Fostering Library Agility with Big Data

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Abstract

The increasing complexity of the information environment has spurred libraries to increase their relevance. Increasing the agility of libraries is worth considering. In the context for this study, Agile library is a user-centred library that permits flexibility, to take risks, and to make responsive changes that address its users' needs, while Big Data is one of many emerging technologies available to foster agility in libraries. Big Data have offered libraries and librarians new ways and methods to collect and analyse data to justify their value and contributions, while at the same time being innovative, flexible, and responsive in giving superior services to its users. This signifies the importance of such technological integrations in the library environment. Against this background, this paper will focus on the perspectives and future agenda of how library agility could be fostered in the Big Data era. This paper will discuss the concepts of *Agile Libraries* and how *Big Data capabilities* could become the determinants for library agility. The biggest limitation of this work is that it remains at the conceptual level and requires empirical research and testing to validate the model. Conceptualizing both concepts of library agility and Big Data capabilities are expected to provide the opportunities for future research directions in library with Big Data technology.

Key Words: Library Agility, Big Data, Big Data Capability, Agile Libraries

1. Introduction

The impacts of technology in higher education have been seen for the past two decades, rapidly changing the library environment. Libraries are pressured to adapt to changing conditions caused by increasing user demands, behaviour, emerging technologies, and the need for cost-efficient solutions. Of particular importance, these unpredictable rapid changes are concretely affecting library performance. This has forced libraries to continually cope with the unpredictable changes in the conduct of their business. The complexity of this ever-changing

environment has spurred organisation like libraries to step forward for relevancy. To remain significant, appropriate deliberation to hasten agility in libraries is worthy of discussion. Garoufallou and Gaitanou (2021) believe that Big Data is undoubtedly a new area of academic research and necessary to discover the phases that influence libraries and the new experiments it presents. Reinhalter and Wittman (2014) highlight that, the term "Big Data" has turned into more commonly used in the headlines of newspapers, proprietary magazines, and academic journals in many disciplines since the year 2012. They added that Big Data is treasured to most subject areas; its abilities, practises, and solicitations are diverse. Therefore, Big Data coordination is suitable to be implemented equivalent with the library's agility needs these days. To be agile in the context of libraries is to be able to move, adapt and constantly improve and creating a better value for the users with product and services according to their needs (Forsman, 2014). Predicting and responding to consumer demands, together with the utilisation of appropriate technologies, will help libraries to introduce incomparable quality products and services that meet the current demand. In contrast, the inability to flexibly react to changes indicates a lack of understanding in introducing products or services due to insufficient knowledge of the current market.

Agility places greater demands on the role of data and information. The quality of business decisions is extremely reliant on the information sources, and the tools utilized by decision-makers, in this context libraries. The accessibility of critical information, and the availability of appropriate analytical tools, will provide knowledge to stimulate thinking and serve as catalyst for new innovations. At the same time, this will allow libraries to evoked productivity improvements related to customer-focus operations and service quality. This suggests that technology is the key driver of enabling agility in libraries. Reliance on organisational IT systems, including process, knowledge, communication technologies, are all important components that seek to enhance agility. Technological tools enable the generation of required information significantly related to organisational responsiveness (Bhatt et al.,2010).

In tandem, the use of Big Data technologies in libraries has been going on since its inceptions. In fact, the rapid development of emerging technologies such as Big Data have offered libraries and librarians new ways and methods to collect and analyse data to justify their value and contributions (Chen et al., 2015). Big Data can provide extremely detailed information about current and prospective customers, which is valuable to gain insight into the motivations, behaviours, and tendencies that drive users within business environment. This detailed information and knowledge will eventually allow libraries to be agile. This paper will focus on the perspectives and future agenda of how library agility could be fostered in the Big Data era. This paper will discuss the concepts of *Agile Libraries* and how *Big Data capabilities* could become the determinants for library agility. Conceptualizing both the concepts of library agility and Big Data capabilities is expected to provide opportunities for research directions in library data with Big Data technology.

