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Defining usability heuristics for adoption and efficiency of an electronic workflow document management system

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by

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We hereby certify that this dissertation, submitted by Steven Fuentes, conforms to acceptable standards and is fully adequate in scope and quality to fulfill the dissertation requirements for the degree of Doctor of Philosophy.

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An Abstract of a Dissertation Submitted to Nova Southeastern University in Partial Fulfillment

of the Requirements for the Degree of Doctor of Philosophy

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Usability heuristics have been established for different uses and applications as general guidelines for user interfaces. These can affect the implementation of industry solutions and play a significant role regarding cost reduction and process efficiency. The area of electronic workflow document management (EWDM) solutions, also known as workflow, lacks a formal definition of usability heuristics. With the advent of new technologies such as mobile devices, defining a set of usability heuristics contributes to the adoption and efficiency of an EWDM system.

Workflow usability has been evaluated for various industries. Most significantly research has been done for electronic healthcare records (EHR). In other areas such as the financial sector and educational institutions there is also some literature available but not as abundant as for EHR. This was identified as a possible research limitation.

The general purpose of this research was to establish and validate an overarching set of usability heuristics for EWDM in general. This was approached by conducting a literature review and a survey on 32 workflow consultants from Hyland Software, Inc. Quantitative and qualitative data was collected focusing on the study's main research question: "what usability heuristics should be defined to ensure the adoption and efficiency of a workflow implementation?"

Findings based on regression testing and expert opinions have suggested a proposed set of usability heuristics. The final list consists of: adaptability to diverse platforms, user control, system feedback, intuitive interfaces, visibility on mobile devices, error management, help, and documentation.

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Chapter 1

Introduction

Background

The usability heuristics defined by Nielsen (1995) have been applied over the years as general guidelines for user interface design. Studies have been conducted using Nielsen's heuristics as a base in different areas. According to Salve and Bhutkar (2011), areas such as multimedia, paper-based web pages, and web design have all been evaluated using Nielsen's heuristics as a base for comparison.

For electronic workflow document management (EWDM) or workflow (interchangeably used with EWDM for purposes of this study), a formal set of usability heuristics based on Nielsen has not been established. Workflow has been defined by Owaied, Farhan, and Hudeib (2011) as "the automation of business processes, in whole or part, during which documents, information or tasks are passed from one participant to another for actions, according to a set of predefined procedural rules" (p. 132).

Typical workflow solutions are found in industries such as electronic healthcare records (EHR), educational institutions, financial industries, and others. All these industries can benefit from automated and more efficient processes which enhance productivity and reduce costs. With the advent of new technologies, it could be assumed that devices such as tablets and other mobile technologies could be integrated into workflow processes. Nielsen's heuristics have not been extensively applied to EWDM systems, therefore the need to explore usability factors that could impact the adoption and efficiency of workflow solutions with new devices was suggested in this research.

A number of different devices and technologies such as tablets currently exist and have been presented as alternatives to reading hard-copy documents. These devices could be incorporated into workflow solutions. Chen, Guimbretiere, and Sellen (2012) indicated that these devices had not been widely accepted in professional or business sectors. This could have been in part due to usability problems. Not incorporating devices into workflow solutions could lead to reduced efficiency in managing large number of documents for businesses since managing paper can elevate operational costs. Integrating these devices with workflow may also lead to process improvements. Nevertheless, in a more recent study Botella, Moreno, and Peñalver (2014) indicated that smartphones and tablets are being used more often on a daily basis as a working tool.

Problem Statement

The integration of mobile devices has been suggested by Cardoso, Jablonski, and Volz (2014) to enhance enterprise solutions. Nevertheless, the authors indicate that the adoption of these devices with workflow has not been successful. According to Cardoso et al. (2014), mobility has been overlooked regarding EWDM systems development. A lack of intuitive interfaces has also been suggested to be a reason for disappointment in workflow solutions and may have hindered its extensive use according to Gesing et al. (2014). Heinicke et al. (2015) have indicated that usability aspects have not been considered in document management systems selection process in general.

Alalwan and Weistroffer (2012) have stated that one of the main drivers for the adoption of electronic document management (EDM) is process efficiency. EDM and electronic content management (ECM) are often used interchangeably. Workflow is a key component of EDM and contributes significantly to the efficiency of a document

management solution. Scott (2011) has indicated that document management promotes increased efficiency and reduced costs. Lowry et al. (2014) have mentioned that workflow cannot only increase efficiency by reducing bottlenecks of tasks but also improve scalability and safety in patient care solutions which have been known to be incorporating mobile devices into their workflow, as indicated by Poulymenopoulou, Malamateniou, and Vassilacopoulos (2014).

The combination of the literature review and the conducted survey have assisted in establishing a set of heuristics which provides valuable insight to this problem and may contribute to future workflow implementations.

