TECHNICAL PAPER

The Pillars of Documented and Digital Data Management

Standardization, Education, and Resources

The answers that were never before available

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1   Introduction

Documentation and digital data management is one of the most archaic and outdated elements of business today. To date, the only component that has excelled is technology, and it has advanced without proper guidance. If documentation and digital data is to move into the 21st century and progress after that, the fundamental thinking behind the concept must change on a global scale.

A quick internet search on Document Control, Document Management, or Data Management results in few, and often misleading, answers.

The two top returns are software platforms and either ISO 9000 or ISO 9001 (two common publications released by the International Organization for Standards Setting).

Various instructional videos made by organizations or individuals are scattered in amongst those results, however none of them offer a full and universal answer to what industries, organizations, or individuals need to know.

The answers that are needed are not *just* what components of a document control procedure need to be considered, but how to create the components of a sound, *all-encompassing documentation and data* control system; the details that go in to each small element, how to categorize and classify information, what different requirements the various divisions of an organization may have for the same piece of information, how to capture and integrate digital data (both from a documented and a purely digital source), and what the various regulatory requirements are (specific to each industry) as it relates to information.

As a result of vague or misleading advice and rules, elements of managing documentation and digital data are unresolved, and have devastating impacts on all involved in any given industry.

These impacts (symptoms) are widely known, however till recently, there has not been a tangible link of the symptoms to the root cause, and there have not been many options for organizations and individuals alike to turn to for help. It is becoming a widely discussed and recognized component of business planning, to the extent that an organization's data and information is becoming accepted as an asset with value.

This broad reaching issue has been micro-analyzed, and this paper will not only identify the details of the impacts, but will identify the three pillars of sound documentation and data management, and provide insight into how this global epidemic is being resolved through standardization, education, and improved resources.

2   Definitions used in this paper

Documentation: refers to both documents and drawings, either controlled or uncontrolled. Documentation includes files used as corporate governance instruction, guidance, or reporting and evidence. It also includes project guidance and reporting, that which provides decisions or the ability to make decisions, general information, concepts, and design, including any financial, resource, or confidential information pertinent to the execution of a project, retail order, or facility. Documentation can be created internal to, or external from, the organization who requires it, and includes current working files.

Data: refers to information that can be extracted from, or is input into, documentation. It also refers to information that does not, nor will ever reside in documentation. Data also refers to purely digital information that is used to integrate software applications, and afterwards, is used in federated searching and reporting (as a result of integration).

Facility: refers to any residential, commercial, or industrial structure or group of physical components (such as equipment and piping) that requires planning, design, construction, operation, and maintenance. Examples include buildings for occupancy, airports and malls, mines, nuclear plants, electrical substations, and oil and gas facilities.

Data Management System: refers to the overall system which includes processes, procedures, software, infrastructure, personnel, and support to manage paper documentation, electronic documentation, and digital information.

While the case studies and tabulated results reference mostly energy, industrial construction, and engineering facility related impacts, the impacts can be correlated to retail and import/export order management, medical device engineering and fabrication, research and development, and residential or commercial build and property management.

These findings relate to both private and public sector environments.

3   Methods of research and evaluation

The methods used to compile this paper include:

- Research on previously published articles, papers, and videos
- Cross-industry evaluations on current documentation and data control strategies, including cost, safety, and performance of organizations
- Implementation of processes, procedures, and education programs, and the changes in functionality of the documentation and data management strategies[1]
- In depth discussions with industry experts in quality, engineering, project management, procurement, cost control, safety, and software

The research into previously published articles includes online research via search engines, online research via associations specific to various industries and fields of study, review of multiple energy industry technical magazines, and papers written by peer network via professional platforms.

The cross-industry evaluations conducted include organizations in the oil and gas, utility, pulp and paper, construction (residential, commercial, and industrial), property management, survey and land management, and retail industries. Evaluations include review of existing procedures and processes, review of resources available such as network and software applications, review of personnel education and understanding, and in depth interviews with a horizontal and vertical cross-section of each organization.

The areas of review covered the following main topics:

- Functionality (creation and use of information)
- Loss of efficiency and information
- Litigation and legal impacts
- Frustration levels of information consumers (internal and cross-organization)
- Regulatory compliance
- Facility and facility crew safety
- Security of information

Reviews of functionality were evaluated post implementation of processes, procedures, and systems, and after education and training, in order to identify improvements to documentation and data management and use.

Discussions with industry experts included topics and case studies relating to access to information, schedule delays, cost implications, operating performance of organizations and facilities, liability, safety and environmental impacts, and current wide spread outcomes of poor documentation and data management.

4   Acknowledgements

The following individuals are to be recognized either for their major contribution to the discussions and evaluations, or for their validation of the findings.

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[1] Evaluations and implementation performed by dms360 Ltd.

5   Findings

Research shows that the momentum to an improved perspective on documentation and data management is increasing. Predominantly this is due to a higher demand from regulatory bodies and activists, and is coupled with the advancements in technology and software applications and increased pressure to improve the bottom line.

One publication notes that data from petrophysics affects the outcome of reservoir decisions that determine an oil company's profitability. The Universal Petrophysics Integrated Control (UPIC) system monitors and controls well log data flow through documentation, addressing operation programming, data acquisition, job follow-up, quality, safety, interpretation, data archiving, training, cost control, petrophysics studies, developments, and points out where improvement (to reservoir decisions) can be made. "The data must be easily accessible and trustworthy."[2]

Also worth noting is that in 2000, there was an initiative for updating the drilling data standards for contractor to operator rig-site data flows to speed up and enhance decision making. This resulted in a further initiative to update the existing methods for data exchange for the internet age.[3]

A review of ISO 9000 reveals the elements requested as a part of that standard, which include the following:

- The methods for performing various activities relating to documentation should be defined and documented
- Documents (that are necessary for the achievement of quality) are to be controlled
- No requirements for management of uncontrolled documentation
- Procedures should provision for:
  - Preparation of documents
  - Standards for content
  - Identification conventions
  - Issue notifications
  - Date conventions
  - Review and distribution
  - Use, copying, and marking
  - Revision control, request, and authorization
  - Identifying changes
  - Indexing and continual improvement
  - Accessibility and security
  - Viruses, fire, and theft
  - Storage and filing of documents
  - Retention

But how do these simple requirements mitigate issues, and how are they provisioned appropriately? The content that is currently missing from the general body of knowledge is; what is the best method for preparation of documentation, what should the issue notifications be, and how would one identify changes (referencing some examples of the above). In addition, it is not noted where and how digital data fits in to the system.

Listing elements of standards is important, but only the first step in their creation. What the best possible practices are on how each element is constructed is the standardization and understanding that is lacking, and that is what is addressed in this paper.

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[2] "Data Management and Quality Control in the Petrophysical Environment" by Omar Al-Farisi, Nassar Dajani, Douglas Boyd, and Ali Al-Felasi, presented at the Abu Dhabi International Petroleum Exhibition and Conference in 2002.

[3] "Efficient Data Management on the Rig of the Future" by Matthew A. Kirkman, Paul David Chapman, Chris Greaves, Harry Turnbull, and David Johnsen presented at the Amsterdam Intelligent Energy Conference and Exhibition, 2006.

