

PRODUCTIVITY IMPROVEMENT THROUGH MOTION AND TIME STUDY

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ABSTRACT

Over time, the pattern of economic competitiveness has changed globally. Many countries have joined the global economic competition to capture global market in order to remain profitable and competitive by increasing its productivity. There are many factors that influence the productivity of a manufacturing organisation. The most widely tackled issue is how to improve efficiency and productivity. Motion and time study technique is one of the productivity improvement techniques used in many manufacturing companies. Motion and time study is defined as a scientific analysis method designed to determine the best way to execute the repetitive task and to measure the time spent by an average worker to complete a given task in a fixed workplace. Motion and time study offers real challenges in organization involving competent engineers, business administrators, industrial relations personnel, especially trained supervisors, and psychologists. The purpose of this paper is to discuss related issues of motion and time study implementation and its influence toward productivity improvement. Data from a study carried out on a sample of manufacturing industries in Melaka shows that motion and time study implementation contributes positively towards achieving productivity.

KEYWORDS: Productivity Improvement, Motion and Time Study, and Manufacturing Organizations.

INTRODUCTION

Malaysia's manufacturing sector, which accounts for approximately 80% of exports and a third of gross domestic product, is officially projected to grow 10.2% in 2004 due to robust demand for electronics exports following the rebound in the global electronics markets (Cheong, 2004). However, there are fears that a managed economic slowdown in China could crimp Malaysia's export performance as China buys close to a tenth of Malaysia's exports. However, the Federation of Malaysian Manufacturers (FMM) rebuts this as it expects Malaysian manufacturers to step up exports to the Southeast Asian nations. Exports to fellow ASEAN members form about 27% of Malaysia's exports and FMM expects it to rise to 40%-50% in five years.

The emphasis on product quality, innovative designs, competitive pricing and efficient delivery continues to be important. The manufacturing sector is facing the challenges of technological advancement and the continuing need to move towards higher added value (Mah Lok Abdullah et al, 2003) and these are driven by: (1) Technological advances in Information and Communication; (2) The demand for knowledge workers to improve productivity. Development of the knowledge-based economy will contribute towards broadening the economic base with the shift of the production possibility frontier. They include the continuing investment in technology, innovation, management best practices, high specialization, as well as workers education, skills and experience.

The manufacturing sector needs to improve productivity through upgrading of its primary production technology. Technology can help to improve overall productivity in different ways through the reduction in production cycle time and costs and better production and process control. Manufacturing firms must achieve a degree of innovative capability in managing production operations, processes and capital equipment. They need to develop and adopt good management systems and practices such as Motion and Time Study, Total Productivity Maintenance, Total Quality Management, Just-In-Time Methodology, Supply Chain Management, etc.

This paper reports the main findings of a study of productivity improvement through motion and time study approach in a sample of Melaka manufacturing companies'. This study included extensive debriefings and data analysis to characterize sources of variability.

THE IMPORTANCE OF PRODUCTIVITY IMPROVEMENT

The only way a business or enterprise can grow and increase its profitability is by increasing productivity in all aspects of a business or industry including sales, finance, production, engineering, cost, maintenance, and management (Niebel, 1988). Important as the production function is, it should be remembered that other aspects of the enterprise also contribute substantially to the cost of operation and are equally valid areas for the application of the cost of improvement techniques.

According to Atkinson et al (1995) and Krajewski and Ritzman (1998), productivity is the value of outputs (goods or services) produced divided by the values of input resources (wages cost of equipment and the like) used:

$$\text{Productivity} = \frac{\text{Output}}{\text{Input}}$$

Based on Barnes (1980), productivity is a term that has number of different meanings although it is most commonly associated with labor effectiveness in industry. In a broad sense productivity is the ratio of output to some or all of the resources used to produce the output. Labour productivity may be defined as "output per unit of time" or "output per labour hour".

Labour productivity = units produced ÷ hours worked

Capital productivity = output ÷ capital input

Material productivity = output ÷ material input

Operation managers play a key role in determining productivity. Their challenge is to increase the value of output relative to the cost of input. If they can generate more output or output of better quality using the same amount of input, productivity increases (Krajewski and Ritzman, 1998). If they can maintain the same level of output while reducing the use of resources, productivity also increases. To profit from productivity improvement, management needs measurement procedures for monitoring productivity performance and identifying improvement opportunities (Miller, 1984).

