SYSTEMS MANAGEMENT AND INFORMATION METRICS BASED ON TIME DISTORTION AND PROFIT

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ABSTRACT

Organizational management systems, for control and command, have attracted a great amount of research and debate since the very origin of management, as its underlying question is: how to manage human activity systems successfully? More recently, the so-called 'Balanced Score Card' approach has assumed dominance in managers' practice. While that approach has its merits, it also has some important limitations; among others it ignores the concept of time and its relation to information. To deal with some aspect of this limitation, this paper introduces a metric, (e.g. mathematical model) based upon information theory (entropy). The entropy in this paper measures the information content of time distortion in organizational performance and links it to the economic outcome (profit). The paper demonstrates how time-based goals can serve as a metrics of both information and economy, and that the relation between information content and economy outcome is not linear. The paper suggests a mathematical model in which the management system and its operating system are carriers of information (as measured in nats) with economic dependence. The proposed model shows, among others, that time-distortion influences economic performance dramatically, including a lever effect, while high information entropy does not necessarily imply high economic outcome. The outcomes of the paper are contra-intuitive and may suggest a new metric for assessing goal oriented information from management system to its operating system. It may also be seen as a model for assessment of management efficiency with respect to time and economy.

Keywords: Systems management control, entropy, time-distortion, goal function.

INTRODUCTION

This article presents a work-in-progress featuring a novel model for managerial control of social organizations, such as firms, NGOs, and public organizations. The proposed model has its foundations in a system-theoretic, cybernetic and entropy-based conception of organization and its information.

As ‘social organization’ is one of the central inventions of human kind, it is crucial that social organizations can be managed properly. Indeed, organizations are instrumental for achieving results that cannot be produced by an individual, and virtually everyone is affected continuously by a variety of organizations, for good and bad (Morgan, 1986). On the other hand, managers that command and control organizations are faced with increasing challenges of complexity steaming both from organizations themselves and from their environment (Roberts, 2004). Various inventions have been advanced to handle this complexity (Mintzberg, 1979, 1983), where one central is the division-based organization (ibid.), while another, more recent, is the so-called 'Balanced Scorecard'. The latter is a particular way of definition and articulating managerial objectives for an organization (Kaplan & Norton, 1996, 2000). On the other hand, a challenge with any approach to management by objectives is that non trivial organizations require typically a large set of objectives to be articulated, communicated and controlled, where a large set of objectives challenges managerial attention and cognition, hence the ability to manage rationally. To this challenge, the here advanced model offers one solution, namely: an entropy-based evaluation of an organization's goal function, which signals both how much information a particular instance of control provides, for a specific goal and for a whole organization, and then a link between that control-information and the organization's economic performance.

The remaining of this paper is structured as follows. Next section summarizes the theoretical foundations assumed here for the formulation of the proposed model, while the section thereafter presents the very model for managerial control, here advanced. Thereafter comes a section that offers a short case that illustrates the use of the here proposed model for managerial control. The final section presents a short discussion and some suggestions for further development of the proposal advanced here.

THEORETICAL FOUNDATIONS

The theoretical foundations assumed here, for the formulation of the proposed model for managerial control of social organizations, stream from systems and cybernetic theories. They form an entropy based notion of information; the key theoretical components, central for the here proposed model, and is summarized in the following.

System and Cybernetic Notion of a Social Organization.

The notion of a '*system*', as conceived by the so-called General Systems movement (Hammond, 2003; Klir, 1991; Le Moigne, 1994), and the affiliated filed of '*cybernetics*' (Ashby, 1960; Beer, 1979, 1981), has showed useful for the conception of an organization and its governance. Checkland (1981) summarized elegantly a handful of central characteristics of any non-trivial system.

