Information behaviour characteristics of project actors in organisation management

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Abstract—Research shows that a large proportion of the working time of project actors is spent processing, communicating and disseminating information that is not relevant to their tasks. This makes information overload (IO) a liability that adversely affects the performance of project actors and the management of their organisations. Some advances have been achieved in structuring information resources to support the decision making process of engineering project actors. However, it is not always possible to structure and direct the right information to the right actor at the right time. Some engineering companies have taken the initiative of resolving this problem by encouraging actors to employ personal information management systems, information sifting systems, product data management systems and other software applications to help manage the problem of IO. These information systems rely on pull technology which contribute towards time delay, inefficiency and cost in actors' information seeking process. The paper draws on information behaviour (IB) literature of engineering project actors to establish a platform for future studies on how IB can inform how information could be structured and made available to the right actor at the right time to facilitate timely decision making and organisation management. This paper proposes the SMART Push information capturing and delivery framework as a solution to IO. This could aid releasing the actor from the entire problem associated with information seeking process in order to focus on the task at hand.

***Index Terms*— Actors, information behaviour, information overload, organisation management, SMART**

I. INTRODUCTION

Advancement in technology and information systems in the past three decades has contributed to the rapid shift in organisation and product life cycle management in engineering industries. This shift has culminated in a challenge of how organisations are managed and deliver projects, as well as how they address rapid changes in rising customer needs and expectations, increasing competition, and expanding markets. One effect of the growing shift is increasing demands of customisation and performance requirements, shorter times for product delivery, and faster time to market. The demands create pressures on companies to improve their performance in order to offer improved service to their customers and remain competitive.

Large numbers of businesses have resorted to the implementation of computer-supported collaborative work (CSCW) systems [1] (such as Enterprise Resource Planning, Building Information Modeling, and many more) to help address that demand. According to [1], CSCW is a category of computer based systems that support groups of people engaged in a common task by providing common interface to a shared environment. For example, in a project environment, it is common to find project actors who work towards achieving a common goal by relying on CSCW systems integration to facilitate information, process and human resource management. The evolution of Enterprise Resources Planning (ERP) systems in industry has been to facilitate the integration of functional activities into a seamless suite of business process within an organisation to facilitate the process management, information acquisition and utilisation of captured enterprise data [2],[3],[4].

Enterprise data forms the backbone of engineering project operations since engineers create, seek, use, and retrieve information to achieve business objectives. Research shows that engineers are constantly overwhelmed by large volume of information resulting in Information Overload (IO) [5],[6],[7],[8],[9] during the different stages of the project delivery process. The impacts of IO on the amount of time engineers spend on information seeking, retrieving and use is evident in the cost of project delivery and performance inefficiencies [8],[9].

Reference [10] confirmed in their investigation into the information seeking practices of engineers that engineers rely on their colleagues and internal reports or project documents for their information needs, which is evident in the findings of [11]. This mode of information seeking is further evidenced by [12]. Engineers' over reliance on colleagues as a source of information can be very costly both socially and economically [8],[13],[14]. Such information from colleagues is normally undocumented and unstructured and is often based on their knowledge and experience [9],[15]. Evidence shows that professionals who work in information rich environments such as engineering spend more time receiving information they had not requested than

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they had, and this pattern reflects in the engineers' information delivery and use [9].

This paper collates evidence from various literature sources to further explore the gaps in engineers' IB and over reliance on colleagues for information and the liability caused by IO, and thereby sets the platform for future research to generate a comprehensive understanding of the organisational impacts of unstructured IB of project actors.

The paper establishes that the problem of IO and information source quality is the main reason for engineering project actors' over reliance on colleagues for the bulk of their information needs; however source quality is often compromised for ease of access. ~To address this, the paper proposes a framework (SMART Push information capturing and delivery system) to facilitate the transfer of information to specific actors and stakeholders within project organization. This will help control IO and provide a structure for effective IB of project actors to facilitate just-in-time information delivery and management [16] through a quality source. This framework aims to deliver context specific information to the actor just-in-time to aid releasing the actor from the entire problem associated with information seeking process in order to focus on the task at hand.

