit penalty cost per unit outage per unit time ($/unit/year)
H	Inventory Carrying cost ($/unit/year)
PR	Selling price ($/unit)
N	Number of production cycles after which the defective items are reworked
P	Production rate (units/unit time)
D	Demand rate (units/unit time)
t_s	Setup time (year/ setup)
Q	Lot size or order quantity (product units)
α	Percentage of reject products
β	Percentage of rework products
γ	Percentage of imperfect quality products
$\bar{I}$	Mean finished products inventory (product units)
C_s	Setup costs of each batch
C_w	Holding cost of defective materials ($/cycle)
C_H	Inventory costs per unit of time ($/cycle)
C_p	Penalty cost ($/cycle)
TC	Total costs per unit of time (unit of money per unit of time)

2.2. Assumptions made

- No Shortage is allowed.
- The demand rate is unit selling price dependent i.e.,

$$D = aPR^{-b} \qquad b > 1. \tag{1}$$

This function is similar to the function considered by Sadjadi et al [10] and Panda and Maiti [9], but we suppose that the price is constant in each cycle.

- Proportions of defective products are constant in each cycle.
- No defective product is produced during the rework.
- The processing and reprocessing are accomplished using the same resources at the same speed.

- No stop is allowed during the manufacturing operations of one lot.
- All parameters including production and demand rates, setup time, etc. are constant and deterministic.
- The number of cycles is a continuous number.

3- Modeling

Figure (2) presents the behavior of inventory level during one cycle.

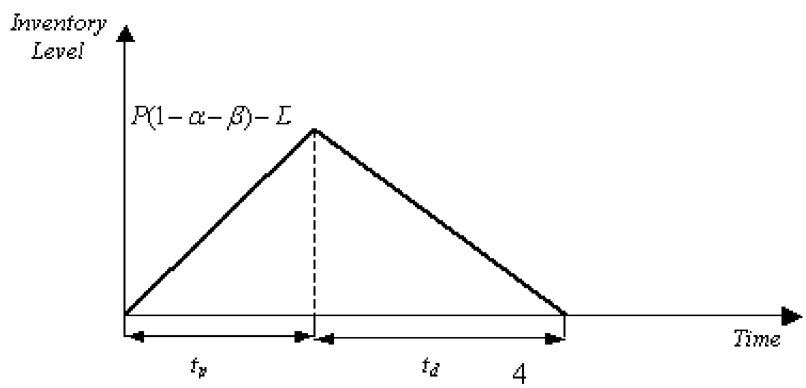

Figure2. Inventory level for one cycle

Defective items from each cycle (βQ) are collected until N cycles are finished after which the defective parts are reworked. (Fig. 3)

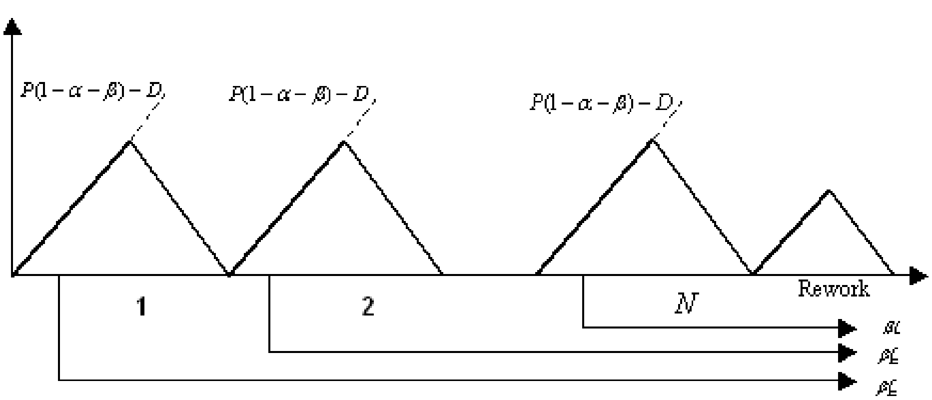

Figure3. Position of rework cycle

To ensure that inventory level will not run into shortages, it is assumed that:

$$P(1-\alpha-\beta) > D \tag{2}$$

The total system costs consist of setup cost (C_s), in-process inventory and finished goods inventory product holding cost (C_w, C_H) and penalty cost (C_p). So total cost is:

$$TC = C_S + C_w + C_H + C_p \tag{3}$$

3-1 Set up cost

The setup cost of the batch quantity Q is calculated as:

$$C_s = k_s t_s \tag{4}$$

3-2 In-process defective products holding cost

The in- process defective products holding cost depends on waiting time for the whole batch of quantity Q during the setup (T_{ws}) and processing time for a component at *N*th cycle (T_{wp}).

The waiting time for setup can be calculated as:

$$T_{ws} = (N-1)t_s + (N-2)t_s + (N-3)t_S + \cdots + 2t_s + t_s = \frac{N(N-1)t_s}{2} \tag{5}$$

To compute waiting time for processing Eq. (6) can be used.

$$\begin{aligned} T_{wp} &= \left(\frac{Q}{2P} + \frac{Q(N-1)}{P}\right) + \left(\frac{Q}{2P} + \frac{Q(N-2)}{P}\right) + \left(\frac{Q}{2P} + \frac{Q(N-3)}{P}\right) + \cdots + \frac{Q}{2P} \\ &= \frac{NQ}{2P} + \frac{Q}{2P}[(N-1) + (N-2) + \cdots + 2 + 1] = \frac{NQ}{2P} + \frac{QN(N-1)}{2P} \end{aligned} \tag{6}$$

Therefore total waiting time for *N* cycle is given by Eq. (7):

$$T'_{wt} = T_{ws} + T_{wp} = \frac{N(N-1)t_s}{2} + \frac{N^2 Q}{2P} \tag{7}$$

And the total waiting time when rework is completed is given by:

$$T_{wt} = T_{wt} /(1-\beta) \tag{8}$$

Hence the holding cost for in-process defective products is given by Eq. (9): (for all lots over the year)

$$\begin{aligned} C_w &= k_w T_{wt} \beta Q = k_w \left(\frac{N(N-1)t_s}{2} + \frac{N^2 Q}{2P} \right) \frac{\beta Q}{1-\beta} = k_w \frac{\beta}{1-\beta} \left(\frac{D(N-1)t_s}{2} + \frac{D^2}{2P} \right) \\ &= k_w \frac{\beta}{1-\beta} \left(\frac{aPR^{-b}(N-1)t_s}{2} + \frac{a^2 PR^{-2b}}{2P} \right) \end{aligned} \tag{9}$$

3-3 Finished products inventory holding cost

The inventory holding cost per cycle is obtained as the average inventory times holding cost per product per cycle.

It is evident from Fig.2 that: $(t_p = Q/P, t_d = h/D)$

$$h = [P(1-\alpha-\beta) - D](Q/P) \tag{10}$$

And also:

$$\begin{aligned} \bar{I} &= \frac{1}{2} h(t_p + t_d) = \frac{1}{2}[P(1-\alpha-\beta) - D] \frac{Q}{P} \frac{Q(1-\alpha-\beta)}{D} \\ &= \frac{1}{2} \left((1-\alpha-\beta) - \frac{D}{P} \right) \frac{Q^2(1-\alpha-\beta)}{D} \end{aligned} \tag{11}$$

Inventory for both good and reworked products over the year can be calculated as:

$$\begin{aligned} C_H &= \frac{1}{2} H \left(1-\alpha-\beta-\frac{D}{P} \right) Q^2 \frac{(1-\alpha-\beta)}{D} \frac{D}{Q} + \frac{1}{2} H \left(1 - \frac{D}{P} \right) \beta^2 D \\ &= \frac{aPR^{-b}}{2N} H(1-\alpha-\beta) \left(1-\alpha-\beta-\frac{aPR^{-b}}{P} \right) + \frac{1}{2} H \left(1 - \frac{aPR^{-b}}{P} \right) \beta^2 aPR^{-b} \end{aligned} \tag{12}$$

3-4 Penalty cost

Producing βQ units of defective products in each cycle reduces the lot size by this amount. These items are reworked after N cycles. The defective products produced in

