A TEST OF THE INFLUENCE OF WEATHER ON EMPLOYEE PRODUCTIVITY IN AN OFFICE ENVIRONMENT

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ABSTRACT

Current research examining the effects of weather on the productivity of office employees is virtually non-existent. This study investigated relationships between weather variables and the productivity of such employees. Of the variables tested, only a discomfort index was a significant predictor of employee performance.

1. INTRODUCTION

It is frequently stated that everyone talks about the weather, but few people do anything about it. A review of relevant literature in the fields of management and psychology indicates that a third part could be added to this old saw; namely, few researchers in these areas consider weather to be an important variable in their studies. Indeed, when the numerous studies considering job satisfaction, work cultures, and employee productivity are reviewed, one has to be amazed that little, if any, mention is made of the possible influences of the weather on employee behavior. Even the more obvious internal physical environment has been given little research attention (6), so it perhaps should come as no surprise that external environmental factors merit even less consideration.

This obvious failure to consider weather and its potential impact on the outcomes of otherwise controlled field experiments would appear to be a consistent and near fatal flaw in the vast body of research now available on employee behavior. Of course, it is possible that the law of large numbers preserves the reliability of existing research results which failed to consider the impact of weather on behavior in the workplace. Presently, however, there is a virtual void in these research data that might serve to either affirm or repudiate this possibility. Additionally, this void is somewhat paradoxical, since research into the impact of weather on employee productivity would seem to be a rather logical extension of the early interest of industrial psychologists in researching possible relationships between productivity and temperature, lighting, and other physical conditions in the workplace. Equally paradoxical is the fact that the National Weather Service and other weather researchers have led the way in conductiong many of the studies seeking relationships between weather variables and employee behavior.

2. A SELECTED REVIEW OF THE LITERATURE

One of the first attempts to examine the impact of weather on employee behavior was conducted by Houghton and Yagloglou (9), who developed an effective temperature index by sampling the instantaneous sensations of people moving between rooms maintained under different environmental conditions. Using combinations of temperature, humidity, and wind velocity, they were able to plot the effective temperature actually felt by people rather than relying only on observed temperature in the workplace. These and subsequent data were later employed by military experts in defining the right kinds of clothing for personnel operating under various weather conditions.

Through the years, studies by other weather experts have examined various relationships between weather conditions and selected economic activities, with particular reference to agriculture, forestry, fishing, manufacturing, construction, transportation, utilities, advertising, insurance, and tourism. These studies, combined with others focusing on linkages between weather conditions and human behavior and health, comprise a substantial portion of W. J. Maunder's (12) classic work on the value of weather.

In very recent years, weather and other environmental conditions have been related to a variety of behavioral outcomes. Preston, Taylor, Martin, and Hodge (13) illustrated, in a survey of 75 residents of an area characterized by five hazards, that even though behavioral adjustments can be made, the severity of perceived hazards is not reduced. The specific hazards included in this study were flooding, severe storms, air pollution, water pollution, and noise pollution. A somewhat similiar study focused on urban violence was conducted by Harries and Stadler (7). These researchers found that temperature and heat stress were associated with aggressive behavior. The conclusions were based on a sample of 4,000 assaults in Dallas, Texas, during 1980.

The social costs of adverse environmental conditions have been suggested in studies like that of Langdon (10), and they appear to be considerable. More specifically, a few recent studies have suggested that the impact of adverse environmental and weather conditions can influence job satisfaction and employee productivity. Charry and Hawkinshire (5) found a strong association between weather

conditions and industrial accidents. A similiar, though less surprising, relationship was found between auto accidents and weather conditions. Vickory, Shaw, and Fisher (15) developed an experiment using 120 college students to test the effects of room temperature, clothing, and task complexity on job performance and satisfaction. They found that subjects wearing appropriate clothing for given environmental conditions showed higher levels of performance and task satisfaction.

Sanders and Brizzolara (14) found, in a study of 30 college students over a five-week period, that high humidity was negatively related to vigor, social affection, and elation. Another study by Hawkins (8) illustrated how, in an office setting, that temperatures in excess of 23 degrees C are associated with feelings of stuffiness and discomfort. Finally, it was noted by Abeysekera (4) that temperature on the job can be directly related to feelings of subjective discomfort in the industrial sector. When considred in their totality, all of these studies lend some credibility to the argument that weather and various climatic factors can influence performance on the job.