Firstly is the *emergence* and *hierarchy*, where a system produces emergent properties that none of its parts produce on its own, such as an airplane's ability to fly. This in turn gives rise to an internal complexity, which is organized in hierarchies, or levels of organization. For example, living systems may be conceived in terms of cells, organs and the organism as such (Miller, 1978), while social organizations, such as firms, organize themselves in terms of divisions, business units, functions, groups, etc. (Mintzberg, 1983). Systems manifest the capability of sending and receiving information both within the systems and between the system and its environment (Miller, 1978). This *communication* is needed to exhibit command and control of a system's behavior, instrumental for the process of adaptation to both internal and external changes. Adaptation, in turn, is crucial for system's survival or sustainability, however conceived or measured – e.g. living or death, or financial profit. This implies that a system may be conceived principally in terms of its *operating sub-system*, which produces whatever the system does, and its *management sub-system*, which commands and controls what is produced by the operating system (Beer, 1979, 1981).

This short expose of a system and cybernetic conception of the structure of a social organization, with regard to its governance, implies that social-systems maybe conceived in terms of a teleological behavior, rather than being purely deterministic obeying passively some natural laws (Le Moigne, 1994). Teleological behavior means here that a social organization may pursue a set of goals, where some are conflicting with each other (ibid.). This understanding of a social-organization in terms of a goal-oriented behavior is central to the proposal put forward here, and is conceived further down in terms of the *Information Matrix* and its link to a *goal function*.

ENTROPY-BASED NOTION OF INFORMATION

The here assumed metric of information is based on Shannon's work (Shannon, 1948), where he suggested 'entropy' as a measure for signals in systems. The stochastic pattern in which a signal might be transmitted could be transferred into probabilistic measure and thereby express the quantity of information. Signals with low probability were considered to have higher information content than those occurring more frequently. To put it more commonplace; a solar eclipse transmits more information than the fact that the sun rises every morning.

In the present elaboration, 'signal' and 'information' are explicitly related to the metric of 'time'. All activities in an organization, such as for instance reading or writing as well as meetings or management can be measured in terms of time. Subsequently, the system in the present elaboration is a time-system where time durations carries information about constructs such as 'wait', 'queue', 'stop', 'start', 'retardation', or 'finish', for instance. Absences as well as presences of activities or constructs are considered as information carriers about the system. For instance; "we have no *queues* in our project presently" or "there is *retardation* with 4 days in process 3", "our *meetings* are *delayed*" transmit important information. As will be demonstrated further down, the here suggested focus on time and time durations opens up a bridge between systems management, information and economy.

It must be emphasized, however, that there are several perspectives of time that has to be considered. On one hand there is the Newtonian perspective, which here is called the *physical* time. The physical time passes smoothly with an even pace and relates to the motion of the earth around the sun. The physical time usually serves as a context to which other system-related values are referred; for instance "completed cars *per week*", "profit USD *per year*", "Salary *per month*". In economy, budgeting or project planning, for instance, the physical time serve as the singular temporal concept.

On the other hand, there is a time perspective referring to humans' subjective experience of time. This time, which here is called *cognitive time*, is based on the time cognition of an individual, and it passes in jerks and jumps, sometimes fast and sometimes slow, and it has a pronounced stochastic development. Indeed, the passage of cognitive time differs from objective time, and the substantial divergences between the two time perspectives have been studied by psychologists the last century (Block & Eisler, 1999).

This paper focus on the *difference* between cognitive and physical time in an arbitrary organization, and this difference, denoted Time Distortion (von Schéele & Haftor, 2013) is defined as:

$$\text{Time Distortion: } \tau i = \left(\frac{t_c}{t_p}\right) i \qquad (1)$$

Specifically, for time distortion in service economy, t_p denotes the time agreed upon in a certain contract, where "i" stands for contract number "i". The physical time t_p serves as an economical *target* for the service delivery, guiding employees about the time frame that must be met. Similarly, t_c stands for the cognitive time, corresponding to time assessments made during the delivery of contract "i". Time distortion τ_i is subsequently a corresponding measure of precision of delivery of time for contract "i". The term "precision of delivery", however, refers to metrics of *physical time*, and is also based on measures of money, quality etc., the term "Time Distortion" stresses metrics of *both* physical time and cognitive time with reference to the same activity.