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cycle 1 waits for $(N-1)$ cycles before it is reworked in the rework cycle. Also the defective items that are produced in cycle 2 waits for $(N-2)$ cycles before it is reworked, and this process continues until the defectives from *N*th cycle. The duration of the last cycle, that is, $(N+1)$ th cycle may not be of the same lengths as that of the previous cycles, which are all equal. The duration of each cycle (except rework cycle) can be calculated as:

$$(t_p + t_d) = t_p + h / D = (1-\beta) Q / D \tag{13}$$

Since by considering of βQ defective items form each cycle, the total weighted waiting time, T_s^n, is: ($NQ = D$)

$$T_s^n = [(N-1) + (N-2) + \cdots + 2 + 1]\left(\frac{Q(1-\beta)}{D}\right) = \frac{(N-1)}{2}(1-\beta) \tag{14}$$

The time of rework cycle should be added to waiting time. So the additional waiting time for rework cycle, $T_s^{(n+1)th}$, is:

$$T_s^{(n+1)th} = \frac{\beta QN}{P} + \frac{(P-D)\beta QN}{D} = \frac{\beta QN}{D} = \beta \tag{15}$$

Therefore, the total waiting time is sum of equations (14) and (15):

$$T = T_s^n + T_s^{(n+1)th} = (N-1)(1-\beta)/2 + \beta = [N(1-\beta) + 3\beta - 1]/2 \tag{16}$$

The penalty cost is considered over both waiting and defective units to prevent producing defective items. This penalty cost is obtained as:

$$\begin{aligned} C_{penalty} &= k_p \frac{\beta Q}{2(1-\beta)}[N(1-\beta) + 3\beta - 1] = \frac{1}{2} k_p \frac{\beta}{1-\beta} D\left(1 - \beta + \frac{3\beta}{N} - \frac{1}{N}\right) \\ &= \frac{1}{2} k_p \frac{\beta}{1-\beta} aPR^{-b}\left(1 - \beta + \frac{3\beta}{N} - \frac{1}{N}\right) \end{aligned} \tag{17}$$

3-5 Total system cost

As pointed out before, the total cost per unit time can be expressed as:

$$TC = C_s + C_w + C_H + C_P \tag{18}$$

Since in this model total cost is a function of $N(= D/Q)$ it can be computed as:

$$\begin{aligned} TC(N) &= Nk_s t_s + k_w \frac{\beta}{1-\beta}\left(\frac{aPR^{-b}(N-1)t_s}{2} + \frac{a^2PR^{-2b}}{2P}\right) + \frac{aPR^{-b}}{2N}H(1-\alpha-\beta)\left(1-\alpha-\beta-\frac{aPR^{-b}}{P}\right) \\ &+ \frac{1}{2}H\left(1-\frac{aPR^{-b}}{P}\right)\beta^2 aPR^{-b} + \frac{1}{2}k_p aPR^{-b}\frac{\beta}{1-\beta}\left(1-\beta-\frac{3\beta}{N}-\frac{1}{N}\right) \end{aligned} \tag{19}$$

In this paper it is assumed that N in continuous, therefore it can be shown that $TC(N)$ in convex function in N. Setting the first derivation of $TC(N)$ to zero, $dTC(N)/dN = 0$, gives the optimal value of N. The first derivation is:

$$\begin{aligned} \frac{dTC(N)}{dN} &= k_s t_s + k_w aPR^{-b}\frac{\beta t_s}{2(1-\beta)} - \frac{HaPR^{-b}(1-\alpha-\beta)}{2N^2}\left(1-\alpha-\beta-\frac{aPR^{-b}}{P}\right) \\ &- \frac{1}{2}k_p aPR^{-b}\frac{\beta}{1-\beta}\left(\frac{3\beta}{N^2}-\frac{1}{N^2}\right) = 0 \end{aligned} \tag{20}$$

And the optimal value of N will be:

$$N = \sqrt{\frac{HaPR^{-b}(1-\alpha-\beta)(1-\alpha-\beta-aPR^{-b}/P) + k_p aPR^{-b}\beta(3\beta-1)/(1-\beta)}{2[k_s t_s + k_w aPR^{-b}t_s\beta/2(1-\beta)]}} \tag{21}$$

It is derived from Eq. (21) that When $\alpha = 0$ and $\beta = 0$ the optimal batch size will be $Q^* = \sqrt{2k_s t_s D/(H(1-D/P))}$ which is same as Q^* in classical model.

4- Numerical example

The optimum value of N is obtained by Eq. (21). Assume $a = 50000$ \$/year, $b = 1.01$, $PR = 150$ \$/unit, P=620 units/year, H=\$130/unit/year, β=0.06, α=0.03, k_s=\$1/min (=\$525600/year), t_s=50 min/setup (=0.0000951 year/setup), k_P=\$180/unit/year, k_w=\$95/unit/year. Hence N=10.93. The optimal batch size Q^* = D/N=29.01 ≈ 29 units/batch. When β and α are zero, the optimal batch size $Q^* = \sqrt{2k_s t_s D/(H(1-D/P))} = 22.34 \approx 22$ units/ batch.

5- Sensitivity Analysis

Now using the above example, a sensitivity analysis is carried out to study how the optimal number of cycles is affected due to the changes of defective rates β (it is assumed that $\beta=2\alpha$) and selling price. The effect of defective rates is surveyed by varying the β values over the range from 0 to 0.12.Table 1 shows that the optimal number of cycles decreases as the defective rate increases. Consequently, the manufacturing batch size increase to keep the total cost as low as possible. Also the effect of selling price is studied by changing the *PR* values over the range from 90 to 450. Table 2 illustrates that by increasing selling price, optimal number of cycles at first increases and then decreases.

β	***N***
0	13.58
0.01	12.92
0.02	12.24
0.03	11.55
0.04	10.84
0.05	10.11
0.06	9.35
0.07	8.56
0.08	7.73
0.09	6.84
0.1	5.87
0.11	4.76
0.12	3.41

Table1. Effect of β on *N*

PR	***N***
90	7.58
120	12.29
150	13.13
180	13.11
210	12.83
240	12.46
270	12.07
300	11.69
330	11.33
360	10.99
390	10.67

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420	10.38
450	10.10

Table2. Effect of *PR* on *N*

The effect of β and PR on N is also illustrated in figures (4) and (5).