2. Literature Review

Embracing changes and creating innovations are the key elements of an agile library. As consumer needs and technologies are constantly changing, libraries must be able to adapt to continue to serve their users and organisations. This spurs the ideas that libraries must strive to be adaptive, flexible, and responsive to its environment. In general, the term *agile* refers to the ability to change or be changed rapidly in response to customer needs and market forces. In the same context, *agility* is defined as ability to prosper in a competitive environment characterized

by constant and unpredictable change (Goldman, et al., 1995). Cho et al. (1996) defined *agility* as "the capability to survive and prosper in a competitive environment or continuous and unpredictable changes by reacting quickly and effectively to changing markets, designed by customer designed products and services". In principle, agility is the ability of an organisation to thrive in a continuously changing, unpredictable business environment. Thus, in accordance to this paper, agility is viewed as valuable organisational attribute that allows organisations to perform with flexibility and responsiveness within a state of uncertainty about the constant changes of the business environment. Garoufallou and Gaitanou (2021) highlight that several questions related to how libraries will follow, implement, assimilate, and work side-by-side with these new revolutions and challenges need to be discussed.

Libraries are part of these organisations, and similarly, libraries too are facing constant changes in their business environment. In this context, libraries are required to be agile, thus signifying the essentials of embedding agile principles to its environment. According to Lusher & Haricombe (1996), an agile library is a user-centred library that permits flexibility, to take risks, and to make responsive changes that will address its users' needs. This view suggests that libraries must adapts to a more agile approach with flexibility and responsiveness as basis to their business. Libraries need to be quick in developing and deploying new services that really meet the needs of the users. In this case, libraries must be able take risks to serve new areas where requirements are emerging and at the same time being responsive to the services as it is evolving. This allows libraries to have much understanding and better chance to flexibly deliver new services that really meets the needs of the users. As stated by Frederick (2016), the leading objective of data science and information professionals is to alter enormous and disorganised datasets into actionable knowledge over analytical thinking procedures. Therefore, actions must be taken by the libraries to meet the needs of the community especially the library users related to the library collections and services provided ever since. Strategic planning on the collections development and services cannot be taken lightly to ensure that the aims and goals of the libraries can be achieved at the end of the day.

On the other hand, it is often found in the literature that agile organisations are frequently grouped into the following four strategic dimensions: enrichment of customers, competitive enhancement by cooperation, mastery of uncertain change and leverage of key people and information (Goldman, 1995). In addition, previous researches have also grouped agility as capabilities in the forms of; responsiveness, competency, flexibility and speed (Sharifi & Zhang, 1999); speed, flexibility, innovation proactively, quality and profitability (Yusuf et al.,1999); discover new opportunities for competitive advantage, harness the existing knowledge, assets, and relationships to seize these opportunities and adapt to sudden changes in business conditions (Setia et al., 2008).

Within the past decade, measures of agility have often been grouped into several dimensions including operations agility, customer agility and partnering agility, information agility, strategic agility, systems agility, market capitalizing capability (Sambamurthy, et al., 2003; Fink & Neumann, 2007; Tallon & Pinsonneault, 2011; Lu & Ramamurthy, 2011; Krotov et al., 2015). These measures of agility are found to be valid to be applied in all types of organisations including libraries. As libraries are both customer and process oriented, thus addressing user needs and operational flexibility as essentials for businesses. This study suggest that agile libraries must be based on main elements that focuses on "operational ability-based" and "customer orientation-based". Figure 1 below depicts agile libraries' essential agility elements.

