Scientific Labor Resource Management for Non Standard Activities & Task: Case Study for Security Workforce

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**ABSTRACT**

**Background:** Overhead labor cost contributes significantly to a company’s operating cost. In recent years, indirect work trends up and becoming as important as direct work in which gains its focus to have an accurate calculation on the indirect labor requirement to effectively manage the resource. However, majority of the indirect works are non-standard activities and the resource requirements are normally based on past experiences gained from former practices. Thus, time requirement-based data is needed for workers’ standard task activities. **Objective:** This paper presents a case study that concentrates on the determination of security workforce staffing level using scientific approach. The study extensively employs the work sampling method to compute the part time and full time workforce requirements. **Results:** The methodology undertaken has been proven to effectively monitor the workforce’ utilization rate of non-standard activities, and thus, this allows the management to design the workforce coverage based on criticality in terms of duty location and time frame. **Conclusion:** Research results contribute to work measurement using a systematic approach to obtain the labor man-hour utilization rate, which optimizes the duty roster arrangement in terms of time schedule and duty location.

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**INTRODUCTION**

In today manufacturing environment, indirect labor has always been the main focus in term of cost reduction but overhead labor cost is also contributing significantly to a company’s operating cost that must not be over looked. In recent years, significant indirect work has trended up and becoming as important as direct work in which may impact the end financial results. This has gained the focus from management to have an accurate calculation of indirect labor requirement so that the indirect resources can be managed effectively. Based on a case study carried out in a contract manufacturing environment, the indirect and direct workforce total annual cost is found to be five times higher than equipment cost, and close to twenty times that of facilities cost. However, majority of the indirect work are non-standard activities and the resource level is normally determined based on past experiences gained from former practices. The consequence of such practices result to either over staff or under staff of resources in which has effects on cost or efficiency. This paper presents a case study of using a scientific approach to determine the time requirement basis for workers’ standard task activities. The study extensively employs the work sampling method to compute the part time and full time security workforce requirements. It also extends its application to monitor the workforce’ utilization rate whose work activities are summed up from non-standard activities. The analysis allows the management to design the workforce coverage based on criticality in terms of duty location and time frame.

Security workforce provides guarding and patrolling services to the factory is a critical function for loss prevention from goods or information, and other critical asset in a company. It is even more critical for company dealing with high technology to prevent industrial espionage. It is a growing service industry in which accordance to the 2013 Barnes Reports on U.S. Security Guards and Patrol Services-Industry Market, security guard service has the highest numbers of employees among the sub-industries in Security Guards & Patrol Services Industry (Barnes,2013). Due to the fact that the skillsets do not fit in to the manufacturing main core task, and the skill requirements of these occupations are relatively homogeneous (Dubé, Kaplan, 2010), the security workforce is usually outsourced. It is hoped that by outsourcing, the expenses in wages...
from the workforce can be reduced. However, the overall expense in security workforce is still higher than the expected reduction due to the so-called ad-hoc ‘contingent work’ that security guard services are expected to be on standby to provide emergency crisis management, especially during surge hours.

**Literature Review:**

**Work Measurement Methodologies:**

Frederick Taylor’s scientific management for labor work began with the objective to set a fair day’s work (Salvery, 2001) pay using a systemic approach. The methodology breaks the task into small and simple actions and thus precise time can be determined for each of the action in the task scope according to the process step. With the introduction of this time and motion study, labor wage is determined objectively. In his book ‘Principle of Scientific Management’ (Taylor, reprinted 1997), Taylor laid down the fundamental principles of large scale manufacturing through assembly-line factories. In another words, time standards are established according to the specific defined job scope. This standard task and work order are repeatable and similar for every worker assigned to the same job in the production line.