I. PROBLEM DEFINITION

Engineering industries have over decades grappled with the IO syndrome by adopting CSCW systems to manage and control it. However, this has proved to be unsuccessful since more and more information is created as customer demands keeps driving the need for information for project delivery and organisational management [8]. Past research have helped further to understand the information needs, seeking, use and retrieval of engineers in project environment. This has helped to establish that project actors compromise information source quality for ease of access and over reliance on colleagues resulting in time delays during the information seeking process.

II. CONCEPTUAL FOUNDATION OF ACTORS' IB

A. Engineering project actors' IB characteristics

The culture of engineering is heavily dependent on creating and handling data and information especially during the design process. For example, the design engineer has to explore different approaches and opportunities and abandoning other versions of design trials before arriving at the final design. Each of the approaches involves the searching, seeking, use and retrieving of information. Sometimes the design engineer may spend more time on acquiring and digesting the information to retrieve the relevant aspects from the bulk information. Other times, little effort is spent during the information seeking process. On the whole, design engineers spend majority of their time retrieving, seeking, and processing information than designing which is a contributing factor to limiting time and speed to new product introduction process. Similarly, the project actor in an engineering establishment is faced with the same process. As a matter of fact, the project actor would wish to just focus on the project execution and delivery process but for that to run smoothly, there is the need for accurate reliable context based information delivery [9],[12],[17]. A recent empirical investigation of engineers IB by [9] confirmed [17] affirmation that 40 to 66% of engineers working time is spent processing, communicating and disseminating information. Project actors require all kinds of different context specific information to carry out their activities. For example, the project manager needs up-to-date information about stakeholders' requirements, status report, planning details, and the performance report about the various project teams/contractors/engineers (actors). At the same time, a stakeholder may require information specific about project progress. Apart from this, an effective project manager needs to have a good knowledge and information about the technical aspect of the project. When the available information is presented in a well-structured (context specific) and timely manner to the project manager, evidence shows that the actor is able to make effective decisions regarding the project and any other problems being encountered [18].

B. The IB of engineering project actors

Information Behaviour (IB) according to [19] "*is the totality of human behaviour in relation to sources and channels of information, including both active and passive information seeking, and information use".* However in this context, IB is defined as the drive to which an actor declares a need for information by going through the search process, analysis, sifting, use and then retrieves that information at a later stage through various channels and sources for process and project delivery and organisation management as shown in fig. 1. Thus the active and passive information seeking processes an actor exhibits to acquire and use information. By passive process the engineer apply the least effort principle [17] to seek information whilst by active process, the engineer spend enormous amount of time and effort to comb through different information repositories and channels to get the right information. This active process many engineers dislike since it's a cumbersome process, time consuming and usually come about as a result of IO.

Project actors in this context are classified as individuals who manage, control, influences or are influenced by a product, process or an activity. The word actor in an engineering organisation is in reference to individuals such as managers, engineers, designers, planners and many more who influences and are influenced by the processes or activities that takes place within the organisation.

The project actors' IB process (fig. 1) starts with a need for a solution to a problem which could be a project or a process or a management issue, by assessing their personal memory for available information. This is followed by approaching the available information system (this could be electronic or non-electronic, and human or non-human) [15], after assessing the available information, the actor uses the information to execute the need. Whilst passive information seeking process is said to be a major contributory factor to information overload as opposed to active information search [9]. It is noted that actors tends to spend time controlling the amount of relevant information requested by employing other personal information management processes to make effective use of available relevant information. Engineering project actors often use

information channels and sources that require the least amount of effort even if it means compromising information quality[10],[20]. The least effort principle according to [1],[17],[21] is the most common principle preferred by engineers [10].

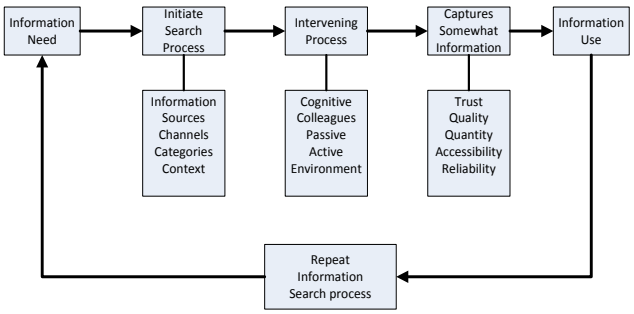

Fig.1. Actors information seeking behaviour (ISB) model

Previous research have linked information overload to the manner in which information is received (i.e. actively or passively) [9]. Actors are likely to request information relevant to their work through trusted sources and channels by neglecting source quality in favour of convenience. However the amount of time spent actively or passively seeking and searching for information from such trusted source is evidently found to take longer and cognitively demanding than when using nonhuman sources [9]. As much as actors are exposed to multiple channels and sources of information; it is argued that different information sources and channels actually help to capture and deliver all kinds of relevant information that enables their use; however source quality is vital to information use and subsequent outcome[9],[12],[15].