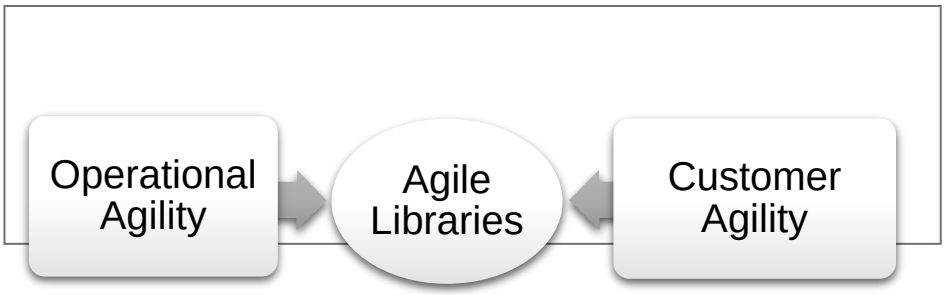

Figure 1: The depiction of essential agile libraries elements

In general, an operationally agile organisation is the one that can quickly and accurately identify great business opportunities which will eventually translate into increased revenues and profits, and also business performance. Operational based agility highlights both flexibility and rapidly responsive operations that are able to initiate innovation in the face of change. Research has also highlighted operational agility as "highly modular, and thus flexible enough to facilitate the rapid design (and re-design) of processes to produce a new good or service" (Krotov et al., 2015). A previous study has shown that, the ability of an organisation to efficiently and effectively process information can contributes significantly towards achieving operational agility, especially in terms of sensing and responding to changes (Teece, 2007). Another study found that leveraging knowledge that derived from an analysis of internal data and information could help organisations realize changes to improve internal operations and processes (Roberts & Grover, 2012). Current research has also evaluated operational agility in terms of its response times to new product launches by rivals, market expansion, changes in product mix, and the adoption of new production IT (Tallon & Pinsonneault, 2011). The high level of interconnectivity and integration of technological modules are important to promote the efficiency of business processes and thus provide operational agility (Krotov et al., 2015). In such cases, interconnectivity and integration allow the collection of data for producing accurate information for decision making, thus supporting operational efficiencies.

On the other hand, sensing and responding quickly to customer-based opportunities for innovation is crucial for any organisation. Customer agility is an organisation's ability to manage changes of customer preferences and needs. It has also been defined as co-opting of customers in the exploration and exploitation of opportunities for innovation and competitiveness (Sambamurthy et al., 2003). Customer agility is assessed in terms of an organisation's responsiveness to changes in demand (Tallon & Pinsonneault, 2011). The concept of customer agility has also been associated with the ability of the organisation in capturing market intelligence related to the customers and effectively reacting upon it (Lu & Ramamurthy, 2011). The application of IT, for example, can enhance customer agility primarily on providing an electronic channel to gather customer feedback, which a firm can then leverage to initiate new processes (Krovtov et al., 2015).

The basis for both of these agilities are mainly about having required information for decision making and turning it into actionable outcomes. This implies that an agile organisation requires efficiency of information access and use across different information needs (Fink & Neuman, 2007). The ability to generate the required information is significantly related to organisational responsiveness. To this effect, organisational responsiveness has also been deemed to be positively related to an organisation's performance (Bhatt et al., 2010). The sharing of real-time, consistent, comprehensive, and highly quality information enables fast,

efficient decision making (Eisenhardt, 1998). Obtaining information from various resources allows organisation to learn more about their customers (Cho, 2006). By doing so, organisations will be able to recognize the opportunities and threats crucial for strategic business projection. In addition, Golub and Hansson (2015) inform that with the application of big data technologies, new knowledge can be obtained, and new services may be delivered to add value to current offerings at the libraries.

This paper suggests that the development of agile libraries must be based on the notion that libraries should be flexible and responsive to operational and user needs by understanding their current environment. With sufficient data and information obtained from various IT resources in their surroundings, libraries will be able to conduct thorough analysis and data analytics to understand their environment and eventually achieve the state of agile libraries. The next sections will further discuss this issue in detail.

2.1 IT, Big Data Capabilities and Agile Libraries

According to Garoufallou & Gaitanou (2021), libraries started dealing with Big Data when they computerised their cataloguing tasks and circulation coordination through OCLC and parallel data-sharing organisations. Therefore, they added that one of the first instances of Big Data in the bibliographic and library environment could be WorldCat, the world's principal network of library content and services, which has the prospective to backing knowledge discovery in various regions. Prior to that, Teets and Goldner (2013) observed on WorldCat and provided clarification of how OCLC is dynamically involved with Schema.org to make this data used all over the web. Lastly, Green and Panzer (2014) discovered how WorldCat data can notify the expansion of the DDC (classification analytics) and how DDC-classified content in WorldCat can assist and benefit the bibliographic atmosphere itself. Here, we can see how Big Data technologies become more and more relevant to the library's agility all over the world.

In general, foreseeing and dealing with opportunities include the ability to generate the required information for decision making and agility. Becoming agile in this context is viewed as a process of utilizing sufficient technology (IT) to produce accurate, quality information in order to support the best decision-making processes quickly and efficiently from a state of uncertainties. The application of IT could facilitate an organisation to sense environmental changes and respond readily to and adapt to these sudden changes (Heckler & Powell, 2016; Trinh-Phuong et al., 2012; Tallon & Pinsonnault, 2011; Setia et al., 2008; Overby et al., 2006). At the same time, Deng (2017) discusses that Big Data offers more high-quality, directed services which categorized by a self-adaptive tailored information system, and this has led to a knowledge information service for supplementary decision-making (Wang, 2016).

