

# Integrating Kibana Dashboards into ContentWorX

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**Abstract**—TEAM IM is a New Zealand based company with multiple clients who possess large number of documents, each of which has rich metadata that is important to those clients. Currently TEAM IM clients use ContentWorX to store and Kibana to visualize dashboards of the metadata. The core problem is that Kibana’s current dashboards and its UI are not particularly useful and are not integrated into ContentWorX. Specifically, for TEAM IM clients, Kibana dashboards are not useful because of complexity. Kibana has a steep learning curve, its UI is feature rich but can appear complex and overwhelming. The solution proposed is to fully integrate Kibana dashboards into ContentWorX and redesign the dashboards. The consequence of this solution would be that TEAM IM client will be better able to understand and analyze the documents metadata.

## I. INTRODUCTION

THE engineering challenge at hand involves TEAM IM clients who use ContentWorX for document storage and Kibana for visualizing metadata dashboards. The primary issue is that Kibana’s existing dashboards lack usability and are not seamlessly integrated into ContentWorX. This challenge results in clients having to switch between two different platforms to access the same information, which can disrupt their workflow, reduce efficiency, and introduce the risk of errors and inconsistencies.

By integrating Kibana dashboards into ContentWorX, users can uncover hidden patterns, spot trends, and make better decisions. The focus is on metadata from client-uploaded documents, such as document names, titles, categories, editing permissions, and timestamps. Data visualization enhances communication and expedites problem-solving.

The motivation behind this project stems from my passion for data visualization and design. Kibana, as a versatile tool, enables dynamic data visualization, and my background in SQL, Angular, and Java makes me well-suited for this project. The aim is to integrate interactive Kibana dashboards into ContentWorX to provide users with timely insights and analytical tools.

It’s essential to emphasize that this project is closely tied to the industry, and I’m a key member of the organization, TEAM IM, driving it. The project’s main goal, initiated by TEAM IM, is to enhance the user experience for their clients. This involves creating a user-friendly interface that seamlessly integrates with ContentWorX. My extensive experience with Kibana and ContentWorX allows me to address client-specific

requests and understand the intricacies of the interface. The integration of Kibana dashboards into ContentWorX is driven by the need to make data more accessible and understandable in today’s data-driven business environment. Data visualization plays a vital role in simplifying complex data for various audiences, which is especially valuable in industries reliant on data-driven decision-making.

In an era where data is central to decision-making, integrating Kibana dashboards into ContentWorX empowers users with real-time data access, aiding well-informed choices. This integration aligns with the evolving data analytics and visualization landscape.

This product has been developed to cater to TEAM IM’s clientele, who rely on Kibana and ContentWorX as integral tools in their daily operations. Clients use ContentWorX to upload documents, and relevant metadata is sent to Kibana to populate dashboards. However, Kibana’s limited user control and organizational capabilities hinder efficient data analysis. The lack of user control affects clients’ workflow and limits their ability to gain insights from data. The proposed solution involves integrating dashboards into ContentWorX. This integration streamlines access to information on a unified platform, increasing user interactivity and simplifying information retrieval.

In summary, this project addresses the need for data visualization in a dynamic business environment. Integrating Kibana dashboards into a web framework enhances clarity, supports decision-making, fosters innovation, and serves as a communication and engagement tool, aligning with the organization’s broader strategic goals.

### A. Sustainability

There are several sustainability goals that could potentially overlap with the project.

- 1) The integration of Kibana dashboards into ContentworX, particularly in the context of improving decision-making, enhancing customer experience, and supporting data-driven social initiatives, aligns with several United Nations Sustainable Development Goals (SDGs) related to “people” or Social Sustainability. These goals primarily fall under the broader SDG 3, which focuses on ‘Good Health and Well-being’, but also have

implications for other SDGs such as:

- SDG 8: Decent work and Economic Growth: Kibana visualizations can also lead to a better customer experience on the company's website, which is particularly relevant in e-commerce and online services. A user-friendly interface with real-time data can improve customer satisfaction and engagement [1].
- 2) The integration of Kibana dashboards into ContentWorX, with a focus on improving business efficiency, making data-driven decisions, and gaining a competitive advantage, aligns primarily with United Nations Sustainable Development Goal (SDG) 8, which is "Decent Work and Economic growth". Here's how this project related SDG 8 and other relevant related to Prosperity and Economic Sustainability:
- SDG 8: Decent Word and Economic growth: real-time data analytics provided by Kibana dashboards can improve operational efficiency, reduce costs, and optimize resource allocation, contributing to economic sustainability [1].
  - SDG 9: Industry, Innovation, and Infrastructure - In finance and investment sectors, Kibana dashboards can provide real-time financial and market data that is essential for informed investment decisions and economic growth. The integration of innovative technologies like Kibana dashboards aligns with the goal of promoting industry, innovative and infrastructure development, which in turn can stimulate economic growth [2].
- 3) The integration of Kibana dashboards into ContentWorX, particularly with a focus on resource optimization, supply chain efficiency, and environmental data reporting, align with several United Nations Sustainable Development Goals (SDGs) related to "Responsible Consumption". Here are the key SDG that this project may relate to:
- SDG 12: responsible Consumption and Production: by reducing waste, improving production process, and optimizing resource use, organizations can contribute to responsible consumption and production practices [3].
  - The system's design and functionality promote efficient resource allocation and do not negatively impact sustainability. It provides data-driven insights that empower users to make informed decisions, preventing resource waste and aligning with sustainability goals. The user-friendly interface fosters transparency and accountability in allocation practices, contributing to economic sustainability.

### B. Final Product and Key Finds

Clients primarily utilize ContentWorX as their central platform for document management. The data visualization

tool employed in this project is Kibana, an open-source solution for data exploration and visualization developed by Elastic. Kibana offers a web-based interface that empowers users to interact with and visualize data stored within Elasticsearch [4].

The project adds a new screen to ContentWorX, dedicated to displaying dashboards and visualizations. The main goal of this feature is to enhance user control and provide a more user-friendly experience. These dashboards and visualizations comprise client-specific metadata pertaining to the documents they upload onto ContentWorX. They facilitate the tracking of document types, with automatic segregation into corresponding dashboards or visualizations upon document upload.

For instance, let's consider a fictional client, 'XYZ Corporation', which uses ContentWorX for managing their documents. XYZ Corporation deals with various types of legal documents, including contracts, agreements, and compliance reports. When they upload these documents to ContentWorX, the system automatically captures essential metadata, such as document types, creation date, author and subject matter. It is important to see metadata across documents because it is a fundamental component of effective document management. It not only simplifies document retrieval but also enhances data accuracy, enables advanced search capabilities, supports analysis, ensures compliance, streamlines collaboration, and facilitates automation and data governance. It plays a pivotal role in making large document repositories more manageable and valuable to an organization.

