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Information Overload: A Conceptual Model

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ABSTRACT*: This age of massive production and usage of information ranging from online resources to print has constantly created the need to educate individuals on Information overload, which happens when one is saddled with the task of processing and accessing excessive information at work and in life generally. Information overload is the abundance of information with limited cognitive processing capacity to the receiver. Despite its widespread discussion, a universally accepted definition or explanation remains elusive due to the diverse terminology employed. This variation in terminology implies differing levels of information overload. There is a dire need to develop a variety of models that assist information designers in understanding, measuring, and determining when an individual becomes overloaded with information. Drawing on Dubin's theory, which provides a systematic framework for conceptual model development, this study utilizes the initial stages of theory building to create a Conceptual Model of information overload and its Primary Components together with their Sub-components. This model serves as a foundation for generating testable hypotheses and operationalizing the concept of information overload for further empirical investigations.*

KEYWORDS*:* information, overload, model, information processing, cognitive overload

INTRODUCTION

Information is an important input in any human activity. For almost as long as there has been recorded information, the world has seen exponential growth in the volume of information materials available in various forms, which has been further accelerated by unprecedented advancements in Information and Communication Technologies [1]. People have been concerned about the increasing volume of information that they must deal with in their daily lives for many centuries, and this has become even more pressing since the advent of ubiquitous digital information in the late twentieth century. This phenomenon has commonly been referred to as information overload [2]. The term "information overload" was coined by American social scientist and professor of political science at Hunter College Bertram Gross in 1964, to refer to an occurrence when the amount of input to a system exceeds its processing capacity, this term was popularized by Alvin Toffler in the 1970s and has been the most commonly used.

Libraries and information science (LIS) professionals and computer scientists have made concerted efforts to deal with this massive propagation of information through various bibliographic control and information

management and retrieval techniques. However, with the massive increase in the volume of published information, both digitally and in print, all over the world, we are on the verge of an even greater information explosion in the coming decades. As a result, new techniques must be developed, as well as existing ones optimized, to address the growing concern of information overload. There is also the urgent need to develop various kinds of models that help designers of information understand, measure and ascertain when an individual is overloaded with information. This study seeks to develop a conceptual model to that effect. A conceptual model is a visual representation of concepts and their interrelationships, serving as a heuristic device to illustrate theories and ideas. It is used to provide coherence to empirical inquiry, helping researchers analyse and understand complex data through visual displays. Although, conceptual models are typically developed based on the researchers' understanding of the research phenomenon, expressing constructs and relationships from their perspective, however, [3], submit that a good conceptual model should possess clarity and simplicity, describes the reality in details, be minimality not containing redundant concepts, complete in covering all the aspects of the particular application domain, conformity to the reality and is translated into testable hypotheses and reproducible. Once developed, these models are tested and refined, with revisions incorporated and recommended for further research. The flexibility of conceptual models allows them to be tested and improved throughout the research cycle, eventually aiding in the formulation of clear and well-defined theories.

Although, in a study by [4], a conceptual model and formula were created for finding information overload however, we submit that improvements can be made in terms of simplicity, conformity to reality and minimalism. Hence, the objectives of this study focus:

- On developing a simplified and minimalist conceptual model that conforms to reality for understanding the complexities of information overload, and the interrelationship that exist within the components in this system.
- A model that can be translated into testable hypotheses as a basis for operationalization for further empirical studies on information overload.

LITERATURE REVIEW

Information overabundance, infobesity, infoglut, data smog, information pollution, information fatigue, social media fatigue, social media overload, information anxiety, library anxiety, info stress, infoxication, reading overload, communication overload, cognitive overload, and other terms have been used to describe the phenomenon of information overload, [2] and even though information overload is a widely debated concept, there is no single generally recognized definition or explanation, there is no single generally accepted definition or explanation of the concept. The different terminologies used to describe information overload goes to suggest that there are varying degrees of information overload.

Alvin Toffler characterised information overload as 'the difficulty a person faces when deciding the presence of excessive information. [5] views information overload as a 'state that exceeds the limited human information-processing capacity. [6] define information overload as an 'overabundance of relevant information that cannot be assimilated, or being burdened with large quantities of unsolicited information. Bawden, Holtham, and Courtney observed that information overload is 'usually taken to represent a state of affairs where an individual's efficiency in using the information in their work is hampered by the amount of relevant, and potentially useful, information available to them. More recently, [2] define information overload as 'that situation which arises when there is so much relevant and potentially useful information available that it becomes a hindrance rather than a help. Given the above definitions, it may be sufficient to conclude that information overload is a result of the abundance of information with limited cognitive

processing capacity of the receiver to effectively process the information and hence affecting the quality of decisions made.

