Gearing Multiple Cost Drivers of Activity-Based Costing Into Operating Leverage Model for Better Production and Profit Planning Decisions

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In traditional calculations of the operating leverage factor, only volume-based cost drivers are taken into consideration. The aim of this paper is to show how use of the traditional approach to calculating operating leverage factor could lead managers to make irrational or inaccurate profit and production planning decisions. In addition, this paper aims to explain how theoretical assumptions of activity-based costing can be combined with traditional ones to create a new model for calculating operating leverage factor. Furthermore; it will be shown, with the help of a numerical example, how the use of a revised model could lead to better production and profit planning decisions than those produced by traditional models.

Operating leverage factor is used to measure the firm's operating leverage at a particular sales volume (Hilton, 2005; Hilton, Maher, & Selto, 2000; Horngren, Foster, & Datar, 2003). Under traditional costing systems, the output level is the only cost driver (Horngren et al, 2003; Johnson, 1990; Cooper & Kaplan, 1991). Therefore, traditionally, total costs are separated into a fixed component which does not change with the output level and a variable component which varies with respect to the output level (Hilton, 1999; Horngren et al, 2003; Hilton et al, 2000). This approach is consistent with the traditional costing systems which were designed for production systems with low levels of technology and overhead costs. (Chen, 1996).

A great deal of overhead costs comprises activity costs represented by non-volume-related cost drivers in new automated production environments (Cooper & Kaplan, 1988). This is due to the high cost of complexity caused when companies started to add capital-intensive and custom-made products with rapidly-growing varieties to their product lines as a result of changing needs of customers in the last forty years (Johnson, 1991). The rapidly growing overhead costs of companies after the 1950s were driven by the number of batches and number of product lines produced rather than units of output (Cooper, 1990).

Resources consumed by batch-level and product-level activities do not change at unit level. Whereas batch-level and product-level costs are accepted as fixed costs in traditional costing systems, they are accepted as variable costs in activity-based costing systems (Cooper & Kaplan, 1991). Nevertheless, the traditional approach to the calculation of operating leverage factor treats setup, inspection, material handling, engineering and similar batch-level and product-level activity costs as fixed with respect to the number of units produced. Since the traditional leverage model takes only volume-based cost drivers into account, the operating leverage factor is assumed not to change at different levels of sales volume within the relevant range of fixed costs. However, changes in batch and product-level cost-driver activity levels result in changes in the batch and product-level costs. Therefore, a modified model taking into account multiple cost drivers of activity-based costing (ABC) can be a better model than the traditional one used to calculate operating leverage factor.

Considering the importance of the issue, this paper, aims to show for the first time, the importance of integrating the multiple cost drivers of ABC into traditional operating leverage model. Thus, the motivation of pursuing such research is that it is unique in that it analyzes the effects of modified operating leverage model with a numerical example on particular managerial decisions. This study is organized as follows: The second section summarizes the related literature of activity-based costing; the third section explains formulation of the activity-based operating leverage model; section four shows, with a numerical example, how the enhanced activity-based operating leverage model yields different results when compared to the traditional one in calculating operating leverage factor; section five of the study suggests managerial implications of the revised formulation; and section six is devoted for the conclusions of the study.

Activity-Based Costing

Traditional costing systems employing volume-based cost drivers in allocating overhead costs have lost relevance in the automated production environments. These production environments have experienced a significant increase in overhead costs and subsequent decline in direct labor costs (Gunesekaran, Marri & Yusuf, 1999).

Activity-based costing was promoted by Cooper and Kaplan in the mid-1980s, based on their experiences with some production companies in the USA. Subsequent studies dealt with the deficiencies of traditional costing systems in the automated production environments (Russell, Patel, & Wilkinson, 2000; Innes, 1999; Baird, Harrison, & Reeve, 2004; Özbayrak, Akgün, & Türker, 2004). The activity-based approach to overhead costs is the extension of the traditional volume-based costing that treats manufacturing overhead as a complex set of costs with multiple cost-drivers (Drake, Haka, & Ravenscroft, 2001). ABC focuses on individual activities as the cost objects (Hicks, 1999).