Since cognitive time varies stochastically, there follows automatically from Eq. 1 that Time Distortion has a stochastic nature as well. Time records of employees, reports about delays, information about retardations of output, project plans etc. frequently exhibit haphazard deviations from targets and goals. In this paper, such deviations are treated as carriers of information. Particularly, mean value and standard deviations of Time Distortion carry information about the system itself. In order to understand a system related to Time Distortion, we shall look a little into some mathematical properties.

THE PROBABILISTIC NATURE OF TIME DISTORTION

Cognitive time distortion exhibits a *stochastic pattern*, *varying* serendipitously during any one day. Empirical investigations show that Time Distortion has a stochastic pattern *both* at the level of an *individual subject* and at the level of a *group of subjects*; however the deviations are more pronounced when, for example, a service is performed by a group of individuals than by an individual actor, hence at the group level (von Schéele, 2001) – see Figure 1.

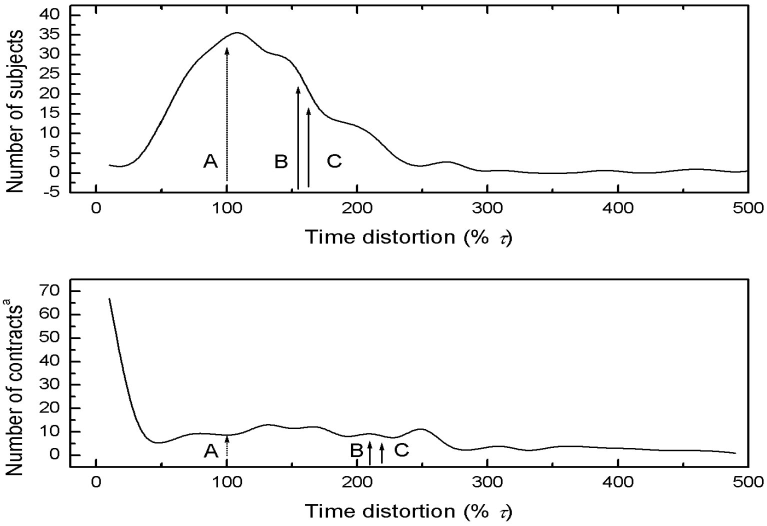

Figure 1. Shows the asymmetrical probability-distribution P(τ) of cognitive time-distortion. The Top Panel illustrates the distribution of cognitive time-distortion for individual time-assessments in a laboratory experiment (N = 224), while the Bottom Panel illustrates the distribution of cognitive time-distortion at the level of a group of individuals (here service contracts, where N = 233 in five service organizations). Arrow 'A' indicates the mean value, μ, of a Gaussian distribution, while arrow 'B' indicates the approximate mean value, μ, and arrow 'C' the approximate expectancy value, E(τ), of the probability distributions P(τ), (based on empirical data from laboratory experiment and a survey of service contracts (von Schéele, 1999, 2001).

The Statistic and Asymmetric Nature of Cognitive Time Distortion.

To further elucidate the statistical nature of the time distortion τ, consider P(τ) as being the probability function of the stochastic time distortion variable τ. Let also $p(\tau)$ express the probability that a time distortion of magnitude τ occurs. The expectancy value E(τ) of the time distortion τ in a set consisting of "i" events, [i = 1…r], can then be defined as E$(\tau) = \Sigma\, p(\tau_i)\, \tau_i$. Provided that the individuals of a given population are unbiased or randomly biased, the time distortion will then exhibit a probability distribution P(τ) with the following properties:

i. P(τ) is not symmetrically distributed around τ = 1, which implies that the arithmetical mean value $\mu_\tau \neq 1$ and the expectancy value E$(\tau) \neq 1$. There exist several empirical evidences supporting this, showing that individuals assessing time exhibit a tendency to *overestimate* the passage of time e.g. (Ashoff, 1985; von Schéele, 2001).

