FACTORS AFFECTING THE WORK EFFICIENCY OF EMPLOYEES IN THE SOLAR CELL INDUSTRY IN BANGKOK AND SURROUNDING AREAS

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ABSTRACT
The objectives of this research are 1) to study the level of work efficiency of employees in the solar cell industry in Bangkok and the surrounding area. 2) to study the factors that affect the work efficiency of employees in the solar cell industry in Bangkok and the surrounding area. A questionnaire was used to collect data from employees in solar cell industry establishments. There were 289 people located in Bangkok and surrounding areas. Statistics were used to analyze the data, including frequency, percentage, mean, standard deviation, and multiple regression analysis. The results of the research found that 1) the work efficiency of employees in the solar cell industry in Bangkok and surrounding areas. Overall, each aspect is at a high level. In terms of quality of work expenses, aspects of workload, time, and methods. 2) Work safety management factors, strategic human resource management, working environment, and innovation management influence the work efficiency of employees in the solar cell industry in Bangkok and surrounding areas.
Keywords: Efficiency, Solar Cell Industry, Bangkok and Surrounding Areas

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INTRODUCTION

Currently, many countries around the world are turning to focus on alternative energy, or clean energy, in line with the trend of saving the world more. Especially the production of electricity from solar energy. This is because such energy is one of the main alternative energies that are chosen around the world. Entrepreneurs also attach importance to the research and development of new solar energy production technologies to meet the increasing demand, which is in line with the Solar Cells and Modules-Global Market Trajectory & Analytics report of Global. Industry Analysts Inc., (GIA) forecasts that the global solar cell and module market is expected to reach USD 127.7 billion by 2063. Governments around the world are accelerating their push for solar cell policies. Currently, the installation of solar energy production systems around the world is rapidly increasing. The total global cumulative installed capacity at the end of 2020 was approximately 714 gigawatts (GW). The top 5 countries with the most installed solar PV capacity in the world in 2020 are: 1) China has the capacity A total of 254,355 megawatts (MW) of solar cells have been installed. China has set a goal to increase wind and solar power capacity to 1,200 gigawatts (GW) by 2030. It is also expected that By 2050, renewable energy consumption in China will account for 60 percent of China's total final energy consumption or 86 percent of China's electric power production. China is considered the leader in the world's solar cell product market. It receives domestic demand from increasing the production capacity of solar energy to control pollution problems and demand from abroad, including the clean energy trend that is becoming popular around the world. 2) The United States already has the capacity to install solar cells. 75,572 megawatts (MW)and the United States has set a goal to reduce carbon emissions by 80 percent in the electricity sector by 2030 and aim to use 100% renewable electricity by 2035. In addition, the Solar Futures Study by the Department of Energy. Also, revealed that by 2035, the United States will have the potential to generate 40 percent of its electricity from solar energy. Solar power will play a key role in transforming the U.S. energy sector into clean energy and will help make the United States. The goal of reducing carbon emissions can be achieved shortly as well. 3) Japan has a total of 67,000 megawatts (MW) of installed solar cell capacity, with alternative energy sources such as solar energy and other renewable energy sources. It has grown in popularity since the Fukushima nuclear disaster in 2011. Japan's installed solar PV capacity could reach 100 gigawatts (GW) by 2025, depending on government policy and solar PV costs. 4) Germany has a total of 53,783 megawatts (MW) of solar cell installation capacity. The German government has proposed increasing the solar cell installation target to 100 gigawatts (GW) in 2030. Even though Germany is a country with little sunshine, 50 percent of the country's total energy consumption comes from sunlight, and this number is expected to rise to 65 percent by 2030. 6) India already has installed capacity for solar cells. 39,211 megawatts (MW). India has set a goal of increasing solar energy production to 280 gigawatts (GW) within 2030-2031. For Thailand, it was found that in 2020 the installed capacity of electricity from renewable energy had a total volume of 12,005 megawatts (MW), an increase of 1.3 percent from the previous year, with an installed capacity of electricity from solar energy of 2,979.4 megawatts (MW), or 24.88 percent (Department of Alternative Energy Development and Efficiency, 2020).