The basic premise of ABC is that products consume activities, activities consume resources and resources consume costs (Cooper & Kaplan, 1988; Baxendale, 2001; Aderoba, 1997; Gosselin, 1997). One of the developments in the theory of ABC in the 1990s was the hierarchical classification of the activities performed at different levels such as unit, batch, product, and facility (Hilton, 1999; Lere, 2002; Colwyn & Dugdale, 2002; Ben-Arieh & Qian, 2003). The resources are consumed by the activities performed within an organization (Cooper & Kaplan, 1991; Schniederjans & Garvin, 1997).

Costs, like activities, may be classified as one of the many types depending on the kind of decision to use resources: unit, batch, product, and facility-level costs (Drake et al, 2001; Gunasekaran & Sarhadi, 1998). Classification of activities in this manner portrays the ability of ABC to recognize the causal relationship between the resources and activities. This, in turn, leads to an understanding that volume-based cost drivers are not the sole cost-drivers. In other words, some costs which are accepted as fixed with respect to the volume-based cost drivers under traditional costing systems are, in fact, variable with respect to some other cost drivers such as number of batches of products and number of design specifications (Hilton, 1999). As a result, operating leverage analysis with the multiple cost drivers of ABC is likely to provide managers with a much more complete picture of the behavior of the costs.

Activity-Based Approach to Measuring Operating Leverage

The traditional approach to measuring operating leverage is based on the assumption that only volume-based cost drivers determine how costs behave. Therefore; facility-level, product-level, and batch-level costs are assumed not to change at a specific level of sales within the relevant range. Theoretical assumptions on which the traditional operating leverage model is based are listed as follows (Horngren et al, 2003):

1. The number of output units is the only revenue driver and the only cost driver
2. Total costs are separated into a fixed component that does not vary with the output level and component that is variable with respect to the output level
3. The behaviors of total revenues and total costs are linear
4. Selling price, variable cost per unit, and fixed costs are constant
5. All revenues and costs can be added and compared without taking into account the time value of money

Based on the assumptions mentioned above, the traditional operating leverage model is derived as follows (Horngren et al, 2003):

$$\textit{Traditional Operating Leverage Factor} = \frac{\textit{Contribution Margin}}{\textit{Net Income}} \quad (1)$$

That is;

$$OLF = \frac{TR - TVC}{TR - TC} \quad (2)$$

or,

$$OLF = \frac{[(P \times Q) - (v \times Q)]}{[[(P \times Q) - [(v \times Q) + \mathrm{FC}]]} \quad (3)$$

Where,
OLF = *Operating leverage factor*
TR = *Total revenue*
TVC = *Total variable costs*
TC = *Total costs*
P = *Selling price per unit*
Q = *Number of units produced and sold*
V = *Traditional variable cost per unit*
FC = *Traditional fixed costs*

Under activity-based costing theory, however, batch-level and product-level costs which are accepted as fixed under traditional approach may vary at different levels of sales volume with respect to factors such as number of production runs and number of design specifications, rather than the number of units of product produced within the relevant range. That is why predicting total costs in the analysis of operating leverage will require multiple cost drivers such as the number of setups, number of output units, and the number of design specifications. Based on that reality, therefore, activity-based assumptions on which the enhanced operating leverage model is to be based are considered as follows:

1. Only facility-level costs are accepted as real fixed costs which do not vary with any cost driver activity level within the relevant range.
2. Even though batch-level and product-level costs are assumed to be fixed with respect to number of units produced and sold which is the sole cost driver under traditional costing systems, they are variable with respect to cost drivers other than production volume such as number of setups or number of design specifications.
3. Selling price, variable cost per unit, facility-level costs, batch-level costs per batch cost driver activity level, and product-level costs per product cost driver activity level are assumed not to change within the period and relevant range.
4. All revenues and costs can be added and compared without taking into account the time value of money.
5. The behavior of total revenues and total unit-level costs are linear in relation to output level within the relevant range.

