A SIMULATION BASED ANALYSIS OF THE VALUE OF INFORMATION IN THE HREBINIAK AND JOYCE TYPOLOGY OF ADAPTATION RELATIVE TO PORTER'S GENERIC STRATEGIES

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ABSTRACT

This study presents information that suggests that Hrebiniak and Joyce's Typology of Adaptation contains an information value bias. The quadrants of their typology, as they relate to Porter's generic strategy types, are shown to produce different locally maximized returns on investment. This result, supported by the analysis of data obtained from a simulation that was developed from a popular business game, lends itself to the argument that there is an optimal amount of funding that specific generic strategy types should be willing to commit to Information Systems technology. From a practical standpoint, the implied bias in information value may demonstrate that organizations may experience a diminishing rate of return on Information Systems investments. Further, it lays the groundwork for future research into implications that discontinuous economic conditions may introduce into the typology relative to the implicit information bias.

INTRODUCTION

Overview

Hrebiniak and Joyce (1985) present the recent literature concerning organizational adaptation as bipolar camps with each representing either the supporters of strategic choice or the supporters of environmental determinism. After briefly stating several of the problems associated with such a binary distinction, they suggest that there is a critical interactive nature between organizational choice and environmental forces. They continue by building a foundation for their position that rests upon a series of cites from the literature. Each of these presents a particular view that either supports or parallels their own thinking relative to the Typology of Adaptation that they develop and present as an alternative.

The Typology of Adaptation

The Typology of Adaptation presents strategic choice and environmental determinism in interaction. That is, rather than holding that organizational adaptation is determined by either strategic choice or environmental determinism, Hrebiniak and Joyce's Typology of Adaptation sees such change as a function of an interaction between the two. In essence, these independent variables are considered as two separate continua and, as such, their interactions result in four main types of organizational adaptation.

These four main types of organizational adaptation directly relate to the four quadrants in the Hrebiniak and Joyce continuum. These quadrants of the Typology of Adaptation are as follows. Quadrant I is characterized by natural selection, minimum choice, and adaptation or selection out. Quadrant II allows for differentiation or focus, differentiated choice, and adaptation within constraints. Quadrant III provides for strategic choice, maximum choice, and adaptation by design. Finally, quadrant IV is marked by undifferentiated choice, incremental choice, and adaptation by chance.

In addition, Hrebiniak and Joyce suggest a relationship between predominant generic strategy and quadrant location. In particular, Porter's (1985) generic cost leader, differentiator, focus, and stuck-in-the-middle strategies are discussed. The cost leader strategy is associated with quadrant I, the differentiator and focus strategy with quadrant II and quadrant Ill, and the stuck-in-the-middle strategy with quadrant IV.

Porter's Generic Strategies

One of the more noted authorities in the field, Michael E. Porter, describes a set of generic strategies that are available for organizational implementation. The highlights of Porter's views on strategy, in particular those considered relevant to this study, are briefly presented in the remainder of this section.

Porter defines three generic strategies that firms may employ in their efforts to earn above-average rates of return. They are focus, differentiation, and cost leadership. The focus strategy is related to the scope of activities, in which the firm engages and consists of two subtypes. Scope of activity is described by the broad-based or relatively narrow strategic activities through which a firm competes. Focus strategies more specifically target segments within broad-based markets. The two subtypes are cost focus and differentiation focus respectively. Since the scope of activities involved in this study is constant, these two strategy subtypes are not relevant and will not be considered further.

The differentiator strives to achieve a competitive advantage by developing some uniqueness, whether actual or perceived, that is valued by a large number of consumers. The willingness of these consumers to pay a price premium greater than the cost of differentiating the goods or services provides a competitive advantage and allows an above-average rate of return to be earned. This implies that costs must be kept as low as possible. The dimensions on which differentiation is based are varied; examples include product and marketing factors.

A firm that employs a cost leadership strategy attempts to achieve a competitive advantage by becoming the low-cost producer in the industry. This low-cost position allows the cost leader to earn an above-average rate of return at prices that are less than or equal to those of its competitors. This assumes that the cost leader's goods or services are perceived as acceptable by the consumer; that is, the product must be differentiated to the extent that price discounting in order to maintain sufficient sales volume does not offset the firm's cost position. The dimensions on which a low-cost position is based are also varied; examples include economies of scale and preferential access to the factors of production.