MOTION AND TIME STUDY

The terms *time study* and *motion study* have been given many interpretations since their origin. Time study, originated by Taylor, was used mainly for determining time standards, motion study, developed by the Gilbreths, was employed largely for the same time, in the early days greater use was made of time study and wage incentive than motion study (Barnes, 1980). It was not until 1930s that a general movement got under way to study work with the objective of finding better and simpler methods of getting job done. Then there followed a period during which motion study and time study were used together, the two supplementing each other, and the combined term *motion and time study* came into use. The purpose of the motion and time study is to improve the effectiveness and the productivity of the work place.

Motion and time study offer real challenges. Industries with the competent engineers, business administrators, industrial relations personnel, specially trained supervisors, and psychologists carrying out motion and time study techniques are inevitably better able to meet competition and better equipped to operate profitably (Niebel, 1988).

According to Barnes (1980), motion and time study is the systematic study of work systems with the purposes of (1) developing the preferred system and method-usually the one with the lowest cost; (2) standardizing this system and method; (3) determining the time required by a qualified and properly trained person working at a normal pace to do a specific task or operation; and (4) assisting in training the worker in the preferred method. Motion and time study is composed of four parts:

- 1. Developing the Preferred Method / Work Methods Design.** In the broadest sense, every business and industrial organisation is concerned with the creation of goods and services in some form utilizing workers, machines, and materials. In a manufacturing plant, for example, the production process might include the procurement of the raw materials, the machining and fabrication of the part, and the delivery of the finished product. In designing such a manufacturing process, consideration would be given to the entire system and to each individual operation which would go to make up the system or process. The design of such a process employs the general problem-solving procedure such as the systematic approach, scientific method, or engineering approach. Method design therefore begins with the consideration of the purpose or goal to manufacture a specific product, to operate a cash-and-carry cleaning and pressing establishment, or to produce milk on a dairy farm. The objective is to design a system, a sequence of operations and procedures that make up the preferred solution.
- 2. Standardizing the Operation / Written Standard Practice.** After the best method for doing the work has been determined, this should be standardized. Ordinarily, the work is broken down into specific jobs or operations which are described in detail. The particular set of motion, the size, shape, and quality of material, the particular tools, jigs, fixtures, gauges, and the machine or piece of equipment should be definitely specified. All these factors, as well as the conditions surrounding the worker, must be maintained after they have been standardized. A written standard practice giving a detailed record of the operation and specifications for performing the work is the most common way of preserving the standard. A job is not measured until it has been defined.
- 3. Determining the Time Standard / Work Measurement.** Motion and time study may be used to determine the standard number of minutes that a qualified, properly trained, and experienced person should take to perform a specific task or operation when working at a normal pace. This time standard may be used for planning and scheduling

work, for cost estimating, or for labor cost control, or it may serve as the basis for a wage incentive plan. Although standard data, predetermined time systems, and work sampling are widely used for establishing time standards, perhaps the most common methods of measuring work is stop-watch time study or electronic time study. The operation to be studied is divided into small elements, each of which is timed with a stop watch. A selected or representative time value is found for each of these elements, and the times are added together to get the total selected time for performing the operation. The speed exhibited by the operator during the time study is rated or evaluated by the time study observer, and the selected time is adjusted by this rating factor so that a qualified operator, working at a normal pace, can easily do the work in the specified time. This adjusted time is called the normal time. To this normal time are added allowances for personal time, fatigue, and delay, the result being the standard time for the task.

4. **Training the Operator.** A carefully developed method of doing work is of little value unless it can be put into effect. It is necessary to train the operator to perform the work in the prescribed manner. Where but one or a few persons are employed on a given operation and where the work is relatively simple, it is customary to train the operator at the work place. The supervisor, the motion and time study analyst, a special instructor, or a skilled operator may act as the teacher. In most cases it is the supervisor who is responsible for training the operator, and the supervisor often depends upon the methods and standards department for assistance in this task. The written standard practice or the element breakdown sheet is a valuable aid to the supervisor in job training. When large numbers of employees must be trained for a single operation; the training is sometimes carried on in a separate training department. Charts, demonstration units, and motion pictures are frequently used to advantage in such a training program.