ii. P(τ) is not Gaussian-distributed, but exhibits instead an asymmetric distribution with a long "tail" for values of $\tau > 1$ (von Schéele & Haftor, 2013). In such distributions it should not be expected that the arithmetical mean value

μ_τ corresponds to the expectancy value E*(τ)*. Serious errors will be committed if a Gaussian distribution of time distortion is assumed in economic calculus, as such an assumption, in turn, builds on presuppositions that both the arithmetical mean value μ_τ and the expectancy value E*(τ)* are equal to unity.

To illustrate the point mentioned in ***ii*** above, an investigation of five service organizations (von Schéele, 2001) showed that the arithmetical mean value μ_τ as well as the expectancy value E*(τ)* of P*(τ)* were greater than 2. Thus, the time estimations of the employees exceeded the actual contracted time, indicating a general *overestimation* of the passage of time. Furthermore, only 16% of the customers received a service-time that matched contractual time. The practical consequences of this were large deviations from budgeted economic outcome as well as poor profitability of the investigated service operations, ultimately resulting in the need to discharge employees (see von Schéele, 2001, for further details).

Consider now shortly the Shannon entropy, thus construed such as frequent events carry less information than infrequent ones. In an arbitrarily organization this can be interpreted as business objectives, goals, or precision of delivery draw less attention if they are on target, than the opposite. To put it somewhat commonplace, business targets that are accomplished contain *less* information than those that exhibit large deviations from objectives and goals. Subsequently, business targets related to time support economic metrics (Time Distortion, precision of delivery) as well as information metrics (information entropy based on Time Distortion). This will further be developed below.

THE PROPOSED MODEL FOR MANAGEMENT CONTROL

The profit equation.

It is assumed here, that a 'goal function' is a formalized expression of a desired condition that has to be fulfilled for an organization. The long term viability of an organization typically includes its ability to master its economy in terms of profit and loss. This axiomatic statement may produce associations to monetary values and economic rates as well as their fluctuations.
The goal function of an organization is revenue-oriented and targets the total contractual time-volume, t_{vol}, in the present context of a service-delivery organization. (Similar, yet somewhat more complicated mathematical logic, is valid for goods producing organizations). The basis for the model is the conventional notion of *profit* (Hadar, 1971):

$$\pi = TR - TC \qquad (2)$$

Here, π signifies profit per time unit, TR the total revenues per time unit, and TC the total costs per time unit. The parameters are expressed in monetary values, preferably defined for the time unit of one year. It is useful to consider the *total workload-time to customers*, t_{vol}, of an economic organization on a yearly basis, while the market price for each hour delivered, p, is considered on an hourly basis. Accordingly, the expression $TR = p\ t_{\text{vol}}$ denotes the total annual revenues of one economic organization, here a service provider, that charges its customer the price of p Euro per hour, for the total time-volume of t_{vol} hours in a year.

Elsewhere (von Schéele & Haftor, 2013) we have elaborated Eq. 2 above to the following expression:

Q(τ,δ) , The **distortion of profit**

$$\pi(\tau,\delta) = p\, t_{vol}(\alpha \Sigma (\varepsilon_i/\tau_i) + (1-\alpha) \Sigma (\varepsilon_i\tau_i) - \Sigma (\nu_{pj}\, \varphi_j/\delta_j)) \qquad (3)$$

Time-distortion of **fixed-price to customer contract**.

Time-distortion of **current-account to customer contract**.