Porter also cautions against the possibility of becoming "stuck-in-the-middle." He states that

> A firm that engages in each generic strategy but fails to achieve any of them is "stuck-in-the-middle." It possesses no competitive advantage. This strategic position is usually a recipe for below-average performance. A firm that is stuck in the middle will compete at a disadvantage because the cost leader, differentiators, or focusers will be better positioned to compete in any segment.

Therefore, based on Hrebiniak and Joyce's Typology of adaptation and Porter's generic strategy types, it seems reasonable to posit an implied bias in the value of information across the typology. Consider for example that, in terms of Hrebiniak and Joyce's Typology of Adaptation, a competitor that is "stuck-in-the-middle", with a lower return on investment relative to Porter's generic differentiator and cost leader, would likely place a higher value on information under most, if not all, economic conditions.

Problem Statement

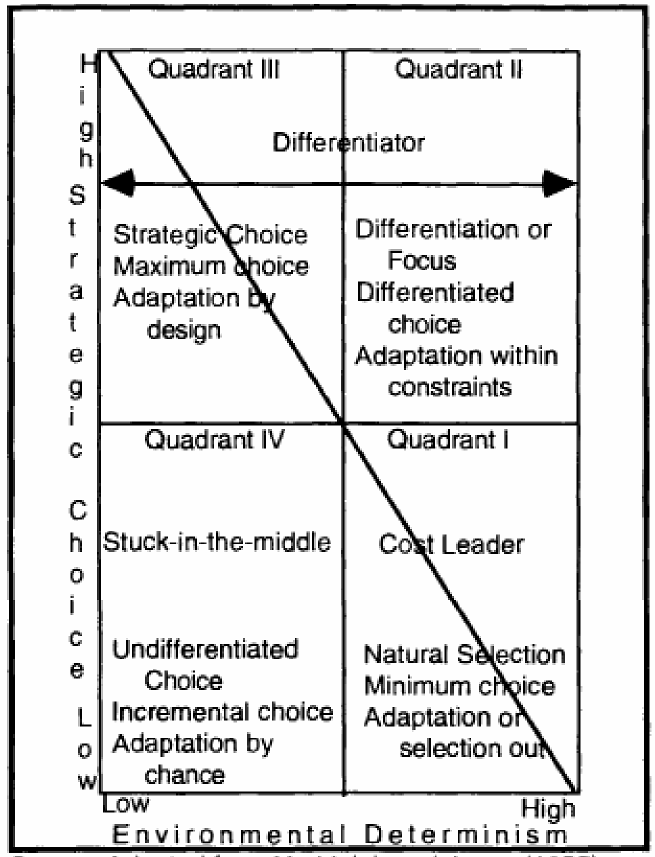
The idea for this study developed from a statement made in *Administrative Science Quarterly* by Hrebiniak and Joyce in which they remark:

> Weber's (1947, 1967) ... discussion also suggests that the outcome of this struggle depends in part on the effectiveness of organizational decision making. The present analysis indicates that: (1) control over scarce resources is central to the relationship between choice and determinism, and (2) strategic choice is possible in all quadrants of Figure 1, although the qualitative nature and impact of the decision process certainly varies with the organization-environment context.

The implication is that effective organizational decision making requires reliable information and that the quality and impact of such decision making may vary based upon quadrant location.

This suggests that information has a value and that value of

Figure 1
The Typology of Adaptation



Source: Adapted from Hrebiniak and Joyce (1985)

information may vary by quadrant. This implication, along with Hrebiniak and Joyce's proposed interaction between organization and environment, may tend to indicate an information value bias in the Typology of Adaptation. Furthermore, since it was suggested that Porter's generic strategies fit certain of the model quadrants, it is possible to consider using these strategies as surrogates for the quadrants. Then holding organizational strategy constant and based upon which of the generic strategies is favored (biased for), it may be possible to determine the dynamic (over time) component of environmental determinism.

In particular, this study wilt use simulation techniques to study Hrebiniak and Joyce's Typology of Adaptation.

Specifically, the value of information relative to Porter's generic strategies will be calculated in order to determine whether any bias is present within the quadrants. If, as expected, a bias in the value of information between Porters generic strategy types within the Typology of Adaptation is demonstrated by this study, the stage for further study will have been set. Future research can then hold strategic type constant and study changes in the value of information over time related to environmental determinism.