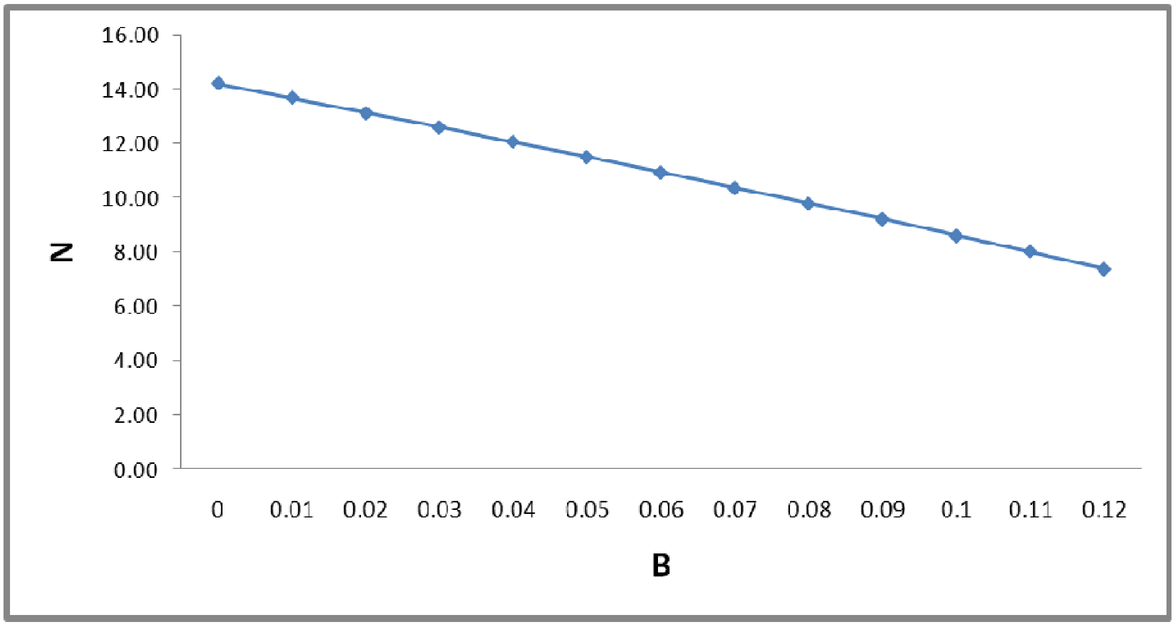

Figure4. Effect of defective proportion β on the optimal number of cycles

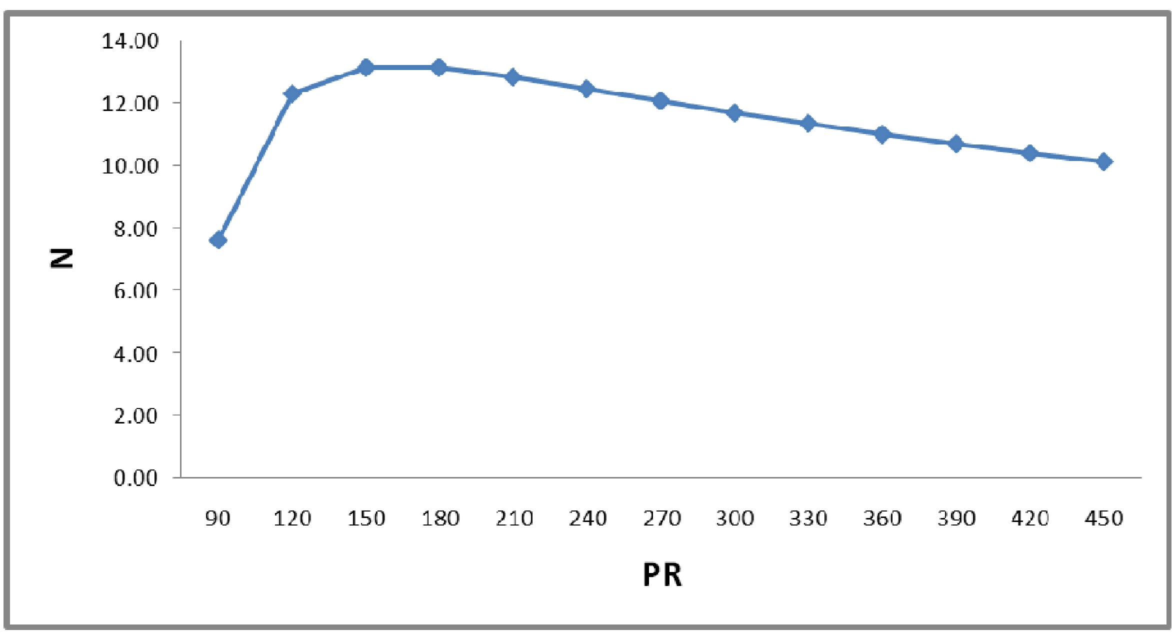

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Figure5. Effect of selling price *PR* on the optimal number of cycles

6- Conclusion

This paper developed a model for determining economic production quantity and optimal number of cycles considering rework and reject situations and price dependent demand. It is assumed that defective items are accumulated for N cycles and after that the defective parts are processed. The penalty costs for defective items are high for higher values of N. The data used in this study show that as β increase, the optimal N decrease and consequently, the manufacturing batch size increase to keep the total cost as low as possible. Also it is concluded that by increasing selling price, optimal number of cycles at first increases and then decreases.

The effect of machine breakdown on this model may be recommended for further study. Another important study may investigate the effect of time value of money on optimal lot size.

7- Reference

1. D.D. Bedworth, J.E. Bailey, Integrated production control systems, second ed., John Wiley & Sons, New York, 1987.
2. M. Ben-Daya, S.M. Nomana, M. Harigab, Integrated inventory control and inspection policies with deterministic demand, Computers and Operations Research 33 (2006) 1625–1638.
3. W.M. Chan, R.N. Ibrahim, P.B. Lochert, A new EPQ model: Integrating lower pricing, rework and reject situations, Production Planning and Control 14 (2003) 588–595.
4. T. Gupta, S. Chakraborty, Looping in a multistage production system, International Journal of Production Research 22 (1984) 299–311.
5. P.A. Hayek, M.K. Salameh, Production lot sizing with the reworking of imperfect quality items produced, Production Planning and Control 12 (2001) 584–590.
6. S.R. Hejazi, J.C. Tsou, M. Rasti Barzoki, Optimal Lot Size of EPQ Model Considering Imperfect and Defective Products, Journal of Industrial Engineering International Islamic 4 (2008) 59-68.
7. M.Y. Jaber, M. Bonney, I. Moualek, An economic order quantity model for an imperfect production process with entropy cost, International Journal of Production Economics 118 (2009) 26 –33.

ISSN 2076-9202

8. A.M.M. Jamal, B.R. Sarker, S. Mondal, Optimal manufacturing batch size with rework process at a single-stage production system, Computers & Industrial Engineering 47 (2004) 77–89.
9. D. Panda, M. Maiti, Multi-item inventory models with price dependent demand under flexibility and reliability consideration and imprecise space constraints: A geometric programming approach, Mathematical and Computer modeling 49 (2009) 1733-1749.
10. S.J. Sadjadi, M .Orougee, M.B. Aryanezhad, Optimal production and marketing planning, Computational Optimization and application 30 (2005) 195-203.
11. R.L. Schwaller, EOQ under inspection costs, Production and Inventory Management 29 (1988) 22– 35.

Optimal Six-Sigma Level in TFT-LCD Manufacturing: A Case Study

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Abstract. This paper deals with six-sigma project decision-making in TFT-LCD manufacturing using multi-objective goal programming approach to assist the project leader in deciding process improving opportunities. The model considers a multi-stage process rolled throughput yield in a TFT Liquid Crystal Display (LCD) major Array, Cell, and Module process. Meanwhile, the other factors such as investment cost, profit, and expected sigma level will be taken into consideration in the model. Numerical result shows an organization can reap the profit through the six-sigma project implementation.

Keywords: Quality improvement; Six-sigma; TFT-LCD; Multi-objectives Programming

Introduction

This study try to answer the following question: whether a six-sigma project is profitable or not? If not, why the cooperation takes the actions in continuous improvements? If yes, what is the optimal six-sigma level and to what extend? This paper uses a multi-objectives (goal) programming (MOP) model to determine the optimal sigma level as an alternative process. The process of MOP involves with defining goal priorities and then iteratively searching for solutions of a linear/nonlinear programming model. Each goal is solved sequentially according to its priority and weight with the previous goal (Zhang and Roush 2001).

Juran (1989) suggested that quality could be accomplished by project and in no other way. A Six Sigma project is targeted to have duration of three to six months. If the six sigma project is not profitable, you had to reject the improvement requirement depends on which decision you made! Here is why we would like to develop a multi-objectives (goal) programming to solve such problems. Moreover, if the resulting process does not improve the sigma level significantly, the investment made may not turn into profit (Kumar 2008).

In the remainder, the literature review is given, followed by describing the problem context and assumptions. Next, the mathematical models are formulated and equilibrium analyses are carried out. Based on the analytical results, managerial implications are drawn concerning with the tendencies of decision variables and profit values generated by the models. Numerical study is then carried out to quantify the analytical results. In conclusions, we summarize our research contributions and provide future research directions.

Literature review

Kumara (2008) has developed two single objectives (Maximum profit under Budget constraint) programming to find the optimal sigma level. The model proposed by Kumara is developed by single objective programming. In a real world application, the objectives are normally multiple. We develop a model by using multi-objectives (goal) programming and calculate the optimal sigma level and suitable process alternative.

The term of six sigma process (Wiki 2009) graph of the normal distribution underlies the statistical assumptions of the Six Sigma model. The Greek letter σ marks the distance on the horizontal axis between the mean, μ, and the curve's inflection point. The greater this distance is, the greater is the

* Corresponding author

spread of values encountered. For the curve shown in red above, μ = 0 and σ = 1. The other curves illustrate different values of μ and σ. Sigma (the lower-case Greek letter σ) is used to represent the standard deviation (a measure of variation) of a statistical population. The term "six sigma process" comes from the notion that if one has six standard deviations between the process mean and the nearest specification limit, there will be practically no items that fail to meet specifications. Criticism of the 1.5 sigma-shift: Because of its arbitrary nature, the 1.5 sigma shifts dismissed as "goofy" by the statistician Donald J. Wheeler. Its universal applicability is seen as doubtful. The 1.5 sigma shift has also been contentious because it results in stated "sigma levels" that reflect short-term rather than long-term performance: a process that has long-term defect levels corresponding to 4.5 sigma performance is, by Six Sigma convention, described as a "6 sigma process".

