

## High value information for managers in organisations

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**Abstract** – Due to information overload, information management for managers in organisations is a big task. It has been recognized that an effective methodology is required to evaluate information to avoid information overload and to retain the critical information for reuse. Various tools and strategies are presented in an attempt to obtain information's "value." This study examines the topic of information overload, the definition of information value, and associated research on the value of information in many fields to resolve this issue. The Bayesian Theorem and information characteristics are used to offer a framework for evaluating information.

**Keywords** – value; information value; Bayesian Theorem; Naïve Bayes Classifier

### I. INTRODUCTION

There are many challenges in managing information in organisations. At present, organisations are dealing with ever-increasing volumes of information. Managers, as the senior staff in the organisations have difficulty performing their major tasks due to being overloaded [1]. They are constantly plagued with fundamental questions such as how much information and what piece of information needed for the decision-making process. Information overload has frequently caused business managers to suffer some negative effects such as becoming frustrated and psychological tension [2].

Information can be easily acquired via ICT, but critical information is difficult to identify, and its value is even more difficult to assess. In order to overcome information overload concerns and find the crucial information to use, businesses must devise some effective strategies. The authors propose that a method for evaluating "the value of information" be devised using existing instruments and procedures.

Information with high value is key to effective decision making. In organisations, managers can ascertain what information to retain and what to discard by putting a value on information [3]. Value of Information (VOI) can be described as "the sum a decision-maker willing to pay for information before a decision is made" [4]. Information value is a very messy concept because information on its own has no universal value. Its value is in relation to the person who uses it, when and for what he uses it. Imagine for example two men stranded in the Sahara Desert. One individual has a sufficient supply of drinking water and another has finished his supply. If one

were to contact these two people with information regarding a well of drinking water in the local city, the information will naturally be of greater benefit to the one who has finished his water source. To the thirsty individual, this information is the most important piece of information at that point in time because it will decide how he can live. When the information enters this thirsty person late by accident and he dies of hunger, the interest of the same information is zero. This then shows that the same information at various points in time will have significant meaning on specific individuals. Consequently, it will be fair to conclude that information value is relative.

Dutta et al. [5] attempted to calculate the value of geophysical data, such as seismic recordings, in locating oil reservoirs. To assess the VOI, Borgonova and Cillo [6] employed probabilistic models that quantified the risk metric, whereas Zhao [3] employed a Bayesian Network. These VOI approaches aimed to offer the right information, in the correct format and quantity, at the right time, to the right person, and for a reasonable price, in order to represent the nature of information and aid in value measurement. These attributes are linked to a number of information properties, including information correctness, reliability, timeliness, and usability.

In domains including economics, public health, and risk management, these strategies are regularly employed [7]. However, there are few examples of managers using information value to aid in decision-making in their day-to-day activities. While organisations' physical and software assets are valued, the VOI in managers' daily tasks is largely neglected. Only a few managers of business organisations would be able to satisfactorily determine the worth of essential information that is critical and important for them to use and monitor. As a result, managers have difficulty finding crucial information that is valuable. This research considers key information as a piece of information effectively used to solve information needs in the context of work.

This paper is organised as follows: Section II provides an overview of information overload, VOI definition, and VOI measurements; Section III presents an information characteristics evaluation methodology; Section IV describes a basic information evaluation framework and Section V concludes the paper.

## II. RELATED WORK

The information overload problem in organisation cannot be ignored. Due to overwhelming amount of information, managers must have felt tension that takes so much of their time and ultimately affects their decision making. Information overload has been studied for over 20 years, and numerous solutions such as organisational information management, intelligent agents, and coping mechanisms have been presented [2]. VOI will assist managers to judge the crucial information at work and reduce information overload.

### A. Information Overload

Information is an important asset in an organisation. When there is so much relevant and possibly valuable information available that it becomes a problem rather than an aid, it is referred to as information overload (B). Information overload results in an unmanageable amount of data. Information overload, according to [8], is a scenario in which someone is aware that relevant information exists but is unable to access and use it properly due to time restrictions. Organizational level information overload, according to [2] and [9], affects the effectiveness of management activities.