The application of technology to boost business performance has been increasingly growing over the past ten years. This is manifested by investment into emerging technology which is replacing the legacy applications. More and more organisations are now investing in emerging technologies because they have reached the point at which the need to use effective tools to support the analysis and application of information captured by these tools for decision-making process has become more important than ever (Sangari & Razmi, 2015). In fact, Big Data technology is part of these new investments. Current data shows that the spending on Big Data and its infrastructure is expected to increase to $101 billion globally until 2020 (IDC, 2017) due to the increasing influx of data available to organisation that requires infrastructure capabilities to analyse and visualize intelligence for business

expansion. For all segments of businesses, the investment for Big Data is promising as it is essentials in the context of utilizing market information for agility.

Deng (2017) says, within the Big Data context, the old-style library service notion has changed, as operative library collection development involves the operative analysis of the library users' needs. As an emerging research field, Big Data is not widely discussed in the library context (Zhan & Widén, 2018). However, there has been little research on the application of Big Data in libraries, recently focusing on data-driven areas such as data visualization for library services, learning analytics, user behaviour analysis, collection use analysis, knowledge discovery and management, and etc. (Huwe, 2014; Wang et al., 2016). From this study's point of view, the research areas as mentioned above does contributes to the agility of the libraries. The data-driven approach, for example, is highly significant as part of decision-making method for library management. Such applications are able to provide valuable insights and knowledge for libraries to be flexible and responsive in their operational services, which would improve customer satisfaction through better services and more efficient uses of library resources. Besides that, Blummer and Kenton (2019) also stress that librarians can use Big Data analytics to assess and improve library services from time to time.

As stated by Garoufallou & Gaitanou (2021), Big Data management in libraries within organizations is very crucial as librarians need to help their users to recognise what Big Data is and how they can effectively manage them so as to accomplish their goals. On the other hand, to be able to gain agility in libraries with Big Data, some Big Data capabilities are needed to serve as antecedents to the concepts of library agility. With the growing diversity in ITs and its applications in all organisations today, the expected impact of adopting specific technology such as Big Data does expect predict the organisations' performance. This study argues that the capabilities of such specific technologies like Big Data are essentials to ensures agility in library. However, there are no specific definition of the term 'Big Data capability' can be found in literatures (Hassna & Lowry, 2015). There are many measures and models being used to define 'Big Data capabilities' thus making the ambiguity on the concepts. According to Hassna & Lowry (2015), Big Data capability (BDC) could be built upon three level dimensions which are Big Data infrastructure capability (BDIC), Big Data management capability (BDMC) and Big Data science/analytics capability (BDAC). Based upon this foundation, this paper suggests that all of the capabilities mentioned, could become strong factors in predicting library agility. The next section will discuss the proposed conceptual model linking both concepts of Big Data capabilities and agile libraries.

3. Conceptualizing the Linkages Between Big Data capabilities and Agile Libraries

Hoy (2014) informs that Big Data applications can produce amazing awareness. The field of networks and digital technologies is undeniably vigorous and swiftly mounting. In turn this has led to the endlessly cumulative dimensions of information (Garoufallou and Gaitanou, 2021). Figure 2 below depicts the conceptual model proposed for this paper. The conceptual model integrates the concepts of Big Data capabilities and Agile libraries in order to leverage the potential of Big Data applications in libraries. They additionally explain the mechanism in which Big Data capability could foster library agility. Against this background, this study contends that efficient Big Data capabilities could predict library agility through high-level sensing and response of a library's operational services and customers' needs. In this case, Big Data creates great opportunity for libraries to anticipate the changing business conditions and customers' preferences, thus providing services relevant to users.