There are many resources through ISO for the management of records[4], however they do not capture the specifics or details that are required for active documentation and digital data.
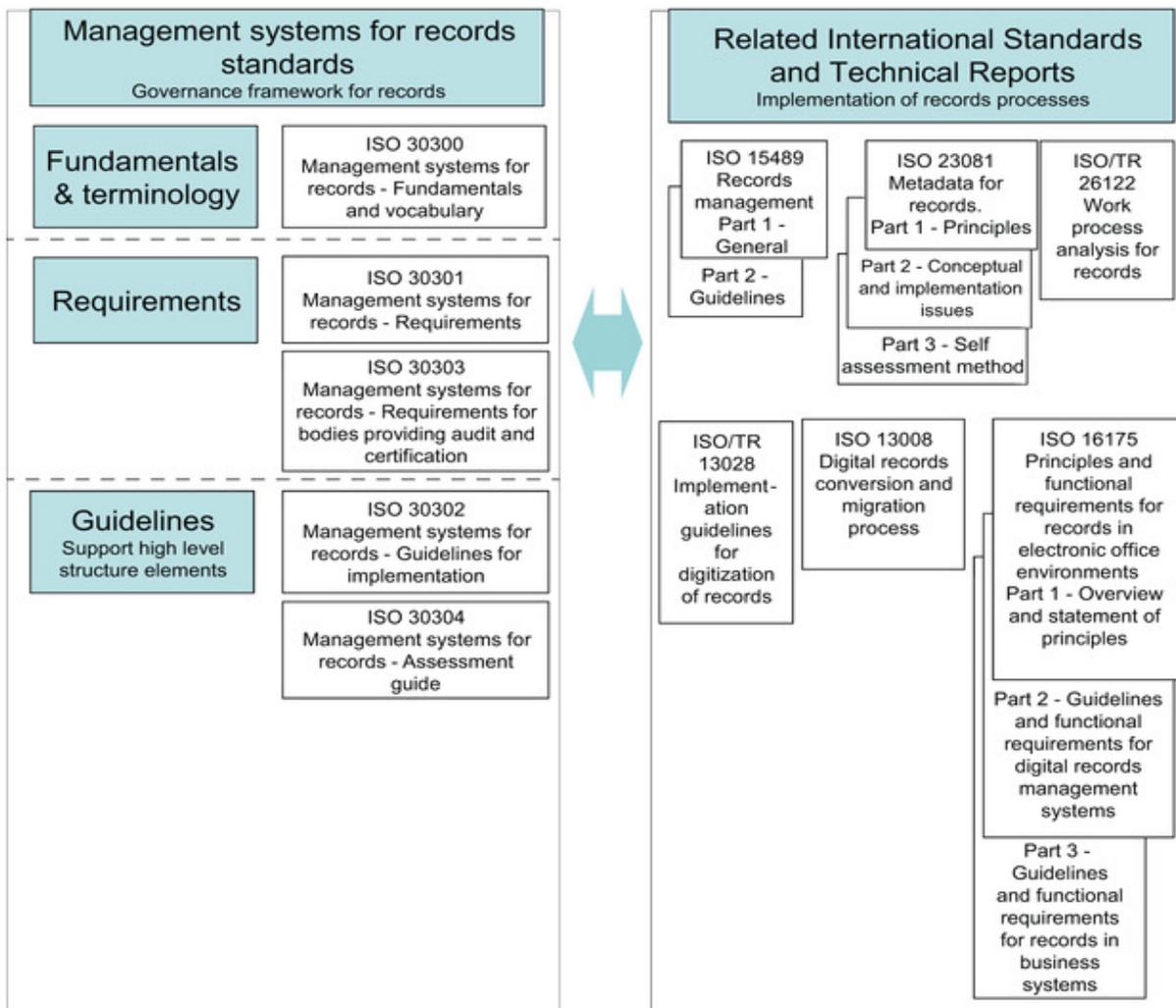
The ISO definitions and terms relating to documents.[5]

Term	ISO 9000:2005 Clause	Definition
Document	3.7.2	information and its supporting medium
Procedure	3.4.5	specified way to carry out an activity or a process (Note: Procedures can be documented or not)
Quality Manual	3.7.4	document specifying the quality management system of an organization
Quality Plan	3.7.5	document specifying which procedures and associated resources shall be applied by whom and when to a specific project, product, process or contract
Record	3.7.6	document stating results achieved or providing evidence of activities performed
Specification	3.7.3	document stating requirements

There is a fundamental difference in the concepts, functionality, and processes between Documentation and Data Management (DM), and Records and Information Management (RIM), and as a result, common definitions can sometimes be misinterpreted depending on where the information is in its lifecycle.
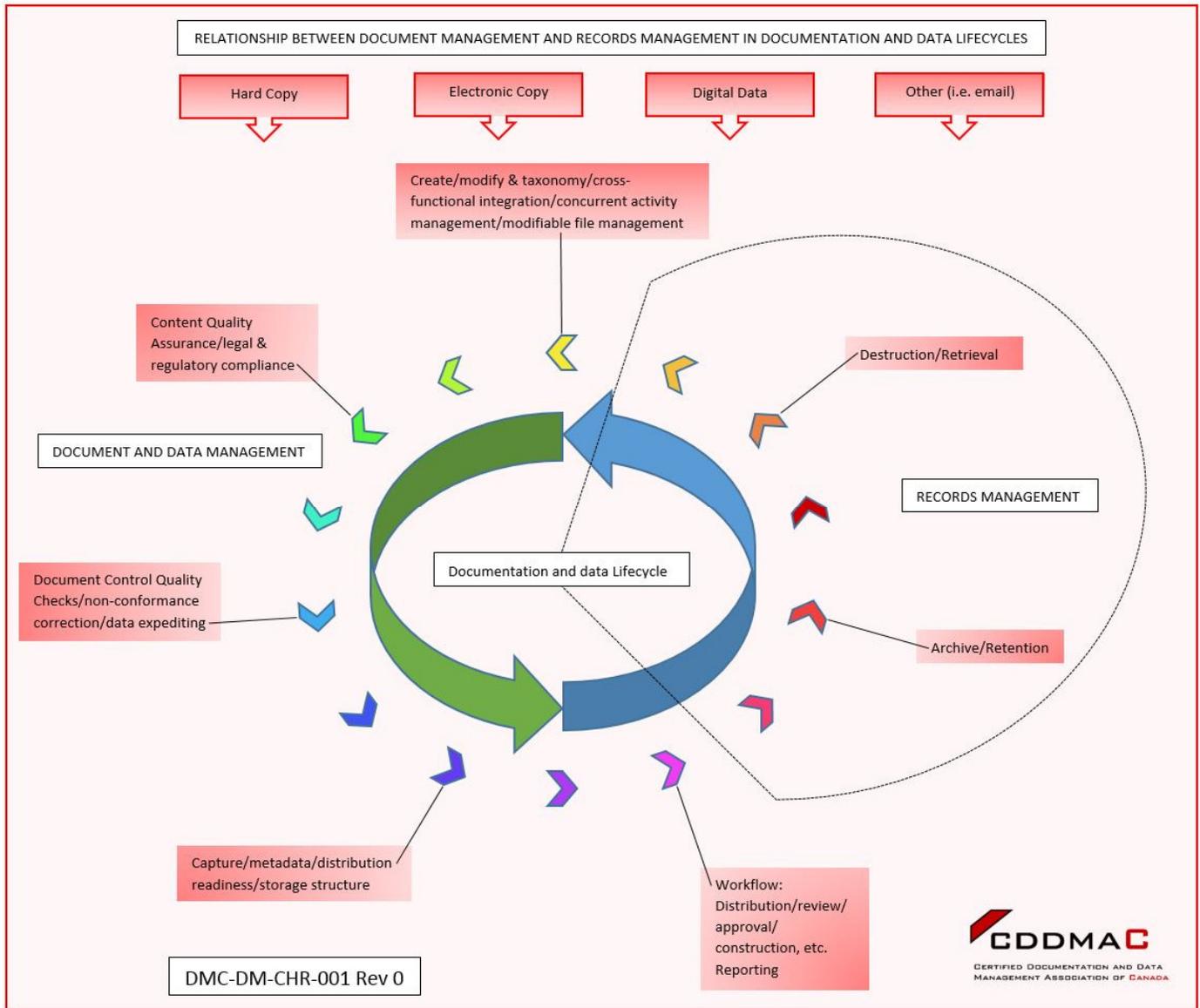
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[4] Table sourced from Introduction section of ISO 30300
[5] Source: ISO 9000 Introduction and Support Package: Guidance on the Documentation Requirements of ISO 9000:2008

