The Decision Maker's Cognitive Load

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INTRODUCTION

Manufacturing and organisational processes have been transformed from manual and labour intensive operations to automated computerised systems during the past few decades. Innovative information systems, robotic, and automated technologies have been the leading drivers and catalysts for new product development and real-time service delivery. Information systems (IS) aim to support the operational and organisational processes and functions ranging from manufacturing to marketing to human resources to accounting and finance. However, with the new technology at our disposal becoming a more integral part of our work and personal lives, we experience a rapid growth in information flow that needs to be captured for decision support. Information is only useful and powerful when it enables real-time decision making with as little effort as possible. We largely fail to recognise cognitive engineering as having an effect on mental and psychological workload and having an impact on the decision makers' efficiency and effectiveness, and eventually having an effect on organisational performance.

Decision makers work not only within complex globally connected entities including suppliers, customers, competitors, regulatory agencies and professional bodies, but they also deal with an abundance of information generated from these processes. Their cognitive load is much higher than that is considered from a pure process and mechanical perspective. Every decision maker has limited knowledge processing and absorption capacity, but increasing demands are being placed on individuals. During the last three decades, a considerable amount of research has been undertaken on the effects of job characteristics on the well-being of individuals, and the Job Demands-Resources model, in particular, has received much attention in this regard (Bakker & Demerouti, 2007).

Numerous organisational and personal factors, such as work pressure, role ambiguity, emotional demands, social support, autonomy, engagement, organisational commitment, performance feedback, and also job-related learning can influence psychological health (see Bakker & Demerouti, 2007). This article focuses on the impact of cognitive load on psychological health and the subsequent impact on making effective decisions.

Decision makers rely on the availability of useful information which they gather through directed and/or undirected knowledge discovery techniques using push or pull or both methods. Push data are generally used for directed discovery, which is generated or made available from internal activities such as transactions, meetings, communication records, and key performance indicators (KPIs) and benchmarking. Pull data are extracted from various sources, including the Internet and social media for undirected knowledge discovery. Information collected from various sources is not useful until it is restructured, cleansed, validated, combined, processed and presented in a useful manner. We often fail to recognise that many of these sophisticated systems may have reduced physical labour at the expense of increased cognitive load. This could even lead to making rushed decisions based on incomplete information. Individuals' decision-making ability would be poor if information is cluttered, disorganised, inaccessible, inaccurate, incomplete, irrelevant, unreliable, complex, outdated and non-validated.

The human brain is by nature inclined to economise and use schemas and heuristics whenever it can, and often these are based on past experiences, and other mental shortcuts in order to cope with the amount of information flowing through the system (e.g. Winston, 2004). People become mentally exhausted as much as they become physically tired. Their brain processing

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diminishes with overstimulation, just as much as their body struggles when there is too much strain on it (e.g. Arnsten, Mazure & Sinha, 2012). In many instances, this seems to be ignored by many organisations and individuals for various reasons, including not being aware of the issues and their impact. Cognitive load is not directly comparable to the number of hours an individual spends at work, but exhaustion is related to mental fatigue that could lead to burn-out (Demerouti, Bakker, Nachreiner, & Ebbinghause, 2002).

This article explores many of the current theories dealing with cognitive load, including the exposure, assimilation and processing of information and how this could affect strategic and tactical decision-making tasks. It also reviews the impact of stress on the ability to perform cognitive tasks (e.g., Helton & Head, 2012). This research synthesises various schools of thought and proposes a *Task-Information-Cognitive Load* (TICL) framework in order to combat the effects of decision makers' cognitive load. Finally, it discusses how information systems (IS) and decision support systems (DSS) theories and practices of knowledge management, information modeling, data integration and visualisation contribute to the development of a Knowledge Management System (KMS) that manages heterogeneous data, reduces the decision maker's cognitive load, and thereby enhances decision support and capacity.

BACKGROUND

A decision maker actively participates and engages in a decision making context that involves related organisational policies, strategies, processes, tasks and resources, including internal and external information. As organisational and decision makers' tasks have widely been covered in much of the recent literature, this section provides only a brief overview of how the human mind works, and the way information is represented and processed in human memory.

Mayer and Moreno (2003) use three key assumptions namely, *dual channel*, *limited capacity* and *active processing* in explaining how the human mind works. They argue that humans process visual (pictorial) and verbal (auditory) information through two separate channels (dual channel assumption), but the processing capacity of these channels are limited (limited capacity assumption) while cognitive processing requires a considerable amount of active processing. Mayer and Moreno (2003) also explain five (5) different ways that the human memory represents and processes information. These include 1) *physical representations* of words, pictures and other physical entities; 2) *sensory representations* via the ears, eyes and other senses of an individual; 3) *shallow working memory* which include images and sounds attended to by the individual; 4) *deep working memory* which includes models constructed by the individual; and 5) *long-term memory representations* which include, for example, any relevant understanding the individual had prior to being introduced to the information presented to him or her. For example, and in summary, words and pictures may be presented to an individual, who then holds representations of these words and pictures in his or her sensory memory. From there, words and pictures are selected and then these sounds and images are organised into a verbal and visual model in the working memory. These verbal and visual models are then integrated with prior knowledge from the individual's long-memory. In the following sub-sections, we briefly present various dimensions and types of cognitive load, and their measurement techniques.

COGNITIVE LOAD

Cognitive load is broadly defined as a multidimensional construct that represents the load imposed on an individual's cognitive system while performing a task (Paas & van Merriënboer, 1994a). It has a *causal dimension*, which reflects interactions between an individual and the *task characteristics*, and an *assessment dimension*, which is reflected by the measurable concepts (such as, mental load, mental effort and performance). Paas, Tuovinen, Tabbers, & Van Gerven (2003) observe that task format, task complexity, the use of media, time pressure, and the pacing of instructions are the key elements of *task characteristics* in cognitive load. They also note that the level of expertise, age, and spatial ability are essential attributes in understanding cognitive load from an *individual characteristics perspective*.

The *assessment dimension* of mental load refers to the interaction between the task and subject characteristics. For example, our current knowledge about a task and the subject characteristics is an indication