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Paper 3:

DANCING TO THE TUNE OF FOURTH PARADIGM

The world has entered a "fourth paradigm" which is more collaborative, more computational, and more data intensive than the previous experimental, theoretical, and computational paradigms. This emerging scientific paradigm is often referred to as e-science or e-research. The current study focuses on the academic librarian's roles in coordinating "fourth paradigm" roles that have been powered by advanced computing capabilities in libraries to assist the researchers. It highlights the fact that by leveraging on technology in all parts of scientific endeavor, cyber infrastructure, and the establishment of data management and data sharing dictates by many research funding bodies, academic libraries have offered support with regard to the shifting needs of their community. The act of embedding the fourth paradigm's role need to be explored by Malaysian librarians. This could be a role on how best to engage in e-science through the development of library-based research data services (RDS). The paradigm offers, an important far-reaching look at the rapidly developing field of data-intensive science. Librarians should engage the "fourth paradigm" roles in ensuring the profession stays relevant. The "Fourth Paradigm" taxonomy will be developed to measure characteristics of the paradigm. The categorization would be offered as part of librarian's competency dimensions which hopefully increases the publicizing of the profession.

KEYWORDS: Fourth Paradigm, Embedded Librarianship, Academic Librarians, Malaysia

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INTRODUCTION

In this world of big Data and information explosion, the niche knowledge of classifying the knowledge production is really in need. Knowledge classification and library classification are librarian's forte. It is a segmentation of branch, specific to a subject. It can be loosely packaged into three primary sections, general knowledge, domain specific knowledge and site-specific knowledge (Gao, 2001). However, library classification deals with the organization and categorization of knowledge for a specific purpose (based on the scope of literature). It is based on the certain principles and schemes, internationally well accepted. The process of library classification follows the three basic; idea, verbal and notation plane. The main purpose of library classification is to provide access to each particular book in the Library. This article is a proposal to package information literacy skills into research lifecycle and rank it using Cynefin Framework.

The research problem for this study focuses is about managing the frenzied activities involve in teaching the ILS. The module of ILS is a strategic tool to handle scholarship roles, and knowledge production activities among academic librarians in Malaysian universities. It is a known fact that it is important for the researcher to establish the study based on a well-articulated problem statement (Creswell, 2005). In many academic libraries the ILS is a very demanding services. Such as that the librarians involved in ILS has to be dynamic and competent and positive in attitude towards research (Khasiah, 2015)

The ILS as activities beyond information searching and techniques are not traditionally perceived as the domain of library management and services. Much of the literature examining new roles for libraries, increase in visibility and in particular the library liaisons' role, described as an area in which library has newly established (Haglund & Olsson, 2008; Healy, 2010). In some libraries, they have included activities such as data curation and management, open access and scholarly communication, and outreach via office hours or web conferencing. The question of how to effectively raise the library's visibility was addressed by integrating ILS with new services (Healy 2010; Haglund & Olsson (2008). Responsibility for these new services was provided by librarians specifically focused on research services, metadata, and digital materials and preservation. All activities mentioned are integrated in the module of ILS. Being visible, and is being strategically embedded. Researchers spend a lot of time intensifying hard work searching efficiently, taking notes, and organizing their data. The visibility of librarians' is by making them approachable by the user and create relationship that would improve the importance of the library services.

By connecting the need to become visible and embedded, this article connects the concepts of sense making (Snowden, 2006) in the era of computing capabilities (Big Data) with the skill of academic librarians. Eventually, librarians have to cultivate ideas on how these concepts and offers support to their community. The team has explored and embraced Web 2.0 technologies extensively to showcase the richness of library services and service delivery in the era of Fourth Paradigm. The team agrees that information literacy service could be of value to all researchers, hence, the team wants to determine whether niche activities of information literacy activities could be developed into a suite of standard services available to all researchers at all levels of competencies across the university and throughout the research lifecycle and relate it with the tools available in the Internet which are most important to them. The team tackles these questions with a multifaceted approach that ultimately leads to the development of a new integrated information literacy activities model based on the research lifecycle.