The key point of quality satisfaction is both of the best quality and gain profit. Sigma level was an index of quality which is meet Voice of Customer (VOC), consider about the Voice of Process (VOP: term used to describe what the process is telling), Voice of Engineering (VOE) and Voice of business (VOB, Tanya 2002). The "VOB" is the term used to describe the stated and unstated needs or requirements of the business/shareholders). Sigma Level (QA Inc. 2007): The predicted long-term Sigma Level for the process, including field failures, based on a (relatively) short-term internal Process Capability estimate. A value of 6.0 corresponds to 3.4 defects per million opportunities (DPMO). Sigma Level = 3*Cpk, Sigma Level may also be calculated based on longer term field failure rates, such as described in Six Sigma Demystified. Using MS Excel's NORMSINV function, the calculation is as follows: Sigma Level =NORMSINV (1-(DPMO/1000000))+1.5, C.D. Edwards(1986) had identified that "Quality consist of the capacity to satisfy wants", Short-term sigma levels correspond to the following long-term DPMO values.

Goal programming (Wiki 2009) is a branch of multi-objective optimization, which in turn is a branch of multi-criteria decision analysis (MCDA), also known as multiple-criteria decision making (MCDM). It can be thought of as an extension or generalization of linear programming to handle multiple, normally conflicting objective measures. Goal programming (Wiki 2009) was first used by Charnes and Cooper (1954) and Cooper and Cooper (1959), although the actual name first appear in a textbook by Charnes and Cooper (1961). Schniederjans (1995) gives in a bibliography of a large number of pre 1995 articles relating to goal programming and Jones and Tamiz (1990) give an annotated bibliography of the period 1990-2000.

The problem context

TFT LCD is combined by two glass substrates and Polarizer as shown in Figure 1. It includes Polarizer, Color Filter (CF), Circuit Plate, Polarizer and White Light Source. There are three major processes in the TFT LCD manufacturing flow. 'Array', 'Cell' and 'Module' are the main process in a typical LCD company (Figure 2).

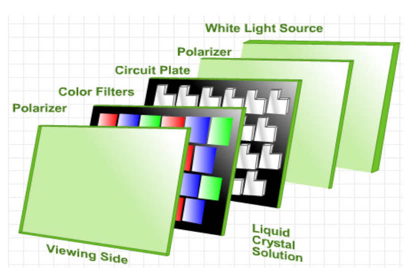

Figure 1: TFT LCD structure (Source: CPT web 2009).

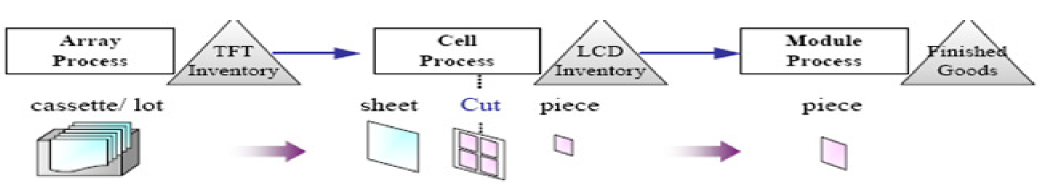

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Figure 2: TFT LCD simple process flow (Source: LG & CPT 2006).

A typical Array, Cell and Module process flow includes: Glass substrate input is the first process in Array, through five of Photo Engraving Process (PEP), a TFT substrate was completed in Array process. A PEP process is meaning through the following process: Thin film deposition, lithography, etching and cleaning process. There are five PEPs in a TFT process in a typical structure. Cell process assembles TFT and CF substrate after PI coating, rubbing process cleaning sealant dispensed and one drop filling process. Module process attaches TAB, backlight, driver IC and packing. A Photo Engraving Process (PEP) is beginning in thin film deposition, and then Photo Resist (PR) coating, the next is pattern exposure, developing, etching and stripping. Figures 3-5 show the process flows.

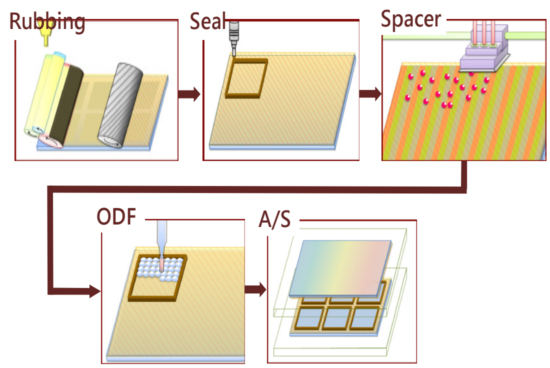

Figure 3: Cell process flow.

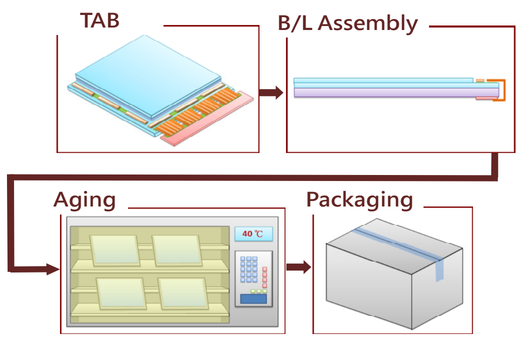

Figure 4: Module process flow.

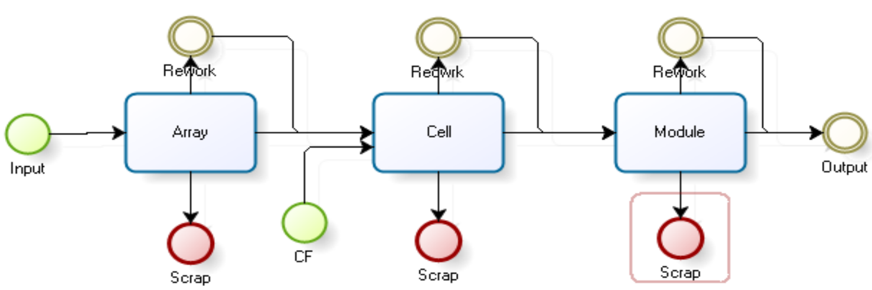

Figure 5: Simple process flow.

Ultimately the goal of Six Sigma is to move toward no variation in process (Elyse 2006). Since we now know what the six-sigma is. We figure out how to calculate it. Count the number of units of output for a specific time period. Count the number of defects that occur for that number of units. Divide the defects by the number of units being measured to get the defects per unit (DPU). Multiply the DPU by

1,000,000 to get the Defects per million units (DPMU). We can look-up the DPMU in the sigma table (Elyse 2006).

We would like to know which sigma level is suitable for a six sigma improving project. The model considers a multi-stage, asynchronous manufacturing process with the opportunity to improve quality at each of the stages. VOC is the key point of constraints, so we got four index including Rolled Throughput Yield (RTY), Zero Bright Dot(ZBD),S Rank and x88 in the model. An example of C-Company of -“TFT LCD Array/Cell Process” illustrates the application of the optimization models developed and results show that in some scenarios implementing Six Sigma may not be financially beneficial.

Case study and analysis

C-company is one of five major TFT LCD OEM/ODM companies in Taiwan. There are four major plants of TFT manufacturing (T2-3G, L1A-3.5G, L1B-3.5G and L2-6G) in CPT Taiwan. Most of Modules manufacturing are in Mainland China. Array/Cell/Module process is a standard three stage process in an OEM/ODM TFT LCD manufacturing FAB. If we would like to evaluate goodness of process, RTY (Rolled Throughput Yield) is one of the evaluating methods. All of the through process station will have their measurement point to check the yield of the process. Array*Cell*Module can get a throughput yield to present the while process goodness product. Rolled Throughput Yield will impact the profit of the product. Figure 6 shows the process.