Dissertation Goal

The main goal of this research was to define an overarching set of usability heuristics which may serve as guidelines for the adoption and enhanced efficiency of workflow solutions in current times. Pandey (2013) has indicated that for complex workflows, user interactions need to be "suited to the device at hand" (p. 295).

This research study focused workflow processes in general, and on suggesting a set of usability heuristics for current workflow implementations using Nielsen (1995) as a starting point.

Research Question

The main research question this study addressed is: Based on Nielsen (1995b), "what usability heuristics should be defined to ensure the adoption and efficiency of a workflow implementation?" A list of heuristics (based on literature) that was initially proposed for workflow adoption and efficiency is presented in Figure 1.

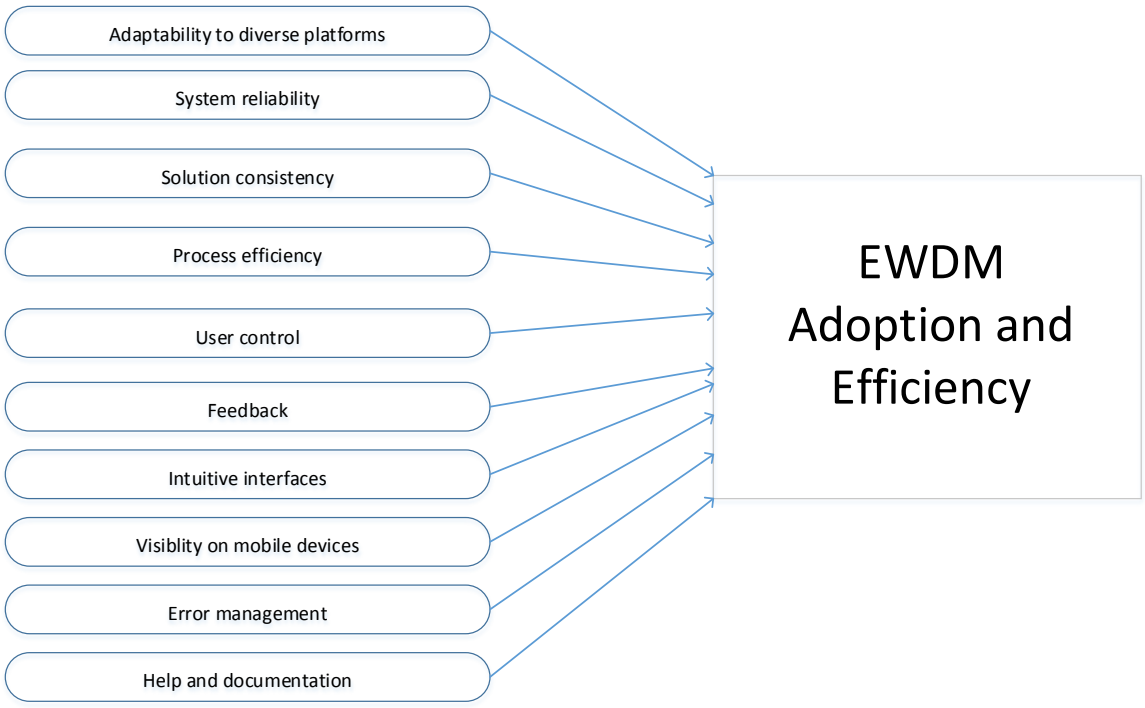


Figure 1: EWDM Heuristics for Adoption and Efficiency

This list was created from diverse studies reporting usability issues. The issues were identified during the literature review and can also be found in Appendix A. As noted by Masip, Granollers, and Oliva (2011), "the heuristics used until now, basically Nielsen's, do not cover all usability features for any interactive systems" (p. 429). Therefore this research helped cover a gap in existing literature regarding workflow thus provide necessary insight of its usability issues.

The heuristics in Figure 1 were organized into three overall themes to simplify the research model and the number of independent variables. The heuristics were grouped together into the following themes:

1. Workflow Performance – consists of system reliability, solution consistency and process efficiency

2. Workflow User Interaction – consists of adaptability to diverse platforms, user control, intuitive interfaces and visibility on mobile devices
3. Workflow Support – consists of system feedback, error management, and help and documentation

Different types of analysis have been performed in usability studies. Grouping usability issues into themes is a method that Hermawati and Lawson (2016) mention in their study on heuristics evaluation for specific domains. This research evaluated the relationship these themes have on adoption and efficiency, and contributed to determine if the proposed set of heuristics confirmed or denied promoting adoption and efficiency of present day workflow systems due to the relationships found.

The specific research questions that this study addressed were:

RQ1: What usability heuristics must be taken into account for the adoption and efficiency of EWDM systems today?

RQ2: How will the new set of usability heuristics enhance adoption and efficiency in EWDM systems today?