The following figure represents the high level differences between DM and RIM during the cycle that documentation and data follows, as per CDDMAC. Note that documentation and data can fall back in to the create/modify portion of the cycle after it has previously been a stored record. Also note that there are different levels of control required at each point in the cycle for the various classifications and classes of information that are identified in an organization.

For example, a published drawing of an existing piece of equipment at a facility may be stored as a record, but when an addition or change to the equipment needs to take place, that published file is to be copied back into the modify cycle to be marked up by the designers of the equipment.

The four main sources of information noted in this figure will also require differing management and control protocols.

RELATIONSHIP BETWEEN DOCUMENT MANAGEMENT AND RECORDS MANAGEMENT IN DOCUMENTATION AND DATA LIFECYCLES

Hard Copy   Electronic Copy   Digital Data   Other (i.e. email)

Create/modify & taxonomy/cross-functional integration/concurrent activity management/modifiable file management

Content Quality Assurance/legal & regulatory compliance

Destruction/Retrieval

DOCUMENT AND DATA MANAGEMENT

RECORDS MANAGEMENT

Document Control Quality Checks/non-conformance correction/data expediting

Documentation and data Lifecycle

Archive/Retention

Capture/metadata/distribution readiness/storage structure

Workflow: Distribution/review/ approval/ construction, etc. Reporting

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6   Case Studies

There are a number of public record incidents surrounding the inefficient and improper management of documentation and data, such as serious injury or death construction incidents, inability to provide documented evidence of due diligence during litigation, as well as cyber security attacks on both office and facility data.

In the San Bruno natural gas pipeline explosion, 12 felony charges were laid including knowingly relying on erroneous and incomplete information when assessing the safety of the pipeline. In a related case against a different organization, a pipeline explosion in 1999 resulted in prison and probation for company officials, and a US$112M in settlement and fines.[6]

One of the contributing factors in the space shuttle Challenger O-ring failure was a known design flaw, where the documentation was not forwarded to the contractor, and warnings from engineers were disregarded. In addition, evidence of a previous failure had not been reported, and the Rogers Commission had concluded it was an accident rooted in history (culture).[7]

In 2014, a steel mill in Germany suffered a cyber-attack that infiltrated the industrial controls, causing massive damage by making it impossible to shut down a blast furnace.[8]

At a recent seminar presented by IBM Security specialists, it was noted that there is an immediate need for dual protection against cyber-attacks; technology based security and standards based security. With the advancement of various software platforms designed to process, store, and share data, there is an ever increasing need to integrate the systems. This leaves entire networks, from office to facility, at risk if just one piece of the network puzzle remains vulnerable to attack.

7   Evaluation Results

The results from the evaluations, interviews, and discussions were tabulated, indicating each typical error in information management, and the resulting initial, secondary, and tertiary impacts. This list may seem extensive, however, it is understood that there are additional impacts not listed here.

The fourteen (14) common errors tabulated are:

- Lost or out of date data
- Inaccurate data
- No quality control of documentation
- Fragmented data
- Duplicated data
- Lack of software application integration
- Slow or inaccurate processing of data
- Poor or lack of processes and procedures in data management
- No version or revision control
- Poor or lack of data expectations
- Poor or lack of search capability
- Poor or lack of communication tracking
- Poor or lack of modifiable file management
- Poor or lack of data expediting

Other than the impacts tabulated, additional research was done to establish how many hours individuals are requiring to perform activities directly as a result of poor documentation and data management.

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[6] Source: CBS News
[7] Source: Aerospace Guide, Space.com, Rogers Commission Report
[8] Source: tripwire.com

The following chart indicates the typical waste on a project or activity.[9]
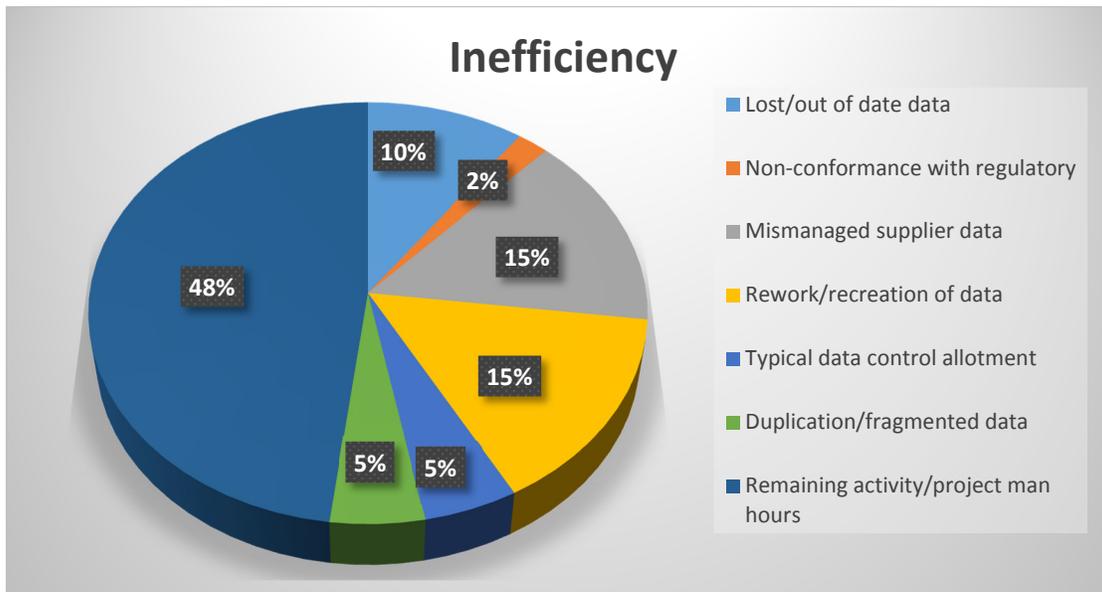
The chart indicates that projects or activities are currently being executed at an efficiency rate of 48%. That 48% includes hours for management, technical work (design, engineering, drafting), procurement (not including cost of purchases), and administration.