Appropriate and timely information is very crucial to carry out daily tasks for the managers. Nevertheless, managers often gather more information than they can process. There are several reasons why managers collect more information than they need. Managers collect information as a commitment to competence which they believe improves decision-making. They are also finding additional details to verify the in-house information and explain decisions. In the process of decision-making, they tend to collect as much information as possible. Their professional survival also depends on the ability to process all of the information [10].

Information overload causes organisations to find answers for these basic questions such as : how much information is needed? Which piece of information is needed and when do they need them? [9]. Investigating for these answers is important for any organization because organisations' processes are information-intensive by nature and could be the strategy to reduce information overload.

### B. Information Value

Value of Information (VOI) analysis is a prominent method for assigning value to information. The benefit of lowering uncertainty through some type of data collection exercise is valued using a VOI analysis [11]. Raiffa and Schlaifer's worked on statistical decision theory at Harvard [12], [13]. VOI has been defined in the literature from two perspectives. VOI

can be described as an estimate of a potential user's willingness to pay in order to gain access to information [14], [15]. Another definition, which is more prevalent in the study, bases the VOI on the (anticipated or achieved) benefits of employing information in management and operations decision making [14], [16]. The study follows the latter definition. This means that the study's goal is to establish a link between information and managerial decisions. VOI has the ability to improve management decision-making [17].

### C. Review on VOI measurements

VOI has a significant body of publications and applications [18]. In the health business [19], oil well and reservoir management [20], supply chain management [21], livestock management [22], and many other industries where information is valued in some way [23], there are toolkits and approaches for analysing VOI.

The VOI is a decision analytic metric in the energy business that quantifies the added monetary value that might be created by gathering information prior to making a decision under uncertainty. A statistical relationship based on regression and machine learning approaches is used to calculate VOI. In the energy industry, estimating the VOI via simulation regression is substantially less computationally expensive than other methodologies [24].

In health economics, the Bayesian technique is frequently used [18], [25], [26]. The establishment of appropriate metrics of clinical benefits and costs associated with an intervention is part of the VOI evaluations. The Bayes Theorem is used to model the evaluation technique, which includes all relevant costs and benefits. The Bayesian model is then used in the decision-making process. The results of the VOI are merged into a utility function, which quantifies the overall "value" and allows for decision-making.

In the field of supply chain management, VOI is being studied extensively [27]. The major facilitator for improving supply chain performance is information sharing [28]. In practice, however, getting more information in the supply chain industry can be tough. Each party wants to make the most money possible, thus they don't reveal information until they have a strong enough incentive to do so [29]. It is critical to understand which information must be communicated in a supply chain and how that information might help to improve the efficiency of the supply chain's operations. To overcome the issues, evaluating VOI before providing knowledge might be beneficial.

VOI is mostly calculated utilising information and decision model characteristics such as predictive and

prescriptive modelling. Information value attributes are also used to describe information characteristics [30], [31], and [32]. Data mining and forecasting are examples of predictive modelling approaches, while optimization, simulation, and multi-criteria decision making are examples of prescriptive modelling approaches [33], [34].

Although evaluating information is a common process when people make a decision or assessment, the concepts, meanings, and procedures for valuing information vary greatly across areas. Due to the fact that information is asymmetric and can be arranged in a variety of ways, VOI procedures are customised to meet the scenarios as well as the modellers' imagination. Nonetheless, the process of calculating VOI frequently involves two dimensions. The first dimension is made up of two elements: why one judges the worth of a piece of information and what kind of information it is. The second dimension is how to evaluate the VOI which involves the modelling approach.

Information characteristics can help quantify information quality or value by representing the nature of the information [21], [35]. The VOI computation can be based on the information characteristics. The Bayesian model is used to model the information. This is because Bayesian modelling is a natural paradigm for decision making and provides a way to handle uncertainty, which is critical in the business world [18]. The information evaluation approach is shown in Figure 1.