The dashboards and visualization created for XYZ Corporation are tailored to their specific needs. These dashboards allow XYZ Corporation's team to effortlessly track the types of documents they upload. For instance, they can have a dashboard that focuses on 'Contracts', another for 'Agreements,' and then another one for 'Compliance Reports'. Each dashboard is automatically populated with the respective documents upon upload, categorizing them for easy access.

This example illustrates how the system utilizes metadata to create customized dashboards for clients, streamlining their document management process and providing a clear, user-friendly interface. It ensures that XYZ Corporation can easily access and manage their legal documents, making informed decisions and efficiently navigating their document repository.

Key components of the ultimate solution include a fully operational dashboard screen that permits user interaction, accurate display of information, and a simplistic design for user comprehension. The primary functional requirement centered on making dashboards accessible to users, enabling them to view relevant information derived from metadata of documents uploaded to ContentWorX. The interface specifications are detailed as follows:

- 1) R1: Data Visualization: The dashboards should be meticulously designed to present data in an engaging and informative manner, employing visual aids like charts, graphs, tables, or maps.
- 2) Data Filtering and Selection: Users should possess the capability to filter and select specific subsets of data based on criteria such as time ranges or other dimensions.
- 3) R2: Collaboration and User Management: The dashboards should support user roles and permissions, granting control over access and delineating different levels of functionality.
- 4) Drop-down List of Dashboards: The interface should feature a drop-down list of dashboards accompanied by check-boxes, facilitating the display of selected dashboards when checked.
- 5) R3: individual Dashboard Panels: Each dashboard should be presented within its dedicated panel. When a dashboard name is checked, the respective dashboard appears within its panel, complete with a collapsible icon. Users can freely rearrange these panels, customizing the dashboard layout as per their preference.
- 6) R4: Two Viewing Modes: Users should have the flexibility to choose between two viewing options: a list view or a two-column display.
- 7) R5: Interface State Preservation: The state of the interface, including user preferences and configurations, should persist across login and logout sessions, ensuring a consistent user experience.

The non-functional requirements, also known as system qualities or quality attributes, specify the expected performance and behavior of the dashboards. These encompass:

- 1) R6: Performance: The dashboards must respond promptly and offer real-time updates. They should be designed in a manner that enhances user comprehension and ease of use. There are 2 concurrent organizations that will be using this dashboards screen, therefore it is important that it is computationally optimal.
- 2) R7: Reliability and Availability: Dashboards should swiftly convey information, presenting it clearly and efficiently. They need to be accessible through a web browser.
- 3) R8: Usability and User Experience: The dashboards should be user-friendly, intuitive, and easy to navigate. Users should gain a quick understanding of the data and interact seamlessly with the interface.
- 4) R8: Performance Efficiency: The dashboards should be optimized for efficient utilization of system resources, including CPU, memory, and network bandwidth.
- 5) R9: Security: Security requirements mandate that users access only the dashboards they are authorized to view.

In the preliminary stages, it was outlined that a single sign-on functionality would be incorporated; however, this was ultimately deferred as it had already been implemented by a colleague.

### C. Evaluation

The objective of our evaluation process was to assess the prototype's alignment with client expectations and to identify areas requiring improvement. Feedback collected from team members and clients played a pivotal role in pinpointing which features met expectations and which needed further enhancement. This iterative process not only refined the prototype but also ensured that it closely adhered to initial requirements and goals. Team IM assessed the system with two client organisations, and this forms part of the basis of the evaluation acceptance testing that I did for the system with TeamIM, in their role as the project sponsor. In the user evaluations, two project sponsors, one a business analyst and the other a support analyst, explored the prototype. Their familiarity with Kibana and ContentWorX made their insights particularly valuable. The feedback received was a mix of positive findings, areas for improvement, and the emergence of new requirements, shedding light on how to refine the prototype for a more user-centric and effective final product.

### D. Related Work

**CASE STUDY: 1 - Insight: A Kibana Visualization Tool for Multidimensional Data Exploration:** Kibana [4] offers several built-in visualizations and a few plug-ins from third parties, however it is missing a tool for multi-dimensional data exploration. A data set containing numerous different columns is referred to as a multidimensional data set or features of attributes. Currently, one needs to create a different visualization for each characteristic and display them all on the Dashboard page to investigate the correlations between multiple attributes. The current issues that are occurring are, lack of usability, lack of integration, inefficiency, and data analysis challenges.

The following requirements, R1, R2, R3, R4, these issues or challenges are the problems that the project intends to solve or improve upon by integrating Kibana dashboards into ContentWorX. It aims to create a more user-friendly, integrated, and efficient system for clients to access, organize, and analyze their data, thus addressing the existing challenges in the current setup. A simple and user-friendly solution is required to effectively utilize Kibana's platform capabilities and allow data analysts to visualize dependencies between different terms and attributes to thoroughly explore the data relationships [5].

A plug-in for developing, preserving, and sharing interactive visualization designs is called Vega Visualization [5]. Vega generates a web-based canvas or SVG Version 5.25.0 and can assist with describing the visual appearance and interactive behavior of a visualization in a JSON format. Vega visualization makes it more difficult for users who are not familiar with Elasticsearch query syntax because it still only allows interaction with a single word or property [6].

Elasticsearch query syntax is used to search, filter, and retrieve data from Elasticsearch, a distributed, real-time

search and analytics engine. Elasticsearch uses a query DSL (Domain-Specific Language) that allows you to express your queries and filters in a structured and flexible manner.

Kibana also supports the security, automation, and response platform Swimlane as a plugin. Swimlane displays a term's behavior in a scale-like figure using Kibana's visualization engine. A visualization in Swimlane is tailored to a particular objective of comparing historical numerical data of one attribute's value to numerical data of other values in that attribute [7]. When the implementation has little to no customization, the issue still exists.

Within the realm of data exploration, Kibana is a widely recognized analytics platform known for its robust capabilities. A notable addition to this ecosystem is the "Insight" Kibana plugin, created by Talal Shoeb. This plugin is specifically designed to facilitate multi-dimensional data analysis, enabling users to visualize numerous data attributes simultaneously and discover intricate relationships within their data-sets. Insight leverages the power of Elasticsearch to swiftly search through vast data-sets, providing an essential tool for data exploration. It's worth noting that Insight seamlessly integrates with Kibana, capitalizing on its design language. The visualization engine behind Insight employs D3, a JavaScript library, to render SVG figures presented on the HTML front end. For enhanced integration and flexibility, Vega-visualization is introduced as a solution.