Work measurement is popularly defined as the application of techniques to establish time standards for a qualified worker to carry out a task at a defined performance level. Time Standards provide a means for the management to measure workers’ performance and to hire the appropriate number of workforce. However, as discussed above, the fair day work is measured based on repeatable work steps. Security work contents, on the other hand, are largely made up of being in stand-by mode, ad-hoc, and non-regular ‘situational’ works. As such, among many work measurement methodologies, a method which is based on the concept of sampling observation is chosen for this study. The methods are ‘Work Sampling’ and ‘Major Unit of Activity’ (MUA).

**Work Sampling:**

Work sampling is a method used for work measurement and analysis and is usually applied to groups of people or individuals whose work is not repetitive in nature. Work sampling theory is based on the probability that a small number of occurrences will follow the same distribution as a longer period of work is being studied. The procedure involves making observations of staff at random intervals and recording their observed work activity in predetermined categories (Prescott et al., 1991). Meanwhile, MUA is a method known for indirect labor measurement which records sampling activity. The cycle time and the volume of each identified activities will be used to establish the final results. In other words, MUA is a ‘volume-sensitive’ method. However, guard service activities contain ‘station-fill’ activities – which are unit activities that require constant attention that are not sensitive to the volume (Rickards, 1987). Hence, work sampling is used as the primary method in this study.

There has been a myriad of viewpoints regarding work sampling applications and effectiveness. This technique has been used to measure the time individuals spend in various categories of activities. It is popularly used to analyze how workers, managers or any individual utilize their time. The result of work sampling is also used to find opportunities to improve productivity. One advantage of work sampling is that it provides an easy and inexpensive way to analyze work. The literature shows many evidences of the work sampling applications in various industries. It is particularly useful in the analysis of non-repetitive or irregularly occurring tasks, which characterizes most construction projects in the USA in the last 30 years, and plumbing work in Scandinavia (Josephson et al., 2013). Work sampling is also used in the health care industry for nursing activity standard time computation and the calculation of the proportion of nursing activities compared to the total time in a typical’s nurse’s shift. In addition, it is used to evaluate the correlation between hospital size and standard times of nursing activities nurses in Belgium (Myny et al., 2009). In Japan, cancer screening units use the results of work sampling study for labor resource and cost calculations (Goto et al., 2014). To add, the U.S. Post Office financial department conducted work sampling across the country for time and cost determination of various functions since as early as 1969 (Mande, 1971).

**The Study:**

**Aim:**

The aim of the study is to determine security guard utilization rate and the proportion of time for each task category. The analysis result is used to optimize the resource staffing level and provide a model for productivity evaluation for this field.

**Study locations:**

The study was carried out in an electronics assembly and box build manufacturing factory located in China. The factory has four storeys with storage areas placed within and outside of the production floors in a fenced up field. The factory is situated in a neighborhood with good infrastructures. There are multiple exit points (doors) for humans and only one loading bay with nine docking platforms for trucks. The loading bay is used for incoming, outgoing, and waste disposal at dedicated platforms respectively. The building is equipped with four goods elevators for raw materials, finished goods, waste disposal, and humans nearby the loading bay. The elevators stop at each floor, and has no specific restrictions or access control. To tighten the security, CCTVs are installed near the elevators. In addition to the loading bay and normal doors, there are the roller
shutters specifically designed for transporting huge equipment through cranes which are locked and opened under special authorization.

The head count in the factory is approximately ten thousands, with seven thousands five hundred and two thousands five hundreds in the production area and office, respectively. Workers who work in the production area use dedicated staircases to enter and exit the production area, worker locker room, and cafeteria. Meanwhile, staff whose primarily work in offices use separate staircases to the office and all other non-production facilities. Security checks are mandatory at the production floor exit points for all users, loading bays, exit doors at lobby, and other doors that connect the offices. There is another check point at the gates for all vehicles passing through and this is the last and final check conducted by the security force.