[7] opined that the enormous foothill of information is of course, at the root of the problem of information stress. Because we all have access to the internet, smartphones, and social media, all information is always at our fingertips. E-mails, apps, photos, videos, and text messages, on and in Facebook, Twitter, Instagram, news outlets, apps, websites, and business presentations. This is only a small slice of what we learn. Or, more precisely, that is directed at us. We consume a lot of information that wasn't available in the past or that we couldn't get access to, however, we now consider it to be indispensable. [8] makes the insightful point that "information overload is a spanning concept that fuses the surplus of information (an external reality) with a psychological response of feeling overwhelmed (an internal reality)". [9] from their study also point out that information overload is usually because of a combination of overlapping factors.

METHODOLOGY

The research methodology for this study is Dubin's theory for building the model [10]. Dubin's theory for building model became appropriate for this research because it holds the systematic framework for developing a conceptual model for any given concept. The proposed conceptual model was built according to Dubin's first four stages of theory building:

1) Defining concepts, units and constructs
2) Define the law of Interaction.
3) Define the boundaries
4) Define the system state.

The first stage identifies and defines the fundamental theoretical concepts. Secondly, the Law of interaction stage elucidates the interaction and interrelationships between these theoretical units. Thirdly, the Boundaries stage defines the scope and limits of the conceptual framework. Lastly, the System states stage describes the conditions under which the theoretical units interact and operate differently within the system. Based on the chosen research methodology, this study will first identify and define concepts and constructs of information overload followed by describing the interaction that exists between these concepts. Then it will define the boundaries within which this conceptual model can hold and show the different states that can occur within the model.

Concepts and Constructs of Information Overload

This study has defined information overload as the abundance of information with the limited cognitive processing capacity of the receiver. From this definition, there are primarily two major identified components: the Human and the information.

The Human

The human, in the context of information overload, is the information processing unit and determines the information processing capacity. An individual's information processing capacity is influenced by their brain structure cum cognition. Information processing capacity has been defined in the aspect of time [11], and quantity [12]. That is the time required to process the information and the quantity or extent of information assimilable while processing the information. Cognition on the other hand is the brain’s ability to process all the information it takes in from the senses (iconic, echoic and haptic). When an individual interacts with information, their brain goes through a cycle of actions. The manner of performing this cyclic

process during cognition is the cognition style of an individual. [13] refer to the cognitive style as a person's habitual prevalent way of perceiving information, processing information, and applying information.

To understand how the brain processes this information, different cognitive architectures have been suggested [14] [15] to describe the information processing sub-systems involved in cognition. The architecture involves sensory memory, working memory and long-term memory. The sensory memory (Haptic, echoic and iconic) captures information and through attention pauses this information to the working memory which processes and temporarily holds important information. The working memory by rehearsal passes this information into the long-term memory where the information can be stored for a more extended period composing one's personal experience and skills.

The working memory can be likened to a temporary workspace for currently processed information. It has a limited capacity and duration for storing information. Moreover, it can be overloaded when there is an increased amount of information to handle or the number of tasks demanding attention simultaneously [16]. It is the working memory that experiences overloaded known as Cognitive load. Cognitive load is influenced by the number and complexity of the elements that interact with each other in the working memory. When the cognitive load is high, it can interfere with thought processes, learning and decision-making. However, the cognitive capability of an individual in the context of the information being processed balances off the load. Cognitive capability by [16] is the threshold level of performance by an individual only regarding a specified class of tasks. Hence, the threshold for one individual is different from another depending on their cognitive capability and the class of information.