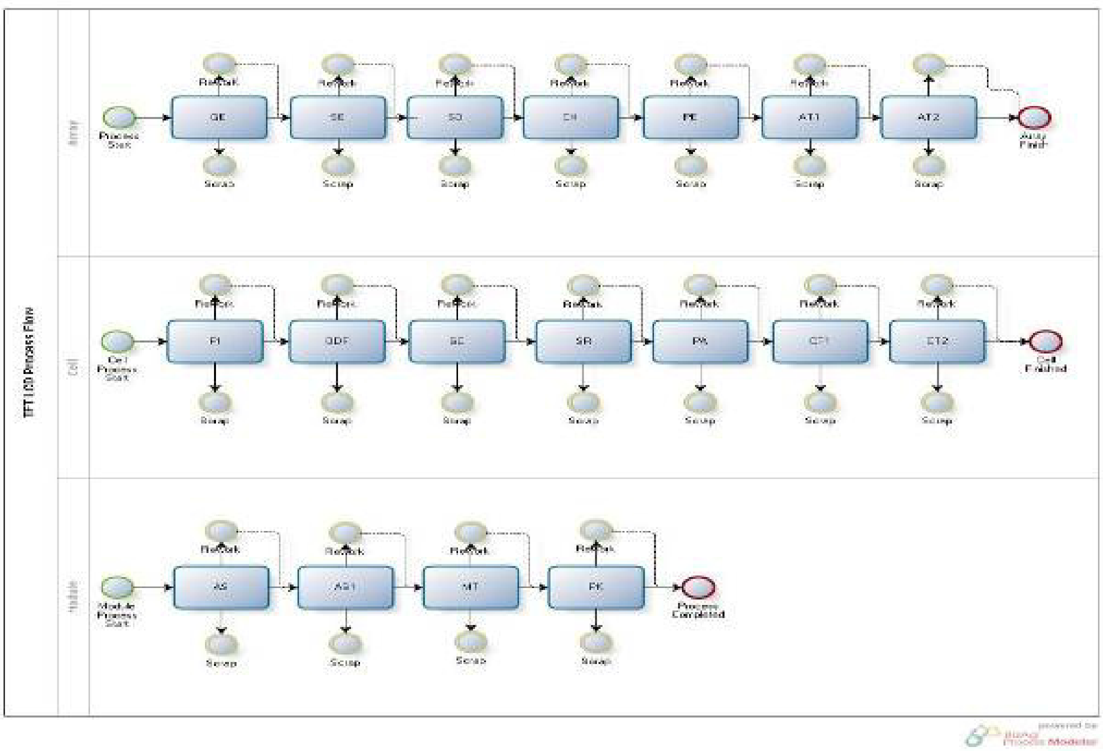

Figure 6: TFT-LCD manufacturing process in C-company.

Rolled throughput yield means goodness of the product through all of the process stages. It is calculating the through process yield by using the method of ‘multiply’ each single stage process yield.

As Figures 7-8 have shown, the cost analysis result of the TFT LCD is around following proportions: Array 32%, Cell 23% and Module 45% (The cost analysis in based on C-company 2008 and 2009 Q1 costs data, it may not suitable for other cases, different Company/Products has different costs structure).

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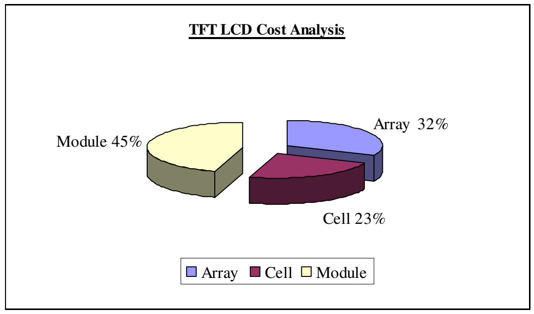
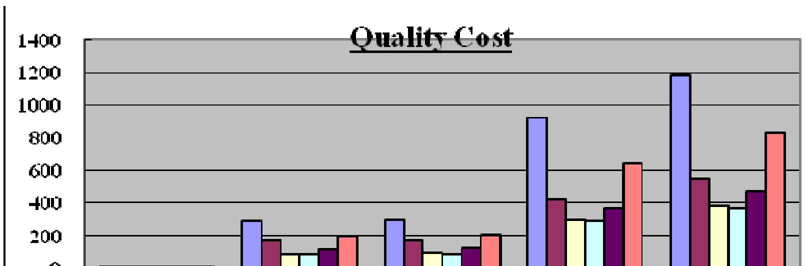


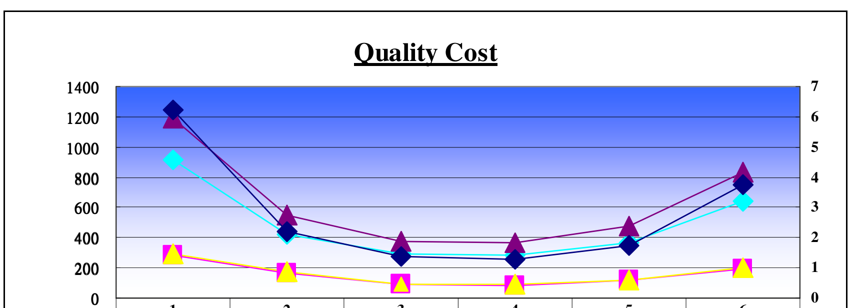
Figure 7: TFT-LCD cost analysis.



	2.4"	17"	18.5"	32"	37"
1	6.23	283.84	294.18	919.18	1188.35
2	2.21	164.13	170.11	421.55	545.00
3	1.36	87.80	90.99	292.94	378.72
4	1.30	85.61	88.73	286.26	370.09
5	1.72	118.09	122.39	364.95	471.81
6	3.74	195.39	202.51	641.22	828.99

Figure 8: Quality cost analysis in C-company.

After the quality cost was analyzed, we can find the cost structure is similar to Juran's optimal quality cost due to IE evaluating the improvement cost as the model. The optimal quality cost is between 3.5 and 4.5 Sigma in C company (Figure 9).



	1	2	3	4	5	6
17"	283.84	164.13	87.80	85.61	118.09	195.39
18.5"	294.18	170.11	90.99	88.73	122.39	202.51
32"	919.18	421.55	292.94	286.26	364.95	641.22
37"	1188.35	545.00	378.72	370.09	471.81	828.99
2.4"	6.23	2.21	1.36	1.30	1.72	3.74

Figure 9: Quality cost by sigma level in C-company.

Summary and further research

After an in-depth case study was carried out, the result showed that sigma level was generally between 3 to 4 sigma by minimizing the total cost.. An ideal process alternative can be applied in current quality process alternative due to a multi-objective programming result. Refer to the optimal quality cost curve of the total quality cost given by Juran, we can conclude that the optimal sigma level of the current process alternative in C-company. We have found the cost structure is similar to Juran's optimal quality cost.

The limitation of this model is due to TFT LCD process only. In the future research, we can implement the evaluate model in the most of manufacturing industry. As a six sigma project needs a lot of investment, using a mathematic model to find the improvement opportunities is a an economic possible method. It's a an interesting finding in this model that optimal sigma level was not six sigma for a real manufacturing company due to the cost consideration. According to the zero quality cost model given by Schneiderman (1986), the optimal quality costs can be reduced if sigma level getting higher and higher.

References

Charnes, A. and Cooper, W.W. (1954), A constrained game formulation of advertising strategies, *Econometrica*, 22, 511.

Charnes, A. and Cooper, W.W. (1959), Chance constrained programming, *Management Science*, 6, 73–79.

Charnes, A. and Cooper, W.W. (1961), *Management Models and Industrial Applications of Linear Programming*, Wiley & Sons, New York.

Graves, S. (1998), Statistical quality control of a multi-step production process using total process yield, *Quality Engineering*, 11(2), 187-195.

Joly, M. and Pinto, J.M. (2003), Mixed-integer programming techniques for the scheduling of fuel oil and asphalt production, *Chemical Engineering Research and Design*, 81(4), 427-447.

Jones, D.F. and Tamiz, M. (1995), Expanding the flexibility of goal programming via preference modelling techniques, *Omega*, 41-48.

Juran, J. (1989), *Juran on Leadership For Quality: An Executive Handbook*, New York, Free Press.

Kumar, U.D., Nowicki, D., and Ramírez-Márquez, J.E. (2008), On the optimal selection of process alternatives in a six sigma implementation, *International Journal of Production Economics*, 111 (2), 456-467.

Markarian, J. (2004), What is six sigma? *Reinforced Plastics*, 48(7), July-August, 46-49.

Schneiderman, M. (1986), Optimum quality costs and zero defects: are they contradictory concepts? *Quality Progress*, November.

Schneiderman, M. and Karuppan, C. (1995), Designing a quality control system in a service organization: a goal programming case study, *European Journal of Operational Research*, 81(2), 249-258.

Zhang, F. and Roush, W.B. (2002), *Multiple-Objective (Goal) Programming Model for Feed Formulation: An Example for Reducing Nutrient Variation*, Poultry Science Association.