Based on the above assumptions, estimation of the costs under activity-based costing can be expressed as follows:

Total Budgeted Costs = [(Number of Units × Unit-Level Cost Per Unit) + (Batch Cost × Batch CDA) + (Product Cost × Product CDA) + (Facility-Level Costs)]

Where,
CDA = Cost driver activity (e.g., number of batches, number of design specifications)

Consideration of multiple cost drivers within the context of ABC, as shown in the above equation, will have a significant impact on the model used to calculate the operating leverage factor. As the traditional model shows, total costs are composed of total fixed costs and total variable costs. If we include the activity-based costs, on the other hand, by introducing unit-level costs, batch-level costs, and product-level costs to equation (3), equation (4) will emerge as Activity-Based operating leverage model as follows:

$$Activity\ Based\ OLF = \frac{[(P \times Q) - (ULC \times Q)]}{[[(P \times Q) - [(ULC \times Q) + (BC \times BCDA) + (PC \times PCDA) + FLC]]} \quad (4)$$

Where;
P = *Selling price per unit*
Q = *Number of units produced and sold*
ULC = *Unit-level costs per unit*
BC = *Batch cost*
BCDA = *Number of batch-level cost driver activity*
PC = *Product costs*
PCDA = *Number of product-level cost driver activity*
FLC = *Facility-level costs*

Due to the classification of costs under activity-based costing, batch-level and product-levels costs are separated from facility-level costs in an activity-based model while they are all combined and regarded as fixed costs in a traditional one. This is due to the fact that only batch-level and product-level costs are the parameters of the operating leverage model which are treated differently under traditional and activity-based costing systems. Facility-level costs are not expected to change with a change in the level of any CDA within the relevant range under both costing systems. Unit-level costs, likewise, are treated the same way under both models because under both traditional and activity-based assumptions, these costs are assumed to change in direct proportion solely to a change in volume. Calculation of contribution margin, therefore, is the same under both the Traditional and the Activity-Based models.

Since only the batch-level and product-level costs are the parameters which are treated differently under traditional and activity-based costing systems while the other parameters of the leverage model (selling price, unit-level costs, and facility-level costs) are treated the same way, they are the ones which constitute the basic difference between the traditional and the activity-based operating leverage models. In other words, such activity-based parameters as unit-level and facility-level costs remain the same in the modified model as they are in the traditional one. However, batch-level and product-level costs are the activity-based parameters that should be modified in the new model.

If product and batch-level activities exist in the production environment, both batch-level and product-level parameters should be added to the enhanced model. If either of the batch-level or product-level activities does not exist in the production environment; batch or product-level parameters, whichever doesn't exist, can be eliminated from the enhanced model. If, on the other hand, batch-level or product-level parameters are eliminated from the enhanced model and they are combined with facility-level costs even though they exist, likely changes in the number of product or batch CDA are ignored. In this case, possible fluctuations in the OLF due to the changes in the batch-level and product-level costs are to be overlooked. Whenever the enhanced model taking into account the multiple cost drivers works better than the traditional one, managers are to be better equipped for more accurate production and profit planning decisions.

In the following section, a numerical example is used to show the difference between the traditional and the activity-based models in calculating OLF.

Numerical Example

In this section, a hypothetical example is used to show how the activity-based approach to calculating the operating leverage factor could provide managers with more realistic results. Table 1 is assumed to represent the actual costs classified with respect to activities, selling price per unit, number of batch and product CDA levels, number of units produced, total revenue, and total profit related to the subject period:

Table 1: *Hypothetical data needed for calculating the operating leverage factor*

Facility-Level Costs (a)	$40,000
Product-Level Costs (b)	$30,000
Batch-Level Costs (c)	$20,000
Unit-Level Costs (d)	$25,000
Number of units actually produced and sold (e)	5,000 Units
Number of batch-level CDA	200
Number of product-level CDA	100
Selling price per unit (f)	$40
Total revenue (g) {e × f}	$200,000
Total profit {g-[a + b + c + d]}	$85,000

