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Degeneracy of MIS under the Conditions of Instability: A Mathematical Formulation

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***Abstract*—**It has been always observed that the effectiveness of MIS as a support tool for management decisions degenerate after time of implementation, despite the substantial investments being made. This is true for organizations at the initial stages of MIS implementations, manual or computerized. A survey of a sample of middle to top managers in business and government institutions was made. A large ratio indicates that the MIS has lost its impact on the day-to-day operations, and even the response lag time expands sometimes indefinitely. The data indicates an infant mortality phenomenon of the bathtub model. Reasons may be monotonous nature of MIS delivery, irrelevance, irreverence, timeliness, and lack of adequate detail. All those reasons collaborate to create a degree of degeneracy. We investigate and model as a bathtub model the phenomenon of MIS degeneracy that inflicts the MIS systems and renders it ineffective. A degeneracy index is developed to identify the status of the MIS system and possible remedies to prevent the onset of total collapse of the system to the point of being useless.

***Keywords*—**MIS, management theory, information technology, information systems, IS, organizational environment, organizations, degeneracy, organizational change.

I. Introduction

THE normal life period of any system is characterized by a low, relatively constant failure rate. In case of products the failure rate is usually random when the exerted pressure exceeds what the system of components can withstand. However, in the case of information systems that are engineered and driven by software engines, the failure takes a number of different forms. The Soft Error Rate (SER) [1] is a close depiction of the type of failure that may inflict the functionality of any information system software. The reasons for such failure could be so convoluted that may be as obvious as a bug in the software code or as mystical as cosmic rays, that would inflict the memory chip at that moment. In addition, other factors would involve the complex interrelationships between the software, the hardware, and the users. In this paper we expand the environment of such failure to include aspect of human behavior in accepting or rejecting certain constructs thus formulating a position. The lack of ability of the system to sustain functionality with a flawless outcome is defined as degeneracy. Degenerate elements may produce different outputs under different conditions. The onslaught of degenerate behavior would start from the commencement of use, or interaction with the user until the end and abandonment of the entire system.

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II. Evolution of Management Information Systems

Many attributes of management information systems were researched and discussed in the annals of management literature [2]. Many cases investigated what constituted the elements of good management, and robust management styles; with the conclusion that a robust MIS is a building block of "good Management" [3]. The jury is still out as to what would be the essence or core of good management let a lone good MIS.

It is abundantly apparent that MIS would not have come this far without the introduction of powerful computing machines. The introduction of graphics and the ability to store and retrieve large chunks of data gave rise to MIS development [4].

A stable system/ organization is characterized, as a second order equation with roots located at the left hand side of the complex domain. (Obviously higher order representation is possible, but with similar conclusions). However, when the roots are on the right hand side of the domain, then the system is always unstable, which could be either exponential that drive the Y-values into infinity very soon, or totally oscillating with increasing amplitude. To define a corresponding stability aspect in MIS, let us empirically define of the predictability of MIS impact on organization as a function the capability to digest, transform, and translate the data input into meaningful information that will lead to better decisions. Metaphorically, digestion/indigestion means less ability to translate information traversing the organization into actions that will impact in resolving the organization reaction toward stimuli. There are two critical determinants of the internal stability of the organization. It can safely be modeled as follows:

Predictability of MIS outcome = f (Capability to process info)

III. Models

In an ad-hoc survey of a convenient sample of 60 middle/top managers distributed among a number of business and government institutions, there was a staggering 87% opinion that information transmitted to reflect management decision on a wide range of management functions has no significant impact on the day to day running of their business and more often the time lag between the perception to actual action, which could sometimes be stretch indefinitely. These results indicate that there is state of degeneracy of MIS, which points to the need for an up-to-date information at every level of management.

The essence of the contribution of MIS in running the organization is to be proactive in the face of uncertainty [5]. In addition, MIS is to help improve the response time between the onset of an event and action in timing and quality. This will have to be rationalized to the ultimate benefit of the organization's struggle with adversity or changes in the environmental variables. This will determine the position of the organization (competitive or otherwise) posture in the future.

Degeneracy indicates the degree by which the MIS will elevate the organizations performance to achieve rationally expected outcome. The term rational is subjective. It may reflect the cumulative impression of the observer on the efficacy of the system. The positive reaction is not a sign of degeneracy, as it is desirable to maximize the reaction, but the negative reaction that may contribute to the demise of the organization is considered here as a degenerate case.