女性主管領導特質與領導效能對於員工工作投入之影響

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摘要

眾所周知，在職場上女性主管由於性別的因素，經常面臨工作條件、相對環境、與人際關係等等壓力，因此，其領導特質與領導效能，對於員工工作投入有某程度的影響，但具體地表現在那些面向上？卻是個複雜的問題；也就是說，在某些狀況下，女性主管對於員工有激勵與鼓舞的作用，而另一方面來看，女性主管的領導，卻容易落入缺乏監督與威嚴的形象，往往會造成員工工作投入程度不高。

整體而言，女性主管的「領導特質」經常展現在：「互動型領導風格」、「包容性組織關係」、「多元化思考方式」、「授權與賦能」、「重視員工教育與成長」等五個構面上，透過「領導效能」的「士氣與凝聚力」、「彈性與適應力」、「效率」、「創新」四個面向轉移，會投射在員工工作投入程度中的：「自我要求」、「認同工作重要性」兩個向度高低，亦即，找出那些女性主管的領導特質與領導效能，對於員工工作投入程度為高度關聯向度，為本研究最主要的貢獻。

關鍵字：領導特質、性別優勢、核心能力

1. 研究動機與目的

近年來，台灣社會很大的一個轉變，就是有大量的女性投入工作職場當中，而隨著女性大量進入社會工作，也開始逐漸有越來越多的女性，進入所謂的男性「管理」階層領域，「女性主管」就是其中一個現象（李秀珠，1998）。女性領導議題已是順應時代且不忽視的議題，基於女性領導特質的獨特性，往往能截取女性特質長處，而補男性特質之短處，反而能促使組織功能更為順利地運行。

職場中，性別問題一直是女性研究領域的重要問題，依據社會性別理論，男女性別角色是由不同的社會文化所決定；大自然賦予兩性不同構造和功能的同時，也賦予兩性各自的性別優勢，然而，經過社會化的結果，出現了“男優女劣”、

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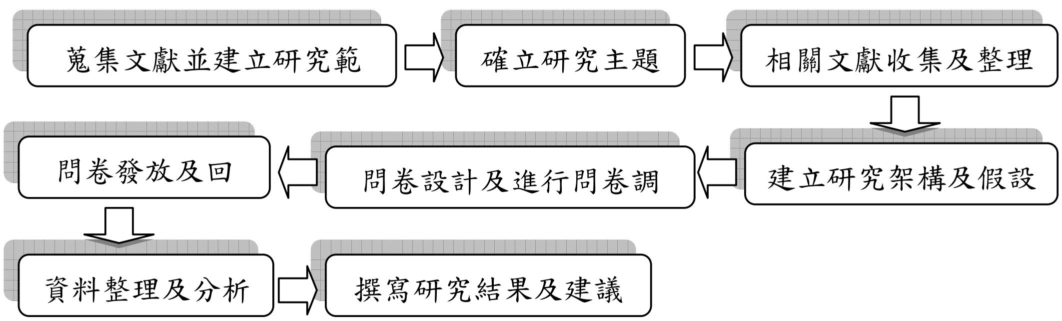
"男尊女卑"、"男主外、女主內"的現象，因此，重新定義分析和認識女性的性別優勢，對於擺脫傳統性別觀念的束縛，樹立女性自信，促進女性的發展，具有十分重要的意義。

本研究以女性主管做為次研究對象，從直屬員工身上探討為主研究對象，並以量化結果來驗證探討，女性主管的領導特質、領導效能與員工工作投入之影響；其中，領導特質部份具有潛在爭議，問題的核心在於：男女是否會因性向和能力的不同，造成領導特質取向的差異，有相關研究聲稱：在組織設置上，性別角色的本質是技術較佳的領導；針對某些行業而言，這樣的立場標記著"女性優勢 "的觀點。Yukl (2002)認為，女性較善於包容性，人際關係，權力分享，以及培育追隨者，因此，從這個角度來看，女性未來會是優越的領導者(Carr-Rufino, 1993; Grant, 1988;Helgeson, 1995; Loden, 1985; Rosener, 1990, 1995)。

研究流程與進行的步驟，如圖一所示：



圖一、研究流程與進行步驟

本研究以女性主管之領導特質與領導效能，對員工工作投入的影響進行調查與探討，以文獻探討、問卷調查等研究方法驗證，問卷對象與範圍涵蓋：高科技產業、製造業、服務業、金融業、學術界、補習班、餐旅業等，但由於主客觀因素，本文限制以女性主管所帶領的直屬員工為主要標的，行業類別則無設限，其餘影響組織績效因素如：組織氣氛、組織結構、組織文化、升遷制度等，則不在本研究之列。

2. 文獻探討

2.1 女性「領導特質」的相關研究

黃麗蓉（1996）的研究中，將女性領導的特質歸納成五點：(1).互動型的領導風格：女性主管人員都很努力的營造合適的工作環境與組織文化，最終目標則

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是達到一種「雙贏」的情境；(2).包容性組織關係：女性領導是從組織的中心往外擴散；而男性則採用由上而下的層層節制領導；(3).多元化思考方式：女性主管喜歡採用「全人格溝通」的方式，與部屬進行較深度的交談，部屬的抱負、理想、家庭與情操等，均是關切的對象；(4).授權與賦能：女性在成長的過程中對人際的交往比較深入而細心，他們有優秀的傾聽和溝通潛能，許多研究皆顯示，女性是絕佳的團隊成員；(5).重視員工的教育與成長：「拉拔他人成長，並引導他們向前」的女性重要本能，在女性逐漸由私領域滲透入公領域的同時，亦一併被帶入組織中。

Helgesen(1995)對女性管理風格與領導特質所做的研究指出：(1).女性工作步調較為穩定；(2).女性不將一些不在預定中的工作視為干擾；(3).女性會抽出時間從事某些與工作沒有直接相關的活動；(4).女性只將工作視為生活的一部分；(5).女性不會整天沉浸在管理工作中，而是參與社會的脈動；(6).女性會和他人分享資訊，且是向四方發展。

2.2 領導效能的文獻探討

一般而言，「效能」為預期目標達成的程度，也就是投入資源的效果，重點在於組織目標的達成；鄭勝文(2003)認為領導效能就是指部屬工作士氣的表現，意即成員的個人期望與組織目標交互作用後需求滿足的心理狀態，產生對組織的認同，願意全心投入工作，發揮團體凝聚力，來提高組織效能，實現組織願景的程度；蔡青宏（1996）綜合領導效能的相關研究，衡量領導效能的指標主要有四個觀念性之評量構面，現分述如下：

(1) .目標達成度：主管所領導的單位，對工作上目標的達成率有多少，其中包含「個人目標達成度」與「團體目標達成度」二個衡量構面。

(2) .部屬態度：反應部屬在此主管的領導下，心理所產生的反應與感受，以及會對主管或組織採用何種應對的態度，包含四個衡量構面：「工作滿意度」、「組織承諾」、「流動率與缺勤率」與「部屬的成就動機」。

(3) .團體歷程：主管對其組織或團體貢獻程度有多少，包含四個衡量構面，即「士氣與凝聚力」、「彈性與適應力」、「效率」、與「創新」。

(4) .領導能力：指由部屬來衡量主管的領導能力與成果，包含八個衡量構面，即「領導者聲望」、「公正無私」、「溝通」、「激勵」、「決策」、「角色明確」、「員

工發展」及「目標清晰」。

2.3 員工「工作投入」相關研究

Dubin(1956)認為：「工作投入」是個體認為工作是「生活興趣中心」的總體評價程度，如認為工作是生活滿意度的重要來源，以個體不同的變項為觀點；Dubin認為工作投入與所謂「新教徒」的工作倫理息息相關，是一種工作的道德特性，以及一種個人的責任，無論被雇用的外在環境如何，任何將這種價值內化的個體是工作投入的。Lawler和Hall(1970)對工作滿意度的界定與Dubin相似，在他們的定義中，「工作投入」是個體認為工作是他們生活的重要部分，認為最切合實際的觀點，是一種個體-情境交互作用的運作情形，並且在工作中他們能夠實現自我認同，工作為滿足他們自身的需要提供了可能性。

Rabinowitz與Hall(1977)定義「工作投入」為：個體生活中知覺，到工作的重要性或是心理上對工作的認同；在此概念下，所強調的是對一般工作的投入，而非對特定工作的投入。因此，Rabinowitz與Hall 認為工作投入的定義是：一種新教徒倫理類型的社會化之結果，是一種個體無論處於何種情況都會堅持自我的特性。

對「工作投入」的另一種解釋是由Allport(1947)提出，他認為工作投入可以被認為是員工參與到工作中的程度，並且認為工作是否能夠滿足他們的需要，如地位、尊嚴、自主權和自我獎賞等等的程度。Gerbing、David和James(1988)認為，工作中的投入程度取決於：個體試圖在工作中實現自我表達(SeIf-express)的程度。