FOURTH PARADIGM

The Fourth Paradigm is envisioned as a new method of nudging forward the frontiers of knowledge, enabled by new technologies for gathering, manipulating, analyzing and displaying data (Hey, Tansley & Tolle, 2010). Efforts to define "Fourth Paradigm" have included focus on everything from central characteristics and computing power to figures and numbers (Ward & Barker, 2013). For this paper, the authors are accepting the definition by Knapp (2013, p. 215). According to him, Big Data refers to "tools, processes and procedures that allow an organisation to create, manipulate, and manage very large data sets and storage facilities".

ERA	SCIENTIFIC REVOLUTION	COMPONENTS OF ACTIVITIES
Thousand years ago	Experimental Science	Description of natural phenomena
Last few hundred years	Theoretical Science	Newton's Laws, Maxwell's Equations
Last few decades	Computational Science	Simulation of complex phenomena
Today	Data-Intensive Science	Scientists overwhelmed with data sets from many different sources • Data captured by instruments • Data generated by simulations • Data generated by sensor networks

Table 1: The Emergence of a Fourth Research Paradigm -Adapted from: Hey, Tansley & Tolle (2010)

METHODS

The study has approached the question of which library services should become part of a standard suite offered to researchers in five levels of research lifecycles (Unsworth, 2000; Vaughan, Hayes, Lerner, McElfresh, Pavlech, L., Romito & Morris (2013) namely, FUND, DISCOVER, GATHER, CREATE, SHARE. Later, the study mapped the behaviour of the librarians using Cynefin Framework to make sense of the ILS activities.

ILS MODULE MAPPED INTO RESEARCH LIFECYCLES

Agreeing to Vaughan, et al (2013) the model demonstrates that the library provides services that fit along a continuum of research lifecycle. The continuum of research lifecycle as it is understood by all researchers. Therefore, the ILS is presented as user centred: they are offered in a package that users can relate to and understand. Furthermore, as found out by Vaughan, et al (2013) all services listed in the research lifecycle model can be performed as modular, phase by phase. This enables a small team of librarian to provide a package according to a lifecycle chosen by a group of researcher in a scalable approach, given a limited number of librarians. In this way, Vaughan et al showed that librarians can provide support in a complete research lifecycle. The model allows the library follow through the entire the research lifecycle. Based on this model alone the library is ready to be a partner through the entire process, not just doing the literature review of a research project.

CYNEFIN FRAMEWORK

The Cynefin Framework (CF) was chosen to select the best projects in support of UiTM needs to increase in the quality of managing the organization with a very tight budget. The project is considered quality if it is very lean and strategic if it can prosper without allocated budget. CF is a tool for sense making to understanding the chaotic world of information. By riding on the current facilities and resources, the information literacy skill (ILS) as a training module for library user, was chosen as a strategic project to be handle by any libraries. The idea of the Cynefin Framework is that it offers decision-makers a "sense of place" from which to view their perceptions (Browning & Latoza, 2005). Or in his own words Snowden (2006) said that "sense making is how we make sense of the world so we can act in it". In the context of library management, the framework is helping the librarians to make sense of the information explosion and data deluge which is challenging the profession. Thus, in the study, there are five quadrants to frame the problems; obvious, complicate, complex, chaotic and disorder.

Table 2: Cynefin Framework

Obvious/Simple/Known is the domain of best practices.	Simple or Known, in which the relationship between cause and effect is obvious to all. The approach suited to this context is to Sense - categorize - Respond (SCR) then apply best practice. This suits a centralized bureaucratic way of working with weak horizontal links in organizations
Complicated/good practice/ Knowable are the domain of good practices.	Complicated or Knowable, in which the relationship between cause and effect requires analysis or some other form of investigation and/or the application of expert knowledge. The approach suited to this context is to Sense - Analyze - Respond (SAR) then apply good practice. This domain • is the realm of most scientific research and of matrix organizational structures.
Complex/emergent practice is the domain of emergent solutions.	Complex, in which the relationship between cause and effect can only be perceived in retrospect, but not in advance. The approach suited to this context to Probe - Sense – Respond (PSR) and then allow emergent practice.
Chaotic/novel practice / Incoherent is the domain of novel solutions.	Chaotic, in which there is no relationship between cause and effect at systems level. The approach suited to this context is to Act - Sense - Respond (ASR) to discover novel practice. Aspects of Chaos Theory developed in mathematical disciplines are relevant to this domain. The connections between individuals and organizations working in this domain are weak.
Disorder/ Causality Unknown is the space in the middle.	If an organization does not have an idea and know where it is, it is in "Disorder." Priority one is to move you to a known domain. This is the middle domain, which is the state of not knowing what type of causality exists, in which state people will have a tendency to revert to their own comfort zone (domain) in making a decision.