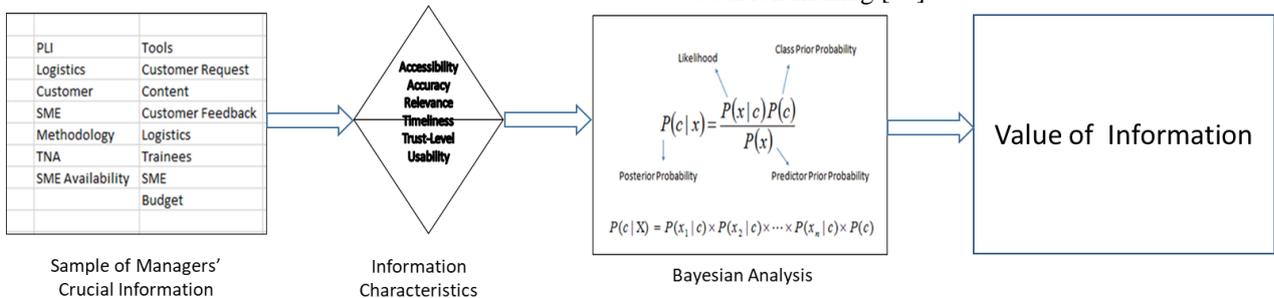


Figure 1. Information evaluation approach

### III. INFORMATION CHARACTERISTICS

A feature or quality of information whose strength influences its value is referred to as an information characteristic. Information quality is classified as intrinsic, contextual, representational, and accessible by Zhao [3]. The characteristics of information are multidimensional, with numerous dimensions such as correctness, consistency, and usability. The traits that distinguish information as a high-quality asset are crucial in assisting the evaluation process and ensuring that the information is highly valued. As a result, information characteristics are

likely to be used as a foundation for judging either information quality or information value [36].

Many information characteristic criteria have been studied based on literature [3], [37], [38], [39], [40], [41], [42]. The focus of this research is on the following information characteristics: accessibility, accuracy, relevance, timeliness, trust level and usability. These characteristics were chosen because they were most mentioned in the reviews related to information value attributes. Accessing the right information at the right time is vital in an information transaction process [3]. Accuracy, timeliness and usability are innate and objective to information [21]. The right information should be relevant to the context and managers should have trust on the piece of information they plan to use [3]. Each information characteristics is elaborated further below:

- i) Accessibility - Accessibility can be described as how the information is reachable and understandable. Information can be easily retrieved and integrated into business processes [43].
- ii) Accuracy - The degree to which information is equivalent to its corresponding "actual" values and verified from the proper source is referred to as accuracy [39]. This information characteristic can be assessed through comparing the value of the information with the value that are correct.
- iii) Relevance - Relevancy can be described as extent to which information is applicable and helpful for the task at hand. Relevant information should address the managers' information needs and be useful for decision-making [44].

- iv) Timeliness - Timeliness refers to the degree which information are up-to-date.
- v) Trust Level - Trust level is defined as the extent to which the manager is willing to use the given information from the given party [45].
- vi) Usability - Usability of information can be described as the extent to which the information can be used to achieve a person's intended goals with effectiveness, efficiency or satisfaction [46].

IV. INFORMATION EVALUATION MEASUREMENT

The information value can be determined using a modelling approach based on the above information properties. This study uses Bayesian Analysis as a method for quantifying expressing information properties, calculating their relationship, and determining the information value. VOI is built on a Bayesian statistical framework, in which probability indicates degrees of belief regarding the likelihood of a parameter's possible values [18].

A. Bayesian Analysis

The main application of Bayesian methods was for knowledge representation under uncertainty, and they became particularly popular in the medical sciences for applications like as disease diagnosis, therapy selection, and treatment outcome prediction in a variety of fields. Diagnostic medical tests, genetics, and spam filters are all examples of applications that use Bayesian analysis [47].

Empirical evidence, according to Bayesian statisticians, is used to revise probabilities rather than to determine probabilities. Before proceeding with testing, Bayesian approaches allow researchers to change their opinions. As a result, Bayesian analysis helps researchers to learn from their previous experiences. Prior ignorance is assumed in classical statistics, whereas Bayesian approaches allow for the introduction of prior probability and learning [48].

