

Predicting Total Assembling Time for Different Apparel Products Utilizing Learning Curve and Time Study Approaches: A Comparative Case Study

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Keywords: Apparel, production, learning-curve, time-study

Background: When an apparel design remains the same and production is labor-intensive and repetitive in nature, average labor time geometrically decreases with the increase in production volume (up to a certain level). This is known as learning curve— a tool for estimating cost, production time and learning rate, and could be used to coordinate planning between allocated time for apparel assembling and meeting deadlines (Stevenson, 2014). In contrast, time study— a work measurement technique, appropriate for short and repetitive tasks, is employed for estimating the production time and working rate at a defined level of performance (Glock, 2009). In reality, it is difficult to determine a certain level of performance for apparel assembling process, not only because of its short, manual and recurring nature, but also the performance level varies according to the workers' skills and stages of assembling- introduction, adoption, and optimum. Therefore, the time allocated for apparel assembling during planning often becomes short and jeopardizes the delivery date. Learning curve approach was first observed in the aircraft industry (Wright, 1936) and later it has been documented in many other industries (e.g., shipping, power plant, nuclear plant, petroleum, chemical processing, semiconductor, etc.). Many articles have investigated operator performance, predicting standard cycle time by learning curve approach (e.g., Bevis, Finnlear, & Towill, 1970; De Jong, 1957). Surprisingly, no previous research has been found where time is predicted by learning curve approach in the apparel assembling process. In this comparative study, both learning curve and time study approach were used in the apparel assembling process to determine which method better predicts the total assembling time.

At the beginning of apparel assembling process, operators take more time to accomplish an operation because it is unknown to them. But over time, operators repeat the operation and gain skill or efficiency from experience and eventually the operation requires less time. Learning from repetition decreases operation time up to the optimum stage (i.e., the best they can do). Learning curve is calculated based on time required to reach double the production units, because each time the production doubles, time per unit declines by a constant factor known as the learning rate (Stevenson, 2014). If the learning curve has an 85% rate (learning rate), the 2nd unit takes 85% of the time of the 1st unit, the 4th unit takes 85% of the time of the 2nd unit. From the theory of learning curve, two equations: $r = T_{2n}/T_n$ and $T_n = T_1 N^b$ (where, r = learning rate, T_n = time required for the n th unit, N = number of completed units, and b = slope of the learning curve) were implemented in this study.

Purpose: In this study, total assembling time for four products (cap sleeve T-shirt, tank top, polo shirt, and underwear) was determined through the learning curve and the time study approach.

Method: Four apparel products were selected from a particular apparel manufacturing firm. Since cycle time of each operation in apparel assembling process is very short in nature (sometimes couple of seconds), for this study one assembling unit represents 100 repetitive tasks. Since learning curve deals with double production, the actual hourly production, cycle time, and assembling time were collected for each operation (conducted by same operator) for units 1, 2, 4, 8, 16, 32, 64 from the introduction stage. Two equations from the learning curve approach and Standard Minute Value (SMV- standard minutes required for a qualified operator) from the time study approach were employed to determine individual operation's learning curve, learning rate and total assembling time of each product. Then the total assembling time prediction was made for total apparel quantity. Though, all operations reached optimum mostly from unit 16, the observation was continued for the rest of the production to ensure reliability and validity.

Finding: Comparison of actual assembling time with the predicted time using learning curve approach (over 90% accuracy) and SMV approach (around 60% accuracy), learning curve was the better predictor (see Table 1).

Table 1

Comparison Between Actual and Predicted Assembling Hours

	Number of operations/operators	Total apparel quantity	Actual assembling hours required	Total predicted assembling hours	
				By learning rate	By SMV
Cap sleeve T-shirt	38	1,00,000	430	442.2	289.02
Tank top	32	2,00,000	1140	1039.7	772.2
Polo shirt	60	50,000	450	389.8	255.1
Underwear	30	1,50,000	1020	1070.7	579.15

Conclusions and Implications: Since apparel assembling is the highest labor involvement process in apparel production, precise forecasting of total assembling time is crucial for any apparel business. This study finds the learning curve approach anticipates assembling time more precisely than time study approach which fosters right planning towards on-time delivery and creates a good brand-vendor relation. Also, it will help managers to set accurate hourly benchmarks from the assembling line- prerequisite for ensuring efficient production. However, predicting assembling time by this approach is not applicable for fashion apparel with entirely new design.

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