By using the data in Table 1, the operating leverage factor for the subject period can be calculated with traditional model as follows:

$$OLF = \frac{Contribution\ Margin}{Net\ Income} = \frac{TR - TVC}{TR - TC} = \frac{\$200{,}000^{*} - \$25{,}000^{**}}{\$200{,}000^{*} - \$115{,}000^{***}} = 2.058$$

* 5,000 units × $40
** Unit-level costs
*** Facility-level Costs + Batch-level Costs + Product-level Costs + Unit-level costs

If the managers continue to use the traditional model, they are still likely to assume that facility-level, product-level, and batch-level costs will not change in the coming period at different levels of volume as long as production volume is within the relevant range. Thus, regardless of the budgeted number of batch and product CDA levels, batch-level and product-level costs are expected to be fixed in the coming period. In this case, the operating leverage factor at a specific volume of sales within the relevant range for the coming period is calculated as 2.058.

The calculations made above indicate that a one percent change in sales will produce a 2.058 percent change in profit at a specific volume of sales within the relevant range. For example, a 10% increase (from 5000 units to 5500 units) in sales is expected to increase profit by 20.58% (2.058 times the 10 percent sales rise).
As long as production volume is within the relevant range in the coming period, the operating leverage factor is expected to remain as 2.058 at different levels of volume.

In these calculations, however, non-volume-related cost drivers are omitted. That is, possible variations in the costs due to changes in the number of batch and product CDA levels are ignored. In this case, a 10% increase (from 5000 units to 5500 units) in sales volume is expected to yield a 20.58% increase in profit only if the number of batch-level and product-level CDA in the coming period will not be different from the one of the current period.

However, the number of batch-level and product-level CDA is independent of production volume. That is, the number of batch-level and product-level CDA may change regardless of the volume of sales within the relevant range. If the number of batch-level or product-level CDA, at a specific volume of sales, will be different in the coming period from the one of the current period, the amount of batch-level or product-level costs will also be different. As a result, a 10% increase in sales volume will not be able to produce a 20.58 % increase in the profit level due to changes in batch-level or product-level costs. In this case, the operating leverage factor should be re-calculated to reflect the changes in batch-level and product-level costs.

For example, if numbers of batch and product-level CDA levels at a specific volume of sales (e.g. 5000 units) are expected to be 240 and 130, respectively, in the coming period, calculation of operating leverage factor with activity-based model is shown below:

$$OLF = \frac{[(P\ x\ Q) - (ULC\ x\ Q)]}{[[(P\ x\ Q) - [(ULC\ x\ Q) + (BC\ x\ BCDA) + (PC\ x\ PCDA) + FLC]]}$$

$$OLF = \frac{[(\$40\ x\ 5000) - (\$5^{*}\ x\ 5000)]}{[[(P\ x\ Q) - [(ULC\ x\ Q) + (BC\ x\ BCDA) + (PC\ x\ PCDA) + FLC]]}$$

* $25,000÷5000 units
** $20,000 ÷ 200
*** $30,000 ÷ 100

As can be seen above, fixed costs (facility-level, product-level, and batch-level costs) are expected not to change despite the expected changes in the number of batch-level and product-level CDA. In this case, the activity-based model results in an operating leverage factor of 2.430. The traditional model, on the other hand, results in an operating leverage factor of 2.058 under the same circumstances. As a result, the activity based model predicts that a 10% increase in sales is expected produce 24.30% (2.430 times 10 percent sales rise) increase in profit.

These computations are based on the assumption that the numbers of batch and product CDA levels, in the coming period, are expected to be 240 and 130 respectively. Since product-level and batch-level costs change at different CDA levels, the operating leverage factor will vary at different batch and product CDA levels, provided that unit selling price, unit-level costs per unit, and facility-level costs are the same in the coming period (as seen in Table 2).