French 及 Kahn (1962)認為自我投入的表現，是一種能力向心性影響自尊的程度，前提是工作表現對工作者是重要的。Siegel(1969) 認為，對於工作投入程度上的差異可以追溯到決定個體行為的早期社會化，及內化過程中所學習到對工作的價值觀傾向。

3. 研究方法、模型建構與結果

本研究對象為女性主管的「直屬員工」為研究對象，有別於大多數論文以「女性主管」為研究對象，對於直屬主管的領導特質、領導效能和員工本身的工作投入之影響進行調查與探討，以文獻分析、實證問卷調查等研究法。本研究並無設

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限於任何行業，亦無設限管理幅度的大小，在本研究中，女性主管帶領的人數不論多或少，女性的特質是不置可否的，舉凡直屬主管或上司是女性都符合本研究所要探討的對象。

本文參考國內外相關文獻，擬定性別、婚姻、年齡、學歷、工作年資、收入等作為員工的基本背景變項，其問卷架構為四個部份：

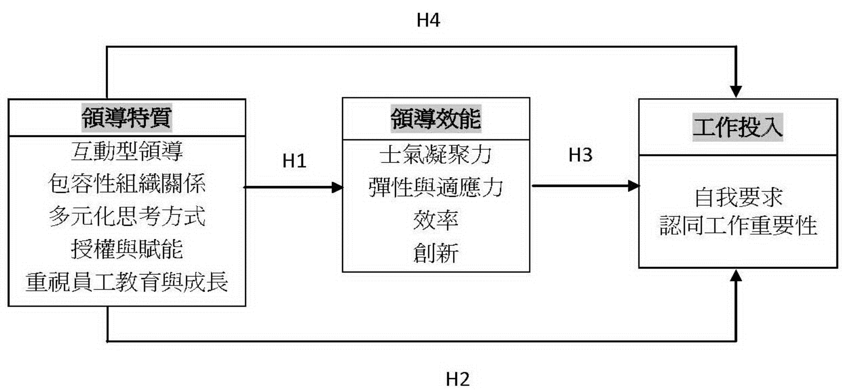
(1). 領導特質包含：互動型的領導風格、包容性的組織關係、多元化思考方式、授權與賦能、重視員工的教育與成長 。

(2)．領導效能包含：士氣與凝聚力、彈性與適應力、效率、創新。

(3)．員工工作投入：自我要求、認同工作重要性。

(4)．個人背景：性別、婚姻、年齡、學歷、工作年資、收入。

各量表計分方式，採用李克特(Likert)五點尺度量表來衡量，是以「非常同意」「同意」「無意見」「不同意」「非常不同意」五個尺度來表示；其中「5」代表「非常同意」、以「1」代表「非常不同意」，至於，研究架構的設計，如圖二所示：



圖二、本研究架構圖

研究假設部份：

假設一 ：女性主管的領導特質對領導效能有正向影響顯著。

假設二 ：女性主管的領導特質對員工工作投入有正向影響顯著。

假設三 ：女性主管的領導效能對工作投入有正向影響顯著。

假設四 ：女性主管的領導特質與領導效能對工作投入有正向影響顯著。

本研究為了解此次研究樣本的基本特性及分佈情況，針對女性主管的直屬員工發放，總共發放了160份問卷調查，計回收數102份（回收率64%），扣除無效問卷（答題不完整者或全部勾選同一項者）25份，共計有效問卷（樣本）77份（約

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佔總發問卷數48%）；樣本之人口統計變項次數分配，如表一所示！

表一、樣本描述統計分析

樣本描述			樣本描述		
變數	人數	百分比(%	變數	人數	百分比(%)
性別			**學歷**		
男性	18	23.4	高中/職	5	6.50
女性	59	76.6	專科	6	7.80
婚姻			大學	50	64.9
未婚	53	68.8	研究所以上	16	20.8
已婚	24	31.2	**工作年資**		
年齡			<1 年	9	11.7
＜20	3	3.90	1-3 年內	13	16.9
21-30	35	45.5	3-5 年內	16	20.8
31-40	27	35.1	>5-10 年	39	50.6
41-50	11	14.3	**收入**		
>51	1	1.30	<20,000 元	14	18.2
			20,001-35,000 元	34	44.2
			35,001-50,000 元	23	29.9
			>50,000 元	6	7.80

至於，研究量表的構面因素，與信度分析如下：

(1) .領導特質：本研究藉由將蒐集到的實證資料經由探索性因素分析，選取特徵值大於1 的因素，並將共同性小於0.4 的題目、因素負荷量小於0.5（Hair, Anderson, Tatham, & Black, 1998）、造成命名困難的題項予以刪除，共刪除3 個題目(包括問卷中的第1、7、11 題)，其因素分析及信度分析的結果，如表二所示，並將剩餘12題題項區分成兩個構面；並分別將之重新命名為「互動與包容」、「授權與賦能」；各量表各構面的的信度其α值皆達0.8以上，領導特質整體的信度其α值也達0.8以上，根據Cronbach(1951)所提出的α(係數或稱為信賴係數)，屬很可信範圍。

表二、領導特質因素與信度分析表

題項內容	因素 一	因素 二	共同性
6. 會以民主包容的態度來領導部屬。	.884		.839
5. 常採取一對一互相溝通，而不只是透過行政來指揮員工。	.808		.708
4. 會在日常工作中，挪出時間與員工共享資訊。	.778		.648
3. 常激勵員工，使員工樂於工作，表現自己。	.731		.723
2. 瞭解員工的優點，並與員工培養良好的互動關係。	.712		.706
10.能尊重部屬的專業自主，充分授權、分層負責。	.695		.600
9. 以全方位之角度，提供實際業務運作之有用資訊。	.568		.578
14.會引導員工不斷地往前進步與成長。		.875	.820
13.總是鼓勵部屬參與學習工作相關的課程。		.802	.680
15.會運用時間來指導及訓練部屬，充份提供學習的機會。		.736	.669
12.對任何決策或任務，都能指導並激發員工爲目標而努力。		.678	.718
8. 所有決策，都能事先作整體客觀的分析和判斷。		.596	.685
轉軸後特徵值	4.693	3.681	
轉軸後解釋變異量(%)	39.11%	30.67%	
轉軸後累積解釋變異量(%)	39.11%	69.78%	
各構面 α 值	0.918	0.888	
內部一致性 α 值	0.940		

(2) .領導效能部分：藉由將蒐集到的實證資料，經由探索性因素分析，選取特徵值大於1 的因素，並將共同性小於0.4 的題目，與因素負荷量小於0.5（Hair, Anderson, Tatham, & Black, 1998）區分為兩大構面，並分別重新命名為「效率與創新」與「士氣凝聚力」，如表三所示，各量表各構面的的信度其 α 值皆達0.8以上，領導效能整體的信度其 α 值也達0.9以上，根據Cronbach(1951)所提出的 α 係數(或稱為信賴係數)，屬很可信範圍。

(3). 工作投入部分：分別為「自我要求」與「工作認同度」兩大構面，其中「工作認同度」的反向題項，本研究更改為正向題項。自我要求向度13題，認同工作重要性向度7題，共20題。「自我要求」其信度 α 值為0.815，「工作認同度」信度 α 值為0.864，整體信度達0.812。

表三、領導效能因素與信度分析表

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題項內容	因素 一	因素 二	共同性
7. 公司作業流程精簡、穩定而流暢，效率很高。	.814		.684
11.部屬們能超越舊有的經驗和習慣，來思考並解決問題。	.765		.602
10. 部屬們能不斷地改良工作方法或流程。	.720		.556
9. 對於各項議題，均能迅速而明確地作出決策。	.708		.644
5. 各種設備都能保持良好的狀態，足以應付各種突發狀況	.689		.629
6. 作業程序能因應需求的不同而予以適當地調整。	.683		.712
12.我的主管強調革新，常鼓勵部屬獨特的洞察力。	.625		.560
1. 部屬之間沒有小團體派系對立的現象存在。		.847	.719
2. 部屬能團結一致接受各種挑戰，朝向共同目標前進。		.823	.817
3. 部屬會互助合作，來解決工作或生活上所遭遇的問題。		.805	.741
4. 部屬保有很高的彈性、適應力強能因應各種內外境的變化。		.733	.715
8. 主管對於上級所要求的事項，能迅速而有效地予以回應。		.521	.500
轉軸後特徵值	4.237	3.641	
轉軸後解釋變異量(%)	35.312%	30.342%	
轉軸後累積解釋變異量(%)	35.312%	65.655%	
各構面 α 值	0.894	0.879	
內部一致性 α 值	0.924		