It can therefore be concluded that right from project or activity kickoff, the man-hour budget is pre-determined to be 48% inefficient (over budget).

Note that this does not include contingencies for schedule delay and client dissatisfaction, and the related expenditures.

8   Tabulated Impacts

The following tables show the three levels of impacts of poor or lack of documentation and data management, and the subsequent elements that need to be implemented to resolve the errors.

8.1   Lost or out of date data

This relates to data that has been lost through accidental or malicious data deletion, files that have become corrupt (through system error or cyber threats), paper files lost through fire, data that has been stolen, and of course data that is not the most current version.

Initial Impact	Secondary Impact	Tertiary Impact
Person did not know data was previously available	Time spent to recreate data	Schedule delays
		Client dissatisfaction
		Increased costs for additional man hours
	Incomplete data for decisions	Plan, design or construction errors
		Facility crews operating and maintaining facilities without data
		Expenditures approved / unapproved inappropriately
		Client dissatisfaction
		Employee frustration due to redundant replication of work

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[9] Data gathered from surveys during interviews. Surveys asked the number of average hours for each activity per person involved in a project or activity.

	Time taken away from actual job responsibilities	Schedule delays
Increased time spent searching for data		Client dissatisfaction
		Shortcuts taken to make up lost time
		Increased hours spent to complete activities
	Activities are delayed or incomplete	Schedule delays
		Client dissatisfaction
		Downstream data users have incomplete data
Person cannot produce data to regulatory body	Permits are declined / revoked	Loss of operating ability / production revenue
		Damaged reputation
		Delayed production to reinstate / redo permits
	Fines / levies due for non-compliance	Damaged reputation
		Financial stability impacts
		Stakeholder / investor concerns
Person cannot provide accurate business reporting	Incomplete data for decisions	Inaccurate project or business management actions
		Stakeholder / investor concerns
	Project or activity progress is not based off all facts	Inaccurate historical data for future estimates
		Inaccurate reporting to clients
		Premature mobilization of construction crews
		Loss of project / client

8.1.1 Concepts and procedural elements that require inclusion into Data Management System:

- Required metadata in either manual or automated system
- Appropriate storage structure
- Improved data backup protocols
- Taxonomy (of documentation and data and subsequent files)
- Management of change process for documentation and data
- Appropriate data auditing standards
- Improved data security protocols and requirements
- Deliverables expediting and tracking

8.2 Inaccurate data

Inaccurate data can be caused either from a lack of understanding what information is required, or how the information is to be completed. For example, either a pressure vessel registration form is submitted but it may not be completed correctly (making the submission redundant), or it was never requested and therefore pertinent information that should have been generated never was, making it impossible to recreate.

Initial Impact	Secondary Impact	Tertiary Impact
Incorrect financial decisions are made	Inaccurate stakeholder reporting	Stakeholder / investor concerns
		Investment dissatisfaction and retraction
	Inappropriate progress / cancellation of projects	Progressing projects could run organizations dry
		Cancellation of projects that could have provided revenue

Incorrect maintenance or operation of facility	Risk to human life	Death or serious injury
		Legal action and fines
		Loss of operating permits
		Financial ruin
		Damaged reputation
	Facility crews operating and maintaining facilities without data	Facility crews rely on experience not factual data
		Emergency shutdowns or repairs will be impeded
		HSE concerns
		Non-optimal operation and maintenance of equipment
	Risk to environment	Legal action and fines
		Loss of operating permits
		Financial ruin
		Damaged reputation
	Regulatory non-compliance	Legal action and fines
		Loss of operating permits

8.2.1 Concepts and procedural elements that require inclusion into Data Management System:

- Deliverables expectations (what, who, how, when)
- Deliverables tracking
- Quality check requirements on submissions (internally and externally sourced)
- Accurate data entry (training, procedures, etc.)
- Deliverables expediting and tracking
- Appropriate data auditing standards
- Management of change (overall process)
- Management of change process for documentation and data
- Approvals matrix and accountability

8.3 No quality control of documentation

Quality assurance and quality control of documentation and data files does not typically include the quality of the content, but rather the quality of representation of the content.

Initial Impact	Secondary Impact	Tertiary Impact
Data is misused for intended purpose	HSE concerns	Death or serious injury
		Prevention of project approval by regulatory agencies
		Legal action and fines
	Product, facility, or equipment diminished quality or damages	Loss of operating permits
		Financial ruin
File numbers are duplicated	Plan, design or construction errors	Loss of operating permits
		HSE concerns
	Confusion in communication	Poor / inaccurate decisions are made
		HSE concerns
	Lack of due diligence evidence	Increased risk during litigation

No revision control	Plan, design or construction errors	Loss of operating permits
		HSE concerns
		Increased cost for re-design
	Confusion in communication	Poor / inaccurate decisions are made
		HSE concerns
	Lack of due diligence evidence	Increased risk during litigation
	Product, facility, or equipment diminished quality or damages	Loss of operating permits
		Financial ruin
Authentication / Approval standards are not met	HSE concerns	Death or serious injury
		Prevention of project approval by regulatory agencies
	Legal action and fines	Damaged reputation
		Financial ruin
	Loss of operating permits	Damaged reputation
Consistency issues	Increased time spent interpreting information	Lower efficiency in activities or projects
		Shortcuts taken to make up lost time

8.3.1 Concepts and procedural elements that require inclusion into Data Management System:

- Personnel education and training
- Available and current processes
- Available and current procedures
- Available and current work instructions
- Quality check requirements on submissions (internally and externally sourced)
- Quality control requirements of data submitters
- Accountability and recourse
- Approvals matrix

8.4   Fragmented data

Fragmented data can relate to either multiple partially completed documents or data files, or it can relate to different files for the same or similar activity, department, or facility located in multiple different locations (network drive, local desktop, external drives, software platforms, or other locations).

Initial Impact	Secondary Impact	Tertiary Impact
Not all data taken into consideration	Poor / inaccurate decisions are made	HSE concerns
		Facility crews operating and maintaining facilities without data
		Increased risk during litigation
		Loss of operating permits
		Stakeholder / investor concerns
	Person cannot provide accurate business reporting	Incomplete data for decisions
		Project or activity progress is not based off all facts
		Stakeholder / investor concerns
Increased effort to consolidate data packages	Time taken away from actual job responsibilities	Lower efficiency in activities or projects
		Shortcuts taken to make up lost time
Data could be mistaken as lost	Duplication of data efforts are made	Lower efficiency in activities or projects
		Shortcuts taken to make up lost time

8.4.1   Concepts and procedural elements that require inclusion into Data Management System:

- Identifying a true system of record for all files
- Ensuring appropriate mapping of system integration
- Improved data security protocols and requirements
- Required metadata in either manual or automated system
- Appropriate storage structure
- Taxonomy (of documentation and data and subsequent files)
- Appropriate data auditing standards

8.5   Duplicated data

Duplicated data is one of the most common errors, and relates to the same files stored in multiple different locations, making it impossible to keep them all up to date and controlled.