In Table 2, calculations of operating leverage factor with the traditional and the activity-based models at different product and batch CDA levels are shown:

Table 2: *Calculation of operating leverage factor with activity-based and traditional models at different product and batch CDA levels*

	Activity-Based Model	
Operating Leverage Factor	Number of Batch CDA Level	Number of Product CDA Level
1.966	220	80
2.397	200	140
2.083	180	110
2.651	240	150
2.011	210	90
1.923*	150	120
2.058	200	100
	Traditional Model	
Operating Leverage Factor	Number of Batch CDA Level	Number of Product CDA Level
2.058	220	80
2.058	200	140
2.058	180	110
2.058	240	150
2.058	210	90
2.058	150	120
2.058**	200	100

$$*OLF = \frac{[(P \times Q) - (ULC \times Q)]}{[[(P \times Q) - [(ULC \times Q) + (BC \times BCDA) + (PC \times PCDA) + FLC]]}$$

$$OLF = \frac{[(\$40 \times 5000) - (\$5 \times 5000)]}{[(\$40 \times 5000) - (\$5 \times 5000) + (\$100 \times 150) + (\$300 \times 120) + 40{,}000]]}$$

$$**OLF = \frac{\text{Contribution Margin}}{\text{Net Income}} = \frac{TR - TVC}{TR - TC} = \frac{\$200{,}000^{*} - \$25{,}000^{**}}{\$200{,}000^{*} - \$115{,}000^{***}} = 2.058$$

As portrayed in Table 2, when the operating leverage factor is calculated with the traditional model, it is expected to be 2.058 regardless of the budgeted number of product and batch CDA levels at a specific sales volume within the relevant range. On the other hand, when the calculation is made with the activity-based model, the operating leverage factor varies at different product and batch CDA levels. For example, if the numbers of batch and product CDA levels are expected to be 150 and 120, respectively, in the coming period, the traditional model calculates the operating leverage factor as 2.058. The activity-based model, on the other hand, calculates the operating leverage factor as 1.923 under the same circumstances.

Even though the number of batch CDA level is expected to fall from 200 to 150 and the number of product CDA level is expected to increase from 100 to 120, the traditional model still assumes that batch-level and product-level costs will not change. If the number of batch and product CDA levels will not be different from those of the current period, there will not be any change in batch-level and product-level costs. In this case, both traditional and activity-based CVP analyses will find the equal budgeted amount of product-level and batch-level costs. Since the facility-level costs are assumed not to change within the relevant range under both of the methods, total budgeted amount of facility-level, product-level, and batch-level costs will be the same under both the traditional and activity-based CVP analysis. Thus, traditional and activity-based models will yield the same result.

In summary, the traditional and activity-based models produce different results if the following conditions are met in the production environment:

- Batch-level or product-level activities exist in the production environment.
- Number of batch or product CDA levels in the following period is to be different from that of the current period.

In order for the traditional and activity-based models to produce different results from each other, both of the above conditions must exist simultaneously. If the batch-level or product-level activities exist in the production system, it means that the batch-level or product-level costs also exist in the same production system. In this case, changes in batch or product CDA levels result in changes in batch-level or product-level costs. Whereas these changes are taken into consideration by the activity-based model, they are ignored by the traditional one. Different treatment of batch-level and product-level costs results in different procedures for budgeting costs.

On the other hand, both models yield the same results under the following conditions:

- Batch-level and product-level activities do not exist in the production environment.
- Even though batch-level or product-level activities exist in the production environment, the number of product and batch CDA levels, in the coming period,

If there is no batch-level and product-level activity performed within the production environment, the batch-level and product-level costs do not exist. In this case, there is no likelihood for the traditional and activity-based models to find different amounts of budgeted costs. If the number of batch or product CDA levels is not to be different in the coming period from the ones in the current period, the batch or product-level costs are not likely to change. Thus, the traditional and activity-based models do not find different amounts of budgeted costs.