**Security guard job scope:**

The security guard work force in the factory is outsourced to a security and patrol services provider. The guards are primarily engaged in performing security scanning using a scanner for everyone at the exit points and at other identified locations, including the exit point in the production area. Surveillance monitoring is carried out at the entrance and exit areas. Similar incoming and outgoing surveillance monitoring and checking procedure is enforced for personal bags at office entrance and exit points. Goods loss prevention is also performed by guards at the goods elevators, storage area and loading bay. Of all the locations, guards must do minimum recording for abnormalities and other administrative reports. Patrolling on defined routes on a pre-defined frequency is a routine task. Guards are also expected to respond to any emergency incident which may cause interruption of business operations. The cycle time for most of the tasks varies during the actual work because they are subject to external circumstances and is a function of the guards’ judgment to handle the situation.

**Design of the study:**

The study had 2 phases. In the first phase, information regarding guard stationing location, route, factory workers people flow and material transportation flow were collected. The locations and routing were mapped to the factory layout plan. The objective of this phase is to identify the ‘hard’ boundary such as exit locations that could be shifted, combined or closed on either temporary or permanent basis with some risks associated with the actions. The change of exit locations and route modification was simulated through the factory layout plan. Taking into account of some ‘risk of losses’, a significant reduction of security resource was expected alongside the reduction of guarding locations and patrolling routes.

The second phase had the objective of identifying and further reducing low utilization locations. The method used in this phase is work sampling and other supplementary methods. This paper focuses on the second phase activities.

The study was conducted by a focus team comprising two industrial engineers, a factory security manager, an outsourced security guard supervisor, and a production supervisor. The author shadowed the industrial engineers to plan for the factory layout, develop the work measurement methodology (work sampling), design the template for data collection, and carry out on-site observations during the data collection stage. The author then analyzed the data and was involved in the many discussion sessions to provide recommendations to implement productivity improvement solutions. In addition, the author also interviewed the security guards in the case study area to understand any potential hiccup issues.

**Pre on-site study preparation:**

A pre on-site study meeting was arranged prior to the commencement of the study in order to ensure the project team members fully understand the scope of the study, the work sampling methodology, and the related processes. Examples of real cases were used to aid the understanding. Members were then asked to focus specifically on security guard-related matters. The team subsequently identified the measures of output, which for this case was mainly associated with the analysis on how the guards utilize their time and where they spent their time. To support the objectives, work categories for the major tasks performed must be identified with clear definition. After the work elements are defined, the number of observations for the desired accuracy and confidence level must be determined. The logic of observation scheduling was also determined with pre-planning routes to be used by the observers. An observation form was designed to include the work categories and other site-specific information. Before the format was finalized, a walk on the trail of the observation route was organized. All the issues surfaced during the walk were addressed and reflected in the modified data collection form appropriately. The observers were briefed and allowed time for practices until they were comfortable with the data collection process prior to the beginning of the observation session. This was one of the important steps to avoid waste of data points. Another key emphasis during the orientation was practicing the technique of ‘snap shot’ in the work sampling methodology. The observer must be able to interpret the actual situations but not ‘wait and see’ before recording the task category.

**Information in data collection form:**

The factory security guards were employed mainly for patrolling and doing security scan-related
works. During the preparation discussions and observations, it was found that apart from the original intended tasks, the security guards were asked to do supplementary works such as reminding the workers to follow the discipline of wearing neat attire in the production line, and observing certain non-security-related tasks in the work area per the request of the work area supervisor.

Designing an effective data collection sheet is a crucial step in the work sampling process. A good sheet will enable the observer to record the observations from the first single glance without ambiguity. The team recorded primary and ‘on request’ tasks as part of the work elements. Each floor, locations and exit doors were specified and preprinted in the form to serve as reminders to complete all pre-identified locations. The forms were printed in a format and size where minimum to no reference was required during use. Figure 1 shows an example of the data collection sheet.

![Fig. 1: Example of work sampling data collection sheet.](image)

**Data collection:**

After numerous meetings and weeks of preparatory research, the work sampling study methodology was developed and implemented in July 2014. A total of forty observation points were located on four floors of the factory. Locations within the production area include the production area entrance and exit points, areas adjacent to the elevators which were used for goods and people, and areas near the washrooms. The non-production working areas include the lobby and other non-production work area entrance and exit points.