Initial Impact	Secondary Impact	Tertiary Impact
Updates to files are not comprehensive	Errors or omissions of vital data is missing	Poor / inaccurate decisions are made
		HSE concerns
		Product, facility, or equipment diminished quality or damages
		Facility crews operating and maintaining facilities without data
	Multiple various files containing various levels of completeness	Poor / inaccurate decisions are made
		HSE concerns
		Lower efficiency in activities or projects
		Increased time spent searching for data
		Product, facility, or equipment diminished quality or damages
Each file can be modified independently	No control in concurrent projects or activities	Duplication of file numbers and revisions
		Increased efforts to merge changes later
Updates to information is not captured in every location	Assumptions of data accuracy are made	Poor / inaccurate decisions are made
		HSE concerns

8.5.1   Concepts and procedural elements that require inclusion into Data Management System:

- Identifying a true system of record for all files
- Ensuring appropriate mapping of system integration
- Required metadata in either manual or automated system
- Appropriate storage structure
- Taxonomy (of documentation and data and subsequent files)
- Improved data security protocols and requirements
- Appropriate data auditing standards
- Personnel education and training
- Available and current processes
- Available and current procedures

8.6   Lack of software application integration

In any organization that relies on software to assist with business processes, there are multiple different software platforms that are required. It is not possible to have just one system for every aspect. However, system integration is the concept of having the various platforms talk to one another.

Initial Impact	Secondary Impact	Tertiary Impact
Rework in duplicating data across systems	Time taken away from actual job responsibilities	Lower efficiency in activities or projects
		Shortcuts taken to make up lost time
Errors in duplication process	Incorrect coding used	No federated data searching
		Inability to search for, or obtain complete search of data
	Inaccuracy of meta data	No federated data searching
		Inability to search for, or obtain complete search of data
Inconsistency in coding of files	No federated data searching	Multiple searches across multiple systems required
		Mismatched meta data fields in different systems
Increased effort to consolidate reports	Pertinent data may be accidentally omitted	Poor / inaccurate decisions are made
	Lower efficiency in activities or projects	Shortcuts taken to make up lost time
Increased effort to consolidate data packages	Time taken away from actual job responsibilities	Lower efficiency in activities or projects
		Shortcuts taken to make up lost time

8.6.1   Concepts and procedural elements that require inclusion into Data Management System:

- Identifying a true system of record for all files
- Mapping of system to system workflows
- Available and current workflows
- Security protocols centering around data categorization and classification
- Infrastructure to business communication, expectations, and rules
- Middleware integration of systems

8.7   Slow or inaccurate processing of data

Processing of data includes scenarios where there is an existing document control individual or group, or when individuals in the organization are tasked with processing their own information. It is typically more efficient to have a dedicated resource, but not always feasible. Therefore, processing rules apply to the document control (documentation and data management) function, as opposed to the document control group or specific individual. Slow or inaccurate processing typically stems from the lack of a system.

Initial Impact	Secondary Impact	Tertiary Impact
Untimely distribution of data	Projects or activities are delayed	Client dissatisfaction
		Stakeholder / investor concerns
		Shortcuts taken to make up lost time
Lack of faith in systems	Data user frustration	Users save files in duplicated location
		Lack of general desire to follow processes
		Low performance of personnel due to frustrations
Incorrect distribution of information	Relevant personnel do not receive information required	Inability to perform activities or functions
		Lower efficiency in activities or projects
		Errors or omissions in design or deliverables

8.7.1 Concepts and procedural elements that require inclusion into Data Management System:

- Personnel education and training
- Available and current processes
- Available and current procedures
- Available and current work instructions
- Quality check requirements on submissions (internally and externally sourced)
- Templated quality control checklists
- Approvals matrix
- Accountability and recourse structure

8.8   Poor or lack of processes and procedures in data management

Often procedures do not encompass all they need to, and many times do not exist at all. Procedures for managing documentation and data extend far outside of the document control department or function, as all departments, individuals, and external parties play a role in information management.

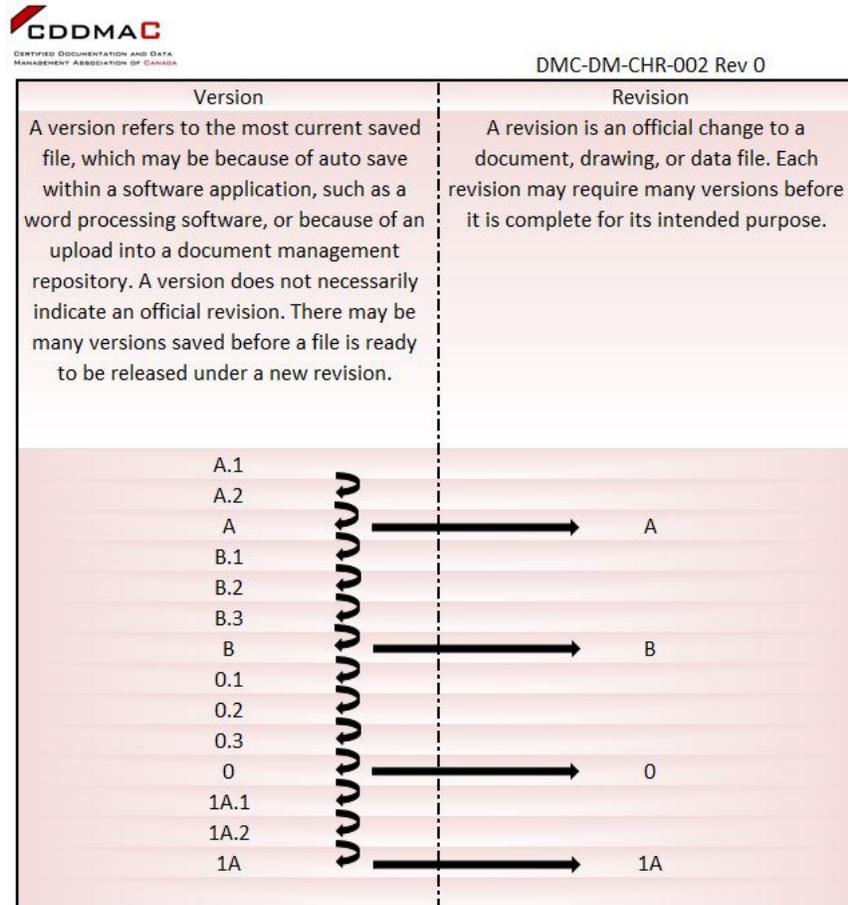| Initial Impact	Secondary Impact	Tertiary Impact
Person does not understand process	Underperformance of activities	HSE concerns
		Product, facility, or equipment diminished quality or damages
		Projects or activities are delayed
		Lost or duplicated data
		Outdated or inaccurate data
Training and personnel management suffers	New hires are slow to be fully functioning	Cost increase to increase staff levels
		Staff not able to contribute to success of projects
		Organization carries staffing overhead burden
		Organization increases hours charged to client without true justification
No quality control over documentation and data	Data is misused for intended purpose	HSE concerns
		Product, facility, or equipment diminished quality or damages
	File numbers are duplicated	Plan, design or construction errors
		Confusion in communication
		Lack of due diligence evidence
	No revision control	Plan, design or construction errors
		Confusion in communication
		Lack of due diligence evidence
		Product, facility, or equipment diminished quality or damages
	Authentication / Approval standards are not met	HSE concerns
		Legal action and fines
		Loss of operating permits
	Consistency issues	Increased time spent reading information
		Time spent to recreate data
		Inability to turn over or receive data during facility acquisition
		New hires are slow to be fully functioning