IV. The Bath Tub Curve

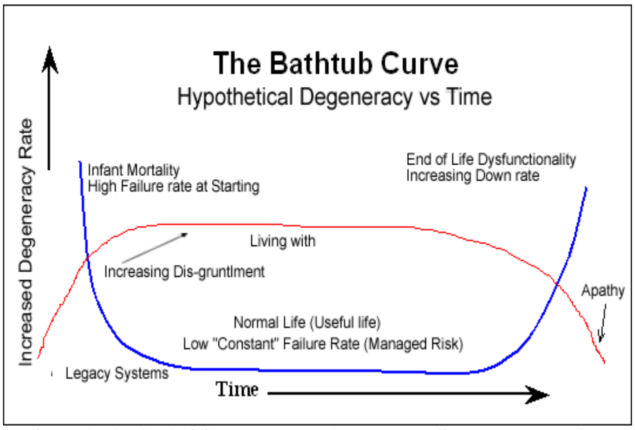


Fig. 1 the bathtub failure curve and corresponding user's reaction curve

Failures rates over time of integrated systems fall into three distinct regions. The first region where the rate of failure falls at a fast pace, but systems would fail in an escalating catastrophic fashion, is referred to as infant mortality, or parts that fail at some relatively higher rate over a short period of time, due to manufacturing defects, software defect, or outright rejection by the users. This is an inevitable situation, however, once the infant mortality period is surpassed; the useful life period is reached with a relatively lower, but stable failure rate. During the useful life, failures are random in time. This phase may take long or shorter time periods, depending on the usability. Most legacy systems are in this stage for a long time, and despite the "low" failure rate, it is a system the organization is living with. In MIS it can stay forever and this is a non-recurring situation; until the system is put on the chopping block (where sometimes substantial investment is thrown away in favor of the older legacy systems when the new one is deemed non-reliable). A good example is a number of people's soft implementations for university registration applications. The final stage is wearing out, the components begin to wear out and fail at some relatively escalating rate. If the failure rate of the component versus time is plotted on a curve, the high failure rates initially and at end of life cycle with relatively low failure rates during the middle period results in a bathtub shaped curve. In MIS applications the last stage or end of life high failure rate occurs when new demands are added and the system is stretched beyond its intended design. The lifetime of any manufactured component can be modeled through its hazard rate h(t)=f(t)/(1-F(t)) [1]. A bathtub shape hazard rate model is appropriate when we have high infant mortality followed by a long useful period and then increasing hazard rate due to aging or non-adequacy [4]. The two change points of the hazard rate are useful in deciding the "burn-in" strategies and warranties in integrated systems, but changeover in MIS.

An ad-hoc survey was presented to a convenient sample of MIS users. They were to rate the probability of declaring failure and how often the possibility of failure at a number of discrete periods on a timeline being stretched from now to the future and the past. The results (see Fig. 2) showed a bathtub like distribution.

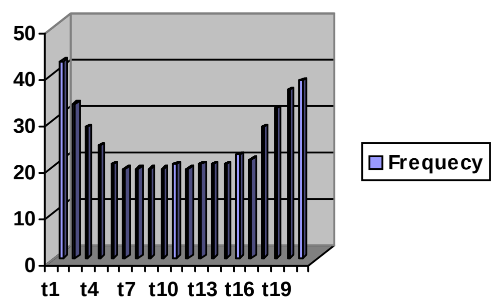


Fig. 2 the distribution of the survey results

This empirical similarity between the failure history of physical component and business information systems is striking. The difference is in the type of components comprising the system, the manifestation of failure, the variables involved, and obviously the type of consequences. Let us define the term instability to mean the period where the infant mortality phenomenon persists. The same can be said about the end of life period but this is not the concern of this research.

The MIS will function within the context of the entire organizations variables or dynamics. These variables can be:

1. Acceptance of the MIS as a new approach to the information flow.

2. Awareness of the criticality of the operations that are running and how does this reflect in sensitivity towards any variance in the new MIS performance.
3. The user friendliness of the new systems and how tolerant the users are.
4. The level of maturity of the organization in its ability to handle variations in the way the new MIS is presenting information.
5. The presence of "bugs" in the system and how the new MIS is tested prior to introduction.
6. The degree of customization the new MIS has undergone and the level by which users can influence its functionality.
7. The ability of the MIS team to handle, absorb, resolve, de-escalate the problems arising in the initial implementation of the system.
8. The relative "political" influence of the users versus decision makers on the suitability of the new MIS.
9. The presence of a reliable, assertive feedback loops to report any dysfunctionality (real or imagined) in the new MIS.
10. The effectiveness (promptness) of the support team in resolving complaints.
11. The time frame of MIS launch and the pressure it may lead to.