To fully understand the Information processing capacity, is to further look at its non-exhaustive sub-components. These sub-components were identified from literature [11] [17] [18] and classified as factors that contribute to information overload on the side of humans. This sub-classification was corroborated by discussions of the concept of the human and its processing capacity.

i. Cognitive capability: it is the threshold level of performance by an individual only concerning a specified class of tasks [16].

ii. Cognitive style: refers to a person's habitual prevalent way of thinking; It is the preferred manner of perceiving a piece of information, thinking through that information, processing that information, and applying the information [13]. It is the preferred way of gathering, organizing, analysing, or recalling information and experience [18].

iii. Required Time: Time needed to complete a task by the individual's cognitive capacity for that task.

iv. Level of prior experience: This is the experience gained in the field before encountering the current information to be processed. it is the experience of producing results for a particular task [11]. Application of Personal experience is called from the long-term memory during information processing in the working memory.

v. Personal skill: refer to a set of individual attributes, qualities, and abilities that enable effective interaction and processing of information. According to [17] as reading and analysing speeds

vi. Personal Motivation: It is the force that compels the individual to see through the processing of information despite the obstacles, and persists with the information even when faced with setbacks. The less personal experience, and motivation a person has in processing a given information the more likely the person may face information overload

The Information

Information is processed data. Regarding to information overload, it is a specified class of data or task needing the attention of the working memory/cognition of the individual. The information determines the information processing requirement.

To fully understand the Information processing requirement, is to look at its non-exhaustive sub-components. These sub-components were identified from literature [19] [4], and classified as factors that contribute to information overload from the side of the information.

i. Quantity of information: the amount of information which is accessible to the individual and is expected to be assimilated for a specific task.
ii. Quality of Information: the degree to which information meets the needs of its users. This may involve the relevance of the information, its complexity, ambiguity, novelty
iii. Information flow (Push/pull): refers to the level of control the individual has towards the information that gets inputted through sensory memory. People have access to diverse information sources. Some are beyond their control and are pushed to them. Others, they have more influence over and can pull from.
iv. Available Time: it is the available time on the information for the individual to complete the task.

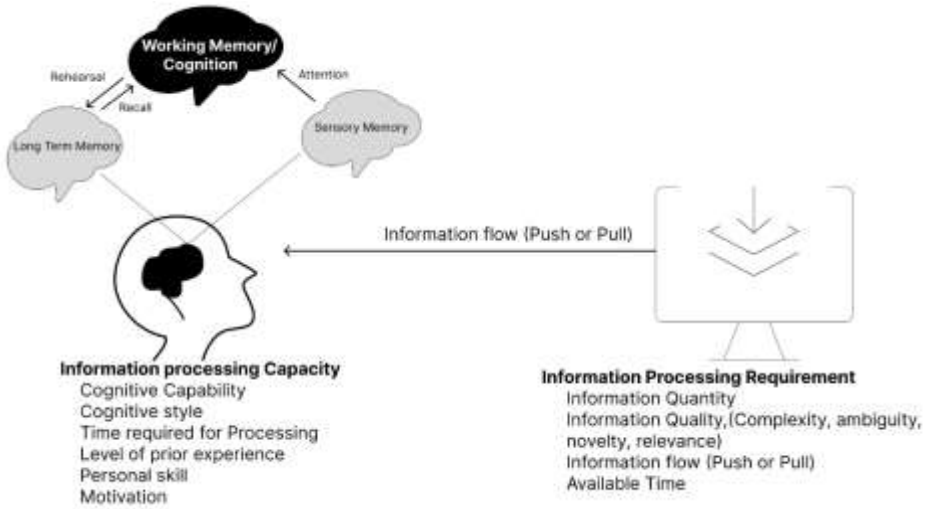

Figure 1. Conceptual model of the Primary Components of Information Overload and its Sub-components

The Interacting Units

Following the two identified components of this system (human and information), there are two interacting constructs: the Information Processing Capacity (IPC) and the Information processing requirement (IPR). The weightings of each of these components, as informed by their subunits interact in varying measures to

create a situation for information overload. Information overload occurs when the information processing requirements (IPR) exceed the information processing capacities (IPC) of an individual (IPR>IPC) [12]. In consonant, hick's Law states the more stimuli users face, the longer it will take them to make a decision.

In other words, if the quantity of information accessible (either pushed or pulled) requiring to be assimilated for a given task at an available time, is more than the individual's processing capacity with regards to his time required to process, additional available time may be required or information overload could occur. Situations for Information Overload and consequences are: when the Information processing requirement is greater than the time required for processing information, all communication input cannot be processed. when Information flow supersedes the information processing capacity of the individual, it will take longer to make a decision. when Information processing requirement exceeds information processing capacity, stress for which coping strategy is ineffective.