The observation activities were carried out round the clock following the production floor operating hours. One observation per hour per location was made for all locations. However, the sequence of the location was randomly picked by the observers within any time during the hour. Due to the electrical device control policy in the study zone, only hard copies were used instead of any hand held computers.

Information recorded by the observers included pre-defined work categories as printed on the sheet, date, time, location, and remarks. Because of the outsourcing and job rotation working pattern, observers could not observe the same persons stationed in fixed locations, and hence no name was recorded.

Work sampling is bound to yield more objective and accurate estimates because it observes and records what is actually being carried out on at the observation moments and it does not rely on memory. In this study, young and inexperienced observers who were from a neutral party were used. With sufficient training and practice of the work sampling process and security guard work tasks, the observers were expected to carry out the observation independently and in a less biased fashion. The author randomly followed the observers to provide coaching and support for both the observers and the guards.

The collected sheets were submitted to an administrative clerk to enter into the database the next morning. The observers would explain any abnormal or troublesome situations on a daily basis while it was still fresh in the memory. They also indicated any major detectable issues and errors so that remedial actions could be taken. The clerk would also scan through the sheets to clarify any data points or comments and recommendations which should be valuable for the study.

**Data analysis:**

Microsoft Excel was chosen for data analysis as it is sufficient for the amount of data from the work sampling study. The data was analyzed for overall guard workforce utilization rate, task distribution by category, and utilization rate by location. Figure 2 shows the overall task distribution data.

As can be seen, scanning of goods and people contributed to half of the security tasks, but the scanning activities did not occur all the time during working hours for all locations. To compare the utilization rate by locations and time, the utilization rate by hourly interval basis was analyzed.
RESULTS & DISCUSSION

In total, more than 7000 work sampling observation data points were collected. In line with the key objective of this study, which is to find out the utilization baseline and to determine the staffing level, the analysis focused on finding productivity opportunities.

It was found that the overall utilization rate showed that more than half of the time was under the group of ‘less or non-value added’ activities: chatting, phone, and idling. The management was not totally shocked by this finding that indicated that the security guards were quite free. However, this has triggered the alarm that an overall re-organizing of workforce was required immediately. It was suggested that the 2R1C (Remove, Reuse, Combine) approach would be used. The utilization rate was further broken down by groups of similar job tasks, namely production area entrance and exit points, elevators points, washroom points, loading and storage control points, and other non-production working area entrance and exit points. Figure 3 is the comparison of task activities distribution between production area and the loading bay. It was seen that the security guards in production spent most of their time on value added activities for their primary tasks; in contrast, loading bay area guards were free most of the time.

Improvement opportunities:

Based on the analysis results in Figure 3, the possibility to combine and reduce the workforce in the loading bay and production floor was identified. The team took another approach by segregating the data by time segment.

The workers break time has been pre-determined but the outgoing shipment and goods arrival schedule was not defined. To understand the actual impact of the working schedule, hourly observation points were analyzed as well in accordance to the locations of similar tasks.

The data collected shows no significant difference among locations for similar type of tasks, but the hourly patterns shown in Figure 4 has led to productivity improvement opportunities. Time zones A0 and B0 (3rd to 5th hour) were the busy time zones for the security guards to perform scanning for production floor workers at the entrance and exit doors. On the other hand, these were the lower utilization rate time zones for the security guards at the loading bay, as indicated by A1 and B1. The security guards from production floor and loading bay could be remobilized so that the total number from the two locations could be reduced.

Another option for the loading bay were filling up the needs include doing security-related jobs such as viewing surveillance cameras images and on-call service whenever there were activities instead of having two stand-by security guards for ‘just in case’ ad hoc needs.

Sampling variations:

There was no emergency incident that occurred during the work sampling study. Past historical records indicated that, on average, less than one emergency case per month took place, but sometimes, two to three emergency cases could...
happen in a month. The occurrence pattern was unpredictable and team’s consensus was to treat this as an isolated case. The other very low data point was the goods scanning activities. The team has consulted the area owner about the scenario and understood that the study was carried out in a very low season. In addition, there was a change of supplier entrance procedure that required less verification from the security guards.