MOTION AND TIME STUDY AND PRODUCTIVITY

There is a body of knowledge which has evolved over the years that is designed to increase the productivity of an organisation and of the individuals who make up the organisation. Motion and time study has as its objective the elimination of unnecessary work, the design of methods and procedures which are most effective, which require the least effort, and which are suited to the person who uses them. Moreover, it provides methods of measuring work for determining a performance index or productivity index for an individual or for a group of workers, a department, or for an entire plant. Although industrial engineers and staff specialists ordinarily perform work in this field, there is a trend toward developing forms of work organisation in which motion and time study and the problem-solving process are used directly by the managers, supervisors, and the employees themselves. In the latter case they assume responsibilities for the design of jobs, determine work schedules, and verify the quality of the work they produce.

RESEARCH OBJECTIVES

The research was carried out in order to fulfil the following research objective:

- i. Evaluate the level of awareness of the Motion and Time Study for productivity improvement and the productivity priorities.
- ii. Identify the issues related to the implementation of the Motion and Time Study for productivity improvement.

Figure 1 shows the research framework used. First of all, the research evaluate the level of motion and time study awareness and productivity priorities among the respondents. Thus, this research identified the issues related to the implementation of motion and time study including reason of implementation, challenges, success factor etc.

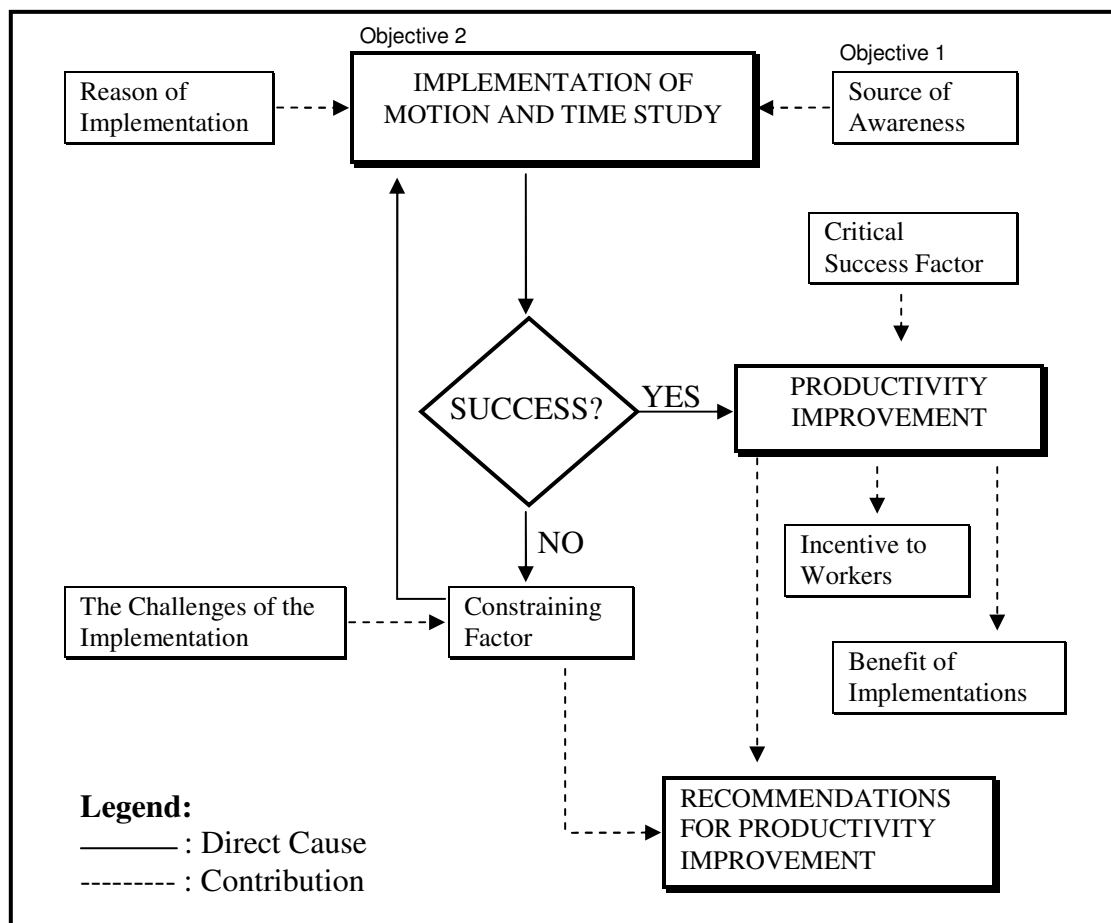


Figure 1: Research Framework

Model of productivity improvement through motion and time study is shown in Figure 2. The research carried out the productivity activities including productivity techniques and the priorities by companies profile through the problem in productivity and the issues. This research suggest the motion and time study technique for productivity improvement. Productivity improvement measured by the increasing of the index of productivty, annual turnover and market share.

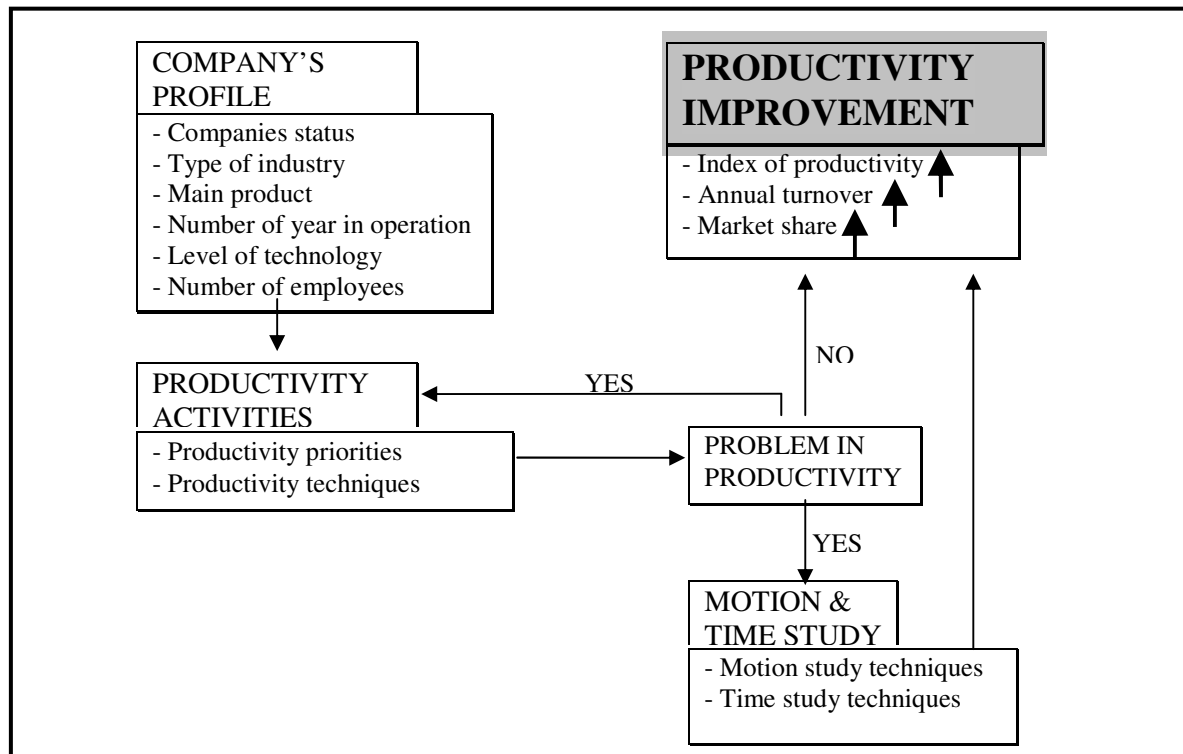


Figure 2: Model of Productivity Improvement through Motion and Time Study

DATA GATHERING

This study has focused on the companies involved in manufacturing activities and operating in Melaka. This study was undertaken by semi-structured interviews and questionnaire survey. The respondents of this survey include the middle managers, operation executives and senior managers. Samples were chosen from a list of companies in MITC (Melaka International Trade Centre) directory.