Table 3: Adapted from Snowden (2006)

THE MODULE OF INFORMATION LITERACY SKILLS

Information Literacy Skills (ILS) module has many facets and each library has their own modules. The module is basically for training reference within one library. This paper would use UiTM library ILS module (E-LiTs) as basis for discussion. The Information Literacy Skills Module plotted with the research lifecycle. By using research processes, adapted from Unsworth (2000) and enhanced by Vaughan, et al (2013) the E-LiTs module is developed into four quadrants of behaviour [activities] for

librarians to support the scholars. It includes: a) Funding opportunities, b) Discovering contents or resources, c) Gathering resources, and d) Creating knowledge.

FUND: Funding opportunities: Seeking grants

Funding opportunities is the act of seeking grants available to fund a research project. According to Western Sydney University (2016) research comprises of creative work undertaken on a systematic basis in order to increase the stock of knowledge. In academia, researchers are particularly committed in order to propagate knowledge. The components of a successful propagation of research include among other, a long-term funding of field research and monitoring. In general, to do research there must be fund, however grants and funders are becoming scares and limited. In Malaysia, the fund from government is dwindling and one need to compete to justify the importance and significant contribution to the society before one can acquire it. Thus, Malaysian scientists need to find other sources to fund their researches. Although researches could search on their own, some activities get better done by someone who is more knowledgeable and expert; who could concentrate and know how to search funding opportunities.

DISCOVER: Discovering contents or resources

According to Spezi & Creaser (2013) data deluge is becoming a major element of the academic library landscape. Over the past five to ten years, libraries have begun to provide data-related services to researchers. Examples include assisting researchers in complying with the data management and sharing requirements of USA funded grants (e.g., National Institutes of Health, National Science Foundation) providing guidance for developing workflows and standard data collection procedures (Gold, 2007); and training researchers on how to better organize, store, and preserve their data (Creamer, Morales , Crespo , Kafel & Martin , 2011). All of the above activities have created new opportunities for librarians, to expand their roles in data services.

GATHER: Gathering resources

Although libraries are normally associated with books, they have numerous other research resources, many of which are beyond the scope of what is easily accessible at home or on the Internet. Librarians are knowledgeable about what information is accessible from each resource and can make your research efforts easier and more efficient. Libraries house a number of resources that you can locate, handle, and use immediately. These physical resources include periodicals, magazines, newspapers, maps, and manuscripts, though some may be used only at the library. Academic librarians are assumed to know where to get source of information by following and tagging the citation? Since knowledge develop and increase exponentially there is no assurance that everybody who knows some tools and technologies could discover and gather all the information. If so, it still will be time consuming.

CREATE: Creating knowledge

Academic publishing is a system that is necessary in order for academic scholars to create, to do peer review of the work and make it available for a wider audience. Knowledge creation comprises of generating and discovering new knowledge of any types, and covers the conversion of tacit knowledge into explicit knowledge and vice versa (Nonaka, 1994). Knowledge creation relates to the creation of new knowledge through practice, collaboration, interaction, and education. It has been generally encouraged among the organizations that have the ability to create knowledge on an ongoing basis have the benefit of being dynamic and competitive (Nonaka & Takeuchi, 1995). It means the competencies to create new knowledge is one of the main sources of the competitive advantage (Nonaka, 1994) which librarian could embark on. Sometimes this issue is not treated as part of knowledge management since it overlaps with *innovation management* (Wellman, 2009). Publishing academic materials are not limited to publishing articles based on researches at the faculties. Librarians do have attentiveness to support knowledge creation.