From the situation of giving more importance to alternative energy or clean energy according to the trend of saving the world. At present, Thailand has 36 solar cell operators, with details as follows: 1) Solar cell production business, 22 cases. 2) Solar cell assembly business, 14 cases, with standards related to solar cells. According to the Industrial Standards Institute (TISI), solar cell products and components need to have standards to control efficiency and safety in use. The Industrial Standards Institute (TISI) has set industrial product standards for Thai solar cells. The equipment and components, both inside and outside of the solar panels, must pass basic safety tests and additional tests that are functional to the solar panels. (Industrial Standards Institute (TISI), 2022) Therefore, when conducting business in the solar cell

industry, executives need to pay attention to the work safety management (Work Safety Management) of employees in industries that produce and assemble solar cells. It must have high safety standards when working and must perform work according to industry standards. This is because one of the most pressing employment problems worldwide is occupational safety (Hamalainen, Takala, & Saarela, 2016). Industrial safety is the leading cause of work-related accidents (Goetsch, 2018). Therefore, organizations must have effective safety management, which is important. It promotes and supports employees to follow safety practices and work in a safe and healthy environment. By doing this work, accidents and injuries can be reduced, resulting in significant cost savings for the organization. In addition, work safety factors are factors that influence work efficiency, which promotes knowledge. Make employees aware of their safety. Safety requirements are employees' perceptions of workplace safety. Hayes, Perander, Smecko, and Trask (2018): Empirical evidence indicates that employees' perceptions of workplace safety are significantly linked to workplace safety. Operational efficiency because employees behave according to safety standards at work, it will affect safety, and injuries from minor accidents will not affect work efficiency. Barling, and Loughlin (2018) Research on employee perceptions of occupational safety Inspired by the work of Zohar (2016), a survey of safety perceptions is important as it can help identify the root causes of accidents. And by doing so, it will effectively reduce accidents. It provides proactive information about security issues. Providing specific work safety management recommendations that must be developed to prevent work injuries and work accidents. With the importance of awareness of safety at work, organizations must increase measures to create awareness of occupational safety among employees. More employees In addition, the Human Resources Management Department is responsible for recruiting and selecting employees. Occupational safety training is required before employees begin work.

Strategic human resource management is considered to play another important role in business organizations. Human resources are an extremely valuable factor for society. Which country has the highest potential for human resources? It can be used to benefit creatively. That country was prosperous and stable in terms of its economy, politics, and society. If any organization has human resources with high potential. The organization will drive towards its goals with maximum efficiency. Therefore, strategic human resource management can be considered. It is the structure of the planned deployment of human resources and activities to help the organization achieve its objectives. Booze and Hachicha (2018). According to Cooke and Xiao (2020), over the past three decades, the concept of strategic human resource management (SHRM) has played an important role in management research and practice. Continuing analysis in this field tends to focus on how strategic human resource management (SHRM) can add value and impact employee performance, which in turn contributes to organizational success. Therefore, strategic human resource management and the performance of employees are closely related. Strategic human resource management can be considered an organization's plans and actions to attract, retain, and develop employees. Employee performance, on the other hand, refers to the extent to which employees meet or exceed the performance expectations set by their organization. Human resource management has a huge impact on employee performance, for example, through recruitment and selection. Training and development performance management compensation and benefits influence employee performance (Aburumman et al., 2020; Siddiqua et al., 2022).

In addition, the organization places importance on occupational safety management and strategic human resource management. For the efficiency of the work of employees in the organization, the working environment (working environment) is one factor that is important to the performance of employees. The workplace greatly affects the performance of employees. Because the environment is conducive to creativity, it contributes to make the organization more progressive. Helping increase positive energy at work also creates good productivity and

success. On the other hand, an unsatisfactory workplace reduces employee performance and causes stress. The physical environment is one of the three most important factors for employee well-being and health, such as a comfortable environment, cleanliness, and appropriate space and desks. A meeting room that is not too formal Sutoyo (2016) Factors in the working environment will undoubtedly affect the performance of employees. Mangkunegara (2018) said that the working environment is the physical environment that affects employee performance, safety, and quality. A work environment feels safe. This helps employees to work optimally and affects their mood. In addition to the physical environment, the social work environment also includes working relationships between fellow employees relationships between supervisors and subordinates, and the mental environment of employees in the organization (Mangkunegara, 2018).

