The reliability and factor analysis validity of a new instrument to measure Illusion of Control bias in What-If DSS production scheduling simulation.

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ABSTRACT

There are several methods of accessing illusion of control that have been used by researchers. Many researchers have measured Illusion of Control (IOC) through questionnaire in experimental situations where subjects need to self report their confidence levels. The instrument developed in this paper is a 7-point Likert-styled questionnaire used together with a Decision Support System (DSS) in a production scheduling simulation has been reliability tested and factor analyzed for validity as a new instrument to measure illusion of control.

Keywords

DSS design. Illusion of control.

1.0 INTRODUCTION

Researchers in the field of Decision Support Systems (DSS) development have realized the relevance of this issue of human cognitive bias in their field of study. Among the biases, Illusion of Control (IOC) was also investigated in DSS research (Kahai, Sollieri, & Felo, 1998; Kottemann, Davis & Remus, 1994).. Illusion of control is displayed due to the unreasonable attribution of personal control to chance tasks; people display overconfidence of the probability of their control on the outcomes in such tasks.

Using a production-scheduling task as the experimental task, Kottemann et al. (1994) studied the use of a what-if or sensitivity analysis computerized decision aid in the USA. They found that subjects displayed illusion of control when they used a DSS that provides them the ability to do sensitivity analysis with the decision numbers. This is referred to as IOC from the use of what-if computer aid.

However, unlike other biases which are purely originating from the human mind while engaging in the decision making, the IOC phenomenon investigated by Kottemann et al. (1994) was derived from the use of what-if DSS.

This paper provides the reliability and factor analysis validity of a new instrument to measure Illusion of Control bias in What-If DSS production scheduling simulation.

2.0 ILLUSION OF CONTROL

In general term, Illusion of Control is defined as:

"An expectancy of a personal success probability inappropriately higher than the objective probability would warrant." (Langer, 1975).

Consistent with the definition by Langer (1975) who started the work in IOC, this IOC construct pertains to the inflated confidence people have in thinking that they actually have control on uncontrollable outcomes.

Langer's (1975) theory on illusion of control involves a "skill" theory of control to account for the perception of control in situations or events that humans actually have no control of. In her theory, Langer explained that skill and chance factors are often closely associated in everyday life (Presson & Benassi, 1996). Examples of skill factors are practice, effort and choice. Skill factors should be used in skill task, where there is a direct relationship between effort and outcome. A person that practices more (and correctly, of course) in his game of tennis may perform better than someone else that practices less, holding all other related variables (e.g. strength, built etc.) constant. However, humans may sometimes fail to distinguish between what is controllable and what is not (Presson & Benassi, 1996). Thus, the main idea behind Langer's theory of illusion of control is that **humans tend to**

introduce skill factors into chance situation. For example, Henslin (1967) found that dice players behave as if they can control outcome. When needing low numbers, they are careful to throw the dice softly, while to get high numbers, they will throw the dice hard (Henslin, 1967).

Kottemann et al. (1994) found that IOC was displayed from the use of a computer aid. The computer aid tested was a sensitivity analysis that is very popular with the use of spreadsheets. Using production scheduling as the experimental task, they found that subjects that used the aid displayed higher degrees of IOC. In other words, the group that had used the sensitivity analysis computer aid stated a higher degree of confidence in controlling demand. This is surely a concern for researchers in the DSS field. DSS, which is supposed to mitigate the effect of cognitive bias, is producing cognitive bias from its use. This phenomenon needs to be studied further to see the root of its cause

In trying to dig deeper into this IOC problem, Kahai et al. (1998) investigated active involvement, familiarity and framing to see their ramifications upon IOC in DSS use. Kahai et al. (1998) studied factors that were identified by Langer (1975) to influence illusion of control to see if these factors would influence IOC in DSS context. Among their findings, they found that active involvement and familiarity in the DSS experimental task led to IOC.

3.0 REVIEW OF HOW IOC IS MEASURED

Many researchers have measured IOC through questionnaire in experimental situations where subjects need to self-report their confidence levels. Matute (1996) in measuring IOC asked subjects to specify their degree of "perceived probability of controlling uncontrolled outcomes". The subjects are to state a number between –100 to 100 with –100 as having completely no control and 100 as having complete control.

Alloy, Abramson & Viscusi (1981) and Golwitzer & Kinney (1989) measured IOC in two parts, which are the subject's "judgment of perceived control" and subjects' "confidence of accuracy of their judgment". Questions related to these concepts needed to be answered by specifying between a scale from "0" (no control) to "50" (intermediate control) to "100" (complete control).

4.0 THE WHAT-IF DSS PRODUCTION SCHEDULING SIMULATION

The experimental task was programmed in Excel 2000 with built-in Visual Basic macros. Subjects faced uncertain demand over a series of time periods. Subjects have to determine a production level and the workforce level with the goal of minimizing total cumulative cost while meeting demand. The three quadratic cost equations based on Holt, Modigliani, Muth & Simon, (1960) formulation of a production-scheduling problem presented below, not known by subjects, are used to calculate the cost incurred.