Time-distortion of **fixed-price employee contract.**

Eq. 3 expresses that profit, $\pi(\tau,\delta)$, is dependent not only on price, p, and total time – volume t_{vol}. In addition, profit is dependent on contract mode, α, time distortion on customer contract "i", τ_i , and employee contract "j", δ_j. In addition, we applied the weighting parameters ε_i and φ_j to adjust for the relative size of customer contract "i" and employee contract "j", as compared to total time delivered. Finally, the parameter ν_{pj} indicated that the price on employee contract "j" is below the market price (the parameter vary between approximately 0,3 – 0,7). In order to measure how many percent profit deviates from budget, Eq. 3 is multiplied with $(100/(1 - \nu_{pj}))$.

The advantage with Eq. 3 lies in that it accounts for the *curve-linear* relationship between profit and time distortion. This implies that a change in time distortion with, for instance, 10 % may produce a change in profit corresponding to, for instance, 20 or 40 %, depending on the input of the other variables. This quality in Eq. 3 is denoted as the *lever effect* of Time Distortion, and we will shortly return to this in the following section.

The information matrix.

The conception of time is a construct for assessment of any kind of *change*. In an organization, "change" may be termed as profit increase, development of overtime work, decrease of sick-leaves, etc. The change in an organization can always be expressed as a target or sub target with reference to varying terms of time (sick-leaves per months etc.). Likewise, the targets may consider level of work-load, work environment, efficiency, precision of delivery, queues, bottle-neck problems, capacity problems etc. Thus, the "change" in an organization corresponds both to Time Distortion as defined in Eq. 1, and profit as defined in Eq. 3.

This paper does *not* treat "change", as a deviation tracked by an external observer measuring it singularly in terms of physical time. Instead, the change of an organization is assessed with the compounded measure Time Distortion in Eq. 1. This measure contains the time target expressed in physical time, and also the target accomplishment as measured in cognitive time. The Time Distortion informs about the system's *perception* of its *own* change.

To formalize the discussion above, consider an organization supplying some arbitrary services. Assume that "r" customers have signed a contract "K_i", where "i" corresponds to customer "i". The supplier consequently holds a contract portfolio K comprising of an array of contracts ($K_1, K_2, \ldots K_r$). Each contract is connected to unique and customer related targets, and every target is measured in physical time. Let t_{p1} denote the physical time of the targets in contract 1. This gives us the following contract portfolio:

$$K = (t_{p1}, t_{p2}, \ldots t_{pi}, \ldots, t_{pr}) \qquad \text{[hours]} \qquad (4)$$

Consider now the service delivery, with events frequently occurring that facilitates or delays the work. From Collopy (1996) we know that the retrospective events of time are frequently *overestimated* and vary between 30 % (Managers, Planners and Business Analysts) up to 120 % (Administrative Personnel). Subsequently, a customer does not receive the physical time volume "t_{pi}" as stated in contract "i", but instead a time volume corresponding to a retrospective, and erroneous, time assessment of the service delivery. To adapt the denominations to Eq. 1, we say that the time delivered is based on the *cognitive time* assessments by the employees. Thus, let "t_{ci}" denote the cognitive time volume delivered on contract "i", which gives us the perceived service delivery of the contract portfolio:

$$N = (t_{c1}, t_{c2}, \ldots t_{ci}, \ldots t_{cr}) \qquad \text{[hours]} \qquad (5)$$

Now, consider for a moment Eq. 1 and combine it with Eq. 4 and Eq. 5. We create "t_{ci} / t_{pi}" corresponding to the Time Distortion of contract "i". This circumscription presents an alternative mode of describing the contract portfolio in Eq. 4. It disregards from constructs such as "orderstock", and focus instead on an array of Time Distortions. Writing it out, we let τ_i signify the Time Distortion, of contract "i", and get the following expression for the Time Distortion of the contract portfolio:

$$T = (\tau_1, \tau_2, \ldots \tau_i, \ldots, \tau_r) \qquad \text{[x100 \%]} \qquad (6)$$