The above-mentioned factors are important to the efficiency of employee performance, especially employees working in the solar cell industry, they must have supervision of work safety management from the Department of Industrial Works. It was found that safety problems in the solar cell industry are related to system-related hazards in electricity. In addition, standards must be controlled to control efficiency and safety of use. (Association for Occupational Health and Safety at Work, 2022) In addition, strategic human resource management factors and the working environment are also factors that are important to operational efficiency, which will affect the success of the organization. Therefore, the researcher is interested in studying “Factors affecting the work efficiency of employees in the solar cell industry in Bangkok and surrounding areas” because the solar cell industry is an important business for saving energy in the nation's households. This will use empirical data to develop and drive the solar cell industry and similar businesses to achieve the organization's goals even more.

LITERATURE REVIEWS

Concepts and theories regarding to operational efficiency

Efficiency refers to how an organization uses its resources, such as available funds and employees, to achieve organizational objectives. Efficiency measures include unit cost, which refers to a measure of cost per unit and expresses the amount of resources used to produce one unit of service. Cycle time measures how long it takes for a process to be completed. Response time measures how long it takes to respond to service requests. Measuring the amount of work in the pending queue. To measure all jobs in the pending queue. Another method is to measure backlog as the amount of work not performed within a specified or target time frame. Staffing ratio, another way to look at headcount is to calculate the ratio of employees to specific duties, or when comparing the entire organization and the use of equipment. Effective use of equipment. Efficiency is the matter of allocating resources through the use of various alternatives. Kumar and Ulati (2010) Therefore, efficiency is an indicator of achieving organizational goals that the employees work according to the specified time. Get a sufficient amount of quality work. Mihaiu, Opreana, and Cristescu (2016). Therefore, work efficiency means time, money, and other resources that must be used to complete the assigned work compared to the standards set by the employer. This suggests that an efficient worker completes a task in the least amount of time possible using the least amount of resources using certain time-saving strategies. Jayamaha and Mula (2017) define operational efficiency. Efficiency consists of two main components: technical efficiency and allocative efficiency. Coelli, Rao et al., (2018) Employee performance efficiency refers to the measurement of the relationship between input and output, or the success of an organization's production (Low, 2016). To increase total productivity to the maximum, the maintenance system recommends eliminating six losses, namely: reduced productivity from the start until stable production, process defects, a slight reduction in speed, idle speed, and stalling. Settings, adjustments, and equipment

failure. The less output that is used to create results. According to Pinprayong and Siengthai (2017), it was found that the differences between businesses and organizational efficiency. Business performance reveals the efficiency of results and output ratios. While organizational performance reflects improvements in an organization's internal processes such as organizational structure, culture, and community.

Plowman and Peterson (1989) have summarized 5 elements of efficiency: 1) The quality of the work (quality) must be of high quality, meaning producers and users benefit, are worthwhile, and are satisfied. 2) Quantity of work (quantity). The work that takes place must be in accordance with the expectations of the agency. 3) Time (time) is the time used to carry out the work must be in a correct manner according to the principles appropriate to the work and up to date. 4) Expenses (costs), all operations must be appropriate for the job. And the method is to invest as little as possible and get the most profit. 5) Methods: Methods of operation or work processes must be appropriate to the work and costs. By using techniques or modern methods applied to work. Zhang, H., and Xing, F. (2010) mentioned factors that affect work efficiency, including 1) work safety management (Work Safety Management means setting guidelines for employees to be aware of their safety in the workplace). There must be work behavior that is free from danger, injury, risk, or loss of workers. 2) Strategic human resource management refers to a strategic approach to decision-making and planning. Related to employment and recruitment strategies, policies, and practices; development training; payment of compensation; and evaluation of performance. 3) Working environment (working environment) refers to various elements related to the physical, social, and mental environment that will facilitate the work of personnel in the organization to proceed smoothly efficiency, and 4) management innovation, (management innovation) means changing traditional operating technology to new operating technology. Organizations must try to create opportunities and conditions that lead to innovation. By leading the organization to respond to the needs of a complex market.