This describes the threshold effect in the interaction between the units of Information Processing Capacity (IPC) and Information processing requirement (IPR). when the information processing requirement surpasses the information processing capacity, it crosses a threshold and leads to information overload. Conversely, if the information processing requirement remains below the information processing capacity threshold, information overload is avoided.

System Frontier and State

The frontier defines the scope and limits of the conceptual framework while the System states defines the conditions under which the theoretical units interact and operate inversely within the system. In this research, the concept of information overload was identified within the realm of individual experiences. This led to the creation of a conceptual model that is personalized to the individual domain's constraints and features.

Furthermore, the system state depicts situations within the model where the elements of the model interact differently [20]. That is, it refers to the collection of variable values and conditions that represent the current configuration and behaviour of the system being modelled. The system state will show when an individual moves from not being overloaded to being overloaded with information. The criteria of inclusiveness, determinate values, and persistence, as outlined by [10], are used to establish and define the existence of a system state. Inclusiveness mandates distinct values for all system units in that state. Determinate values require measurable unit values via accurate instruments. Persistence necessitates the system state's stability over a duration.

To establish a conceptual model whose state conforms to reality for understanding the complexities of information overload, this study makes an analogy using Hooke's law principle of elasticity which states that:

$$F=k\Delta L \qquad \text{…. eqn (1)}$$

Making ΔL subject of the formula

$$\Delta L=F/k \qquad \text{…. eqn (2)}$$

where ΔL is the amount of deformation (the change in length, for example) produced by the force F, and k is a proportionality constant that depends on the shape and composition of the object and the direction of the force.

The human brain can be likened to an elastic material in this context. Cognitive style and capabilities are commonly constant over time but change and expand respectively depending on situational context. When

we encounter new information, it exerts a force on our working memory/cognitive processes. The more information we encounter, the greater the force applied to our brains. Similar to an elastic material, the human brain also has its limits of capacity. It can process and retain information up to a certain extent. If the incoming information exceeds this capacity, it's akin to the elastic material being stretched beyond its elastic limit. However, unlike an elastic that stretches to permanent deformation, our cognitive resources can become strained leading to reduced focus, diminished memory retention, and impaired decision-making ability.to corroborate the analogy is the definition of information overload by [21] [22] as an inverted U-curve.

Following this analogy, Hooke's law formula is adapted to show a realist conceptual model of information overload. In this case, will be:

$$ILL=IPR/IPC \qquad \ldots\ldots. \text{ eqn (3)}$$

Where: ILL = Information Load Level (Cognitive expansion depending on the demand placed by the processing requirement of the information)

IPR= Information Processing Requirement;

IPC= Information Processing Capacity (A cognitive factor that varies based on Sthe composition of the human, and the context of the information.)

By this, distinct values may be established for the sub-components that will inform the overall value of IPR and IPC respectively. Consequently, show the system state from one state to another as values change. This will be done in future research.

As a result of establishing the interacting components and establishing a direction for establishing distinct values for all system units in that state. It is possible to show a conceptual model for information overload. This model shows 2 thresholds that indicate when the system changes its state. They are the tipping point and breaking point.

The tipping point is the point in the presented model where the model shifts from one state of not overloaded to overloaded. At this point, there is an excess amount of information than needed but the individual may just be able to carry on despite the impact on the quality of the decision.

The breaking point is the point in the presented model where the model shifts from an overloaded state to a cognitive overload. We describe cognitive overload to be a higher degree of information overload where an individual's cognitive resources become overwhelmed, information can no longer be assimilated leading to a general decline in processing tasks, and the abandonment of tasks. it is the point where the cognitive threshold level of performance by an individual only regarding a specified class of tasks has reached.

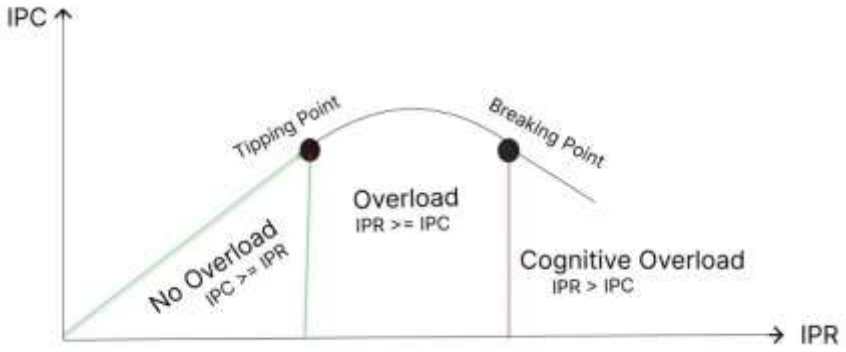

Figure 2. Conceptual Model of Information Overload

DISCUSSION

With little or no information, individuals have little or nothing to process and consequently may make poor decisions. As the amount of information grows, so does the amount of information processed and the quality of decision-making. However, after a certain point, the decision-maker has received more information than he can process, resulting in information overload and a decrease in decision-making ability. Any information received after that point will be ignored.