In Eq. 6, the Time Distortions of service deliveries vary stochastically, sometimes corresponding fairly well with the contracted time volume, sometimes falling below or, as well, exceeding it (Ashoff, 1985). Mathematically, it can be suggested that T is a discreet random variable with a probability mass function $p(\tau) = \Pr\{T = \tau\}$. For a more comprehensive discussion on random variables and entropy, see Cover & Thomas (2006). In reality, the probability mass function $p(\tau)$ exhibits low values when the Time Distortion τ is low, and, likewise, take low values when τ is high. This means that there is a small probability for large errors in over- or under-estimation of time in a contract portfolio. Simultaneously, there is a moderate probability for the Time Distortion corresponding to the value 1, which means that the cognitive time may correspond to the physical time.

The probability mass function of Time Distortion, too, can be written as a discrete variable, forming of an array of probabilities:

$$P = (p_1, p_2, \ldots p_j, \ldots p_s) \quad [x100\%] \quad (7)$$

Here, p_2 for instance, can signify the probability that the Time Distortion meets a certain discrete strata or level. This may correspond to the expression that "there is 20 % probability that the Time Distortion lies in the interval of 75 % - 85 % of target value".

Consider now for a moment an organization with three sub targets, each target clearly stated in terms of time. These sub targets might for instance be activities in a process or a project, as well as service deliveries in terms of a contract. It is convenient to follow up these targets by means of controlling the Time Distortion, as of Eq. 6. A more dynamic description of target accomplishment is rendered by Eq. 7, and this forms the base for a decision matrix (Restle & Greeno, 1970; von Schéele & Haftor, 2014). We have modified this decision matrix by including target accomplishments.

Table 1. Information Matrix with three sub-targets and three levels of target accomplishments.

	Target accomplishment		
	Perfect	**5 % late**	**10 % late**
Sub Target 1	p_1	p_2	p_3
Sub Target 2	p_4	p_5	p_6
Sub Target 3	p_7	p_8	p_9

In Table 1 above, we find the probabilities p_i gathered in an Information Matrix. The columns of the matrix indicate to which level a target has been accomplished. For instance, sub target 1 might have been met perfectly 30 %, while 40 % corresponded to a delay of 5 %, and the residing 30 % being delayed 10 % during the time of observation. It is important to understand, that "target accomplishment" corresponds to the strata or levels as mentioned under Eq. 7. Thus, the more levels of target accomplishment, the clearer impression of the probability mass function $p(\tau)$. We recommend at least 15 levels of target accomplishment with reference to Time Distortion.

It is here stressed that the Information Matrix in Table 1 has the following properties:

- Each row has a probability sum = 1
- Each sub Target has its own *unique probability mass function* of $p(\tau)$.
- Each sub Target renders its own unique *average* of time distortion, τ_i.

The Information Matrix considers accomplishment of several targets and sub-targets simultaneously. Unlike the balanced score card (Kaplan & Norton, 1996, 2000), the

Information Matrix stresses metrics based singularly on Time Distortion and goal achievement. The reason to this is that there is a strong *lever effect* between Time Distortion and profit (as in Eq. 3); a small change of Time Distortion creates a strong effect on profit as measured in monetary values (von Schéele & Haftor, 2013). Therefore, monetary targets mixed with time targets in the same Information Matrix create large tension between the sub-targets. This aggravates the interpretation of the system's Time Distortion. Thus, make sure that sub-targets are of the same type, and that there are no concealed curve-linear mechanisms interfering.

The Information Matrix can easily be expanded with reference to *conditional* probabilities in a service production. For instance; it might be of interest to distinguish between information in department A and department B. The problem is solved by using the taxonomy "sub-target 1 *provided that* it is performed in department A", or "sub-target 2 *provided that …*" The information entropy equation that is recommended for this situation is *conditional* entropy (Cover & Thomas, 2006), but is beyond the scope here.