C. Impact of IO on the engineering project actor

Information overload (IO) has been researched for over four decades and has no universally agreed definition since there are different definitions associated to what constitutes IO. However for the purpose of this paper IO is defined as the exposure of project actors to abundant information from multiple information channels and sources (the point where the actor does not know how and what to do with available information) which tend to distract the engineer from effectively making decisions and using the information. The inability for organisations to capture and share the needed information at the right time to the right actor poses a challenge which if not resolved could impact on the technological advancement, social and economic trends that is taking place in engineering organisations [5],[8],[14],[22]. The problem of IO arises when an organisation has no structure to manage, monitor and control information flow to project actors. This may result in the organisation being exposed to both relevant and irrelevant information through multiple channels and sources. As a result relevant available information may go unused [22], resulting in IO. Information overload may also come about as a result of the increasing diversity and rapid increase in volume of information required by actors and created by actors as a result of the work being carried out [8],[14],[23]. Other research has shown that the bulk of the information overload menace emanates from actors exposure to different information and communication channels and sources (both electronic and non-electronic, human and non-human). Information overload is a major problem faced by organisations and different measures have been proposed or adopted by organisations to manage it however the problem still persist. This research proposes a framework that focuses on integrating the information seeking behaviour of engineering project actors and the organisation as a whole to facilitate effective structure of information capture and delivery system just-in-time at the right quality and quantity for effective organisationl management and project delivery as shown in fig. 1.3.

E. Project actors' information sources selection process

Due to the nature of engineering activities and the composition of engineering organisational structures, engineering project actors are exposed to multiple channels and sources of information. This tends to be a good thing when the channels and sources are used effectively and information is transferred from the right source through the right channel to the right actor [24], just-in-time for use. It becomes a setback when information delivery through these channels are unstructured, unregulated and leads to overloading the actor thereby impacting on efficiency, time and value which is often the case.

Information channels within an engineering establishment can be categorised into internal and external. Actors usually choose their channels based on the type of information required, channel accessibility, channel reliability, delivery time and type of tasks being performed. Multiple internal channel categories such as information from colleagues (face-to-face), emails, technical documents, machines, company internet and intranet systems, academic documents, and many more forms the initial point of call when actors begin their information seeking process. However, these actors are also exposed to the external channel category of information which includes internet, different websites, emails, technical magazines, journal articles, professional bodies, academicians, social network forums, and experts on specific fields.

Concomitant to these channels is the increased availability of rapid electronic information sources and channels, which contribute greatly to the increasing volume of information that engineers are exposed to during their information seeking process which is a major challenge. There is no evidence to suggest that the internet has exacerbated the problem of information overload however, evidence shows that as a result of open access to the internet, information transfer from the internet is done at such a fast rate that actors are overwhelmed by the problem caused by this sources category [8],[15]. For example the sheer volume of electronic mails received by engineers over specific periods contributes to information overload that engineers experience [8]. Actors acquire information not only through the traditional printed and archival sources but, also through open forum (websites, colleagues, information libraries and many more). Another important factor that concerns actors' information source selection is source accuracy and quality. Since the open web source and other electronic sources are unregulated and unfiltered, research suggest that evaluating and selecting a quality source have become more of a

challenge than ever [13],[25], and that actors do not necessarily choose sources based on accurate information provision [26]. They are more interested in how easy information can be acquired and used rather than the quality and accuracy of the information.