Empirical evidence is used to revise probability, not to determine them in the first place, according to Bayesian statisticians. Prior to testing, Bayesian approaches allow researchers to update their opinions. As a result of Bayesian analysis, researchers are able to learn from their previous experiences. Bayesian approaches allow for the use of prior probability and learning, whereas classical statistics presume prior ignorance [48].

$$(Posterior\ probability) = \frac{(Likelihood)(Prior\ probability)}{(Marginal\ likelihood)} \tag{1}$$

or, considering two events, A and B:

$$P(A|B) = \frac{P(B|A)P(A)}{P(B)} \tag{2}$$

where P(B|A) is the probability of A, conditional on B; P (A|B) is the probability of B, conditional on A; P(A) is the prior belief of the probability of A; and P(B) is the unconditional probability of B [49]. Taking Information Value and Accessibility as an example, the probability of “Information Value” (is high, mid, low) can be calculated as

$$p(Value|Accessibility) = \frac{p(Accessibility|Value)p(Value)}{p(Accessibility)} \tag{3}$$

The calculation of VOI involves the calculation of the probability of the information characteristics. This calculation involves a family of algorithms. Thus, it needs a classification algorithm based on Bayes algorithm which introduces Naïve Bayesian classifier.

B. Naïve Bayesian Classifier

The term "Naive Bayesian" refers to a group of classification methods based on Bayes' Theorem. Statistical classifiers are Bayesian classifiers. Class membership probabilities, such as the likelihood that a given dataset belongs to a specific class, can be predicted using Bayesian classifiers.

In simple terms, a Naive Bayes (NB) classifier assumes that the presence (or absence) of a particular feature of a class is unrelated to the presence (or absence) of any other feature. For example, a fruit may be considered to be an apple if it is red, round, and about 4 inch in diameter. Even though these features depend on the existence of the other features, a NB classifier considers all of these properties to independently contribute to the probability that this fruit is an apple [50]. Given the class variable, NB is also a simple Bayesian network that assumes all features are conditionally independent. Despite their naive design and oversimplified assumptions, NB classifiers perform far better than one might expect in many complex real-world scenarios. NB classifiers are a traditional solution for problems like spam detection and are especially popular for text classification. [51]. Figure 2 shows the structure of the NB classifier as a special case of Bayesian Analysis.

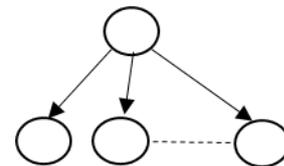
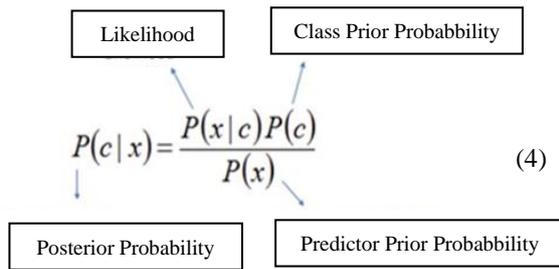


Figure 2. Structure of Naïve Bayes classifier

Assume that a set of samples  $x_1, x_2, \dots, x_k$  is given with their associated class labels  $c_{x1}, c_{x2}, \dots, c_{xn}$  where  $c_{xn} \in \Omega = \{c_1, c_2, \dots, c_n\}$ . Further assumes that the samples have  $n$  features denoted as  $z_1, z_2, \dots, z_n$ . The task is to use the samples to learn a naïve Bayes model that will predict the label  $c_x$  for any future sample  $x$ . A general NB classifier which uses the Bayes rule to compute the posterior of classification variable  $c$  based on the feature variables  $x_1, x_2, \dots, x_n$  can be described as follows :



- $P(c|x)$  is the posterior probability of class (target) given predictor (attribute). (What we want to know)
- $P(x|c)$  is the likelihood which is the probability of predictor given class.
- $P(c)$  is the prior probability of class.
- $P(x)$  is the prior probability of predictor.

Mathematically, it can be written as

$$P(c|x) = P(x_1|c) \times P(x_2|c) \times \dots \times P(x_n|c) \times P(c) \quad (5)$$

which means that the joint conditional probability is the product of all the marginal conditional probabilities. This is applying the independence assumption.