Purpose of the Study

This study will use a simulation of *The Executive Game* (Henshaw and Jackson, 1990) coupled with a search oriented decision support system (DSS) to develop locally optimized returns on investment for Porter's generic strategies as they relate to Hrebiniak and Joyce's Typology of Adaptation. Porter's categories will be used as a basis for the development of these simulated returns on investment because of Hrebiniak and Joyce's indication that Porter's generic strategies were directly related to their Typology of Adaptation quadrants. The simulator is discussed in more detail in a later section of this paper.

Limitations

The reader should be aware that this research, like most, was limited. Among the limitations that may have affected this study are several that involve the simulation itself.

First, even though noted authors including Peter Senge (1990) of MIT support the testing of assumptions in 'microworlds", care should be taken in generalizing to any specific business environment.
Second, the economic conditions used in this study were *The Executive Game* defaults. Using different economic conditions might produce different results. This could be tested by editing the game defaults and running the experiment again. Third, game length was held to two years in both actual and simulated play. This is the same length of time that students normally play. Running the game for different amounts of time may produce different results.

There are also possible limitations in the area of strategy. First, there are other valid strategies that were not tested. For instance, Eisenhardt (1990, 1992) suggests that fast decision making has become strategic. Including such "Quick Response' strategies may produce different results. Second, arbitrary decisions were made about how to best quantify Porter's generic strategies using the available decision variables provided for by the game. This problem arose because the game's approximation of reality is not sufficiently detailed to allow for exact representation. It is possible that another implementation might produce different results.

Another limitation is the qualification placed on the maximized rates of return produced through the use of the DSS that was developed. While it seems reasonable to think that these values are at or near an optimal value for each firm, there has been no attempt made to prove that this is the case. Different starting values for the decision variables might produce different results.

Finally, much of the information upon which the DSS design is based was drawn from the individual experience of a single game administrator. Although this experience spanned a number of years and several editions of the game, additional input from different sources might result in different outcomes. However, the experimental results produced through the use of the DSS follow theoretical expectations and, therefore, the use of such experience seems justified for the purpose of this study.

METHODOLOGY

Overview of the Experiment

A simulator based on *The Executive Game,* a widely recognized general management game, was used in this study as a vehicle to empirically analyze the value of information in the Hrebiniak and Joyce Typology of Adaptation relative to Porter's generic strategies. Specifically, a simulation of the game, supported by a search oriented decision support system, was used to develop locally optimized decisions for a balanced set of strategies.

The values of the relevant optimized decision variables were then used to develop locally optimized returns on investment for Porter's generic differentiator and cost leader strategies. These returns on investment were then considered to be representative of the maximum value of information associated with a particular quadrant based on Hrebiniak and Joyce's assignment of Porter's generic strategy types to each of the quadrants. In addition, Porter's "stuck-in-the-middle' position was included along with a "static" strategy in order to provide balance and a reference point. The specific details related to how this was accomplished are presented in the following section.

Data Collection

The simulator was based upon and developed from ideas, flowcharts, and code provided by the authors of *The Executive Game.* It was tested to a matter of cents in tens of millions of dollars by running identical input through both *The Executive Game* and the simulator and comparing the resulting output. The small amount of error noted was attributed to rounding errors.

Simulated players in *The Executive Game,* like their student counterparts, are required to make quarterly decisions for their firms. These decisions consist of determining a value for nine decision variables. They are price, marketing, production, materials, maintenance, plant and equipment, research and development, robotics, and dividends.

The actual procedure for making these decisions for the different strategy types will be covered in the next section. This section will describe the general behavior of the three sets of strategies that were developed and implemented. Specifically, they were pure, mixed, and static strategies.

The first set consisted of separate individual generic strategies that tend toward either cost leadership or differentiation. These pure strategies were either one type or the other; they did not vary between types as the game progressed. The intent of this set of strategies was to simulate highly effective players in terms of the strategy being employed in the game. From the start of play they optimize their decisions as they attempt to achieve competitive advantage.

The second set involved experimentation as a method of learning. These mixed strategies included a quarterly variation between a cost leadership strategy and a differentiation strategy; like Porter's "stuck-in-the-middle" position they were not consistent as time passed. In addition, a random component was introduced to simulate learning; the probability of making a better decision improved with each quarter. Like real-world managers they tend to become better decision-makers as the game progresses. That is, they learn as they make and implement decisions then experience the consequences of their actions.