Demand begins with 2500 units. Actual future demands were calculated as follow. If t is current period, demand at period $t+1$ is equal to demand at t plus 100 and then randomize by ± 200 units.

Workforce level change cost =

$$60\,((\text{current workforce} - \text{new workforce})^2) \qquad (1)$$

Worker overtime/ idle time cost =

$$0.5(((\text{new workforce} * 5) - \text{new production})^2) \qquad (2)$$

Cost for Non optimal inventory =

$$0.02((\text{current inventory} + \text{new production} - \text{new demand} - 300)^2). \qquad (3)$$

Subjects do not know this actual demand. Forecast numbers are not given to subjects and are substituted with past period sale figures to provide them with an anchoring point in determining the production level.

Workers' optimal productivity are 5 units/period and optimal level of inventory is 300. These values remain constant throughout the experiment. At the very top, average total cost thus far incurred is displayed. Below it is the past period sales.

Important cells were color-shaded to ease instructions to subjects. In the blue shaded cells were the current inventory and current workforce levels. The green shaded area is where the subjects input the production and workforce level decisions. Subjects need to also input what they expect sales were going to be in the yellow shaded cell. The DSS automatically disallow subjects to input values of production and workforce level that fall outside reasonable range. For example, if production was specified too high compared to workforce level that would shoot up overtime cost, the DSS would prompt the subject to change it.

The button marked "Use these numbers and proceed to next period" do exactly that. Subjects could simulate scenarios in each period by entering levels for anticipated sales demand, workforce level, and production level. The system takes these inputs to calculate the tentative costs.

5.0 INTERNAL CONSISTENCY AND FACTOR ANALYSIS OF IOC QUESTIONNAIRE

26 Malaysian MBA students undergone the what-if DSS simulation and then were given the IOC questionnaire. The IOC questionnaire has eight

questions. Table 1 below lists the eight questions in the IOC questionnaire.

A 7-point Likert-style scale here does not mean or imply that we used the true Likert Scale. It only means that the questionnaire's items have 7 response categories (i.e. Very Strongly Agree, Strongly Agree, Agree, Neutral, Disagree, Strongly Disagree, Very Strongly Disagree). A true Likert scale has only 5-point. This then comes to the question how the respondents' scores are calculated. It is common practice in behavioral studies to have only the design of the questionnaire based on Rensis Likert's scale (thus the term Likert-"style") but the calculation not following Rensis Likert's calculation of respondent's score (i.e. the Likert Scale) (Babbie, 2004). Consistent with the common practice, respondent's score is just the summation of the item scores while noting reverse scoring for items in reversed wordings. To be specific, a 6-item seven-point Likert-styled questionnaire will be totaled as a composite score; the possible range for respondents' scores would be between (& including) 6 and 42.

Table 1: IOC questionnaire

	Questions/items
Q1:	I feel that I can predict sales very accurately
Q2:	To what extent did you have control over the accurate prediction of future sales
Q3:	I am able to guess the true sales precisely
Q4:	What percentage of other decision makers, who are also undertaking this production scheduling exercise, do you feel are performing poorer than you.
Q5:	My estimates of real sales, when I was deciding on the production numbers, were always correct
Q6:	I am in control, when it comes to predicting next period sales accurately
Q7:	Overall, I feel very confident of the accuracy of my prediction of future sales
Q8:	Percentage wise, I feel that I am the top __% of those taking the production scheduling exercise.

The reason for a 7-point instead of a 5-point Likert-styled questionnaire for IOC is just to simply give subjects a broader range to express themselves. At 7-point response-categories is also better than a 5-point in discriminating between respondents' perceptions of IOC. In other words, using 7-point is more sensitive in measuring IOC than using 5-point.

The Cronbach's Alpha calculated for the IOC questionnaire was .8781, which is quite high (close to one) suggesting that the items are very inter-related.

A one-factor rotation shows consistent positive scores with only the score for item 4 slightly lower. The two eigenvalues bigger than one are 4.403 and 1.407. Note that the second eigenvalue is only slightly bigger than one. A scree plot suggests two factors exist.

Item 4 shows a very low correlation (<0.4) with other items, whereas even have a negative correlation with item 6. Actually, item 4 and item 8 were added as dummy items initially. The following paragraphs illustrate the factor analysis when these two items are dropped. We would then see a better instrument without these items.

Cronbach's alpha jumps to 0.8887without items 4 and 8. Factor analysis suggests only one factor exist. High positive factor loadings exits for all the items. A scree plot shows only one eigenvalue bigger than one. Thus, the final IOC questionnaire is without including items 4 and 8. However, researchers can put items 4 & 8 in their questionnaire but should not include them in calculating IOC scores.

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