Cyber security incursions	IT systems at risk	Lost data
		Stolen data
		Legal action and fines
		Time spent to recreate/retrieve data
	Operational technology at risk	Loss of control of facility and facility equipment (via programming hack)
		HSE concerns
		Legal action and fines
		Emergency shutdowns required

8.8.1 Concepts and procedural elements that require inclusion into Data Management System:

- Deliverables expectations (what, who, how, when)
- Personnel education and training
- Third party consulting assistance and expertise
- Cross-functional Working Committee
- Available industry standards and best practices
- Identifying a true system of record for all files
- Required metadata in either manual or automated system
- Appropriate storage structure
- Taxonomy (of documentation and data and subsequent files)
- Improved data security protocols and requirements
- Appropriate data auditing standards
- Continual improvement and process auditing
- Management of governing documentation standards and processes
- Implementation and training plan
- Management of change (overall process)
- Deliverables expediting and tracking
- Approvals matrix

8.9 No version or revision control

There is a vast difference between version and revision control, and both have their own unique elements surrounding control.

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Version	Revision
A version refers to the most current saved file, which may be because of auto save within a software application, such as a word processing software, or because of an upload into a document management repository. A version does not necessarily indicate an official revision. There may be many versions saved before a file is ready to be released under a new revision.	A revision is an official change to a document, drawing, or data file. Each revision may require many versions before it is complete for its intended purpose.

Initial Impact	Secondary Impact	Tertiary Impact
Distrust of retrieved data	Time spent investigating relevance of data	Low performance during activities
		Schedule delays
		Client dissatisfaction
		Shortcuts taken to make up lost time
Revision numbers are duplicated	Plan, design or construction errors	Loss of operating permits
		HSE concerns
	Confusion in communication	Poor / inaccurate decisions are made
		HSE concerns
	Lack of due diligence evidence	Increased risk during litigation

8.9.1 Concepts and procedural elements that require inclusion into Data Management System:

- Available and current procedures
- Available and current work instructions
- Personnel education and training
- Available industry standards and best practices
- Required metadata in either manual or automated system
- Appropriate storage structure

8.10   Poor or lack of data expectations

As previously mentioned, many document control and other departmental processes do not provide an all-encompassing structure for the management of information, and this includes the vital aspect of setting expectations for documentation and data. Requirements do not just focus on which files are required, but who will create them, how they will be structured and named, what elements are required within, and how they will be processed, checked, and submitted.

Initial Impact	Secondary Impact	Tertiary Impact
Miscommunication of deliverables required downstream	Downstream data users do not receive all information required	Incomplete data for decisions
		Product, facility, or equipment damages
		Facility crews operating and maintaining facilities without data
	Data turned over may be missing key information	Incomplete data for decisions
		Product, facility, or equipment diminished quality or damages
		Facility crews operating and maintaining facilities without data
Miscommunication of deliverables required upstream	Contractors are unable to complete activities	Schedule delays
		Client dissatisfaction
		Shortcuts taken to make up lost time
	Assumptions are made due to incomplete data	Product, facility, or equipment diminished quality or damages
		Facility crews operating and maintaining facilities without data
Unspoken assumptions on expectations	Errors or omissions in design or deliverables	Product, facility, or equipment diminished quality or damages
		Client dissatisfaction
		Legal action and fines
		Stakeholder / investor concerns

8.10.1   Concepts and procedural elements that require inclusion into Data Management System:

- Cross-functional Working Committee
- Available industry standards and best practices
- Deliverables expectations (what, who, how, when)
- Templated forms for issuance to various data sources (contractors, vendors, etc.)
- Available and current processes
- Available and current procedures
- Deliverables expediting and tracking

8.11 Poor or lack of search capability

One of the most frustrating and time consuming impacts to the day to day use of information is not being able to find, or find all of, the appropriate information required for any particular activity or reason. This is caused by a lack of appropriate search fields (metadata), inaccurate metadata capture, and inability for federated (cross-software) searches.

Initial Impact	Secondary Impact	Tertiary Impact
Data user frustration	Users save files in duplicated location	Updates to files are not comprehensive
		Each file can be modified independently
		Updates to information is not captured in every location
	Low performance of personnel due to frustrations	Shortcuts taken to make up lost time
		Lack of general desire to follow processes
Relevant data may be overlooked	Incomplete data for decisions	Plan, design or construction errors
		Facility crews operating and maintaining facilities without data
		Expenditures approved / unapproved inappropriately
		Client dissatisfaction
	Incomplete reporting	Inaccurate stakeholder reporting
		Inappropriate progress / cancellation of projects
Increased time spent searching for data	Lower efficiency in activities or projects	Schedule delays
		Client dissatisfaction
		Downstream data users have incomplete data

8.11.1 Concepts and procedural elements that require inclusion into Data Management System:

- Required metadata in either manual or automated system
- Identifying a true system of record for all files
- Appropriate storage structure
- Taxonomy (of documentation and data and subsequent files)
- Improved data security protocols and requirements
- Ensuring appropriate mapping of system integration
- Appropriate data auditing standards

8.12 Poor or lack of communication tracking

So many decisions are relayed outside of formal documentation, and it is becoming ever increasingly important to place a level of control and structure surrounding unconventional communication.

Initial Impact	Secondary Impact	Tertiary Impact
Loss of due diligence evidence in the event of litigation	Increased risk during litigation	Increased fines
		Damaged reputation
Loss of ability to retrieve decisions	Increased risk during litigation	Increased fines
		Damaged reputation
Inability to share communication with team	Team members are not up to date with communication and decisions	Lower efficiency in activities or projects
		Duplication of efforts across team members

8.12.1 Concepts and procedural elements that require inclusion into Data Management System:

- Email storage protocols (within mail application or software, not network drive)
- Communication retention parameters
- Email creation and use guidelines
- Email subject line guidelines
- Approvals matrix

8.13   Poor or lack of modifiable file management

Modifiable files fit into different categories of information, including project documents, digital data bases, CADD drawings, corporate governance documentation, operational data, and facility documentation. Each category requires different levels and structures for control.