It's important to mention that our users are well-versed in Elasticsearch and its query syntax, making this integration a viable option. Vega-visualization offers extensive customization capabilities, allowing users to fine-tune their visualizations with precision, including data transformations and interactive elements. This integration with Kibana enables users to embed their visualizations into the Kibana environment and combine them with other Kibana components like filters and controls. This broadens the range of data exploration options, providing users with powerful tools to interact with their data effectively.

#### **CASE STUDY: 2 - A Review of Dashboards for Data Analytics in Nursing:**

To inform clinical practice and research, this review of clinical data for the literature examines the value and effectiveness of dashboards that query electronic health records. The type of database integration, visual characteristics, purpose, and time focus (such as retrospective, real-time, or predictive) were examined to discover emergent trends about fundamental dashboard aspects. The amount of readily available digital data for use in clinical and business decision-making has significantly increased in recent years due to the increased adoption of electronic health records, but the current methodologies for database analysis in healthcare have been ineffective for directing evidence-based decision-making. The article discusses the drawbacks and difficulties of using data dashboards in healthcare settings, including the need for an organizational culture that values

data-driven decision-making and technical issues with database management and data properties [8].

The authors William et al identified the main themes and dashboard descriptions in the literature by conducting an inductive content analysis using a constant comparative technique. Additionally, they used NVivo qualitative data analysis software, version 10, to conduct a literature study. The single keyword dashboard was used to search the electronic databases PubMed and CINAHL for peer-reviewed papers, yielding a total of 398 results. A total of 81 publications were found to meet the requirements after a preliminary evaluation based on article titles and abstracts.

For the literature study, they also used NVivo qualitative data analysis software, version 10, from QSR International Pty Ltd, Doncaster, Victoria, Australia [9]. NVivo is a user-friendly computer software program designed for researchers to systematically and individually manage, analyze, and visualize qualitative data and documents. It caters to the needs of researchers who possess expertise in coding and qualitative data analysis methods [10]. The most important features dashboards should have:

- 1) 1. A database should be able to combine data from many databases that employ various data formatting methods. The level of data analysis automation will depend on how well the databases are integrated.
- 2) 2. The visual characteristics of the dashboards should be straightforward graphical presentation, intuitive brief assessment of important performance indicators, and promotion of evidence-based decision-making. Column graphs, scatter plots, pie graphs, and other visuals can be used in dashboard layouts.
- 3) 3. Dashboards are designed to benchmark performance as well as summarize and analyze data to give performance comments. Programs for quality assurance and quality improvement can benefit from bench-marking dashboards. When dashboards are configured correctly, they can alert users when a particular statistic deviates from permissible ranges, allowing them to take swift remedial action to reduce or stop undesirable events.
- 4) 4. The dashboards' time focus. Dashboards can be used to collect retrospective data from medical records, provide real-time monitoring of patient treatment, or apply database analysis to forecast future outcomes [11].

The advantages highlighted in this literature study include dashboards' capacity to analyze massive volumes of data and provide the findings in a clear, visual style. Additionally, decisions should be provided that encourage data-driven decision-making for executive-level management and assist improvements in efficiency and quality. A great degree of customization to certain objectives and workflows is another benefit. Utilizing well specified key performance indicators to give accurate and valid measurements used to assess performance over time, as well as the capability of dashboards to coordinate patient care across various providers

[12].

Both technological and societal considerations might be used to identify dashboard usage restrictions or drawbacks.

- 1) 1. Clinicians' concern over electronic performance monitoring.
- 2) 2. Information overload is brought on by a propensity for over-watching KPIs.
- 3) 3. Using KPIs that, in the opinion of physicians, cannot be modified directly.

The functionality of dashboards that deal with database administration concerns and data attributes may be hampered by these technical constraints [13]. Most of these features that are identified in paragraph 3 are specific requirements for this project from the client side.

Further testing and implementation will be done on the remaining features such as developing the dashboards to be time focused. This would be a good implementation in terms of security, if a user leaves their screen on, then the dashboards will time out themselves which would help prevent unauthorized people from looking at the dashboard and its relevant information. A similarity that is encountered in this review and this project is that both have large amounts of data. An advantage highlighted in this study is the ability for dashboards to have the capacity to analyze massive volumes of data and display the findings in a clear, visual style.

### CASE STUDY: 3 - A Review of dashboards in performance management: Implications for design and research:

The effectiveness of dashboards in performance management is discussed in this review [14]. The importance of dashboards being adaptable and offering theory-based assistance to assist users in choosing the best presentation options is stressed. The essay also offers a research agenda to direct ongoing investigations in this field. This study provides a thorough examination of the interdisciplinary literature with the goal of identifying important concerns that organizations might need to consider while putting dashboards into place. The evaluation concentrates on the function of dashboards as decision-support tools in performance management and outlines potential design problems that need to be resolved when putting them into practice.

Dashboards are used in accounting information systems as decision-support tools [14]. The first study question is: What are the design characteristics of a successful dashboard? The second is: Is there a general dashboard design approach that might work for all different sorts of users inside an organization? How much should users' tasks and knowledge—for instance, their education, experience, and skills—be considered when developing a dashboard? Do dashboard designers need to provide unique solutions based on the cognitive and personality types of end users? The writers searched through articles using keywords in research databases such ProQuest, Business Source, EBSCO, Emerald, JSTOR, SpringerLink, and Wiley to conduct a review of the literature. Their key phrases were "dashboards,"

TABLE I  
COMPARISON BETWEEN CASE STUDY 2 AND PROJECT REQUIREMENTS

Project Requirements	Case Study Features
Data Visualization (R1)	Data visualization is discussed as a valuable feature, aligning with the requirement for engaging data presentation.
Data Filtering and Selection (R2)	The case study mentions the capability for users to filter and select specific subsets of data, which is in line with this requirement.
Collaboration and User Management (R3)	The case study doesn't explicitly address user management but highlights the importance of data-driven decision-making for executive-level management, which relates to the collaboration aspect.
Drop-down List of Dashboards (R4)	The case study emphasizes the use of dashboards within dedicated panels, which aligns with the requirement for a drop-down list of dashboards and panel display.
Individual Dashboard Panels (R5)	The case study mentions the presentation of dashboards within dedicated panels, corresponding to this requirement.
Two Viewing Modes (R6)	The case study discusses different time focuses for dashboards, not directly related to two viewing modes but may have some relevance.
Interface State Preservation (R7)	The case study does not directly address interface state preservation but discusses the customization of dashboards, which relates to user preferences.

"visualization," and "performance management." Additionally, they complied with Webster and Watson's (2002) advice [15].