The third strategy set consisted of only one type, namely the static strategy. This strategy type did not arise from the literature or any particular theory; it was intended to provide a point of reference for the other strategies and to provide balance to the simulation runs.

Decision Support System Considerations

The strategy types were implemented and their decisions optimized by developing and binding a Decision Support System (DSS) to the simulation. The DSS accepts the price preset at each price point for the individual strategies (discussed in the next section) and through the simulator manipulates the marketing and production decision variable values to locally maximize profit based on the economic conditions and demand levels specified by the game. The computer code to accomplish this is not presented here; however, the remainder of the procedure upon which it is based is discussed below.

Once the values for marketing and production that maximize profit are known, the DSS is able to directly compute the required values for the material, maintenance, and plant and equipment decision variables. Finally, any cash on hand at the beginning of the period, and not yet spent, is allocated based on the given strategy of the player.

The specifics involved in this allocation procedure are as follows. The differentiation strategy spends half of its remaining cash for research and development and half for robotics. The static strategy allocates all of these funds to dividends. The cost leader strategy purchases robotics with half and additional plant and equipment with the other half. Both mixed strategies divide their excess cash on hand equally for research and development, robotics, additional plant and equipment, and dividends.

In addition to automating the production of decision variable values, the DSS allowed the returns on investment to more closely approximate optimum levels. Providing an optimum return on investment subject to the constraints of the study allowed for equivalent comparisons of the results generated by the various firms employing different strategies.

Although the resulting returns on investment of the individual firms (and thereby Porter's different generic strategies) were optimized in a manner similar to dynamic programming, it is realized that these values may not be at a true maximum. However, given the simulated player's circumstance in any given quarter, the DSS was not able to determine better values through calls to the simulator. This circumstance is primarily due to three factors: the starting positions provided for the firms in the first quarter, their competitive actions and reactions as they attempt to maximize their positions relative to individual constraints, and the resulting starting positions for the following quarters. It should be further noted that any other use of the words "optimize" and "maximize" in this study is meant to be considered similarly qualified.

Simulation Runs and Data Collection

In order to develop locally optimized returns on investment for Porter's generic differentiator and cost leader strategies for *The Executive Game,* a number of runs were made using the decision support system and simulation. The simulated runs covered the typical range in which student players normally price their product. Specifically, this range was from twenty dollars to thirty dollars per unit. It was determined by querying a single game administrator with a number of years experience through several editions of the game.

For the purposes of this study, a price point is defined as a specific price from the discrete range tested. Five separate game runs were completed for each of five price points. Each individual run for the separate price points consisted of providing an initial set of decision variable values to the decision support system. With the exception of the value for the price decision variable, the initial default values provided by *The Executive Game* were used. Since each game consisted of eight quarters and five firms, a total of 1000 observations were generated by the simulator for this study.

In addition to the generic differentiator and cost leader discussed earlier, three other players were simulated. One player was set up as a static player. For the most part, the static player's decisions did not vary over time. That is, the static player tended to maintain the original values of the decision variables. The one exception was that excess cash on-hand was paid out as dividends. Two players were set up as mixed players. These two players alternated their generic strategies each quarter in an attempt to simulate Porter's "stuck-in-the-middle" theory. The purpose of the static and mixed strategies was to provide a reasonable balance to the simulation. Using a more realistic set of strategies, as opposed to using only pure generic strategies, should tend to produce unbiased results.

The static player's price was always that of the price point. It was also the average industry price. The differentiators price was always five percent higher than the average industry price and the cost leader's price was always five percent lower than the average industry price. Although the mixed players' individual average game price was the same as the industry average price, their individual quarterly price alternated between the price of the differentiator and the cost leader.

After an initial request each quarter to *The Executive Game* simulator to establish a base position upon which to judge the results of each firm's current set of decisions, the decision support system would manipulate each firm's decision variable values according to a set of heuristics appropriate to its generic strategy classification. Specifically, while holding price constant, each firm's marketing expenditures and production volume were varied in an attempt to increase profit until sales volume either equaled or reached its closest point to market potential. Learning was simulated by allowing the decision efficiency of the mixed strategy firms to approach their optimum over time.