Initial Impact	Secondary Impact	Tertiary Impact
Modifiable drawing files are lost	Time spent to recreate drawings (pre-As Built or As Is) and project or corporate governance documents	Inability to identify underground components during As Built
		High cost for rework / increased project budgets
		Schedule delays in submitting deliverables
Modifiable drawing files are held hostage	Damaged reputation	Financial ruin
		Loss of future work
		Stakeholder / investor concerns
	Legal action and fines	Financial ruin
		Damaged reputation
		Loss of future work
Lack of drawing files for turnover facility acquisition	Loss of data for facilities	Facility crews operating and maintaining facilities without data
		HSE concerns
	Time spent to recreate drawings (pre-As Built or As Is)	Inability to identify underground components
		High cost for rework
Duplication of drawing numbers or revisions	Design or construction errors	Loss of operating permits
		HSE concerns
	Confusion in communication	Poor / inaccurate decisions are made
		HSE concerns
	Lack of due diligence evidence	Increased risk during litigation
	Product, facility, or equipment damages	Loss of operating permits
		Financial ruin
Reduced capacity for collaboration	Duplication of files prevalent	Updates to files are not comprehensive
		Each file can be modified independently
		Updates to information is not captured in every location
	Confusion in communication	Poor / inaccurate decisions are made
		HSE concerns

8.13.1   Concepts and procedural elements that require inclusion into Data Management System:

- Identifying a true system of record for all files
- Required metadata in either manual or automated system
- Appropriate storage structure

- Taxonomy (of documentation and data and subsequent files)
- Improved data security protocols and requirements
- Chain of custody mapping and rules
- Ensuring appropriate mapping of system integration
- Appropriate data auditing standards
- Deliverables expectations (what, who, how, when)
- Available industry standards and best practices
- Personnel education and training
- Available and current processes
- Available and current procedures
- Available and current work instructions
- Quality check requirements on submissions (internally and externally sourced)
- Templated quality control checklists
- Concurrent modifiable file and 3D model protocols
- Management of change process for documentation and data

8.14 Poor or lack of data expediting

Expediting has mistakenly only been applied to the logistics and shipment of people, parts, and equipment, however any item or task that has a required due date is submitted to expediting. The largest gap found in most organizations is the lack of expediting of documented and digital deliverables.

Initial Impact	Secondary Impact	Tertiary Impact
Documentation submissions are late	Assumptions are made due to incomplete data	Product, facility, or equipment damages
		Facility crews operating and maintaining facilities without data
	Downstream data users do not receive all information required	Incomplete data for decisions
		Product, facility, or equipment damages
		Facility crews operating and maintaining facilities without data
	Errors or omissions of vital data is missing	Poor / inaccurate decisions are made
		HSE concerns
		Product, facility, or equipment damages
		Facility crews operating and maintaining facilities without data
	Facility crews operating and maintaining facilities without data	Facility crews rely on experience not factual data
		Emergency shutdowns or repairs will be impeded
		HSE concerns
	Incomplete data for decisions	Design or construction errors
		Facility crews operating and maintaining facilities without data
		Expenditures approved / unapproved inappropriately
		Client dissatisfaction
	Increased effort to consolidate data packages	Time taken away from actual job responsibilities
	Not all data taken into consideration	Poor / inaccurate decisions are made
	Person cannot produce data to regulatory body	Permits are declined / revoked
		Fines / levies due for non-compliance

		Incomplete data for decisions
Documentation submissions are missing	Data turned over may be missing key information	Incomplete data for decisions
		Product, facility, or equipment damages
		Facility crews operating and maintaining facilities without data
	Downstream data users do not receive all information required	Incomplete data for decisions
		Product, facility, or equipment damages
		Facility crews operating and maintaining facilities without data
	Errors or omissions of vital data is missing	Poor / inaccurate decisions are made
		HSE concerns
		Product, facility, or equipment damages
		Facility crews operating and maintaining facilities without data
	Facility crews operating and maintaining facilities without data	Facility crews rely on experience not factual data
		Emergency shutdowns or repairs will be impeded
		HSE concerns
	Incomplete data for decisions	Design or construction errors
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	Increased effort to consolidate data packages	Time taken away from actual job responsibilities
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	Person cannot produce data to regulatory body	Permits are declined / revoked
		Fines / levies due for non-compliance

8.14.1 Concepts and procedural elements that require inclusion into Data Management System:

- Deliverables expectations (what, who, how, when)
- Available industry standards and best practices
- Personnel education and training
- Required metadata in either manual or automated system
- Ensuring appropriate mapping of system integration
- Appropriate data auditing standards
- Available and current processes
- Available and current procedures
- Available and current work instructions
- Deliverable tracking mechanisms (spreadsheets, software, etc.)

9   Discussion

The findings of this paper highlight the evidence of the Black Swan: "First, [the Black Swan] is an outlier, as it lies outside the realm of regular expectations, because nothing in the past can convincingly point to its possibility. Second, it carries an extreme impact. Third, in spite of its outlier status, human nature makes us concoct explanations for its occurrence after the fact, making it explainable and predictable."[10]

The risks to an organization and its operations due to lack of documentation and digital data management are high, for many reasons (as outlined in this paper). However the solution, albeit a potentially long term implementation globally, is not an overly difficult one, but it does require cooperation between many groups.

There are three pillars, or avenues, to this solution, and the issues currently being experienced by organizations cannot be resolved unless all three pillars are present.

The three pillars are standardization, education, and resources.

The first relates to the need for national and international, cross-industry standardization in documentation and digital data management. It is understood that there will be some industry and regional specific nuances that will need to be considered, however there must be an overall consistency to the approach taken in managing information.

This standardization will result in easier access to relevant information, consistent security of various categories of information, it will include information management compatibility of contractors, and improve the ability to request, analyze, and integrate the data of facility acquisitions into a purchaser's systems.

An additional element to standardization includes the assurance that appropriate and holistic internal processes and procedures are created in organizations, and provides a consistent high quality of service from software sellers and data management consultants.

Education is key to creating a resource base that is not only able to accurately analyze the exact risks and gaps in an organization's specific documentation and data management system, but is able to properly assist or create processes and procedures (based off the standards) to suit each specific organization and their unique attributes and culture.

Historically, the lack of formal education has left resources unable to provide the complete guidance and support that is sorely needed. This extends to all levels of documentation and data management, be it a junior role in a document control department, a document control manager, technical data managers, or documentation and data integrated management consultants (including Business Analysts and Technology professionals).

It is an unfortunate reality that in the field of documentation and data management, number of years' experience does not equate to numbers of years' growth. With the recent appearance of university level education, designation of professional documentation and digital data managers is forthcoming.

The following table[11] shows the typical areas of knowledge CDDMAC expects from their professional documentation and data managers.

Areas of knowledge for security, workflow, storage, taxonomy, software requirements, best practices, digital metadata (specific to each division)	DIVISIONS OF DOCUMENTATION AND DATA MANAGEMENT			
	Corporate Document Control	Vendor Document Control	Modifiable File Management	Publishing Documentation
Accounting queries and issues	x			
Archiving closed Project documentation	x	x	x	x
Asset Integrity Management		x	x	x
Assigning documentation numbers	x	x	x	x
Bid Opening/Receiving bids and proposals		x		

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[10] The Black Swan by Nassim Nicholas Taleb, 2010, Second Edition

[11] Table compiled by dmeHolistic Inc. who has designed a two year university certificate program currently available at the University of Calgary.