Visual and practical design features are being separated into two categories. The qualities that explain what the dashboard can do but only indirectly relate to visualization are known as functional features. The principles of visualizing data, or how effectively and efficiently information is presented to the viewer, are referred to as the visual features. The dashboard's functional characteristics must match its purpose(s) for it to be effective: A poor fit could lead to sub-optimal conclusions by giving the decision maker insufficient decision cues and symbols. Encoding and decoding are two independent stages in the visualization process. They are made easier by using textual qualities like text and symbols, which are themselves represented by straightforward visual elements, as well as visual attributes like shape, position, and color. When decoding is done "correctly," where perceived data amounts and connections represent the real data, visualization can be helpful. When the most information can be viewed in the shortest period, visualization is effective [16].

Colors are used in dashboards to distinguish between

objects or to recognize and identify them, which may enhance the visualization process. The user can become distracted using color excessively, which may have a negative impact on decision-making. Maximizing the data-ink ratio, which gauges the amount of ink used to depict data relative to the overall amount of ink needed to print the graph, has been recommended as a solution to this issue. To provide business intelligence at all levels of the organization, new generation dashboards are required to: (1) align business processes with the most recent information; (2) use intuitive and simple visuals to deliver information to busy executives; and (3) provide reliable navigation.

If targets are exceeded, dashboards and workflow management systems may be coupled to provide users with recommendations for possible courses of action based on decision tree rules. The existing dashboard solution should be improved by knowing the features that make it successful before new features are added, it is suggested. To achieve functional fit, dashboard features must correspond to their purposes. While the functional capabilities of drill down and presentation flexibility might fulfil all the dashboard's objectives (consistency, monitoring, etc.). Users may prefer raw data aggregated data; therefore, dashboard design must take this into account when determining how well functional design aspects meet user characteristics.

This evaluation acceptance emphasizes the need for dashboards to be completely connected with an organization's data warehousing or online analytical processing system to give users access to precise data for dimensional analysis. Task comparison is necessary for the cognitive fit theory, and graphs provide a better tool for doing this. Users should have the choice to convert to a different display format, such as a tabular format, if they prefer it. A comparable approach as described above might be used for users with diverse user backgrounds and personality types (for example, an accountant with strong analytical skills) [17]. In terms of the visual characteristics, another component is suggested. According to the principles of visualizations, where the objective should be to enhance and complicate, hinder, or bias perception, colors should be used, and graphs should be designed accordingly. Dashboards should continue to be brief, easy to use, and consistent with the original concept. This will enable decision-makers to concentrate on the information that is most important and urgent [18].

1) *Kibana*: Kibana is an open-source data visualization and exploration platform, developed by Elastic. This platform is used for interacting with and visualizing data stored in Elasticsearch [19]. Elasticsearch is a distributed, open-source search and analytics engine designed for storing, searching, and analyzing large volumes of data quickly and in near real-time. It serves as a valuable tool for individuals and organizations looking to analyze their data [20]. Kibana allows users to create various types of visualizations, such as charts, graphs, tables, and maps, making it easier to comprehend complex data-sets. This functionality is particularly important

for industries where data-driven decisions are essential.

One of Kibana's key features is its ability to provide real-time data visualization, enabling the creation of interactive dashboards and visualizations. This is particularly useful when timely data insights are required. In addition to its visualization capabilities, Kibana also supports data filtering and selection, helping users focus on specific data subsets based on their criteria. It offers user management and collaboration features, allowing for role-based access control [21].

Overall, Kibana is a versatile tool for data analysis, well-suited for various use cases. It simplifies the process of working with data and is a valuable component in the realm of data analytics.

2) *TEAM IM and ContentWorX*: TEAM IM is an established enterprise specializing in information management. With over 20 years of experience, they have been successfully delivering content management and unstructured data solutions to their customers. TEAM IM's expertise spans various industries and technologies, enabling them to offer valuable insights and practical solutions for solving real business challenge [22]. They have built strong partnership with industry leaders such as M-Files, Microsoft, Oracle, Elastic among others. TEAM IM primary serves clients in the public sector, leveraging their local and international knowledge to address their specific needs and requirements [23].

Clients utilize ContentWorX to gain information such as:

- Central repository of documents with search metadata.
- Empower collaboration within the workforce for incremental document updates, security, and traceability.
- Automatic data classification.
- Rules for retention and disposition of documents managed in accordance with national archive rules. Kibana allows users to interact and analyze data through customizable dashboards, charts, graphs. Kibana enables users to gain valuable insight and make data driven decisions.

#### E. Key Findings

The problem at hand centers around the user-unfriendly nature of Kibana in terms of dashboard visualization and interaction. Users grapple with the challenge of navigating and comprehending identical information presented differently on two distinct platforms. To address this predicament, the solution involves the integration of Kibana dashboards into ContentWorX. This is facilitated by the automatic transfer of document metadata, uploaded by users onto ContentWorX, into Kibana. Ensuring a smooth transition from one platform to the other is crucial. Seamless integration between Kibana and ContentWorX eliminates disruptions, reduces confusion, and enhances the efficiency of data analysis and decision-making.

The decision to integrate Kibana dashboards into ContentWorX carries significant importance because, despite both platforms presenting the same information, they do so in distinct ways. This integration serves as a pivotal step for the company as it promises to enhance the usability of the ContentWorX interface.

The crucial responsibility of evaluating and scrutinizing the integration of these dashboards will rest with TEAM IM's clients, who not only represent the primary users of this interface but also play a central role in this assessment process.

- The efficacy of these dashboards' functionality will be gauged based on their performance metrics.
- This evaluation acceptance encompasses parameters such as the loading speed of the dashboards, the responsiveness of filters when users adjust.
- and the overall speed of the dashboards while running within the interface.

As part of our evaluation acceptance testing, we will assess our solution based on several key requirements. One crucial requirement is that the dashboards present accurate and relevant information. It's essential that the integrated dashboards align with the specific informational needs articulated by the client. These dashboards come preconfigured, and any necessary modifications must be made outside of ContentWorX.

#### F. Tools and Methodology:

A pre-existing website known as ContentWorX serves as the foundation for dashboard integration. ContentWorX is already in active use by several clients and has been constructed using Angular on the front-end. Angular's advantages lie in its structured and modular approach, fostering a systematic method for developing web applications. Angular adheres to the Model-View-Controller (MVC) design pattern, facilitating the separation of responsibilities, software organization, scalability, and maintainability. It also boasts a feature called "Two-way data binding," which automatically synchronizes data between the model and the view. Any alterations made to the model are instantly reflected in the view and vice versa. This simplifies the development process and reduces the need for redundant code [24].