Decision Implications of the Activity-Based Operating Leverage Model

If the above conditions are met, use of activity-based operating leverage model could result in more rational and accurate profit and production planning decisions than the traditional model. As can be seen in Table 1, total amount of sales revenue and profit for the current period are assumed to be $200,000 and $85,000 respectively. If the managers of the above mentioned hypothetical company want to increase the level of production, they would want to see the net effect on profit of that increase in production and sales level so that they can make their plans accordingly. As calculated in Table 2, OLF is assumed to be the same (2.058) at different batch and product CDA levels. Therefore, expected change in profit will seem to be the same regardless of the number of batch and product CDA levels. On the other hand; if batch or product CDA levels are to change independent of the production level, calculation of OLF with traditional model could be misleading as explained above. Thus, as long as production volume is within the relevant range in the coming period, the operating leverage factor is expected to remain as 2.058 at different levels of volume.

In that case, managers could assume that a one percent change in sales will produce a 2.058 percent change in profit at a specific volume of sales within the relevant range. For example, a 10% increase (from 5000 units to 5500 units) in sales is expected to increase profit by 20.58% (2.058 times the 10 percent sales rise). In this case, managers would make production planning decisions accordingly. For example, managers would think that they should increase production level by 14.57% (30%÷2.058) if they want to increase profit by 30% in the coming period. Thus, they will increase production from 5,000 units to 5,728 {(5,000 × 14.57%) + 5,000} units to achieve that 30% increase in the profit level. In this regard, production planning decisions and arrangements are to be made to produce 5,728 units to attain 30% increase in profit. In this sense, depending on the desired profit level, production planning decisions will mainly be based on the OLF. Therefore, inaccurate OLF could result in irrational production planning decisions.

As mentioned above, calculations under traditional model are made by assuming that batch-level, product-level, and facility-level costs do not change as long as production volume is within the relevant range. However; when the activity-based parameters are integrated into the traditional model, it is understood that even though facility-level costs remain the same within the relevant range, batch-level and product-level-cost may stray from their current amounts depending on the factors other than production volume which is the sole cost driver under traditional costing systems. Thus, if the quantity of the factors that result in changes in batch-level and product-level costs varies in the coming period, traditional model calculates inaccurate OLF. For example, as can be seen in Table 2, if the quantity of batch-level and product-level CDA levels in the coming period are expected to be 150 and 120 respectively, OLF is calculated as 1.923 with activity-based model. In this sense, managers would think that they should increase production level by 15.60% (30%÷1.923) if they want to increase profit by 30% in the coming period. Thus, they will increase production from 5,000 units to 5,780 {(5,000 × 15.60%) + 5,000} units to achieve that 30% increase in the profit level. On the other hand, with traditional model it is still calculated as 2.058. In this case, the company will not be able to attain a 30% increase in the level profit by producing 5,728 units as calculated under traditional assumptions, due to changing batch-level and product-level costs. As calculated with the revised model, the company should produce and sell 5,780 units rather than 5,728 units to reach 30% increase in the level of profit. In this case, OLF should be re-calculated and a revised new model and production planning decisions should be reconsidered.

Table 3 makes the comparison between the traditional and the activity-based models in term of the quantities of output that should be manufactured, at different batch and product CDA levels, to achieve 30% increase in the level of profit in the coming period:

Table 3: *Calculation of output level required to attain 30% increase in profit with activity-based and traditional models at different product and batch CDA levels*

Activity-Based Model			
Operating Leverage Factor*	Number of Batch CDA Level	Number of Product CDA Level	Planned Output Level
1.966	220	80	5,763
2.397	200	140	5,626
2.083	180	110	5,720
2.651	240	150	5,566
2.011	210	90	5,746
1.923	150	120	5,780†
2.058	200	100	5,728
Traditional Model			
Operating Leverage Factor*	Number of Batch CDA Level	Number of Product CDA Level	Planned Output Level
2.058	220	80	5,728
2.058	200	140	5,728
2.058	180	110	5,728
2.058	240	150	5,728
2.058	210	90	5,728
2.058	150	120	5,728
2.058	200	100	5,728