The decision support system was then able to compute the plant and equipment, maintenance, and material decision variable values required to support the optimized level of sales volume. Finally, the decision support system allocated any remaining cash on hand to research and development, robotics, and dividends based upon the generic strategy in use by the firm. Maximization of profit was accomplished by allowing the decision support system to make repeated calls to the simulator with the new values of the decision variables determined by the above procedure.

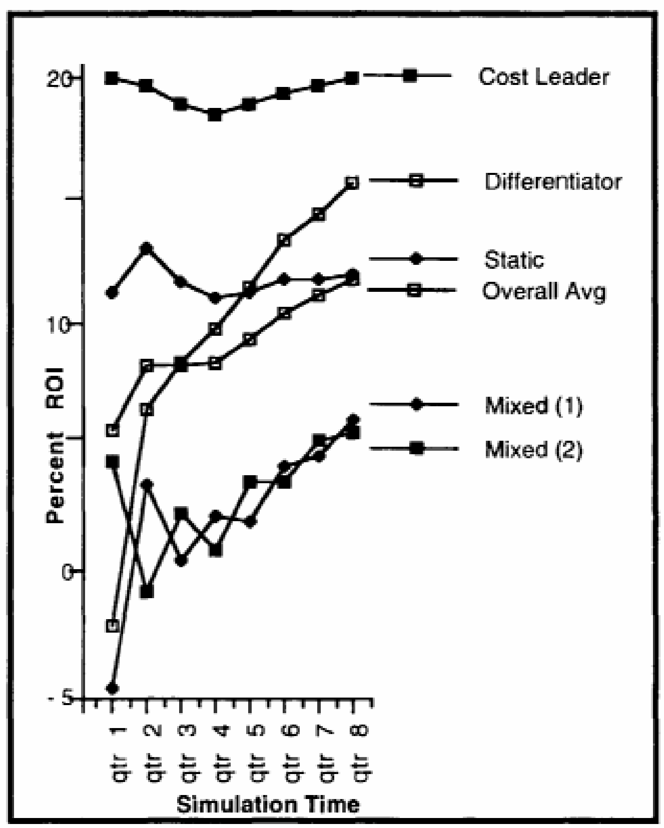
The values of the decision variables that result from these simulation runs will be used to develop the locally maximized returns on investment for the generic strategies. These returns on investment will be used to determine the value of Information for the generic strategy types within the default environment of the simulator.

FINDINGS

Simulation Results

Figure 2 graphically illustrates the results and is followed by a brief discussion.

Figure 2
Average Simulation Cumulative ROI



Source: Primary

Overall, the descriptive statistics developed from the 1000 simulated observations indicate that the pure strategies were better performers than the mixed strategies. This result is in agreement with Porter's theory on generic strategy types. More specifically, the cost leader was the overall performance leader with an average cumulative return on investment of 19.43%. The differentiator maintained second place with a cumulative ROl of 15.28%. The static player was third with 11.59%. The two mixed strategies were last; mixed 1 earned 5.66% cumulative while mixed 2 earned 5.11%. The overall firm average ROl was 11.41%.

The cost leader strategy always captured the largest market share while the mixed strategies always captured the smallest. Theory readily supports the cost leader's position. The mixed strategy position, for this as well as the other findings presented, is due in part to both the simulated learning component and the inefficiencies involved in supporting multiple inconsistent strategies.

The relationships between the decision variable values developed by the DSS for the different strategy types was as expected. Price was the one variable whose value was preset; it was not manipulated by the DSS. The other relationships are as follows.

The static player invested most heavily in marketing. This was expected because it was not allowed to invest in robotics or to increase research and development. The remaining firm order for marketing was the differentiator, the cost leader, and the mixed strategies.

Production tended to follow market share as would be expected. Likewise, maintenance, materials, and plant and equipment expenses were related to production volume. R&D expenditures were lead by the differentiator and were followed by the cost leader, the static player, and the mixed strategies in order.

Robotics followed the same pattern with the exception that the static player was not allowed to invest in automation. Finally, the static player lead the mixed strategies in dividends paid out. The differentiator and cost leader were not allowed to pay dividends.