The integration process involves both front-end and back-end technologies, along with an Oracle database. The front-end, responsible for creating the dashboard screen, was built using Angular Typescript, with Visual Studio Code as the framework. For processing information, the back end was developed using Java, along with additional APIs. Angular's support for the "iframe" element was particularly beneficial during the integration. The Oracle database was chosen because it aligns with the company's existing data storage practices. It was used to store dashboard information, including name, URL, type, position, index, category, and description.

On the back end, Java was employed, and the Spring Boot framework [25] was leveraged, featuring the CRUD

Repository library. The CRUD library offers built-in functions for data retrieval, manipulation, and management within the database. Spring Boot's CRUD Repository simplifies database-related tasks by abstracting many complexities, promoting best practices, and reducing boilerplate code. This allows developers to focus on their application's core logic rather than database intricacies. The compatibility of CRUD functionalities with the Oracle database made it an ideal choice for this project, and various back-end classes adopted the CRUD Repository due to its ease of use [25].

## II. DESIGN AND IMPLEMENTATION

### A. Conceptual Design

The architecture of the system comprises three fundamental components, the front-end, the back-end and the database. The front-end is responsible for overseeing the web interface/UI, granting users the capability to visualize and interact with various elements on the screen, such as buttons, links, and search bars. In this context, the front-end empowers users to view dashboards within panels and engage with these panels. Users can collapse and expand panels as needed, as well as relocate them. Moreover, this component enables users to manage dashboard/visualization names through check-boxes. These names are presented in a drop-down list, each accompanied by an associated checkbox. By clicking these check-boxes, users can display specific dashboards within their individual panels. All these functionalities reside in the front-end domain, as it exclusively governs what users see on the screen and their interactions with it.

Within the domain of the front-end, users are empowered with a range of essential capabilities:

**Visualizing Dashboards:** The front-end provides users with the capability to visualize dashboards within distinct panels. These panels serve as dedicated spaces where users can view and work with specific dashboards, offering a clear and organized presentation of information. As shown in fig 5 and fig 6(at the bottom of the page), the panels are displayed in a list and 2 columns.

**Interacting with Panels:** Users can engage with these panels in various ways. They have the flexibility to collapse or expand panels as needed, allowing for a customized and adaptable workspace. This feature enables users to focus on the information that matters most at any given moment. The figure, "fig.7" shows the two columns being expanded to show the two dashboards, as does fig.5 and fig.6

**Panel Management:** The front-end component also facilitates panel management. Users can easily relocate panels, creating a layout that suits their workflow and preferences. This intuitive functionality enhances the user's control over their workspace, contributing to a more efficient and tailored experience.

**Dashboard and Visualization Selection:** In the front-end, users have the power to manage their dashboard and

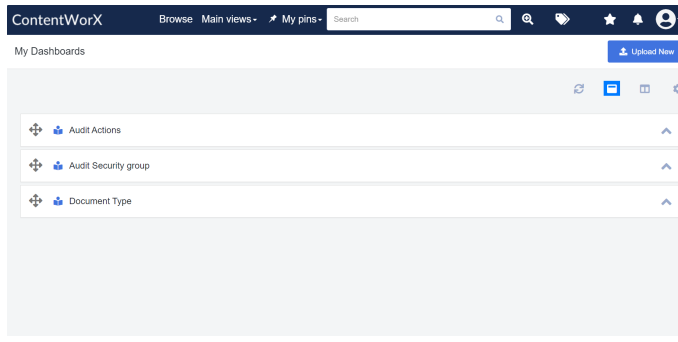


Fig. 1.

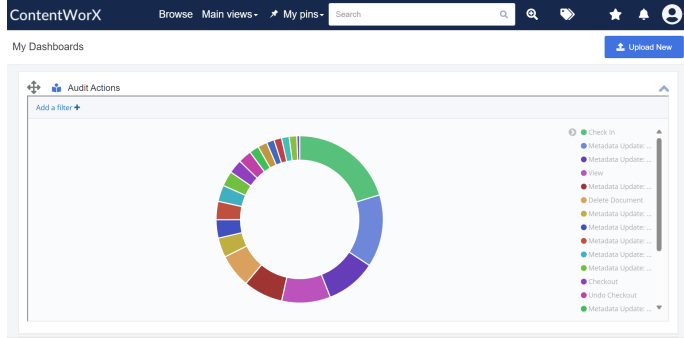


Fig. 2.

visualization selections. The system presents users with a drop-down list of available dashboards, each accompanied by an associated checkbox. By simply clicking these checkboxes, users can handpick specific dashboards for display within their individual panels. This feature not only simplifies dashboard selection but also enables users to have a clear overview of the available options. This drop-down list and check-box selection is shown in fig.3 and fig.4. The drop-down list shows the names of the dashboards.

In summary, the front-end component is the user's window to the system, exclusively governing what is displayed on the screen and dictating their interactions with the integrated dashboards. It ensures that users have a highly interactive, customizable, and efficient experience, granting them the tools needed to tailor their workspace to their preferences and work effectively with the available dashboards. This front-end design is rooted in user-centric principles, prioritizing usability and flexibility.

## B. Implementation

1) *Front-end:* At a high-level, the chosen approach for integration revolves around the utilization of the HTML iframe component. The selection of the iframe component is rooted in its inherent isolation capabilities, which mitigate conflicts between embedded content and the broader web page. This feature proves particularly advantageous when integrating third-party widgets, such as Kibana dashboards (Kibana even provides an iframe code for users to embed these dashboards/visualizations into their systems). Importantly, these widgets operate independently from the website's CSS,

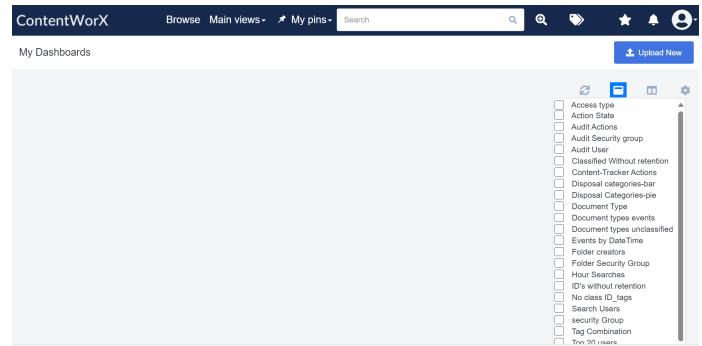


Fig. 3.