From the literature review, the following research hypotheses can be formulated.

H1 Occupational safety factors, strategic human resource management, work environment, and management innovation influence the performance of photovoltaic industry employees in Bangkok and surrounding areas. From the literature review, the conceptual framework can be drawn as shown in Figure 1.

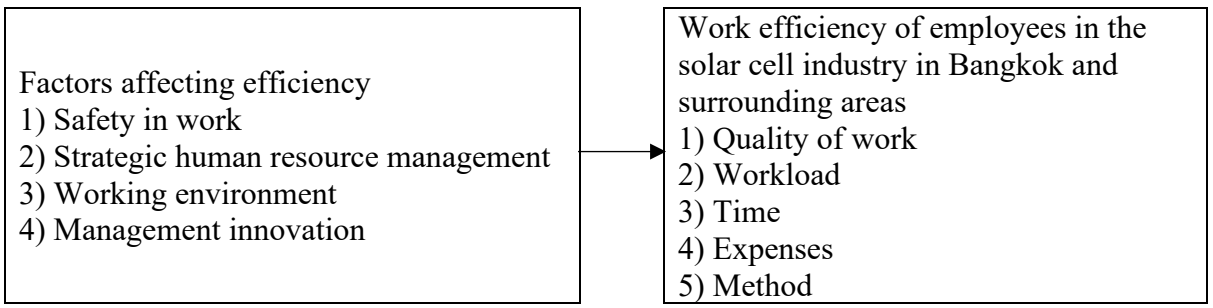

Figure 1 Conceptual Framework

RESEARCH METHODOLOGY

The population in this study includes: employees in solar cell industry establishments located in Bangkok and surrounding areas, totaling 1,050 people (Industrial Energy Institute, 2022), and a sample size of 289 people was obtained from Yamane's sample calculation formula (Taro Yamane, 1973). The belief value at the 95 percent level uses a stratified sampling method.

The research tool is a questionnaire consisting of Part 1: personal factors of the respondents, including gender, age, and educational level. Average monthly income Period of working time. The nature of the questionnaire is multiple choice. Section 2: Factors affecting work efficiency. The nature of the questionnaire is a Likert scale with 5 levels of scoring criteria, including the

highest equal to 5 points, the high equal to 4 points, the moderate equal to 3 points, the slightest equal to 2 points, and the least equal to 1 point. Part 3: Work efficiency of employees in the solar cell industry in Bangkok and surrounding areas. The nature of the questionnaire is a Likert scale with 5 levels of scoring criteria, including the highest equal to 5 points, the high equal to 4 points, the moderate equal to 3 points, the slightest equal to 2 points, and the least equal to 1 point.

Before using the tool to collect data, the objective consistency (IOC) test and reliability test of the questionnaire through Cronbach's alpha were systematically carried out. From the examination, it was found that the IOC was equal to 0.953 and the Cronbach's alpha was equal to 0.895, indicating that the research tools were of sufficient quality (Polit & Beck, 2006; Hair et al., 2012) to get information. This study sent questionnaires to employees of photovoltaic industry establishments. That are located in Bangkok and surrounding areas. In data analysis, descriptive statistics were used, including frequency, percentage, mean, standard deviation, and multiple regression analysis.

RESEARCH RESULTS

1) Most of the respondents were male 64 percent, 75.67 percent were under 35 years of age, 60 percent had less than a bachelor's degree, 63.00 percent had an average annual income of less than 50,000, and in work between 5-10 years, the percentage is 65.67.

2) The work efficiency of employees in the solar cell industry in Bangkok and surrounding areas is at a high level overall and in each aspect. In terms of quality of work, costs, workload, time, and methods, as shown in Table 1.

Table 1 Mean and standard deviation of work efficiency of employees in the solar cell industry in Bangkok and surrounding areas.