3. PURPOSE AND METHODOLOGY

This study was initiated to examine the belief that weather factors do have an influence on productivity and, additionally, that this influence is important even when employees are not exposed to the weather during working hours. Stated more specifically, the study was designed to test the hypothesis that meaningful relationships exist between certain weather variables and employee productivity in an office environment.

Data Sources

To test the stated hypothesis productivity and weather data were collected in an unobtrusive manner by utilizing historical records. Production records for data input clerks in the regional office of a large service-oriented business were acquired for a period of one calendar year. These production data were uniform over the one-year period with less than one percent of the data being incomplete. After collection, the daily production data were standardized by calculating a productivity index for each working day. This index was expressed as a percentage of 100 and was calculated by dividing actual daily production by a daily standard that had been established throught the company's work measurement program. This calculation can be expressed as follows:

$$DPI = ADP/EDP$$

(expressed as a percentage of 100)

where: DPI = Daily Production Index
ADP = Actual Daily Production
EDP = Expected Daily Production

Performance data were matched with available information on weather and air quality. Public health (air quality) data were initially considered promising, because the metropolitan area where the study was conducted has been noted for its environmental problems.

Air quality data collected from the county public health office included the following:

Carbon Monoxide. Reported in parts per million. Collected on an hourly basis with daily means used as the basis for computations.

Ozone. Reported in parts per million. collected hourly with daily averaes used for computations.

Sulfur Dioxide. Reported in parts per million. Collected hourly with daily averages used for computations.

Total Suspended Particulates. Data collected on a daily basis.

None of these environmental/air quality variables were significantly correlated with performance. For this reason, they were eliminated from additional consideration.

A series of climatological data were obtained from the National Oceanic and Atmospheric Administration (NOAA) for the metropolitan area under consideration. Data were collected on the following variables:

Temperature. Collected daily in terms of the maximum, minimum, average, and deviation from normal throughout the 24-hour period.

Precipitation. Collected as water equivalent inches.

Barometric Pressure. Expressed as inches of mercury at the collecting station's elevation above sea level.

Sunshine. Expressed as a percentage of the maximum possible for a given day.

Dew Point. Collected on an hourly basis.

Initial runs of these data produced only the percentage of sunshine as a possible correlate of performance. Subsequent runs that tested deviations from monthly and previous day averages for these climatological variables contributed no meaningful improvement in predicting performance. To ensure that no potentially useful predictor variable was excluded, meetings were held with National Weather Service personnel, who suggested the possible use of a more "aggregated" measure of climatic conditions, the discomfort index. This index was computed as follows Mather (11):

$$DI = T - 0.55\,(1.0 - 0.01\,rh)\,(T_d - 58)$$

where:

T = air temperature in degrees F
rh = relative humidity
T_d = dew point temperature in degrees F

As noted, standards have been established for this index to indicate where actual human discomfort begins with exposure to various combinations of temperature and humidity.

Research Questions

The primary research question in this pilot study was whether air quality and selected weather variables influence worker in "insulated" office

environments. Air quality data were initially eliminated since they showed no significant correlations with performance. This left only the question of climatic conditions. Since the percentage of sunshine was marginally "insignificant" in the initial analysis of weather variables, it was retained for additional examination.

There was also a question in the researchers' minds regarding the time period during which the discomfort index would be most influential on employee behavior. Initially, there was a feeling that the index should be computed at 6:00 a.m., because it was thought that a person's first impression of temperature and humidity in the morning would "set the stage" for the remainder of the day. However, there was also reason to believe that an average of the discomfort index between 6:00 a.m. and 9:00 a.m. would be a good measure, since this would cover the commuting time of most employees. In view of this, the dependent variable (productivity/performance) and the independent variables (percentage of sunshine, the discomfort index at 6:00 a.m., and the average discomfort index between 6:00 a.m. and 9:00 a.m.) were intercorrelated. The results are shown in table 1.

Table 1. Intercorrelation of Weather and Performance variables

	X1	X2	X3	X4	X5
X1	1.00				
X2	-0.25	1.00			
X3	-0.26	0.99	1.00		
X4	-0.10	0.13	0.14	1.00	
X5	-0.10	0.96	0.95	0.14	1.00

X1 = Percent Sunshine

X2 = Discomfort Index at 6:00 a.m.

X3 = Effective Temperature

X4 = Productivity

X5 = Discomfort Index Average of 6:00 a.m. and 9:00 a.m.