RESEARCH LIFECYCLE	BEHAVIOUR	ACTIVITIES (EXAMPLE)	Example of TOOLS
FUND searching	Seeking grants	Finding funding opportunities, writing grant proposals	
DISCOVER	1. Finding - serendipitous 2. Finding - structured 3. Keeping current	1.Browsing, literature, web 2.Identifying, tagging 3.Known item searching for books, journals, following citations 4.Push/pull awareness: SDI, RSS feeds, e text mining, web browsing	1. JSTOR, Google Scholar, Amazon 2. Nature Network, SciSpace, Research gate 3. Library Catalogs & Indexes, Web of Knowledge 4. JSTOR, Google Books,
GATHER	1. Collecting 2. Acquiring 3. Organizing	1.Physical resources, lab bookings, digital documents, web resources, datasets, surveys, images 2.Borrowing, purchasing, licensing, accessing, requesting 3.Citation management curating datasets	1. CiteULike, BioLoit, JISC, 2. Amazon, Government Archives 3. EndNote, Procite, BibTex, Connote, CiteULike
CREATE	1. Annotating 2. Analysing 3. Describing 4. Reviewing & rating 5. Writing 6. Archiving	1.Active reading 2.Scripts, code, algorithms, 3.Annotating tagging, 4.Social networking 5.Document management, collaborative authoring 6.Storing or self-archiving	1. Zotero, EndNote, Mendeley 2. Source Depot, SAS, 3. Publons 4. LaTeX, Microsoft Word, Procite, 5. Google Doc
SHARE	1. Publishing 2. Teaching 3. Data Sharing 4. Rights	1.Communicating a message 2.instruction, guideline, or training 3.access, meetings, lectureship, 4.copyrights, legal, social, or ethical principles	1. Adobe, ID 2. ClickClass, CourseLab 3. Kobo, DRAFT2 DIGITAL

Table 4: Model of information literacy skill (ILS)

ILS MODULE INTO CYNEFIN FRAMEWORK

Agreeing to Association of College and Research Libraries (2015), the information literacy is a set of abilities which requires individuals to 'recognize when information is needed and have the ability to locate, evaluate, and use effectively the needed information.' Information literacy is the foundation for lifelong learning. Sense making out of chaotic collection of information is meant to improve activities in knowledge creation. In a nutshell, being librarian, they need to communicate their tacit knowledge otherwise it remains personal.

Thus, in the ILS module the idea of handling all sorts of information and knowledge is quite chaotic. This needs an examination in order to establish the suitability of the Cynefin framework, developed for knowledge management, as a tool for sense making in library services. According to Snowden and Boone (2007), eventually the knowledge that grows, increases competence for sense-making and adaptation of information to suit various contexts of need. Cynefin Framework is neither a complete solution to all library services problems. However, in this study the team present suggestion and argument to demonstrate how it provides a new lens through which to make sense of the kaleidoscope of ILS activities and tools to manage research lifecycle. Cynefin Framework show how it affords a plotting of changing perspectives of ILS activities over time

RESEARCH LIFECYCLE	**BEHAVIOUR OF LIBRARIAN**	**ACTIVITIES (EXAMPLE)**	**CYNEFIN FRAMEWORK**
FUND	Seeking grants	Finding funding opportunities, writing grant proposals	**SIMPLE** is the domain of **best practices**. / disorder
DISCOVER	1.Finding - serendipitous 2.Finding - structured 3.Keeping current information	1. Browsing , literature , web 2. Identifying ,tagging 3. Known item searching for books, journals, following citations 4. Push/pull awareness: SDI, RSS feeds, e text mining, web browsing	**COMPLICATED** i s the domain of **good practices**. / disorder
GATHER	1.Collecting 2.Acquiring 3.Organizing/classification	1. Physical resources, lab bookings, digital documents, web resources, datasets, surveys, images 2. Borrowing, purchasing, licensing, accessing, requesting 3. Citation management curating datasets	**COMPLEX** is the domain of **emergent solutions**. / disorder
CREATE	1.Annotating 2.Analyzing 3.Describing 4.Reviewing & rating 5.Writing 6.Archiving	1. Active reading 2. Scripts, code, algorithms, 3. Annotating tagging, 4. Social networking 5. Document management, collaborative authoring 6. Storing or self-archiving	**CHAOTIC** is the domain of **novel solutions**. / disorder
SHARE	1.Publishing 2.Teaching 3.Data Sharing 4.Rights	1. Communicating A Message 2. Instruction, Guideline, Or Training 3. Access, Meetings, Lectureship, 4. Copyrights, Legal, Social, Or Ethical Principles	**DISORDERED**