This study developed a theoretical framework based on and resource-based view (RBV) (Penrose, 1959; Wernerfelt, 1984; Rumelt, 1984). This study adapted Dynamic Capabilities (DCs) as a theoretical foundation as an extension to RBV as suggested by Teece et al. (1997). RBV emphasises more on sustainable competitive advantage, while DCs are more focused on the issue of competitive survival in response to rapidly changing contemporary business conditions. The rationale for leveraging DC is based on the potential to provide the ability to use sufficient data and information to help organisations integrate, build, and reconfigure internal and external competencies. This serves to address the rapidly changing environment, thus allowing organisations to become nimble and more flexible. Teece et al. (2016) described DC as organisational and managerial competences for understanding the environment and developing business models that address new threats and opportunities based on the knowledge to innovate, adapt to changes and create changes that are favourable to customers and unfavourable to competitors. This study uses the DCs view to argue that big data capabilities (BDC) are crucial for today library organizations in order to in developing and deploying new services that really meet the needs of the users and justify their important roles.

This study suggests that BDC improves sensing and responding capabilities by enabling libraries to create rich information and knowledge about their users and services. These abilities will allow libraries to remain flexible and responsive in the course of business. This means that libraries will stay agile and perform well in today's unpredictable environment, keeping up with increasing demands from users concerning library services and use. Specifically, the ability to deliver business insights through data management, infrastructure (technology) and talent (staff) ability to convert company into a competitive body is very critical in current situation, including library organizations. The next section elaborates the concepts of BDC and Agile library.

3.1 Big Data Infrastructure capabilities

Big data is among the most popular main factors that contribute to changes in the way decisions and business transactions are made. The use of big data and technological availability, according to the document, has led to innovation growth, a boost in the quality of delivery, and added value to industries. In today digital environment any digital services will require an effective BDIC. According to Wamba et al. (2017), BDIC include the connectivity, compatibility, and modularity of the infrastructure. Within this context, Seddon et al. (2017) insists that the technological resources are most important to enable big data in any organization. In addition, having integrated business intelligent platforms for example, has the potential to supply organization with high quality data for informed decision making. In the same fashion, Hassna & Lowry (2016) indicates that BDIC is "a sub-capability that reflects the organisational technical architecture that supports Big Data initiatives and includes required hardware, software and related technologies required for collecting, storing, integrating, processing and retrieving huge amounts of structured and unstructured data from different sources at rest and in motion".

3.2 Big Data Management capabilities

Big Data management capabilities (BDMC) refer to "*the principles and skills to collect, integrate, model and process huge structured and unstructured data sets from different sources and provide these data to the relevant users in secure, certain and timeless manner*" (Hassna & Lowry, 2016). In similar views, BDMC involves capabilities such as planning, investment, coordination, and control that contributes to value creation and

employee ambidexterity (Wamba et al., 2017; Shamim et al., 2019). The ability to experiment with data, can fosters trials and errors and also encourages an intrusive approach towards big data. According to Shamim et al. (2019), such capabilities could encourage staff to experiment with big data frequently and to assess their transformations and building values for better services and efficient planning that allows an exploration of new possibilities. This is also in line with findings by Zeng & Glaister, 2018, indicating that data management capability is the ability to translate data-generated insights in an agile and responsively into actions that can lead to the identification of opportunities and the creation of value.

3.3 Big Data Analytics capabilities

Big Data analytics capability (BDAC) often referred as the application of advanced analytic techniques including data mining, statistical analysis, predictive analytics, etc. on Big Datasets as new business intelligence practice (Russom, 2011). According to Hassna & Lowry (2016), this capability refers to an organisation's ability to analyse and mine huge amounts of structured and unstructured data. In the technical context, data science capabilities concern the utilization of advance data analysis, data mining and machine learning algorithms for analytics, predictive analysis, pattern discoveries and so forth. In specific, this capability involves data personal expertise within the organization to have technical knowledge, and technology management ability, which in this context is the big data technology (Wamba et al., 2017).

3.4 Operational agility

Within the context of Agile library, Operational agility (OA) may refer to the ability to efficiently and effectively process information that contributes significantly towards sensing and responding ability by collecting operational related data to identify opportunities and uses of business processes to turn priorities into action. A previous study has shown that, the ability of an organisation to process information contributes efficiently and effectively significantly towards achieving operational agility, especially in terms of sensing and responding to market changes (Teece, 2007). Another study found that leveraging knowledge that derived from an analysis of internal data and information could help organisations realise changes to improve internal operations and processes (Roberts & Grover, 2012). Collections of data is important to identify opportunities and uses of business processes to turn priorities into action. Krotov et al. (2015) denotes that an organisation that displays the highest level of OA is one that is *"highly modular on the inside and thus flexible enough to arrange itself in a way that facilitates the rapid design (and re-design) of processes to produce a new good or service"*. This idea is aligned with Sambamurthy et al. (2003) that described an operational agile organisation as those that have ability to accomplished speed, accuracy, and cost economy in the exploitation of opportunities that could come from the modular technologies and integration of business processes that allows collection of data in producing accurate information for decision making.