RESULTS AND DISCUSSION

Table 1 shows the main features of the respondents. In term of the type of manufacturing activities, the majority of the companies are involved in electrical and electronic industry. This is followed by those involved in manufacturing plastic products. The majority of the respondents are Malaysian based companies. Among the foreign-owned companies, the Japanese firms appear to have significant presence.

Most of companies (about 65%) appear to be mature, with more than 10 years in operation. Generally the respondents claim to have a moderate level of technology in place. The higher level of technological applications resides within the multinational companies.

Table 1: Respondents Profile

No	Items		Percentages (%)			Notes
			MNC	SME	Total	
1	Products Index	Electronic & Electrical	30.8	23.1	53.8	The main products index of manufacturing sector in Melaka Industries
		Engineering / Casting	3.8	7.7	11.5	
		Plastic	-	19.5	19.5	
		Iron & Steel Products	7.7	7.7	15.4	
2	Country of Origin	Malaysia	3.8	50.0	53.8	-
		Singapore	11.5	-	11.5	
		Taiwan	3.8	-	3.8	
		Japan	3.8	7.7	23.1	
		Others	7.7	-	7.7	
3	Number of Years In Operation	Less than 10 yrs	7.7	26.9	34.6	Mean = 17 years
		11 – 20 yrs	15.4	23.1	38.5	
		21 – 30 yrs	15.4	7.7	23.1	
		More than 30 yrs	3.8	-	3.8	
4	Number of Employees	Less than 100	-	19.2	19.2	Mean = 615
		101 – 300	3.8	23.1	26.9	
		301- 500	15.4	11.5	26.9	
		More than 500	23.1	3.8	26.9	
5	Annual Turnover	Less than 25 M	11.5	50.0	61.5	Count in Malaysian Ringgit (RM); M : Million Mean = RM58,134 615
		25 M – 49 M	7.7	7.7	15.4	
		50 M – 75 M	7.7	-	7.7	
		More than 75 M	15.4	-	15.4	
6	Level of Technology	Low Tech	-	11.5	11.5	Not computerized, Low application of modern tools
		Moderate Tech	15.4	46.1	61.5	Moderately computerized, Beginning to adopt automation
		High Tech	26.9	-	26.9	Highly computerized, Application of flexible automation

N = 26 (MNC = 11; SME = 15)

a. Productivity Priorities

As can be seen in Table 2, quality accounted for 22.0 percent of productivity priorities, followed by production (20.6 percent), cost (15.7 percent), time (13.9 percent), machine utilization (12.1 percent), workforces (11.1 percent), and flexibility (4.7 percent). Besides that, one of the respondents company was focused on innovative products as one of productivity priorities in their company. The score in Table 2 was counted by cumulative score base on respondent answers in questionnaire survey. The higher score shows the most priorities of productivity by Respondents Company. By the way, as can be seen in Table 2, it is easier to show the priorities of productivity by ranking.

Table 2: Productivity Priorities

No	Item	Score	Percent (%)	Ranking
1	Productions	150	20.6	2
2	Cost	114	15.7	3
3	Time	101	13.9	4
4	Workforces	81	11.1	6
5	Machine Utilization	88	12.1	5
6	Quality	160	22.0	1
7	Flexibility	34	4.7	7

N= 26

Score = Cumulative of rating score by respondent base on the productivity priorities

$$\text{Percent (\%)} = \frac{\text{Score}}{\Sigma \text{ Score}} \times 100.$$

b. Productivity Techniques

Table 3 shows the productivity techniques used by respondents. The companies mainly use Statistical Process Control (25.0 percent), Just in Time techniques (20.2 percent) and Total Quality Management (17.9 percent). Besides that, Motion and Time Study technique is ranked number 4 (12.9 percent), followed by FMEA (9.4 percent), MRP (9.4 percent) and the others (1.2 percent). The other techniques are Total Productivity Management (TPM), Quality Function Deployment (QFD) and Six Sigma Approach.

Base on the interview, the multinational companies implement their productivity techniques through the parent companies. The major factor affecting the implementation includes factory facilities, investment capital, experience employee etc. The production and operation activities in respondent companies are responsible to top management. Any decision of top management will change the productivity techniques used.

