Workplace scheduling literature review

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Literature review

There are many explanations about ‘ workforce scheduling’. Workforce scheduling, also called labor or staff scheduling, is a difficult and time consuming problem that every corporation or company that has employees working either on shifts or on irregular working days must solve (Kimmo J. Nurmi, 2013). Workforce scheduling which also involve personal scheduling (roster) with the routine to ensure the task is being performed well. (J. Arturo Caastilo-Salazar, 2007). The workforce scheduling problem relates to some topics which include days-off scheduling, shift design and workload assignment (Carlos Montoya, 2006). Traditionally, workforce scheduling can be split into cyclic workforce schedule and non-cyclic workforce schedule. (Nysret Muslin, 2003). Traditional scheduling can be divided into three categories: day off scheduling, shift scheduling and tour scheduling. The tour scheduling is a combination of former two scheduling (S. J. Sadjadi, 2011).

Moreover, many studies have illustrated the benefit of workforce scheduling. Workforce scheduling is to minimize the total cost to complete specific tasks (Fowler et al., 2008) or the number of workers (Lagodimos and Leopoulos, 2000), or to maximize the productivity performance (Chu, 2007). Staff scheduling can help reduce different involving costs, such as surplus, shortage, hiring or layoff in demand (M. Darayi, 2011). Workforce scheduling is to meet the customer demand and reduce the cost to satisfy the constraint (Abdullah Alsheddy, 2009). A good workforce scheduling also can avoid the strong assumptions and let decision maker know well to choose a flexible manner to interaction of cost and services quality (Castillo, Joro, & Li, 2009). A good schedule can help an organization meet service rate and

reduce the cost from day to day (S. Liao, 2011). A good shift arrangement of employee can match the time of varying customer demand for the services while satisfying some applicable regulations and minimize the overall cost (Sun, 2012). To lower down the exposure of any ergonomics hazard, workers are either assigned to carry out tasks at different working areas within the same working day or follow the rotating workforce schedule (Tanuchporn, 2012).

Furthermore, many researchers studied the philosophy of rotating work schedules. Rotating workforce scheduling is the assignment of labors to shifts in a cyclic schedule (Musliu, 2011). An efficient two-phase algorithm for cyclic days-off scheduling is developed (Alfares, 2003). A simulated annealing approach to resolve a cyclic employee scheduling problem is proposed (Brusco, 1993). Heuristics algorithm is proposed by Gartner and Wahl (1998) to tackle the manual construction of rotating workforce schedule problems. Besides, production scheduling also is a part of workforce scheduling. It is the process to satisfy demand by determines how much production will occur in the next planning horizon. The horizon can separate into long, medium, and short. The effective production planning process is a fundamental for success in manufacturing operations. Production plan can contribute the maximum profit and minimum cost by produce the products in right amount and right time. The implementation of the plan will much more easily in the practice when the production planning is supported by workforce scheduling. The manager need to make a better production schedule through understanding the human factor incorporate with production planning therefore it will form a better performance of

production system (Othman, Bhuiyan, & Gouw, 2012). In addition, the empowerment workforce scheduling can be defined as the employee decision power. The empowerment workforce scheduling can separate into three such as short term plan, long term plan and preference. The first is short term plan is defined as what is the next plan for the next job. The second is long term plan is plan for particular day or period. The last is the preference. It refers to the preference of employee in daily plan. (Abdullah Alsheddy, 2009)

Nonetheless, there are few researchers considered human factor or called it as ‘ ergonomics’ in their research. The proposed models or philosophy in their research focus on ‘ number of people’ rather than ‘ the individual’s inner capabilities’ such as personality, skills, knowledge, attitude and strength, which reduce the flexibility of the working schedule to keep pace with growing complexity of entire business practices (Birch, O’Brien-Pallas, Alksnis, Tomblim Murphy & Thomson, 2003; Castley 1996; Jensen, 2002). In reality, everyone has his or her difference and working limitation. According to Dul and Neumann (2009), the contribution of ergonomics to different company strategies and the objectives of different business functions supported in the organization can be seen. Many companies think that ergonomic relates to healthy and safety, but not practice ergonomics factor into their employees’ working schedule. Besides, many ergonomics models have been developed without knowing how to be implemented in a certain company (Butler, 2003). Most people think that workforce is adaptive, so there is no place for ergonomics. According to Bidanda, Needy (2005), human factors are difficult to be quantified into mathematical model. There

is a need for the model that incorporated ergonomics, but only few studies are successful.

Other than that, for computation convenience purpose, many researchers come out a lot of assumptions that hinder the accuracy and effectiveness of their proposed ideas towards real world scenario. For instance, non-linear staff scheduling model by F. Saberian and M. Darayi (2011) is based on the assumption of only one type of workforce available. The workforce is non-heterogeneous which means any task can be given to any available worker. If a task is given to a worker who cannot perform well, the work system performance or productivity would be influenced badly. Besides, many studies assumed that each task can only be one worker to carry out. In fact, there are many situations or tasks that need two or more workers to work together. According to the study of production control with workforce scheduling by Chin Yao and Cheng I (2008), they assumed no delay or scrapping of parts happens during the machining process and all products are sent and sold right after the order quantity is done. Such assumptions create unrealistic situation which cannot be effectively used in the real world although it simplify the computation process.