From the table, it can be seen that the discomfort indices were highly intercorrelated. The same was true of the "effective temperature" variable that was included as a promising correlate.

Since X3 (effective temperature) was highly correlated with both X2 and X5 it was dropped from the analysis. The average discomfort index (X5) was also eliminated. This left only the discomfort index at 6:00 a.m. (X2) and the percent of sunshine (X1) as possible correlates of productivity. Since performance data were available for 245 work days, daily values of the percentage of sunshine and the discomfort index at 6:00 a.m. were calculated for each corresponding work day. A standard stepwise regression was run using performance as the dependent variable.

The stepwise regression entered only X2, or the discomfort index, at 6:00 a.m. The r value obtained for this variable was -.138 which yielded an F value of 4.71. With 1/243 degrees of freedom, this is statistically significant at p = 0.05. Therefore, this analysis found that the discomfort index at 6:00 a.m., or approximately the waking hour for most employees, was the most influential factor relative to the performance of "climatically insulated" office workers. Moreover, as would be expected, the higher the value of the discomfort index, the lower the productivity, as indicated by the negative r value.

4. DISCUSSION SUMMARY, AND CONCLUSIONS

This study was conducted to test the hypothesis that the weather has an influence on the productivity of people at work. More specifically, as a pilot project, the study sought to uncover the essence of relationships between weather factors and productivity over a one-year period. If the data had revealed a strong association between selected weather factors and the productivity variable, the stage would have been set for extending the study to other sites, to other types of job situations, or to non-production data such as job satisfaction.

While indicating possible relationships, the data failed to show statistically significant relationships between productivity and any of the direct measures of weather isolated in the study. In fact, only the aggregated measure of discomfort was strong enough to be retained in the regression equation. Therefore, an immediate question which comes to mind is what caused the lack of strength in possible relationships between weather related variables and employee productivity?

Several plausible explanations arise which retain the fundamental premise of the study while explaining the weak associations noted. First, it is possible that the inside office location of the work force mitigated the influence of external weather factors to the point where virtually all possible relationships were minimized. Second, it is also possible that the relatively temperate sunbelt location of the research data base mitigated the influence of weather-associated variables on the *productivity of the employees* studied. Third, the standard of production for this group was so tightly established that substantial variability in daily productivity was not possible. Fourth, the influence of the weather on the level of productivity is not as strong in clerical jobs as might be true of other factors excluded from measurement. Indeed, such factors as sex, age, ion levels, clothing match, supervisory skills, or organizational climate could so overwhelm the possible effect of the weather that this variable pales by comparison.

Another plausible explanation comes to mind which does not retain the fundamental premise of the study. Perhaps old wives' tales concerning the weather are invalid in this day of climatically controlled office settings. This would negate the influence of weather variables on the productivity

level of such employees while explaining the weak association found in this study, which reflects only the significance, and not the importance, of the discomfort index on productivity.

Because of the points raised above, the temptation is great to conclude that the influence of weather is relatively unimportant on the productivity of office employees. Yet, the strength of the common sense belief that we do feel more energized and ready to work on nice days than on dreary rainy days is such that it merits a greater depth of investigation. It is recommended, therefore, that others follow our lead and study this area further, rather than letting these less than impressive results consign the idea to the pile of other interesting, but not very productive, research results. Specifically, it seems apparent to us that subsequent studies should be done pursuing the relationship between weather and productivity in a number of potentially useful ways.

The most obvious and, perhaps, the potentially most rewarding avenue for future research would be to replicate this study in other geographic locations. The relatively temperate sunbelt location of this research may have mitigated the influence of weather-associated variables on the productivity of those employees included in the study. Therefore, similar studies conducted in less temperate locations would serve to validate or refute this possibility.

A second avenue that suggests itself would be to gather selected demographic data on participants in the study group. With these data, one could test the possible influences of weather variables on the productivity of employees categorized by age, sex, length of service, educational level, or other characteristics. Finally, a third potential avenue for research would be to develop an experimental design whereby the effects of all variables except the weather could be either isolated or controlled in the conduct of the study.

Undoubtedly, other avenues for study can be identified by thoughtful researchers, and it is our hope that this pilot effort wil be of value to such persons. In this regard, the lack of strength in the relationships measured in this study should not be viewed as a deterrent, but as a useful caution to be heeded in the exploration of related areas for future research.

FOOTNOTES AND REFERENCES

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