All of those information characteristics (derived from Section 3) can be used to quantify VOI using the equation (5). Thus, creating this information evaluation framework:

$$\begin{aligned}
 &P(\text{Value}|\text{Accessibility, Accuracy, Relevance,} \\
 &\text{Timeliness, Trust-level, Usability}) = \\
 &P(\text{Accessibility}|\text{Value}) \times P(\text{Accuracy}|\text{Value}) \times \\
 &P(\text{Relevance}|\text{Value}) \times P(\text{Timeliness}|\text{Value}) \times \\
 &P(\text{Trust-level}|\text{Value}) \times P(\text{Usability}|\text{Value}) \\
 &\times P(\text{Value}) \quad (6)
 \end{aligned}$$

An example can be used to illustrate the information evaluation process. Important documents related to manager’s work task that contain crucial information can be used for the evaluation process. Sample documents can be customer requirements, meeting agendas, fax, letters, notices, reports, and memos. For the document, manager needs to make a judgement about each information characteristic identified in the in Section III. The manager can access the documents using questionnaire with some help of definitions of information characteristics such as the accuracy of the document is (good, mid, or bad); trust level of the document (yes or no), and so on. The criterion of the information characteristics may take the following values: “low” or “poor” (below 40%), “medium” (<40-80%) and “high” or “good” if above 80%. In addition, the manager needs to make value (high, mid, or low) judgements after the judgements of the

information characteristics have been made. All the inputs need to be summarised into probability table. Table 1 shows the sample inputs of the judgements summarised as probability(6).

Table 1 Sample Inputs of Manager’s Judgements Summarised as Probability

Value	A1	A2	R1	T1	T2	U1
<b>High (80%)</b>	90%	85%	80%	83%	95%	90%
<b>Medium (50%)</b>	60%	65%	61%	67%	70%	67%
<b>Low (35%)</b>	35%	33%	25%	23%	32%	21%

\*\*A1-Accessability, A2-Accuracy, R1-Relevance, T1-Timeliness, T2-Trust Level, U1-Usability

Using Equation (6), the Value of the crucial information can be quantified as below:

For High Value :

$$\begin{aligned}
 &P(\text{Value}|\text{Accessibility, Accuracy, Relevance,} \\
 &\text{Timeliness, Trust-level, Usability}) = 0.9 \times 0.85 \times 0.8 \\
 &\times 0.83 \times 0.85 \times 0.95 \times 0.8 = 0.347
 \end{aligned}$$

For Medium Value :

$$\begin{aligned}
 &P(\text{Value}|\text{Accessibility, Accuracy, Relevance,} \\
 &\text{Timeliness, Trust-level, Usability}) = 0.6 \times 0.65 \times 0.61 \\
 &\times 0.67 \times 0.7 \times 0.67 \times 0.5 = 0.037
 \end{aligned}$$

For Low Value :

$$\begin{aligned}
 &P(\text{Value}|\text{Accessibility, Accuracy, Relevance,} \\
 &\text{Timeliness, Trust-level, Usability}) = 0.35 \times 0.33 \times 0.25 \\
 &\times 0.23 \times 0.32 \times 0.21 \times 0.35 = 0.0001
 \end{aligned}$$

The Value can be obtained by normalizing the High, Medium and Low Value. Table 2 shows the normalized value and VOI.

Table 2 depicts the normalized value and VOI

Value	Normalised	VOI (%)
High	0.903	90.3%
Medium	0.096	9.6%
Low	0.0002	0.02%

The probability of the documents being high value is 90.3% and medium value is 9.6% and low value 0.02%. This indicates that the documents have VOI of 90.3%. Therefore, the documents have high value and can be used by the managers as crucial information.

## V. CONCLUSION

To demonstrate how the Bayesian technique would be used to aggregate the numerous information features and

their metrics into an overall judgement of value, the framework is formulated as illustrated in Section IV. This understanding of how probability figures function will be useful in future study projects.

To quantify an accurate numerical result of VOI, the information evaluation framework will rely on data collection among each information characteristics. Methods to collect this type of data will be devised as part of future study to measure the success of managers in retaining the crucial information and overcoming information overload.

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