Some commercial software such as LINGO, CPLEX, ILOG CPLEX are commonly used to solve their problems. However, commercial software cannot deal with big-sized problem. According to Wongwien and Suebak Nanthavanji (2012), LOG CPLEX can solve 37 out of 57 test problems, due to out of memory error and exceeding the computational time limit. The situation is more applicable or suitable in small or medium-sized companies which employee size is much less than big companies. The large companies

or institutions, especially multinational companies, cannot use one kind workforce scheduling model to resolve their human-related problem. Hence, some uncommon staff scheduling studies is reviewed further with detail.

In the study of Musliu, Gartner and Slany, (2002) found out that there is a four steps framework that can be applied in the real society and it is a very powerful tool for solving problems. First step, we should referring to our given job work load and enhance our views on possible ways to work out on that problems. Next, we can proceed to step 2, which is we needed to choose the best way for weekends off. In other word, it is necessary for us to connect the features of weekends off with the job's work load that we have received. Due to the existence of step 1, so the researchers mentioned that whenever there is a problem occurs in step 2, we can easily solve it efficiently. The researchers created the step 3 to meet another two goals, one of the goals is on the shift change constraint, while another goal is bound on the number of consecutive shifts per sequence. In this step, we should list out all the possible shifts sequences given job subjected to both goals. Lastly, in step 4 decision makers are able to come out with a better schedule, as they have a complete view in all aspects. Due to the decision makers have bound as well as recorded all the successive shifts and the shift change constraints, so they able to accurately schedule the timetable. In addition, this framework has it limitation as well, which is the decision makers cannot apply in a large group of employees. However, the researchers have suggested that the decision makers able to employ this framework by categorize them into a few teams and implement it.

In the study of Kimmo J. Nurmi and Jari R. Kyngas (2013), a workforce scheduling framework is proposed. The workforce scheduling process is mostly emphasized on short-term planning and is divided into many sub-phases. This sub-phases approach can deal with not difficult situation. Another advantage is lowering down the computational complexity. The framework is divided into two main phases which are preprocessing phase and staff scheduling phase. The preprocessing phase is composed of workload prediction and preference scheduling sub-phases. This phase really needs the understanding of the attribute of the employees, the needs of the customers, and determining staffing requirements based on the latter. The staff scheduling phase consist of shift generation, days-off scheduling and staff rostering (partitioning and resource analysis). Each sub-phase in this phase has its constraints based on the study of a Finland company. Each constraint in each sub phase should not be violated or optimize the violation to the lowest level. PEAST (Population, Ejection, Annealing, Shuffling and Tabu) algorithm is used to resolve scheduling problem. PEAST algorithm also is used in a real scenario, such as school timetabling and sports scheduling problems. Their research has contributed to improved systems for the Finland Company and its customers.

In the study of Tanuchporn Wongwien and Suebsak Nanthavanji (2012), the ergonomic workforce scheduling problem is addressed and ergonomic issue is more concerned. Different worker team size, non-homogenous workforce with limited task flexibility and pre-defined task operation schedules are concerned in the reseach. Hence, an integer linear programming model is developed and approximation procedure for solving big problems is

proposed. Feasible rotating work schedule condition is addressed such as hazard exposure towards each individual worker must not exceed the permissible limit, workers must not assigned to the tasks that they cannot carry out and the number of workers to perform a task must equal to the number of workers required by that task. The approximation procedure is then formulated into a program using Optimization Programming Language (OPL) and the result is compared with ILOG CPLEX's outcome. About 81% similarity of the both result which can conclude proposed approximation procedure can solve ergonomic WSP with worker limitation and task requirement efficiently and effectively.

In the study of Srimathy Mohan, scheduling part-time personnel with availability restrictions and preferences are mentioned in the research. The size of the part-time personnel is growing fast and constitutes a major proportion of service and retail industries (N. Conway and R. B. Briner, 2002). Part-time workforce are considered as supplement to the actual permanent workforce and most studies aims to reduce the cost by employing the minimum number of low cost part-time workers. This research mentions the availability of part-time workers may vary widely from time to time and must use different approach from traditional employee scheduling problems. Other than aforementioned industries, this problem also happens in newspaper industry and scheduling of substitute teachers in many school districts. An integer programming model is proposed and takes employee availability, preferences and seniority into consideration. The proposed model can be solved quickly by using the branch-and-bound enumeration procedure with additional cuts.

In the study of Mohammed Othman, Gerard J. Gouw, Nadia Bhuiyan (2012), a model that considers personalities, training, skills of personnel and also the workers' fatigue, breaks and recovery levels is proposed. The research seeks to minimize the cost of employment, lay-off, training and overtime, reduce the number of lay-off workers with high performance, reduce the break time and reduce the average fatigue level of workers. They developed a multi-objective mixed integer programming model to determine the number of employment, lay-off, training and overtime for each worker type. Four objective functions are mentioned in the proposed model. The first objective is cost reduction. The second objective is top performance workforce lay-off minimization. The third one is non-operating time minimization. The last one is minimization of fatigue rate. This model also helps to solve the production planning problem by implementing the human factors. Overall performance has been improved with the model assumption.

In overall, the employee needs to have proper schedule, he or she may work efficiently to help an organization gain a profit. In addition, workforce scheduling should be done properly and overcome the geographically location problem due to different region, in which, can assign different employee to the particular work place.