Fig. 4: Task activities distribution by hourly interval.

**Productivity improvement:**

As stated earlier, the objective of conducting this work sampling study was to identify the overall security workforce resource savings. Through the study, an equivalent of 25% of man-hour savings was identified, which, if implemented, would not compromise the level of loss prevention performance. The savings was mainly through the sharing of guards for adjacent locations, rescheduling selective pre-determined operating hours, and redesigning the routing of people flow with hard boundary. For this site, a 10-feet height partition was recommended to enable more effective patrolling service. The guards’ duty roster has been enhanced with a flexible number of security guards during peak and off peak hours. The management had taken the educated decision based on the work sampling results to restructure the workforce and schedule. In doing so, more effective control for risk prevention, as well as a more favorable accounts balance sheet were successfully achieved.

**Study limitations and concerns:**

Only one out of the six identified categories of work tasks demonstrate the characteristics of a predictable schedule and fixed work operating procedure, while the other five tasks were mostly unpredictable in terms of occurrence pattern, frequency, schedule, and operating procedure. Work sampling is the more suitable work measurement method for tasks with such characteristics (Thong et al., 2014). To drive security workforce efficiency, there are a few critical factors must be considered in addition to the utilization rate:

- **Risk level classification:** Different physical and non-physical risks such as information risks should be evaluated on a periodic basis and categorized to various levels. The categorization is normally associated with the protection and prevention levels to be enforced.
- **Loss prevention measures:** Security posts should be equipped with prevention tools and in accordance with the procedures that match the intended loss prevention performance.

- **Culture:** Environmental factors such as workers and users’ working culture and mentality, familiarization of the systems, acceptance of the type of security solutions, and education level affect the overall loss prevention setting.

Of all the factors above, the factory set the intended performance level to counter measure the potential loss in dollars or in any other form resulted from theft and damage. The security guard staffing model is part of this tactical plan and is included in the factory’s expense budget. While lower security service cost is targeted, elimination of the guards at certain locations is ruled out from the consideration. For example, even though security guards at the lobby exit points show the lowest utilization rate for goods and people scanning, patrolling, documentation and other physical work, a full time guard remains at that location.

**Conclusion:**

The job of a security guard contains a considerable degree of freedom with regards to methods utilized and the level of judgment required. It also has a limited number adequately covered written standard practices, a fluctuation of workload which is subject to very little control, and the necessity to adhere to certain management practices to ensure maximum acceptance and cooperation on a large scale (Olm, 1960). The present study demonstrated that security workforce productivity can be measured with scientific approach, which in this case is work sampling work measurement methodology. This method can be easily modified to suit to local conditions and unusual working patterns.

Given the fact that each job site has its specific site scenarios and factors that affect the productivity profile, much resource savings can be achieved if the tasks are meticulously reviewed. For example, in this
study, approximately 50% of the security guard’s time is spent idling, and 25% of the appropriate workforce reduction can be attained, as seen in the work sampling analysis of the study. In other words, this non-production function may deem too high or too low in terms of work resource allocation. The key benefit from the study is that it has created the awareness that indirect activities cannot be entirely ignored since they demand a portion of the available employees’ time and resources. Work measurement by using work sampling is one of the systematic approaches that can be used to produce measurements that are expressed in terms of countable units. Workforce requirements can be derived from systematic and logical approaches instead of best estimates, gut feel, past experiences or estimation from past financial spreadsheets.

**Future Research:**

The research will look into tasks which involve more complicated cycle times, event occurrence patterns, fluctuating workloads and jobs with variations that require judgment. Techniques which are typically used in the service sectors may be adopted in various scales to meet the purposed measurements. The challenges of these tasks will contribute in the improvement of the methodology. As a result, a more effective labor resource utilization and work performance measurement can be achieved.

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