表四、女性領導特質、領導效能與工作投入之相關分析

	1	2	3	4	5	6	7	8	9
領導特質(1)	1								
領導效能(2)	.650**	1							
工作投入(3)	.295**	.419**	1						
互動與包容(4)	.963**	.588**	.243*	1					
授權與賦能(5)	.933**	.655**	.291*	.811**	1				
與士氣凝聚力(6)	.575**	.897**	.333**	.523**	.588**	1			
創新與效率(7)	.618**	.942**	.428**	.557**	.617**	.696**	1		
自我要求(8)	.302**	.422**	.940**	.276*	.257*	.323**	.440**	1	
工作認同度(9)	.230*	.337**	.891**	.156	.283*	.286*	.331**	.683**	1

**. 在顯著水準爲0.01時 (雙尾)，相關顯著。

*. 在顯著水準爲0.05 時 (雙尾)，相關顯著。

總體而言，女性主管的「領導特質」、「領導效能」、與「工作投入」間關連度分析，由表四可知，其相關性皆呈「正相關」且達顯著水準($p < 0.01$)，顯示女性主管的領導特質越強，則員工們的工作投入也會相對較高。

女性主管的「領導效能」與「工作投入」之相關性，皆呈正相關且達顯著水準($p < 0.01$) ，顯示女性主管的領導效能越強，則員工們的工作投入也會相對較高。

至於「迴歸分析」部份：

(1). 「領導特質」對「領導效能」：由表五中（模式1）可得知，女性主管的領導

特質與領導效能達顯著正向影響($\beta = 0.650$，$p < 0.001$)；模式1(R^2 =0.422，F=54.764， $p < 0.001$)，且由領導特質預測領導效能具有42.2%的解釋力。

(2). 「領導特質」對「員工工作投入」：由表五中（模式2）可知，女性主管的領導特質對員工工作投入達顯著正向影響（ $\beta = 0.295$ ， $p < 0.01$)；模式2（ R^2 =0.087，F=7.124， $p < 0.01$)，核心能力預測員工工作投入具有8.7%的解釋力。

(3). 「領導效能」對「工作投入」：由表五中（模式3）可知，女性主管的領導效能對員工工作投入達顯著正向影響（ $\beta = 0.419$ ， $p < 0.001$)；模式3（ R^2 =0.176，F=15.965， $p < 0.01$)，領導效能預測員工工作投入具有17.6%的解釋力。

(4). 「領導特質」透過「領導效能」 (中介變數)對「工作投入」：由表五中（模式4）可知，女性主管的領導特質透過領導效能對員工工作投入達顯著正向影響（ $\beta = 0.390$ ， $p < 0.001$)；模式4（ R^2 =0.152，F=13.464， $p < 0.001$)，核心能力透過領導效能預測員工工作投入具有15.2%的解釋力。

表五、領導特質、領導效能與員工工作投入之迴歸表

自變項/依變項	領導效能	工作投入		
	(模式 1)	(模式 2)	(模式 3)	(模式 4)
領導特質	.650***	.295**		.039
領導效能			.419***	.394**
F	54.764***	7.124**	15.965***	7.923***
R^2	.422	.087	.176	.176
Adjusted R^2	.414	.075	.165	.154

註：*p<0.5 **p<.01 ***p<.001

4. 結論與建議

本研究發現：(1). 女性主管的領導特質對領導效能上均達顯著相關，這結果顯示出女性主管的領導特質越強，所呈現的領導效能越高，故假設H1成立。(2). 女性主管的領導特質對員工工作投入有顯著相關，顯示出在女性主管的領導特質領導下，員工的工作投入程度越高，故假設H2成立。(3). 女性主管的領導效能對員工工作投入有顯著相關，這結果顯示出女性主管以團隊歷程(效率與創新、

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與士氣凝聚力)來帶領員工的方式，讓員工們的工作投入程度越高，故假設H3成立。(4). 女性主管除了領導特質(互動與包容、授權與賦能)外，更須透過團隊歷程(效率與創新、與士氣凝聚力)的方式，使員工工作投入程度提高，故假設H4成立。

當然，女性管理者應具備雙性優勢，這是女性人才未來發展的方向，也就是說，在具備女性優勢的同時，也必需要具備一些男性的優秀品質，具親和力而不失原則，注重細節而不失全局，擅長打理而不失決斷力，不斷提升自己的特質領導能力。

最後，中介效果方面，本研究具有發現性的價值，從分析結果而言，若要預測員工的工作投入，女性主管的領導特質(互動與包容、授權與賦能)對員工的工作投入可以有顯著的預測效果。但若透過領導效能的團隊歷程(效率與創新、與士氣凝聚力)，會更增女性主管對員工工作投入的影響程度。所以，女性主管除了本身具有的特質外，還必須透過領導效能來輔助呈現，以激勵員工更加投入工作。

女性柔性化的領導模式將絕對是未來的發展趨勢；權威型與命令型的男性領導模式，已即將被人性化、情感化的領導模式所取代，由於女性具有感情細膩的心理特點並善於把這一優勢融入管理之中，融合了男女兩性的特質，形成了女性獨特的管理風格。事實上，在成功女性的身上，既有女性的溫柔、細膩、洞察、富於情感的一面，又有男性的剛強、果斷、勇敢、意志堅定的一面。

参考文獻

1. 李秀珠、林乾文，1998：《領導型態、性別、與領導效能》，中華傳播學會。
2. 黃麗蓉，1996，「組織中的女性領導」。人事管理33 卷6 期：頁19-25。
3. 蔡青宏，1996，「企業主管領導效能評量之研究」，國立成功大學企業管理研究所碩士論文。
4. 鄭勝文，2003，「空軍飛機修護基層主管領導型態與領導效能關係之研究」，國立中正大學企業管理研究所碩士論文。
5. Allport G. W., 1947, “The psychology of participation”, Psychological Review,

ISSN 2076-9202

54(3), pp142-158.

6. Carr-Rufino, N., 1993. “The promotable woman: advancing through leadership skills”. Belmont, CA: Wadsworth.
7. Cronbach, 1951, “Coefficient Alpha and the Internal Structure of Tests” (*Psychometrika v. 16 no. 3*).
8. Dubin, R., 1956, “Industrial Worker’s Worlds: A Study of the Central Life Interests of Industrial Workers”, Social Problems, Vol. 3, pp131-142.
9. French, J. R. P., Jr., & Kahn, R.A., 1962, “Programmatic Approach to Studying the Industrial Environment and Mental Health”, Journal of Social Issues, Vol. 18, pp1-47.
10. Gerbing, David W. and James C. Anderson., 1988, “An Updated Paradigm for Scale Development Incorporating Unidimensionality and Its Assessment”, *Journal of Marketing Research*, 25 (May), 186-92.
11. Grant, J., 1988. “Women as managers: what they can offer to organizations”. Organizational Dynamics, 56–63.
12. Helgeson, S., 1995, “The female advantage: women’s ways of leadership”. New York: Doubleday/Currency.
13. Hair, J. F., Jr., Anderson, R. E., Tatham, R. L., & Black, W. C., 1998. “Multivariate
data analysis with readings” (5th ed.). Englewood Cliffs, NJ: Prentice Hall.
14. Lawler, Edward E.; Hall, Douglas T., 1970，”Relationship of job characteristics to job involvement, satisfaction, and intrinsic motivation”. Journal of Applied Psychology. Vol 54(4), Aug, 305-312.
15. Loden, M., 1985, “Feminine leadership: or how to succeed in business without being one of the boys”. New York, NY: Times Books.
16. Rabinowitz, S., & Hall, D. T., 1977, “Organizational Research on Job Involvement”, Psychological Bulletin, Vol. 84, No. 2, pp265-288.
17. Richeson, J.A. & Ambady, N., 2001, “Who’s in charge? Effects of Situational Roles on A Bartol”, K. M., Martin, D. C., Kromkowski, J.A., 2003, Leadership and the Glass.
18. Rosener, J. B., 1990, “Ways women lead. Harvard Business Review”, 68(6), 119–125.
19. Rosener, J. B.,1995, “America’s competitive secret: utilizing women as a

management strategy". New York, NY: Oxford Univ. Press.

20. Siegel, L., 1969, "Industrial Psychology", Rev. Ed, Homewood, ILL: Irwin.
21. Yukl, G., 2002, "Leadership in organizations". Upper Saddle River, NJ: Prentice-Hall.p.412.

ISSN 2076-9202