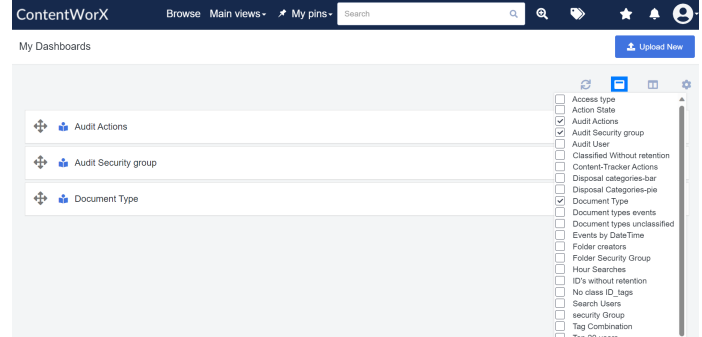


Fig. 4.

JavaScript, or other components.

**Iframe:** Various solutions suggest using iframe and X-Pack reporting to help with the integration of the dashboards. The first time Kibana runs, it extracts a custom build for the Chromium web browser, which runs on the server in headless mode to load Kibana and capture the rendered Kibana charts as images. Existing solutions suggest using iframe HTML element which represents a nested browsing context, embedding another HTML page into the current one [20]. iframe has attributes which can be altered depending on the dashboards themselves and exterior settings such as the UI itself. As the development will be carried out in Angular, it will be possible to use the iframe HTML element as angular supports HTML.

2) *Back-end:* The back-end, a vital component of an application, assumes the responsibility of managing and processing data, as well as executing the logic and functionalities necessary for the application's operation. It operates discreetly behind the scenes, typically concealed from the end user's view, yet remains indispensable for the application's seamless functioning. In the context of integrating Kibana into ContentWorX, the back-end played key roles in the following areas:

- **Data Storage and Management:** The back-end was tasked with the management of data, involving interactions with the Oracle database I employed. This encompassed data storage, retrieval, updating, and deletion.
- **APIs (Application Programming Interfaces):** The back-end often exposes APIs that enable the front-end (user interface) and other external systems to engage with the application. I utilized GET, PUT, POST, and UP-



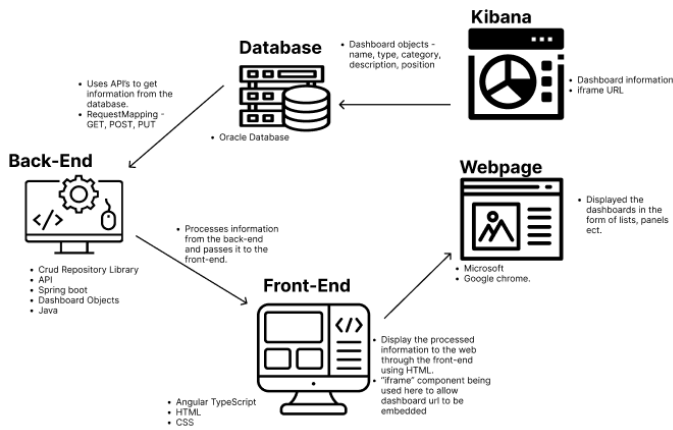


Fig. 5. Architectural diagram

DATE APIs to retrieve data from the database. These APIs define endpoints and methods for manipulating and retrieving data. In the back-end, I established a class named "DashboardObjectsController" with RequestController and Request-Mapping. The RequestMapping, set as ("/api/1.0/dashboardobjects"), serves as an interface to handle various HTTP methods, including POST, PUT, GET, and DELETE. The "DashboardObjects" class, which I defined, encapsulates essential get and set methods for dashboard properties and specifies their data types. Request-Mapping plays a crucial role in facilitating data transfer from the back end to the front end and offers testing capabilities.

- **Server-Side Rendering:** In the realm of web applications, the back end can undertake server-side rendering, generating HTML and other content to be presented in the user's browser. This is particularly significant for Search Engine Optimization (SEO), a process aimed at optimizing a website's technical configuration, content relevance, and link popularity [26]. Its objective is to enhance the discover-ability, relevance, and popularity of website pages in response to user search queries.

In terms of this system's architecture, the dashboard data finds its repository within the Oracle database. This data set comprises essential dashboard attributes, including name, index, type, visualization, position, and description. To ensure proper recognition and processing by the back end, these attributes are defined as either bytes or var-chars.

On the back end, I have established a "DashboardObject-sRepository.java" class that encompasses various methods. These methods encompass saving the entity, retrieving the entity by its assigned ID, returning an array of all entities, retrieving the entity by its designated name, and verifying the existence of an entity based on a given ID. I have implemented CRUD (Create, Read, Update, Delete) functionalities on the back end using Spring Boot APIs, which encompass PUT, POST, GET, and DELETE operations. These CRUD functionalities are invoked from the front end,

enabling me to fetch data from the database and present it on the user interface in a customized manner. For instance, by utilizing the GET method from the back end to the front end, I receive an array of dashboard properties stored in the database. Subsequently, I can manipulate this data as needed and choose to display, for example, only the dashboard names in a user-friendly list format for user selection.

Furthermore, the decision to employ the "iframe" component was informed by its exceptional compatibility. Iframes enjoy widespread support across virtually all modern web browsers, ensuring dependable cross-browser compatibility. This, in turn, simplifies the development process by reducing the complexity of engineering solutions for various browser environments.

The iframe approach seamlessly aligns with the envisioned features, including the individual display of each dashboard within its panel and the implementation of the ability to move and drag them. It also harmonizes with the display options of both list and column views, ultimately enhancing user control within the interface. After thorough consideration and factoring in constraints such as time and technical limitations, this approach was endorsed by the company as the optimal solution.

### C. Challenges

Throughout the project, I encountered various technical challenges and engaged in crucial discussions. One significant technical challenge revolved around establishing the connection between the back end and the front end. This required working with APIs that were unfamiliar to me, leading to difficulties when implementing methods. Additionally, determining which classes to create and where to incorporate them posed a challenge. TEAM IM maintains a substantial repository on both the front end and back end, and comprehending the code structure was a time-consuming task.

To tackle this challenge, I opted to replicate the UI's home screen design for consistency. The code for the home screen already existed in the company's repository, providing a useful design reference. However, I still faced technical hurdles because the information displayed on the home screen derived from a more complex structure with multiple components and modules. Understanding this intricate setup proved challenging, as it involved various methods and APIs.

Furthermore, using the Oracle database was a new experience for me. During the project's development phase, my initial task was to insert data into the database, ensuring that the data types selected were appropriate for seamless communication with the back end.

1) *Displaying Dashboard Panels:* While developing, I encountered an obstacle related to displaying dashboard panels in both two columns and a list format when users

clicked the respective icon. This task involved organizing dashboards into different arrays for the right and left columns, as well as ensuring each dashboard was assigned to its own panel with functional move capabilities. The issue I faced was that the dashboards didn't separate into their designated arrays (left and right), but rather remained in a single container. Consequently, when attempting to move a panel, all the dashboards on the screen moved simultaneously. This task was time-intensive, preventing me from implementing the state-saving functionality.