Table 3: Productivity Techniques used by Respondents

No	Item	Score	Percent (%)	Ranking
1	Motion And Time Study	10	38.5	4
2	Failure Mode and Effects Analysis (FMEA)	8	30.8	5
3	Just in Time System (JIT)	17	65.4	2
4	Total Quality Management (TQM)	15	57.7	3
5	Flexible Manufacturing Systems (FMS)	4	15.4	7
6	Material Requirement Planning (MRP)	8	30.8	5
7	Statistical Process Control (SPC)	21	80.7	1
8	Others	1	3.8	8

N = 26

Score = numbers of respondents whose implement the techniques listed above.

$$\text{Percent (\%)} = \frac{\text{Score}}{N} \times 100.$$

c. Productivity Measurement and Index of Productivity

Based on the questionnaire survey and interview, the respondent companies have their own productivity measurements and almost all of them do not use index of productivity. This is because, the Japanese companies especially used their own term of productivity measurement techniques. For all respondents, fulfilling the customer demand is very important compared to measures or something else which are not easy to implement. Unfortunately, the many respondents are not specify the measurement techniques used because of the confidently policy.

d. Productivity Issues

All the respondents faced many problems in improving productivity in their companies. There are many factors that contribute to the problem. The problems are:

- (1) Inconsistent production volume,
- (2) High operator turnover,
- (3) Resource constraint, and
- (4) Workers' skill and attitude.

e. Level of Motion and Time Study Awareness

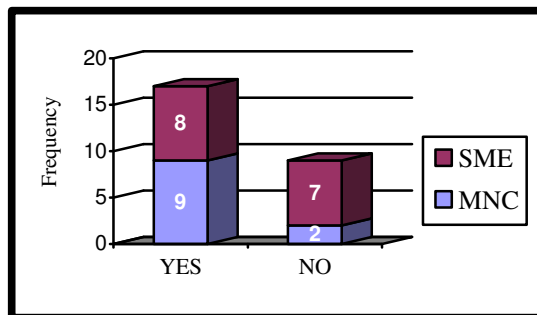


Figure 3a: Level of Awareness for Motion and Time Study

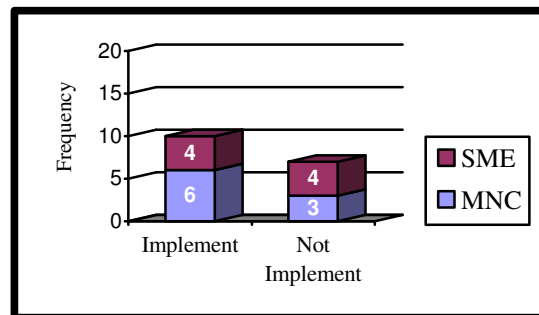


Figure 3b: Motion and Time Study Implementations

According to the Figure 3a, the level of awareness for motion and time study is “high”. It can be seen from Figure 3a, out of a total 26 respondents, 65.4 percent of them are aware about motion and time study compared 34.6 percent of them not aware of motion and time study as a technique for productivity improvement. The figure shows that almost of all MNC are aware about motion and time study compared to SME.

Figure 3b shows the motion and time study implementation of the respondents. From the figure, only 58.8 percent out of a total 17 respondents (which are aware of the motion and time study) implement motion and time study. MNC (35.3 percent) implement more compared to SME (23.5 percent). By the way, we can conclude that the level of implementation motion and time study among the respondents is still ‘Low’. This is because, only 38.5 percent of respondents implement motion and time study technique compared to other techniques (refer Table 3).

f. The Sources of Awareness

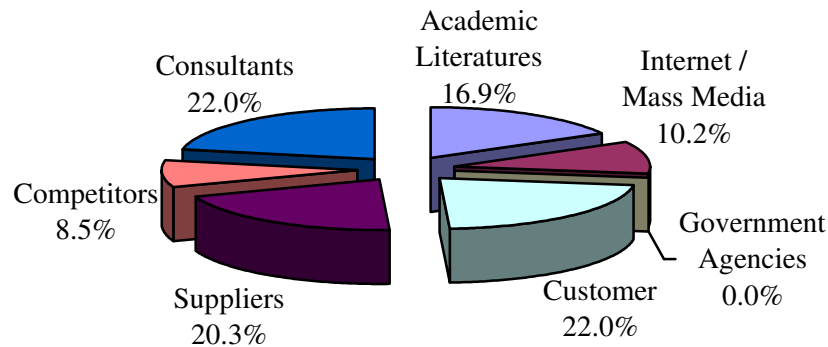


Figure 4: The Sources of Awareness for Motion and Time Study

Figure 5 shows the sources of awareness for motion and time study. As can be seen in the Pie Chart above, the main sources of awareness are customer and consultants. It was followed by suppliers (20.3 percent), academic literatures (16.9 percent), internet / mass media (10.2 percent) and competitors (8.5 percent). Unfortunately, there was no indication of sources of awareness for motion and time study technique from government agencies.