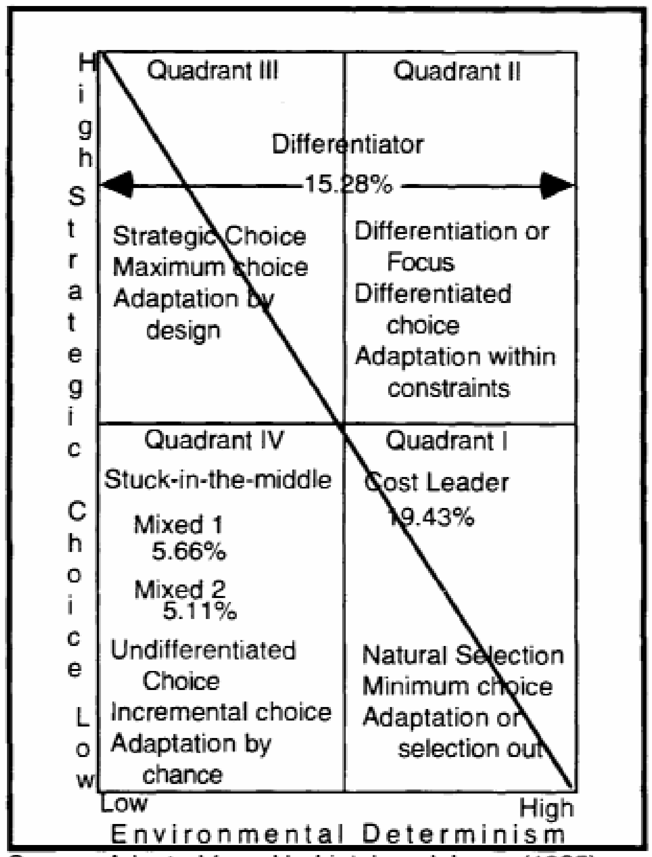
SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

Hrebiniak and Joyce's implication that effective organizational decision making requires reliable information and that the quality and impact of such decision making may vary based upon quadrant location was the impetus for this study. This suggested that information may have a value and that value of information may vary by quadrant. This implication, along with Hrebiniak and Joyce's proposed interaction between organization and environment, led to the proposition of an information value bias in their Typology of Adaptation.

Since it was suggested that Porter's generic strategies fit certain of the model quadrants, the Cost Leader, Differentiator, and Stuck-in-the-middle strategies were used as surrogates for the quadrants. Holding organizational strategy constant it was suggested that there was a bias in the value of information between the quadrants of the Hrebiniak and Joyce Typology of Adaptation model. The results of this study are summarized in Figure 3.

Figure 3
Value of Info. Bias Within the Typology



Source: Adapted from Hrebiniak and Joyce (1985)

Conclusions

In particular, this study used simulation techniques to study Hrebiniak and Joyce's Typology of Adaptation. Specifically, the value of information relative to Porters generic strategies was calculated in order to determine that bias is present within the quadrants. This bias is taken as an indication of the value of an Information System to the various generic strategy types to which they are associated.

For instance, under the assumptions that an Information System was available that could collect the proper information, correctly analyze that information, and that 'rational' management would act on that information in a timely manner, there is a maximum value that an organization would be willing to pay for such locally optimized information upon which to base its decisions. This value could be calculated as the difference between the value of information of the quadrant to which the organization wishes to adapt and the return on investment that the organization is currently realizing.

As an example, consider the following scenario. Suppose that a differentiator in Quadrant II is earning a non-optimized return on investment of 10.43%. In this case, if the organization would like to obtain an Information System to assist its decision making efforts to move to a Cost Leader position in Quadrant I, it would not be willing to spend more than 9% return on investment on such a system. Of course starting from different quadrants or different non-optimized returns on investment would produce different levels of optimal Information Systems investments. From a practical standpoint, the implied bias in information value may demonstrate that organizations may experience a diminishing rate of return on Information Systems investments as they approach their optimal rates of return.

Recommendations

Thus, the stage for further study has been set, future research will concern itself with studying changes in the value of information over time related to shifts in economic environment. This will be accomplished by holding strategic type constant and then manipulating the simulation's environmental variables in order to provide a growth, a stable, and a declining environment in which to study the interactions between organizational choice and environmental determinism relative to changes in economic conditions. In short, the various generic organizational types that exist within differing environments under varying economic conditions should be provided with a better understanding of the relative value of information that may be available. This should lead to a better overall understanding of the relative value of Information Systems to these organizations.

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