Table 5: ILS module into Cynefin Framework

Agreeing to Association of College & Research Libraries (2015) the information literacy is a set of abilities which requires individuals to 'recognize when information is needed and have the ability to locate, evaluate, and use effectively the needed information.' Information literacy is the foundation for lifelong learning. People use information in sense making, as a representation (such as selecting raw data in small pieces to help people make sense of the data), selection (acting with interpretation that worked before), and retention (enacted interpretation retained for future use). Beliefs play a major role in this activity. Sense making out of chaotic and deluge of information to improve activities in knowledge creation is about using tacit knowledge (personal - which is gained through apprentices or on the job training); explicit knowledge (object or rule based); cultural (shared assumptions and beliefs that shape an organisations identity. In a nutshell, doing the job as librarian, they need to communicate their tacit knowledge otherwise it remains personal. Thus, in the teaching of ILS the sense making decisions are done during the interaction; otherwise the idea of handling all sorts of information and knowledge is not acknowledged.

Identifying a need for information and understanding its context is an ILS attribute. ILS underpins information behaviour in providing awareness of information sources; activities such as, how to search and use information appropriately for solving information needs and leveraging will generate new knowledge. The generation of new knowledge results from using information, in a process that combines with sense-making and adjustment.

Simple Contexts: The Domain of Best Practice

Seeking fund and grants is in the obvious quadrant or Simple quadrant. The act of searching agencies or companies that could fund a research can be done by Reference librarian using her knowledge and skill in searching strategies and techniques. In Simple systems, cause and effect are known and linked through direct, predictable causality. If librarian apply Simple systems to a chaotic context, it may result in dysfunction.

Most of the systems that we as library managers use are Simple (such as handling procurement processes or audit the user requirements for articles). Simple contexts are characterized by stability and clear cause-and-effect relationships that are easily discernible by everyone. In this area of “known knowns,” decisions are unquestioned because all parties share an understanding. Areas that are little subject to change, such as problems with getting a funder, processing documents and fulfilment of a project funded, usually belong here. Simple contexts, properly assessed, require straightforward management and monitoring. Here, library managers sense, categorize, and respond. That is, they assess the facts of the situation, categorize them, and then base their response on established practice.

Complex - Discover: Complicated

The process of gathering library resources and collection in all formats (collecting and acquiring) later organizing and classification of resources belongs to Complex quadrant. Complex contexts, unlike simple ones, may contain numerous right answers. Though there is a clear relationship between cause and effect, not everyone can see it. This is the territory of “known unknowns” While library managers in a Simple context must sense, categorize, and respond to a situation, those in a complicated context must sense, analyze, and respond. This approach is not easy and often requires expertise: An acquisition department may know that something is wrong with the library collection, such as certain topics or titles not acquired, listing from vendors not check or responded to, budgets not enough-because the customers are complaining, but the acquisition librarian knows the policy and procedures of the library and they have to follow through.

Complicated Contexts: The Domain of Experts

Complicated contexts, may contain multiple right answers, and though there is a clear relationship between cause and effect, not everyone can see it. This is the realm of "known unknowns." While library managers in a simple context must sense, categorize, and respond to a situation, those in a complicated context must sense, analyse, and respond. This approach is not easy and often requires expertise: A reference librarian who was asked to find literature will need to consistently update in the searching techniques and strategies. Only she may execute the styles which certain search engines or database in which she planned to search, she is the master of the landscape of knowledge. Repeatedly she will evaluate her strategies and techniques – further down the road, she will know that different subjects and search engines will need different approaches.