3.5 Customer agility

In same light, Customer agility (CA) refer to as an organisation's ability to manage changes of customer preferences and needs. The concept of CA has been associated with the ability of the organisation to capture market intelligence related to customers and react upon it. In current settings, sensing and responding quickly to customer-based

opportunities for innovation and competition is crucial for an organisation like libraries to thrive. For that to happen, it requires organisation's ability to manage changes of customer preferences and needs accordingly.CA has also been defined as co-opting of customers in the exploration and exploitation of opportunities for innovation and competitiveness (Sambamurthy et al., 2003). The concept of customer agility has also been associated with the ability of the organisation on capturing market intelligence related to the customers and reacting upon it (Lu & Ramamurthy, 2011). Often, CA is assessed in terms of organisation's responsiveness to changes in demand, innovation, and pricing (Tallon & Pinsonnault, 2011). IT infrastructure such as BD technology can enhance customer agility primarily on providing an electronic channel to gather customers' feedback in which a firm can leverage and initiate new processes from it.

Based on the underpinning theories and previous studies, the framework was then developed accordingly to serve the objective of this paper. The conceptual model, as illustrated in Figure 2, outlines the relationships between BDC and Library Agility and will set up the direction for further exploration in the future research.

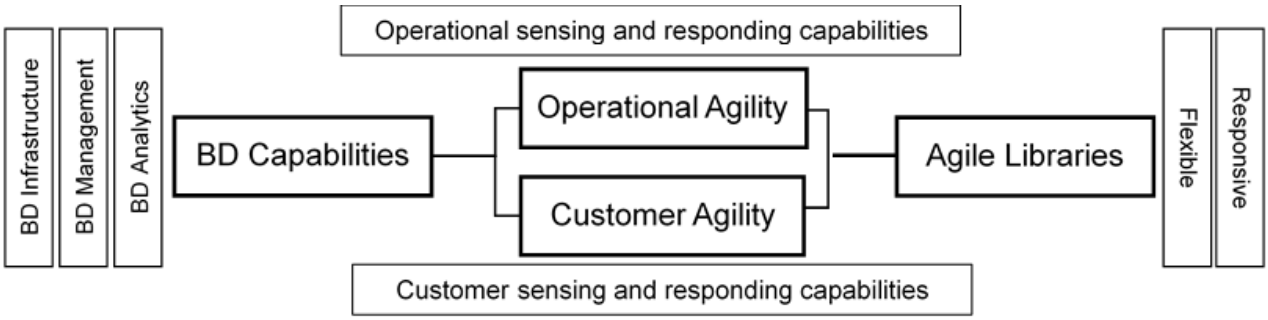

Figure 2: Depiction of the proposed conceptual model integrating Big Data capabilities and Agile libraries

4. Conclusion and future works

To address the compelling demand for theorizing on the impact of Big Data on library agility, this paper has proposed a conceptual model explaining the mechanism in which Big Data capability could become the antecedents of agile libraries. This conceptual model integrates the concepts of Big Data capabilities and Agile libraries in order to leverage the potential of Big Data applications in libraries while explaining the mechanisms through which Big Data capability may foster library agility. The biggest limitation of this work is that it remains at the conceptual level and requires empirical research and testing to validate the model. At the same time, Virkus and Garoufallou (2020) inform that libraries must target to simplify knowledge creation in their communities. This is important to ensure that libraries can systematically deliver information to the users in the simplest way immediately every time they need any related information or services from the libraries. So that, more related research need to be conducted to see the impact of library agility by coordinating Big Data technologies can be proven.

Conflict of interest

The authors declare no potential conflict of interest regarding the publication of this work. In addition, the ethical issues including plagiarism, informed consent, misconduct, data fabrication and, or falsification, double publication and, or submission, and redundancy have been completely witnessed by the authors.

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