* See Table 2
†{(5,000 × 15.60**%) + 5,000}
** 30%÷1.923

As can be seen from Table 3, output level doesn't change regardless of the number of batch and product CDA levels when calculations are made with traditional model. However; when the activity-based model is used, planned output level changes at different batch and product CDA levels. That is, as batch or product CDA levels change the production levels required for achieving a 30% increase in profit also change. By considering these differences, managers should take into consideration the expected changes in batch and product CDA levels in calculating OFL which will in turn have significant influence on production planning decisions. Likewise, when managers want to analyze the percentage increase in the profit at alternative production volume levels via OLF, they may be misled if they use a traditional model. As shown previously, OLF was calculated with the traditional model as 2.058 regardless of the numbers of batch and product CDA levels as long as production volume is within the relevant range. Therefore, a one percent change in sales is expected to yield a 2.058 percent change in profit at a specific volume of sales within the relevant range. For example, a 10% increase (from 5000 units to 5500 units) in sales is expected to increase profit by 20.58% (2.058 times the 10 percent sales rise). However; if the same calculations are made with the activity-based model, different results emerge at different batch and product CDA levels. Table 4 presents the differences between traditional and activity-based operating leverage models in calculating expected percentage change in profit at a production level of 5,500 units.

Table 4: *Calculation of expected change in profit at a planned output level of 5,500 units with activity-based and traditional models at different product and batch CDA levels*

Activity-Based Model				
Operating Leverage Factor*	Number of Batch CDA Level	Number of Product CDA Level	Planned Output Level	Expected Change in Profit (%)
1.966	220	80	5,500	19.66
2.397	200	140	5,500	23.97
2.083	180	110	5,500	20.83†
2.651	240	150	5,500	26.51
2.011	210	90	5,500	20.11
1.923	150	120	5,500	19.23
2.058	200	100	5,500	20.58
Traditional Model				
Operating Leverage Factor*	Number of Batch CDA Level	Number of Product CDA Level	Planned Output Level	Expected Change in Profit (%)
2.058	220	80	5,500	20.58
2.058	200	140	5,500	20.58
2.058	180	110	5,500	20.58
2.058	240	150	5,500	20.58
2.058	210	90	5,500	20.58
2.058	150	120	5,500	20.58
2.058	200	100	5,500	20.58

* See Table 2
† 10††% × 2.083
†† Planned change in production level

As can be seen in Table 4, a 10% increase in the production level is expected to produce a 20.58% increase in the profit level regardless of the batch and product CDA levels as long as production volume is within the relevant range. If calculations are made with an activity-based model, on the other hand, a 10% increase in production volume could produce higher or lower increase in profit than 20.58% depending on the number of batch and product CDA levels, which is not taken into consideration by traditional models. Thus, the activity-based operating-leverage model could be a better tool for managers to make more rational and accurate production and profit planning decisions. If, for example, batch and product CDA levels are to be 200 and 140 respectively in the coming period, expected change in profit is calculated as 23.97% by the activity-based model even though it is still calculated as 20.58% with the traditional model. In this case, profit planning decisions will be based on inaccurate calculations.

Conclusions

Operating leverage factor is used to measure the firm's operating leverage at a particular sales volume. However, the traditional approach that employs only volume-based cost-drivers may fall short in calculating OLF in automated production environments. Therefore, the use of a model which takes multiple cost-drivers into consideration will result in more rational decisions than the traditional model in the automated production environments where non-volume related costs incur. This paper has explained, with a numerical example, how the enhanced activity-based model produces different results from those of a traditional one in the calculation of OLF. Inaccurate calculation of OLF, in turn, results in inaccurate production and profit planning decisions. If the batch-level or product-level activities exist within a production environment, and if the number of batch or product CDA levels in the coming period is to be different from the one of the current period, the traditional and the activity-based models will yield different results in calculating the OLF. Thus if both of the conditions mentioned above are met, use of the activity-based model rather than the traditional one could result in more accurate production and profit planning decisions. If, on the other hand, batch-level and product-level activities do not exist in the production environment, use of the activity-based model does not produce different results from the traditional model. Likewise, even though batch-level or product-level activities exist in the production environment, if the number of product and batch CDA levels in the coming period is the same with those of the current period, again both the traditional and the activity-based model do not produce different results. In that case, fortunately, the traditional operating leverage model does not mislead managers in making decisions.

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