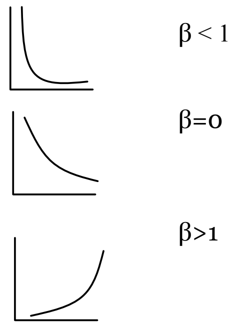
Some or all of the variables above may influence promote, stifle, or even instigate a state of instability in the implementation of an MIS. The instability period will start to cease, or the curve will turn eastward, once compromises start to sink in and the organization will realize that is it time to live with whatever the system is offering. The timing of this turn is a function of similar sets of variables as above.

V. Mathematical Treatment

MIS systems are usually subjected to stress tests. The purpose is to weed out the "bugs" that may exist and hold down the system from performing. The tests are usually designed or customized, and randomized based on specific features that exist or performed by the MIS system. The term pass /fail does not apply across the board on all functionalities. In addition, the term scenario is used to indicate a pattern or battery of tests the system is subjected to. The issue of failure on the other hand becomes murky and laden with opinion and viewpoints. The final or ultimate is that the system will perform as intended and generate the expected outcome under every scenario. The intended outcome are usability, and output. The repeatability is germane to computer systems (software); in other words once it runs in a certain manner it will keep spewing the same outcome for the same input. The speed is no longer an important issue in most business MIS. The CPU speed had exceeded even the most optimistic expectations [6]. Let us define the Weibull degeneracy function as a two-parameters Weibull density function to denote the rate of failure

$$D(t) = \frac{\beta}{\eta}\left(\frac{t}{\eta}\right)^{\beta - 1}$$

Where: D(t) is the probability of degeneracy at period t, it is here to mean a degeneracy index; β is the shape parameter which can be estimated as shown in Table 1below; and η is the characteristic life. Notice that:



Where β=linear combination of the variable indicated in the Table 1 below.

The values of β and η are determined by following different approaches [5],[7],[8]. In this paper it is estimated as explained in the table below:

β is a linear combination of the eleven variables described above. They are scaled as a result of the initial testing period as follows:

TABLE I
TABULAR FORMAT FOR COMPUTING THE VALUE OF B

#	Description	Index 0-1	Rating 0-10	Computed Rating
1	Acceptance of the MIS as a new approach to the information flow.	**Ex. 0.8**	**9**	**7.2**
2	How variance in the new MIS performance is critical to the process.			
3	The user friendliness of the new systems and how tolerant the users are.			
4	How MIS is presenting information congruent to the level of maturity of the organization in its ability to handle variability.			
5	How the new MIS is tested for the presence of "bugs" in the system prior to introduction.			
6	The level by which users can influence customization of functionality.			

7	The ability of the MIS team to handle, absorb, resolve, de-escalate the problems arising in the initial implementation of the system.			
8	The relative "political" influence of the users versus decision makers on the suitability of the new MIS.			
9	The presence of a reliable, assertive feedback loops to report the dysfunctionality (real or imagined) in the new MIS.			
10	The effectiveness (promptness) of the support team in resolving complaints.			
11	The time frame of MIS launch and the pressure it may lead to.			

The sum of column 4 will be used to compute the value of β after dividing by 110. On the other hand experts estimate the value of η , and depending on the factors of technological innovations that are relevant, the life span of the given MIS is estimated under the best of conditions.

The survival of an MIS system suffering from the symptoms of degeneracy can be explained metaphorically like a meteorite entering earth atmosphere, it may or may not cause damage. Another metaphor, is an aircraft flying in a hostile territory, it may or may not be shot down by enemy gunfire; if it escapes the enemy fire, it must drop enough bombs on the enemy to prevail The essence of these events is randomness.

IV. Conclusions

The examination of the survey results indicated the application on of the Weibull function to estimate the infant mortality behavior of the MIS life cycle. The degeneracy index of any MIS implementation will benefit in the assessment of status of the system and points to the need for the introduction of better designs. In addition, it will help in avoiding the pitfalls of debugging an already launched system. This index is derived from and will depend heavily of the results of the initial testing. The aim is to reduce this index to the minimum. Further research in conducting the parameters estimation technique will be a contribution.

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