The Information Matrix gives *only information* about the *spread* of the probability function of the Time Distortion; it does not inform about *how well the target has been met*. It relies on the assumption that a business organization is a goal-seeking system with reference to time targets. Therefore, low information entropy may not necessarily imply that the system has an output close to target. Nevertheless, it is considered highly improbable that low information entropy occurs during any other condition than high target achievement, see conclusions below.

THE INFORMATION ENTROPY OF TIME DISTORTION

The distribution of the mass function *p(τ)* Eq. 7 may be scattered or well collected, the shape can be flat or peaked; its appearance carries information about the production process of the service. Most service deliveries correspond fairly well to the contract, which means that the Time Distortion falls close to 1 (see Eq.1). However, some service deliveries deviate very much from the contract. Information about these deviations can be modeled using the information entropy equation (Cover & Thomas, 2006). The entropy is a measure of the *average uncertainty in the random variable*, which in our case happens to be the Time Distortion τ with its probability mass function *p(τ).*

Information, as understood here, is a *reduction* of uncertainty. As long as a service delivery meets the target, there is little information to exert from the business system. However, when a service delivery is far from target, there is much information of interest to the business system. Our interest is now to measure the information content regarding an organization's target accomplishment. We therefore combine Eq. 4, Eq. 5, Eq. 6 and Eq. 7, and using the same denominations as above, the equation for information entropy H_S is defined as:

$$\mathrm{Hs} = -\sum_{i=1}^{s} p_i \ln p_i \qquad [nats] \qquad (8)$$

In Eq. 8, Hs stands for *information content of the Time Distortion regarding an organization's target accomplishments.* The metrics suggested to this Information entropy is "nats", since the logarithm is based on "e" – the natural logarithm (Cover & Thomas, 2006). Of course, entropy might have been measured with the binary logarithm, giving us the metrics in "bits". This suggestion was however discarded, due to the fact that time perception of human beings does not correspond to a binary function, but presents a rather fuzzy mechanism consisting of more shades than "right" or "wrong".

To sum up, we now have Time Distortion (Eq 1), profit (Eq. 3), Information Matrix (Table 1) and Information entropy (Eq. 8); the same raw data (time distortion) constitutes input in both profit Eq. 3, and Information entropy Eq.8. Let us have a short illustration of the proposed model below.

An Illustration of the Proposed Model

Assume a consultant company has defined terms "small" and "medium" project and formulated the following targets:

1. Sub target A: Prestudies of "small projects" shall be performed within 5 working days.
2. Sub target B: Prestudies of "medium projects" shall be performed within 7 working days.
3. Sub target C: All projects in the organization shall have a perfect precision of delivery with reference to total budgeted time.

As spelled out in Eq. 3, both TR and TC are influenced by the Time Distortion. Let us now assume that the following conditions are valid for Eq. 3:

a) All contracts are fixed price contracts, implying that $\alpha = 1$.
b) The margin v_{pj} is defined as 0,6.

In addition, let us assume that the stratas of target accomplishments are as few as three, as written in Table 1 below. This gives us three time distortions to follow up. Following the formal notion of Eq. 6, we have: T = (1, 1.05, 1.10).

A dynamic simulation for the three sub targets A, B and C gives us the probability mass function *p(τ)* (see Eq. 7). Since each sub target has its own probability distribution, Table 2 below exhibit an arbitrary solution of the Information Matrix. Observe that each row corresponds to the probability sum = 1.

Table 2. Illustrates an Information Matrix with three sub-targets and three levels of target accomplishments (from von Schéele & Haftor, 2014).

	Target accomplishment		
	Perfect	**5 % delayed**	**10 % delayed**
Sub Target A	0,50	0,38	0,13
Sub Target B	0,22	0,67	0,11
Sub Target C	0,86	0,07	0,07

This fictive scenario exhibits a spread of the target accomplishments; Table 2 shows that 86 % of all activities related to sub-target C were perfect on time. Likewise, 67 % of all activities related to sub-target B had a deviation of 5 % from budgeted time. The scenario above gives us the following outcome for the profit Eq. 3 and the Information entropy Eq. 8:

$\pi(\tau,\delta) =$ 89,8 % of budgeted value.