To address this technical challenge, my external supervisor, who also served as my colleague, provided some guidance, although due to high-priority tasks, we couldn't engage in a detailed walk through. Additionally, I explored potential solutions on platforms like Stack Overflow, seeking insights from individuals who had encountered similar issues in the past.

In essence, the back-end functions as the core of the software application, managing critical operations that ensure the application's effective and secure operation. It collaborates with the front end, forming an integral part of a full-stack application, with each component having distinct roles and responsibilities to contribute to the overall functionality and user experience.

#### *D. Requirements and Constraints*

This project encompassed a range of requirements, encompassing both functional and non-functional aspects. The primary functional requirement centered on making dashboards accessible to users, enabling them to view relevant information derived from metadata of documents uploaded to ContentWorX.

The product aims to provide users with an interface where they can select their preferred dashboards from a list. Once chosen, these dashboards should each be displayed within their individual panels, offering the flexibility to be moved, collapsed using a toggle icon, or presented in a list format. Furthermore, the chosen screen layout should be saved, allowing users to retain their customized view upon subsequent logins. The design of this project was influenced by its specific requirements and limitations.

In the process of planning and designing this project's requirements, several constraints were taken into consideration. These constraints included time limitations and technical restrictions, given that this project is part of a company's product portfolio. As an employee of the company, I allocated one workday, equivalent to 8 hours, to this project. This time-frame encompassed planning, design, and initial development efforts. Additionally, I recognized the potential need to prioritize other projects within the company, which would necessitate working on this project at different times.

Technical limitations were also a factor. Within TEAM IM, there are regular updates and patches applied to keep

the software aligned with the latest technology. Occasionally, these updates might take longer than anticipated or encounter back-end issues, leading to extended periods of inaccessibility for ContentWorX. Given these constraints, we meticulously crafted the interface design and requirements, ensuring they were tailored to address these limitations. These constraints and restrictions significantly influenced my decision-making process during the design phase.

Despite thorough consideration of constraints by the stakeholders, the company, and myself, there were occasional instances where some constraints were not fully accounted for. Throughout the development process, various limitations and restrictions significantly influenced the design and development phases. Specifically, I encountered challenges in implementing requirements 5 and 6. While I managed to partially implement requirement 5, it was marred by errors and bugs that cropped up during development.

Several issues emerged, such as protracted app and OS patching processes that consumed substantial time. Initially hosted on AWS, the website was later migrated to OCI (Oracle Cloud Infrastructure), resulting in a temporary disruption of the interface, rendering it inaccessible for my work. Additionally, I was assigned another high-priority project crucial to our clients, which diverted my attention and caused a delay in my development efforts.

Another recurring technical hurdle involved setting up the environment, where the back-end experienced failures attributed to Spring Boot and LDAP errors on multiple occasions. Addressing these errors proved time-consuming, with the initial instance taking several days to resolve. This impediment halted progress as I couldn't run the back-end. The solution involved configuring the build each time such errors surfaced.

Furthermore, time constraints arose due to concurrent university courses that required my attention, compelling me to prioritize these academic commitments at certain junctures.

#### *E. Sustainability Considerations*

While sustainability considerations hold increasing importance across various domains, including software development, there are instances where they may not have a direct relevance to software projects or application development. In the context of this specific project, sustainability considerations are not applicable, and here are several reasons why they do not pertain to its development:

- **Virtual Nature of Software:** The interface I've designed is a virtual product that operates on hardware infrastructure. It does not consume significant tangible resources such as energy, raw materials, or water during its use. This is because there is small amount of data and the clients aren't in their millions. Consequently, environmental sustainability concerns related to resource consumption do not apply to this project.

- **Energy Efficiency:** This project, being a software endeavor, does consume some energy when running on devices. However, it proves to be more energy-efficient when compared to many other technologies. Energy consumption by software is often considered negligible in contrast to resource-intensive processes like manufacturing.
- **Limited Material Resources:** The project does not necessitate the extraction or utilization of finite material resources. As a result, concerns regarding material scarcity or depletion are less relevant.

The primary scope and focus of this project revolve around the integration of Kibana dashboards into ContentWorX, with a heavy emphasis on development. This project is software-centric, involving the creation and deployment of digital solutions that are intangible and do not directly deplete physical resources or emit pollutants. Furthermore, the project's target clients prioritize the preservation and enhancement of ecosystems and species in Aotearoa New Zealand, with a focus on safeguarding land, water, and sea, as well as promoting resilient landscapes, ecosystems, and species to mitigate client risks.

### III. EVALUATION

#### A. Objective

Our aim is to understand which features and functionalities of the prototype meet the client's expectations and which aspects require further improvement. By collecting feedback, we can pinpoint areas that need more work, adjustments, or enhancements. This information is invaluable for the development of a second version of the project, ensuring that it aligns more closely with the client's evolving needs and objectives.

The evaluation acceptance also serves as a critical checkpoint to ascertain the client's acceptance of how well key project requirements have been fulfilled. We assess the degree to which the prototype aligns with the initial requirements and the significance of any gaps or deviations in terms of design, functionality, or implementation. By identifying these gaps, we can take corrective actions to ensure that the final project aligns closely with the client's vision and objectives.

In summary, our evaluation acceptance process is a dynamic and iterative feedback loop that helps us fine-tune our prototype to better meet the project sponsors expectations and ensure that the project aligns with the identified requirements and goals. It serves as a vital step in delivering a solution that not only meets but surpasses the client's expectations.

#### B. Process

The way I ran this evaluation acceptance process was with two colleagues. On their company laptops, I pointed out the dashboard screen and all they had to do was utilize what that screen was providing them. When thinking about who to

conduct this testing process with, I had to make sure my team members knew how to work with Kibana and its dashboards, as the people who will be utilizing this screen will be familiar with Kibana and its features. When I found the two team members who were well-versed with Kibana, I gave them a brief explanation of my motive and the product. I conducted this evaluation acceptance with both the team members. I handed them my laptop with the dashboard screen, and I asked them to display the dashboard and personalize them however they want. I also asked them for feedback, features they want to add or take out. Each user test took about 20-30 minutes.

I am running this evaluation acceptance testing on colleagues as they are project sponsors of this project, and I am also an employee of this company, getting their opinion of this product would be useful in terms of what features they expect, what they did not like, what could have been better. TEAM IM also ran user studies using two clients to gather feedback to inform their responses.

#### C. Participants

I ran the evaluation acceptance testing on two Project Sponsor. One of the customer's roles in the company is a business analyst. They do application testing for the company, whenever a code change is made or a new release has happened, they are responsible for testing the functionality of the interface. Making sure that the information is correct, and everything works as expected.