The identification of a particular information source is dependent on the source type, type of needed information, the relationship between the seeker and the source and the context within which the project is being executed [27]. Reference [28] found that engineers limitation to selecting good information sources is linked to the lack of understanding professional engineers get from majority of engineering literature due to its technical (sophisticated mathematical content) language composition. They found that the lack of accessibility to specific information also contributed to the usage of specific information sources. According to [28], engineers will simply not be attracted by improving the quantity or quality of information contained in information library, but by pushing the library to them (pushing the right information to the actor). They further emphasised that channel quality and accessibility is the single most important determinant of the overall extent to which information is used by stating that experience in the use of a familiar channel enhances the engineers channel accessibility. This is an affirmation of the push technology [8],[29],[30], where information is pushed to the user according to the user profile of information needs of activities being performed as shown in fig. 1.2. By this, IB of engineers according to [28] is linked to the fact that engineers want to apply minimum effort to acquiring the right amount of information needed to execute their activity. Trust, source quality and accessibility are perceived to be a dominant factor of actors' source selection rather than the cost [20],[27].

The problem with the current push technology systems (fig. 2) is that the project actor is actively (at the center) involved in the information seeking process which is detrimental to project delivery success.

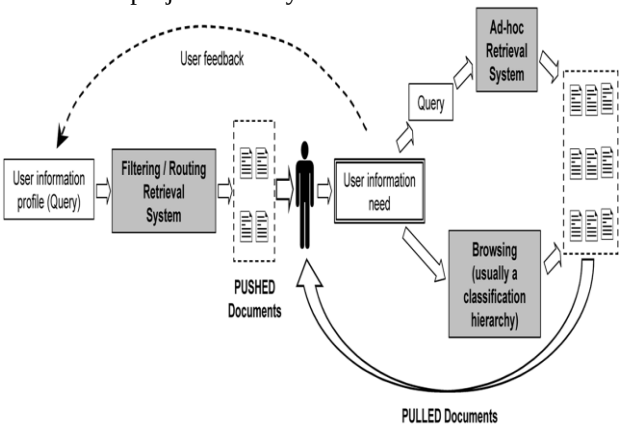

Fig.1.2. The Push technology adopted from [30]

II. PROPOSED SOLUTION

Establishing a well-structured information capture and delivery system to support the information use behavior [31] of project actors will go a long way to save cost, speed up project delivery process and organisational management and promote effective information seeking, use and retrieval process. Fig. 1.3 shows a structured framework for a SMART Push information capture and delivery framework to aid the effective ISB of project actors. This framework is designed to facilitate the capturing and movement of context specific information from a central information hub to specific information context trays (context station). This will then be *pushed* to the actor thereby freeing the actor from the active process of information seeking and IO. All this information will be digitised except information from colleagues (tacit knowledge) which would first be captured into a digitised credible technical document (intelligent information). Among items that could be supplied to the context information tray is colleagues with specialist knowledge and experience on specific information context. At the context tray, information specific will be *pushed* to the project actor(s) on a just-in-time principle to facilitate the effective and measureable use of received information. Actors will have the opportunity and time to focus on delivering their task whilst their request is being managed and dealt with. Actors would be required to feedback project progress status report which would be made available at the context tray section for accessibility by stakeholders upon request. It is hoped that this pragmatic approach will help reduce if not eliminate the menace caused by information overload, social and economic impact on project actors and its consequences to the business. As part of this proposed solution, experienced and knowledgeable actors would be encouraged (incentivised) to document their knowledge and experiences (intelligent information) in the form of a technical (context specific) reports or articles which will be peer-reviewed and kept in the information context station for use even when the actor (intelligent actor) is not available or made redundant. This will help in learning from past projects, having context specific information readily available for training and other purposes.