H_S = 2,3321 [nats]

This means that the profit only reaches 89,8 % of budget due to delays in the system. Simultaneously, we see that the information in the system reaches a level of 2,3321 nats.

CONCLUSIONS

From this paper following conclusions can be made:

1. A business system with Information > 1 can *never* present perfect target accomplishment.
2. Should *all* sub targets be perfect on time, making column “Perfect” = 1, leaving the other columns = 0, the profit $\pi(\tau,\delta)$ = 100 % (of budgeted value), and H_S = 1. This is interpreted as *perfect business systems with perfect target accomplishments, void of all kind of Time Distortions, contains no Information.*
3. It is important to notice the following, though highly improbable, conclusion as well. Should all sub target have a target accomplishment corresponding to, for instance, column “Perfect” and column “5 % late” corresponds to 0, and column “10 % late” corresponds to 1. This outcome, indeed, influence the profit dramatically, making $\pi(\tau,\delta)$ deviate very much from 100 % of budgeted outcome. Simultaneously, H_S = 1. This is interpreted as *business systems with exact the same Time Distortion with reference to all sub targets, can never meet budgeted profit, and they contain no information.*

Some insights.

The variation of information H_S and profit $\pi(\tau,\delta)$ in a system is exceedingly complex. For certain, it can be concluded that the distribution of τ and δ (that is, time distortions in Total Revenues and Total Costs) have a large influence on the information level H_S as well as on the profit $\pi(\tau,\delta)$. In general, it is assumed that a healthy organization has a narrow distribution around target accomplishments, thereby affecting the profit $\pi(\tau,\delta)$ to be close to 100 %, and the information H_S to take a low nats value. Nevertheless, both functions, $\pi(\tau,\delta)$ as well as H_S, are curvilinear and do not exhibit any regular pattern with reference to each other. Main confounding factors are the Variance of time distortion in Total Revenues and Total Costs, *and the mode of contract – which means that it has to be considered whether the time* distortion has occurred on fixed price contract or contract on current account.

It might be tempting to conclude that the frequently applied measures of an organization, based monetary values, are better and more reliable. Should it therefore be suggested that it is easier to focus only on the profit equation and neglect the information entropy? Our answer to this is: *No*. The profit equation displays *aggregated* information about economic outcome. It does not follow target accomplishment of sub-goals. The strength with the information entropy is therefore that it considers many different targets simultaneously, and measure information about the systems behavior with reference to its goals.

Discussion and Further Development

A central motivation for the formulation of the here proposed model is to support managers in their understanding of the organization that is managed. In this sense, the here proposed model has the merit that it offers a comprehensive conception of the organization, in terms of a function of organizational objectives and their fulfillment or otherwise. The main advantage with the profit equation is its ability to display aggregated information about target accomplishments with respect to time related to profit. The profit equation does not exhibit target accomplishment of sub-goals, which are commonly not expressed econometrically, such as targets associated to market shares, targets linked to work environmental aspects or targets referring to corporate image, sustainability or political fulfillments.

Information entropy, on the other hand, considers many different targets simultaneously, and measure information about a system's behavior with reference to goals. A Goal Matrix can consist of sub-targets referring to work environment as well as economic objectives, though it is recommended that the goals are spelled out in the same sort (time). It may consist of environmental targets as well as political targets, formulated in terms of time. Thus, information entropy may be considered as a tool to measure target achievement at a meta-level. It can be a tool for assessing manager's work as well as specific sub-goals of importance to the organization. Indeed, of essential importance is managers' ability to formulate targets at a meta-level. These targets must be specific, measurable and time-based.

As suggested in the beginning of this paper, the here proposed model is not meant to be a substitute to current management control practices but rather as a complementary tool, helping to control a large set of organizational goals.

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