CDDMAC
CERTIFIED DOCUMENTATION AND DATA
MANAGEMENT ASSOCIATION OF CANADA

Areas of knowledge for security, workflow, storage, taxonomy, software requirements, best practices, digital metadata (specific to each division)	DIVISIONS OF DOCUMENTATION AND DATA MANAGEMENT			
	Corporate Document Control	Vendor Document Control	Modifiable File Management	Publishing Documentation
Chain of custody of 3D model files			x	
Chain of custody of modifiable drawing files			x	
Chain of custody of modifiable facility document files			x	x
Compilation of (RFQ) Packages		x		
Compilation of Award Recommendations		x		
Compilation of Purchase Order (PO) Packages		x		
Compilation/Update of Facility Data Books - overall, including electronic versions and hard copy versions, binder ordering coordination etc.	x	x		x
Compilation of Expediting reports		x		
Concurrent 3D Model management			x	x
Concurrent project drawing management			x	x
Conflict resolution during Squad Review process	x	x		x
Construction Work Packages		x		x
Contingency Planning	x			x
Coordination of Construction and Operations Site deliverables		x		x
Coordination of site Material Received Reports		x		x
Coordination with Project Schedule for upcoming deliverables		x	x	x
Corporate Accounts Payables and Receivables	x			
Cost Estimates		x		x
Cost tracking of all Purchases comparing budgeted with actual and fund reallocations	x	x		
Digital Metadata	x	x	x	x
Email Management	x	x	x	x
Engineering Project Costs				x
Ensuring all non-conformances are dealt with	x	x	x	x
Ensuring CADD requirements are met by all parties			x	
Entering new hire information into Timesheet and Accounting system	x			
Expediting all CADD file returns			x	
Expediting Corporate Squad Reviews	x			

Areas of knowledge for security, workflow, storage, taxonomy, software requirements, best practices, digital metadata (specific to each division)	DIVISIONS OF DOCUMENTATION AND DATA MANAGEMENT			
	Corporate Document Control	Vendor Document Control	Modifiable File Management	Publishing Documentation
Expediting Engineering Squad Reviews				x
Expediting shipments		x		
Expediting Vendor documentation submissions		x		
Expediting Vendor Squad Reviews		x		
Formatting Corporate Documentation	x			
Formatting Project Documentation	x			x
Internal approvals on all Vendor/Manufacturer Invoices		x		
Issuing PO package	x	x		
Issuing RFQ Packages	x	x		
Logistic RFQs	x	x		
Logistics/Freight terms and condition reviews with Vendors	x	x		
Maintain and publish Project Distribution Matrices		x		x
Maintain and publish Project RA(S)CI Charts		x	x	x
Maintaining and publishing Site Distribution Matrices				x
Maintaining integrity of modifiable corporate governance files	x			
Maintaining Master Stick files with up to date copies	x	x		x
Maintaining revision integrity	x	x	x	x
Maintaining transfer site with regards to Engineering Documentation				x
Maintaining transfer with regards to Vendor documentation		x	x	
Maintaining Vendor/Manufacturer MSAs	x			
Managing Bid Clarifications		x		
Managing expense claims	x			
Managing Inspection contracts and reports	x	x	x	x
Managing Progress Payments		x		
Managing Vendor documentation submissions		x	x	
Man-hour Estimate reporting	x	x		x
MOC and Change Management; PCNs, Trends	x	x	x	x
Non-conformance reports			x	x
Processing Vendor/Manufacturer Invoices		x		
Progress reporting	x	x	x	x

Areas of knowledge for security, workflow, storage, taxonomy, software requirements, best practices, digital metadata (specific to each division)	DIVISIONS OF DOCUMENTATION AND DATA MANAGEMENT			
	Corporate Document Control	Vendor Document Control	Modifiable File Management	Publishing Documentation
Project Contract Administration			x	x
Project Forecasting		x		x
Project Initiations and Closeouts		x	x	x
Project Scheduling	x			x
Quality assurance and Quality control of CADD files			x	
Quality Checking and publishing Corporate governance documentation	x			
Quality Checking and publishing Engineering drawing and documents			x	x
Quality checking PO Packages		x		
Quality checking RFQ Packages		x		
Quality documentation requirements for construction				x
Quality documentation requirements for manufacturing		x		
Quality documentation requirements for operations and maintenance		x		x
Receipt and Processing of all Company Contractor Invoices	x			
Receiving and utilizing DDR		x		
Regulatory requirements (various)	x	x	x	x
Request for Quote (RFQ) Bid Analysis		x		
Requesting modifiable drawings and documents from Third Party		x	x	
Requesting published drawings and documents from Third Party	x	x		x
Retrieving archived documentation	x			x
Software functionality	x	x	x	x
Squad Reviews (general)	x	x		x
Third Party Contract Administration	x	x	x	x
Timesheet Entries	x	x	x	x
Timesheet Processing	x			
Tracking Inspections		x		
Tracking man hours against deliverables (Earned Value)		x		x
Transmittal requirements	x	x	x	x
Updating and maintaining Master Index/software metadata	x	x	x	x
Updating Corporate templates	x			
Updating technical library	x			

NOTE: Often when all four divisions require the same area of knowledge, the knowledge is specific to each division's unique requirements, and will have variances in the processes, rules, and best practices.

Software improvement has a large role to play in the resolution of documentation and data management issues, however improving both the software platforms as well as the customer's ability to accurately evaluate which software's functionality is most appropriate to their business needs, requires both the standards and the education in place.

As the demand for better documentation and data management software rises, so will the mandate for companies who develop and configure software to be educated in the customer's business needs surrounding holistic information governance.

This will create better availability to honest applications that no longer raise costs as a result of specialized customization (just to achieve basic documentation and data management requirements), which will inevitably increase financial and logistical access to automation of processes for smaller companies in all regions of the world.

10   Conclusion

There is no reason for documentation and data management (and all the subsequent tools and support) to have such negative impacts in the lives of individuals, workers, business owners, clients, infrastructure, physical structures, or consultants.

The impacts of poor management in all categories of information are so drastic that it includes death. Information management must no longer be a burden, a hurdle, nor held hostage.

By collaboration and compliance between countries, organizations, departments, and individuals, this issue can be resolved.

However, it absolutely requires the three pillars; standardization, education, and resources.

ABOUT THE AUTHOR

Bernadette Bosse has almost two decades as a Purchaser, Inventory Controller, Expeditor, and Documentation and Data Expert in industries including mining, utilities, energy, pulp and paper, and construction.

She has been involved in all facets of the progression of both a project and an organization, and has created and implemented Documentation Management, Data Management, Drafting, Project Management, Procurement, Quality, and Asset Management systems and processes.

Bernadette currently owns and operates a consulting company of Subject Matter Experts that specializes in Information, Documentation, Data, and Communication Management, with additional divisions focused on Project Quality and Project Excellence. dms360 Ltd. is expanding further into international consulting.

Ms. Bosse designed and created a two year online university certificate program that is currently offered through the University of Calgary, and will be available in the Asian region, Africa, and the Unites States in the next year.

She has also created additional courses in Documentation Management in the SharePoint environment available through SAIT Polytechnic.

Ms. Bosse is currently the Chairman and CEO of the Certified Documentation and Data Management Association of Canada, and has led the first edition of documentation and data standards creation and publication. As CEO, she is responsible for the establishment of standards committees to further advance the breadth of the standards offered.

Regional associations around the world are currently being established under an international umbrella to ensure that all reaches of the globe can obtain an equal level of education and certification.

Ms. Bosse has been awarded the Honorary Fellow of the Institute of Information Management Africa (IIM-Africa).

She currently lives in Calgary, Alberta, Canada, and travels to various regions across many continents to speak, teach, and consult in support of this movement.

You can visit CDDMAC at their website, cdma-ca.com or email Bernadette at bbosse@cdma-ca.com