The second project sponsor's role in the company, is a support analyst. They are responsible for patching and updating the systems such as windows, Linux, they are also responsible for app and demo patching which means making sure that ContentWorX is up to date.

Both project sponsor are familiar with Kibana and ContentWorX.

#### D. Results

The feedback I got from both the team members was both positive and critical. They outline the features that really helped them with understanding the dashboards and navigating their way around the screen. They also do, however, state some of the features that they had trouble with, and that were not very useful. Some questions that team members had asked me were:

- "Is there a way to save the dashboard information, like in a CSV or download it?"
- "Can I customize the dashboard within ContentWorX?"
- "How do I know what time frame this information is coming from/can I change the time frame?"
- "How can I share this dashboard with people in my organization/does it have the ability to be shared with

people?”

I personally did not think about implementing these features, as it just did not cross my mind which was a short coming from my side. Although I do consider these features as future work, something that could be done in future to improve the functionality and design for this interface, this would also make the screen more user controlled. This would result in users fully making this interface personalized.

**Project Sponsor 1:**  
Positive Findings:

- The layout is easy to understand and navigate.
- Dashboards can be customized with ease.
- Display options (list or two columns) provide a sense of user control.
- Alphabetical ordering of dashboard names aids user understanding.

**Areas of Improvement:**

- Dashboards cannot move between columns in two-column view.
- Issues with removing dashboards in the two-column layout.
- Small lines appear on the top of the page in two-column mode.
- The left dashboard cannot move to the right column.

**Project Sponsor 2:**  
Positive Findings:

- Consistency in design with the home screen layout is appreciated.
- Users can easily customize panels.
- Dashboards load quickly when panels are uncollapsed.

**Areas of Improvement:**

- Lack of clarity in locating the drop-down for dashboards (As shown in fig 6, that is the screen that users will see once the "My Dashboards" options has been clicked as seen in fig5 5).
- Suggested changing dashboard icons to represent their type.
- Requested a feature to collapse/uncollapse all dashboards at once.
- Limited user control in the two-column view, including moving dashboards and removing them.
- Limited user control in the two-column view.

**E. Analysis**

Based on the feedback and discoveries, we can summarize the following:

**Meeting Requirements:** The prototype has successfully met some of the initial requirements, such as ease of navigation, fast loading times, and user customization.

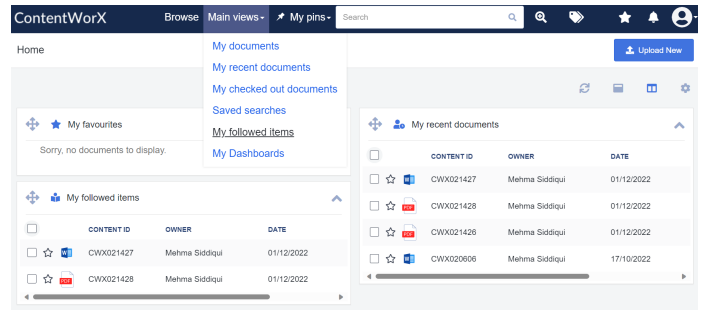


Fig. 6.

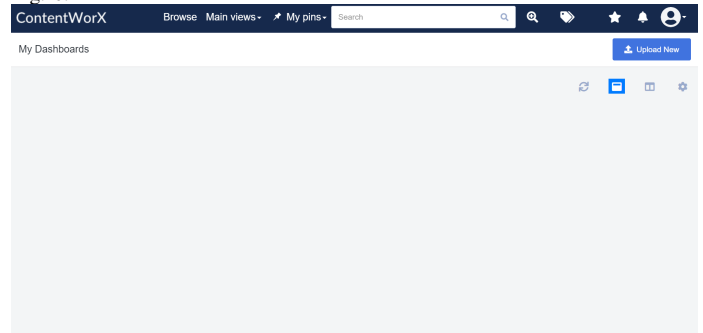


Fig. 7.

**Areas for Improvement:** There are several areas where the prototype can be improved to enhance the user experience. This includes addressing issues related to the two-column view, improving the clarity of dashboard icons and drop-down location, and providing features for batch collapsing and uncollapsing of dashboards.

**New Requirements:** The feedback has highlighted new requirements that were not initially known, such as the need for a clear indicator of dashboard drop-down and improved dashboard icons.

**Key Takeaways:** The feedback from both Project Sponsors has been invaluable in identifying improvements that can be made to enhance the prototype’s functionality and design. By addressing these suggestions, the product can become more user-controlled and personalized. The key discoveries include both positive aspects and areas for refinement, and they will guide the development of the project in future iterations.

Here is a table displaying the requirements that were met:

Original Requirements	Status
Ease of navigation	Met
Fast loading times	Met
User Customization	Met
A clear indication of drop-down menu	Not met

**IV. CONCLUSION**

Integrating Kibana dashboards into ContentWorX represents a significant step towards improving user experience and aligning with sustainability objectives. The project aims to enhance data visualization capabilities while contributing to

sustainability efforts. The focus is on user empowerment and document management, emphasizing accessibility, organization, and compliance. The user interface is designed for ease of use and customization, offering an enhanced user experience. The harmonious combination of data and document management drives overall improvements, with ongoing refinement based on team and user input.

## V. FUTURE WORK

In the quest for continuous improvement, several avenues can be explored to enhance the integrated Kibana dashboards within ContentWorX. First, offering users an array of enhanced customization options will allow them to tailor their dashboards and workspace to their precise requirements. The addition of advanced analytics, including predictive capabilities and machine learning algorithms, will provide deeper insights and support more data-driven decision-making. Enabling real-time collaboration features for multiple users, along with ensuring mobile responsiveness, will ensure accessibility and teamwork across devices. Furthermore, a robust focus on data security measures and integration with a broader range of data sources will be pivotal. Artificial intelligence-powered insights can elevate data analysis, and comprehensive user training and support resources will empower users to maximize the system's potential. Scalability and a feedback loop with users will be crucial for adapting to the organization's evolving needs. Additionally, continuous performance optimization, accessibility considerations, and strict adherence to data governance and compliance standards will be paramount in shaping a successful future for the project.

Taking into considerations the evaluation acceptance testing that was carried out on the project sponsor, there were suggestion from the project sponsor when they were doing the evaluation such as :

New Requirements	Status
Clear indicator for dashboard drop-down	Met
Improved dashboard icons	Met
Batch collapsing/uncollapsing	Met
Two-column view improvements	Not met
Enhanced user control	Not Met

## VI. ACKNOWLEDGEMENT

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With heartfelt appreciation, Mehma Adnan Siddiqui

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