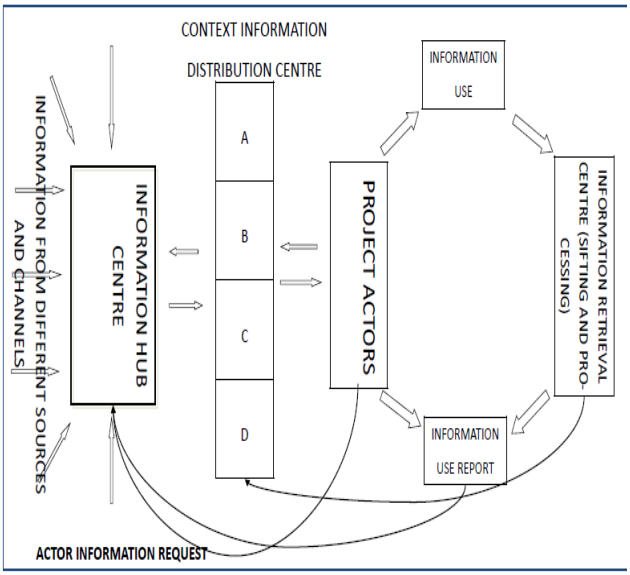

Fig. 1.3. SMART Push information capturing and delivery framework

III. PRACTICAL IMPLICATIONS AND BENEFITS

It has been established throughout this research that the impact of IO to an engineering organisation and any business can be very costly both socially and economically. It has also been affirmed by different authors and researchers that contacting colleagues (tacit knowledge) is the preferred information sources that engineers use during their

information seeking process. By businesses adopting this SMART Push information capture and delivery system, the problem of IO on the actor and the organisation would be controlled, monitored and eliminated. Information would be captured into a central hub, sifted and structured into specific context for delivery to the actor at the right time via the right channel.

The actor will be assured of source (trusted source) and information quality and the right quantity of needed information. If the actor requires an experienced colleague to support in the task in hand, s/he will have the assurance of not wasting time looking for that intelligent information sources since the information context hub will cater for that needs. Where the colleague is no longer available, that colleagues knowledge would have been captured in the form of a peer reviewed technical report and it will be made available to the actor in need.

Other stakeholders will be able to access any needed information at any stage of the project or process by activating a request at the context centre and the information would be delivered just-in-time for use.

The benefits of this proposal to the business include quality information from trusted source, assured effective information use and behaviour of the engineering project actor, and enhanced project delivery process, easy access to information on just-in-time bases, cost savings opportunities to the organization and control over information overload.

Organisation could end up producing intelligent information for educational purposes, training, and capture the knowledge and experience of their intelligent and expert employees as well as encourage their employees to become authors and reviewers of captured context based documents. This could drive competition.

IV. DISCUSSION

Other studies that investigated actors' information behavior concludes that ease of access, trust, reliability and the least effort principle to the information seeking process are the main objective of the engineering actor [12],[17],[25],[32]. Perhaps one of the main reason why actors preferred relying on colleagues for information is the fact that existing repositories do not offer the right kind of context specific information [12]. For example [28] postulated that engineers were more satisfied with having information delivered to them than the other way round which further affirms the 'principles of least effort' [17],[25] and the SMART Push information capturing and delivery system. Although technology currently exists to support access to information held in legacy archives, there is evidence that project actors hardly rely on such technologies when making key project decisions [33]. This often results in sub-optimal decisions or in some instances a re-invention of the wheel [34]. The problem of sub-optimal decisions is likely to accentuate in the emerging cloud computing environments, where large volumes of project information could be available to project actors through shared virtual workspaces which could further contribute to the IO syndrome. To date, there has been substantial work done on the structuring of information resources to support the decision maker in the project organisation [31]. However, structuring what information to be available to which actor would not only call for an appreciation of their role in the project environment, but also their information use behavior [35] and free them from spending huge amount of time on the ISB process.

The SMART Push information capture and delivery system will form the bases to effective information behaviour of project actors where context relevant information would be captured and structured for just-in-time delivery to the actor and other stakeholders for use.

V. CONCLUSIONS

In this paper, a synthesis of literature on information seeking behaviour and characteristics of engineering project actors has been undertaken to explore the potential influence of information seeking process in project delivery activities and organisations management. It has been argued that whilst the engineering profession is heavily dependent on information, multiple information sources and channels to information accessibility are helpful to the actors' IB during project design, execution and organisation management. But it has a seemingly negative influence (IO) on the actors ISB and the effectiveness of information use, performance and process delivery. Actors over reliance on colleagues have also been found to be very helpful to effective project delivery and information seeking process. However since the availability of the tacit knowledge deliverer (colleague) cannot be guaranteed at all times, the SMART Push information system will seek to alleviate this problem. Source quality in particular is found to be compromised for ease of access and availability by actors. It was found that actors have no or limited control over received information which affirms the information overload syndrome. Revelations from other industry sectors (namely health, academic, engineering and information sciences) and actions being taken have thrown more lights on the menace caused by information sources, channels and information overload. This led to the proposal of the SMART Push information capturing and delivery system which is an on-going research that will eventually be developed and deployed in industry for use.

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