Aspect	Description	$\bar{X}$	S.D.	Result
1	Quality of work	3.91	0.50	Much
2	Workload	3.89	0.49	Much
3	Time	3.81	0.45	Much
4	Expenses	3.85	0.50	Much
5	Method	3.69	0.53	Much
Total		**3.83**	**0.48**	**Much**

3) The occupational safety management factor has a β value of 0.235, strategic human resource management has a β value of 0.329, the internal organizational environment has a β value of 0.243, and management innovation has a β value of 0.131, which indicates that it has a positive influence on the work efficiency of employees in the solar cell industry in Bangkok and surrounding areas. Statistically significant at the 0.05 level, with Sig. values equal to 0.000, 0.000, 0.001, and 0.002, which are consistent with the set assumptions. When analyzing the correlation coefficient (R), the value was equal to 0.759, which indicates that the group of independent variables is highly related to the dependent variable. The prediction coefficient is equal to 0.659, which indicates that the group of independent variables affects the work efficiency of employees in the solar cell industry in Bangkok and surrounding areas by 64.1 percent.

In order, the equation can be written as follows.

$Y = 0.947 + 0.329X_1 + 0.243X_3 + 0.235X_1 + 0.132X_4$

From the regression coefficient analysis, it was found that the factors of occupational safety management, strategic human resource management, work environment, and management innovation have the ability to jointly predict the performance of industrial employees. Solar cells in Bangkok and surrounding areas

The strategic human resource management factor had the greatest effect on forecasting (Beta = 0.243), followed by the organizational environment (Beta = 0.192), occupational safety management (Beta = 0.123), and management innovation. (Beta = 0.120), with details as shown in Table 2.

Table 2 Multiple regression analysis of factors influencing the work efficiency of employees in the solar cell industry in Bangkok and surrounding areas.

Factors	**Unstandardized (b)**	**SE**	**Standardized (β)**	**t**	**Sig.**
(Fixed value)	1.101	0.104		10.632	0.000
Safety in work	0.123	0.020	0.235	.10662*	0.000
Strategic human resource management	0.243	0.022	0.329	9.818*	0.000
Working environment	0.192	0.032	0.243	4.405*	0.001
Management innovation	0.120	0.101	0.131	3.632*	0.002
R = 0. 756		Adjusted R^2 = 0. 659			
R^2 = 0.580		SE = 0.103			

* Statistical significance at the 0.05 level

DISCUSSION & CONCLUSION

A study of factors affecting the work efficiency of employees in the solar cell industry in Bangkok and surrounding areas. The researcher has brought important points to discuss the results according to the research objectives, as follows:

1) Work efficiency of employees in the solar cell industry in Bangkok and surrounding areas. Overall, each aspect is at a high level. In terms of quality of work expenses, workload, time, and methods, this may be because the executives have standards for managing safety in the workplace. There is human resource management that is consistent with responsible positions. There is a working environment that is conducive to working and applying management innovations in administration. As a result, it affects the work efficiency of employees in the solar cell industry in Bangkok and surrounding areas. at a high level. Consistent with research results consistent with the concept of Sedighi, van Splunter, Brazier, van Beers, and Lukosch (2016) mentioned the components as well: 1) Quality of work refers to the results of work that are correct. The work must be meticulous and orderly, and no errors occur. 2) The cost of work refers to the result of using resources to perform the work according to the assignment, with consideration of worthiness and economy. 3) Quantity of work refers to the results of work accomplished compared to the specified amount of work or the amount of work that should be done according to the standards set by the organization. 4) Time refers to the results of work or the results of work as assigned. Completed before or within the period specified by the organization from the above. It can be seen that knowledge development is important and affects work efficiency, and the research work of Prayuda, R. (2019) studied the influence of transformational leadership, corporate, atmosphere, innovative behavior, and employee participation in the performance of industrial employees with job satisfaction in the digital age. The results of the study found that the work efficiency of industrial employees is associated with job satisfaction in the digital age. It is at a high level in every aspect.

2) Work safety management factors, strategic human resource management, working environment, and management innovation. It influences the work efficiency of employees in the solar cell industry in Bangkok and surrounding areas. This may be because the executives have systematically managed work safety. Have good strategic human resource management. There is a well-organized work environment, and management innovations to operations, thus increasing efficiency in operations. Consistent with the research results of Arijanto, A.,

Widayati, C. C., and Pramudito, O. (2022), the factors affecting employee performance were studied. (Study on the Regional Coordinating Agency for Banten Province in Jakarta). The results showed that work safety management, strategic human resource management, the working environment, and management innovations affect employee performance.

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