In a Complicated context calls for investigating several options- many of which may be "excellent", "good practice" as opposed to "best practice" is more appropriate. For example, the routine method to text mining for an SDI (Selective Dissemination of Information) portfolio; certain subject field may unknown by the librarian; new hot science, new findings, new innovation – to develop the portfolio for a customer will need a lot of analysing and understanding of the field; emphasizing certain area of discoveries over another discoveries, might be equally valuable. The effort usually requires a discussion with the user. Entrained thinking is a danger in Complicated contexts, too, but it is the experts (rather than the library managers) who are prone to it, and they tend to dominate the domain. When this problem occurs, innovative suggestions by non-experts may be overlooked or dismissed, resulting in lost opportunities. Working in unaccustomed surroundings can help librarians approach teaching library user more creatively.

Chaotic Contexts: Novel Practice the Domain of Rapid Response

As Snowden (2006) described it, "In a Chaotic context, searching for right answers would be pointless: The relationships between cause and effect are impossible to determine because they shift constantly and no manageable patterns exist—only turbulence". This is the jurisdiction of unknowable. Library managers must first act to establish order, then sense where stability is present and from where it is absent, and then respond by working to change the condition from chaos to complexity, where the identification of emerging patterns can both help prevent future crises and distinguish new chances. Top-down communication is vital; there is very small chance for reaction. Still, the chaotic domain is always the best place for library managers to drive innovation, especially in Social networking and publishing activities.

In the quadrant of Disordered, the library activities taught in the information literacy modules involve the act of sharing (data, information, knowledge) the librarians usually become the integrator the activities of publishing, teaching information skills, managing data sharing, and consultation about the legal, copyrights and publishing rights. Even though this component of service still very new to librarians, however being an emphatic staff, librarians usually will try to fulfil these roles. Many of them can be found in the Research Support Division (e.g. Library University Kebangsaan Malaysia; and the Academic Services Division (Library University of Malaya). Many are collaborating with research, teaching and publishing activities (Zakaria, 2016)

CONCLUSION

Academic librarians daily have to approach the "Fourth Paradigm" as an embedded role. The study is about how the academic librarian can manage the problem of big data. As big data is about data deluge, thus this paper is proposing to ease the task by introducing the development of a paradigm in an information literacy skill module called E- LiTS using the Cynefin Framework. The chores such as

coordinating resources and facilities that have been bonded by the research process to assist in managing the multiple levels and services appeared in the ILS Modules. The E- LiTS is an encapsulated model of managing several activities introduced in an ILS Modules. This is in accordance to the needs for an increase of productivity in scholarly publications.

The key vision for any forward looking organizations was embedded in the concept of an organization dedicated to ongoing innovation across disciplinary boundaries (Dewey, 2004). An organization designed for open use in experimentation, creation, and research in dozens of disciplines across the university. Through physical spaces and technology infrastructure designed to be adaptable, reconfigurable, and interchangeable, the building itself is designed to be an object of research. In order for a university to provide essential support to its researchers and remain competitive with peer institutions, the university library should initiate a distinctive Fourth Paradigm's function that provides empathy to the publishing activities. This paper has examined the LIS discipline being stack with, an information literacy

The study considers that Cynefin Framework provides a means of making sense of change in LIS to be indispensable when LIS is trying to create permits as a discipline. Cynefin Framework also provides a mechanism to match problems to solutions, and match issues to methodologies in the context of time and place. While recognizing the value of order in scientific methods of research and best practice guidelines in practice, Cynefin Framework also allows us to place emphasis on the incorporation of Complexity and Chaos Theories into the more ordered set of tools we have for understanding the world. This is particularly relevant when the changing economic, social and environmental issues in that world drive ongoing change and diversity in IS and ICT artefacts. The team recommends the use of Cynefin Framework as a sense-making tool for LIS research as we move into a future where complex human enterprises will trust on a miscellaneous, changing set of social ICT tools for communication and synchronization of their collective interacted activities.

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