According to the proposed model, if the overall weighting on the human side (IPC) of the model is greater than the overall weighting on the information side (IPR), the system is not overloaded. This means that the individual or system can handle the amount of information that needs to be processed.. In fact, at this point, there is proportionality between IPR and IPC. As IPR increases so do those IPC meet the demands of IPR. However, this proportionality stops at the tipping point, when information overload begins to occur. At this point, the weighting on the information (IPR) side is greater than or equal to the weighting on the Human side (IPC). Even at this point, some individuals are still able to cognitively rise to the new load level experienced for some duration, however, if the weighting on the information side (IPR) is generally greater than that on the human (IPC) side then the system reaches its breaking point and the system is cognitively overloaded. Based on the conceptual model the value of ILL shows the state of Information Load. In the context of information overload the Information processing capacity is the dependent variable. It responds to the changes/ demand of the Information processing requirement

Table 1. Deterministic Values

IPC	**IPR**	**ILL**	**System State**
5	3	0.6	Not Overload
5	7	1.4	Overloaded
3	9	3	Cognitive Overload
5	5	1	Tipping Point
5	10	2	Breaking Point

Applying ***equation (3)*** above, while future research will employ proven tool to determine the values of the variables in the formula. Let's assume that the deterministic values of the variable are on a scale of 1-10 as shown in Table 1, when plotted will produce the likely outcome using the proposed conceptual model as seen in figure 3.

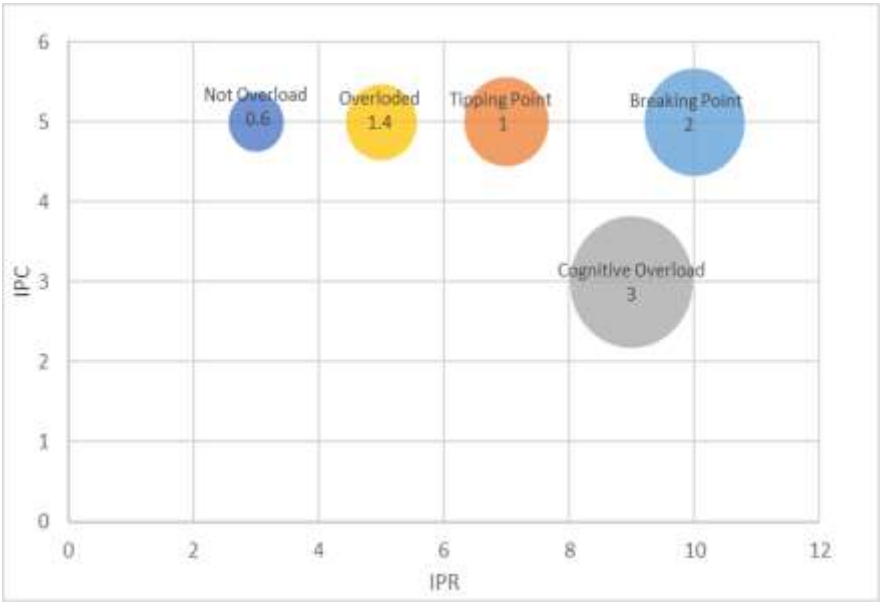

Figure 3. Overload Assumed Deterministic Chart

CONCLUSIONS

Information overload is the abundance of information with limited cognitive processing capacity. Information overload results in ineffective processing of information received, hence affecting the quality of decisions made. Designers of technology must design with the reality of the impact of information overload in mind. To this, a conceptual model of the primary components of information overload and its Sub-components was developed together with a conceptual model of information overload. The model is simplified and a minimalist conceptual model that conforms to reality for understanding the complexities of information overload, and the interrelationship that exist within the components in this system. This model will form as a basis for the operationalization of variables of this system for further empirical studies on information overload.

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