g. Focus of implementation / person in charge / year of implementation

Base on interview and questionnaire survey, the main focus of implementing motion and time study include reduce the time of unnecessary movement, as a way of job monitoring and productivity improvement. Person in charge in the implementation usually are senior manager and operation manager or production manager. The implementations depend on the operation activities, scope of implementation and the procedure. The mean of year of implementation motion and time study is 4.5 years.

h. Purpose of Implementation

As can be seen in the Table 4, there are six main reasons of motion and time study implementation. Base on the mean of agreement score (see Table 4), it is clear that all of the reasons listed in questionnaire survey are agreed by the respondent with the higher score. Increase productivity (4.90), job efficiency (4.90) and quality improvement (4.80) are mainly the reasons of the implementation motion and time study rather than reduce operation time per part (4.60) compete in local market (4.00) and fulfilling market demand (3.60). This is because, the mean score of the reasons considering that respondent strongly agreed. Beside that, the other reason of the implementation of motion and time study are improve skill of workforces, improve the old systems of productivity improvement and efficiency of job monitoring systems.

From the analysis, we see that the reasons of implementation motion and time study are not significant between the mean score and the testing variables (see Table 4). The results of causality test between the reasons and testing variables including factor of number of year in operation, number of employee, annual turnover, company status, level of technology and Parent Company (see Table 1) in general succeed to reject the null hypothesis of causation. However, the result indicates that the relationship between fulfilling market demand and the number of employees is significant ($p < 0.05$).

Table 4: The Reason for Motion and Time Study Implementations

No	Item	Mean	SD	The Causality Test					
				F (1)	F (2)	F (3)	U	H(1)	H(2)
1	Increase Productivity	4.90	0.316	0.466	0.679	0.601	0.414	0.414	0.934
2	Fulfilling Market Demand	3.60	0.966	0.099	0.000**	0.715	0.314	0.737	0.561
3	Compete in Local Market	4.00	0.943	0.466	0.095	0.956	0.645	0.645	0.628
4	Reduce Operation Time per Part	4.60	0.699	0.819	0.549	0.473	1.000	0.693	0.522
5	Job Efficiency	4.90	0.316	0.466	0.679	0.601	0.414	0.414	0.934
6	Quality improvement	4.80	0.422	0.123	0.397	0.439	0.759	0.221	0.243

N = 10

* consider disagreed by respondents (mean ≤ 3.5).

** Significant at the 0.05 level

F (1) : F-Test between item and numbers of years in operation.

F (2) : F-Test between item and numbers of employees

F (3) : F-Test between item and annual turnover

U : U-Test between item and company status

H (1) : H-Test between item and level of technology

H (2) : H-Test between item and types of product indexes.

i. Success Factor

Implementation motion and time study in general increased the productivity for most of the respondents. In fact, the success of the implementation of motion and time study has being dominated by several of success factor (see Table 5). Based on the mean score of agreement of the success factor in motion and time study implementation generally show that most of the success factor listed in questionnaires survey are similar with the success factor of implementation motion and time study by respondents.

The main success factors in implementation of motion and time study is top management commitment (4.80), followed by interdepartmental cooperation (4.70), good planning and control system (4.40), company technical capability (4.40), effective training (4.40), experienced work forces (4.30), steady fund inflow (4.30) and clear product strategy (4.00). In-depth market study, supplier feedback and consultants credibility are not considered as important success factors. Every one of success factors is not significant at the 0.05 level between the testing variables. The results of the causality test show that not significant (see Table 5).

Table 5: Success Factor in Implementation Motion and Time Study

No	Item	Mean	SD	The Causality Test					
				F (1)	F (2)	F (3)	U	H(1)	H(2)
1	Top Management commitment	4.80	0.632	0.544	0.513	0.601	0.221	0.414	0.934
2	Clear Product Strategy	4.00	1.054	0.911	0.753	0.584	0.576	0.576	0.335
3	Inter Department Cooperation	4.70	0.483	0.982	0.699	0.763	0.285	0.789	0.411
4	Steady Funds Inflow	4.30	0.949	0.724	0.345	0.733	0.113	0.542	0.151
5	Good Planning and Control System	4.40	0.699	0.725	0.808	0.261	0.724	0.814	0.584
6	Company's Technical Capability	4.40	0.516	0.057	0.779	0.495	0.453	0.080	0.463
7	Experienced Work Forces	4.30	0.675	0.817	0.929	0.470	0.724	0.480	0.733
8	Effective Training	4.40	0.516	0.751	0.779	0.211	0.617	0.453	0.463
9	In-Depth Market Study	3.00*	0.943	0.148	0.133	0.537	0.645	0.249	0.238
10	Suppliers Feedback / Comment	2.80*	0.632	0.724	0.762	0.575	0.464	0.903	0.257
11	Consultant's Credibility	2.80*	1.033	0.287	0.660	0.778	0.825	0.507	0.266

N = 10

* consider disagreed by respondents (mean ≤ 3.5).

** Significant at the 0.05 level

j. The Challenges

Table 6 shows that out of 8 types of challenges listed in questionnaire survey, only 5 of the challenges faced in implementing motion and time study by respondents. The challenges are mainly on lack of cooperation from workers (4.50), followed by inexperienced project leader (4.20), unavailability of relevant consultant (4.00), staff training (4.00) and lack of inter departmental cooperation (3.90). The items of the challenges were selected by mean score of respondent's answers.

However, the respondents considering disagreed for insufficient funds, no commitment from top management and unclear product strategy are the challenges faced in implementing motion and time study (see Table 6). This is because, mean score of the challenges are below than 3.5 to show disagreeing. In additional, base on Table 5, the success factors of the implementation

motion and time study were including the challenges listed whose disagreed by respondents. Thus, there are not become the challenges for respondents.

The results of causality tests between the challenges faced by respondent and testing variables shows that no causation. It is because, all of the significant value (refer Table 6) shows that not significant at the 0.05 level. Thus, null hypothesis was rejected and alternatives hypothesis used to show that no causation.

Table 6: The Challenges Faced In Implementing Motion and Time Study

No	Item	Mean	SD	The Causality Test					
				F (1)	F (2)	F (3)	U	H(1)	H(2)
1	No Commitment from Top Management	3.40*	0.966	0.857	0.421	0.881	0.823	0.737	0.200
2	Unclear Product Strategy	3.40*	0.843	0.238	0.062	0.914	0.038**	0.065	0.242
3	Lack of Interdepartmental Cooperation	3.90	0.738	0.829	0.393	0.722	0.563	0.728	0.266
4	Insufficient Funds	3.00*	0.816	0.571	0.796	0.067	0.429	0.429	0.634
5	Lack of cooperation from workers	4.50	0.707	0.840	0.768	0.621	0.393	0.464	0.485
6	Inexperienced Project Leader	4.20	0.632	0.341	0.898	0.064	0.903	0.714	0.223
7	Staff Training	4.00	0.934	0.092	0.322	0.201	0.171	0.171	0.316
8	Unavailability of relevant Consultant	4.00	1.247	0.770	0.339	0.887	0.570	0.363	0.511

N = 10

* consider disagreed by respondents (mean \leq 3.5).

** Significant at the 0.05 level

CONCLUSIONS

The study shows that there are many benefits to be obtained by implementing productivity improvement effort. The mainly purpose of the implementation of motion and time study by respondent are increase productivity, job efficiency, quality improvement, reduce operation time per part, compete in local market and fulfilling market demand. The success of the of implementation motion and time study had been contributed by several success factors such as top management commitment, interdepartmental cooperation, good planning and control system, company technique capability, effective training, experienced work forces, steady fund inflow and clear product strategy. Unfortunately, the companies implementing motion and time study face many challenges such as cooperation from workers, followed by inexperienced project leader, unavailability of relevant consultant, staff training and lack of inter departmental cooperation.

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