Relevance and Significance

Usability heuristics based on Nielsen (1995) have been established for different uses and applications as general guidelines for user interfaces, yet this has not been done previously for present day EWDM systems. These can affect the implementation of industry solutions and may play a significant role regarding adoption and process efficiency. Therefore, defining a set of usability heuristics for workflow contributes to understanding factors that impact the adoption and efficiency of an EWDM system.

This research is significant since its results will provide guidelines for the adoption and efficiency of future workflow implementations. The guidelines will serve as a model for workflow solutions by addressing issues impacting the adoption and process efficiency of EWDM systems.

Barriers and Issues

One of the barriers for this research was to identify subject matter experts on workflow usability. Botella, Alarcon, and Peñalver (2014) indicated that usability evaluators could be considered experts depending on their level of education. Nevertheless, the authors proposed that an expert could also be identified depending on their professional career combined with a university degree. They noted the importance of collecting other attributes such as skills or projects which may identify their expertise and proposed how to validate them.

Easton and Easton (2013) presented a paper where they presented a graph of ECM visionaries identified by Gartner, a respected information technology research firm. In the graph, Hyland Software, Inc. was positioned as a visionary and leader. In 2016, Hyland was once again positioned as a visionary and electronic content management leader. This was relevant for this research since SMEs from Hyland were available to be surveyed and provided insight which led to establish a new set of heuristics and overcome this barrier. Hyland Software is a firm that has implemented workflow solutions worldwide.

Limitations, and Delimitations

Limitations

Limited research exists for business implementations and workflow usability other than healthcare. The lack of literature for other industries presented a limitation. Nevertheless, sufficient literature was found to support the research goals and findings.

Delimitations

Hyland agreed to support the research providing contacts to survey. The main delimitation of this research was that all survey participants only had significant workflow experience with Hyland's ECM software known as OnBase.

Definition of Terms

For purposes of this research the following terms were defined for survey respondents:

1. Adoption - the act of implementing and using workflow solution. (Mosweu, Bwalya, & Mutshewa, 2016a).
2. Efficiency - when desired results are obtained according to user effort & expectations. Keyboard short cuts, type ahead options and ease of use (Ahmed & Arif, 2015).
3. Intuitive interfaces - naturally and instinctively understood. Aesthetically pleasing and functional (Joyce, Lilley, Barker, and Jeffries, 2014).
4. Performance - the act of expecting the executing a process in a timely manner (Mosweu et al., 2016a)
5. Support - alerts, notifications, feedback, documentation, help, and error management (Joyce et al., 2014).

6. User controls - ability to continue, undo, cancel or rollback a task (Ahmed and Arif, 2015).
7. User Interaction - ease of use, intuitive, consistent and clearly displayed user tasks, effortless input (Joyce et al., 2014).

List of Acronyms

1. BPM - Business Process Management
2. ECM – Electronic Content Management
3. EDM - Electronic Document Management
4. EHR – Electronic Healthcare Records
5. EWDM – Electronic Workflow Document Management
6. IT – Information Technology

Summary

A formal set of usability heuristics based on Nielsen has not been established for EWDM systems. The adoption of workflow solutions implemented with new technologies has been overlooked according to Cardoso et al. (2014). Process efficiency has been stated by Alalwan and Weistroffer (2012) as one of the most important drivers for the adoption of workflow solutions. This research focused on proposing a set of usability heuristics for workflow implementations. This was accomplished by evaluating the heuristics that should be identified to ensure the adoption and efficiency of a workflow implementation. The new set of usability heuristics for workflow assist in contributing to understand factors that impact adoption and efficiency for future workflow implementations.

Chapter 2

Review of the Literature

Introduction

The literature review was conducted to provide a theoretical foundation for this research. It was found that limited research exists on workflow usability in industries other than healthcare. Nevertheless, sufficient literature was found to support the overall purpose of the study.

Background

User interfaces according to Shneiderman et al. (2017), have facilitated progress in fields such as healthcare, education, management, engineering, and science. Recent research regarding workflow is available for most of these fields. Dell et al. (2015) for example, conducted a study on global development organizations and gathered data from 23 organizations in 16 countries in an attempt to evaluate collaborative practices and the transitioning from paper to digital workflows. They indicated that “coordinating information across paper and digital materials has proven challenging” (p. 2). The data entry process has been described as a major workflow bottleneck.

Kim (2013) suggested that user interfaces designed to improve the user’s experience in EHR consequently improves clinical workflow processes. Negative effects such as lower effectiveness, less efficiency, limited collaboration, errors, and patient care quality are indicated by the author as problems related to usability. According to Kim the early identification of these issues as well as addressing them through usability evaluation can improve overall conditions and reduce costs.

Regarding mobile usability, Joyce (2014) has indicated that “research has shown that traditional usability evaluation methods cannot be readily applied to the evaluation of native smartphone applications” (p. 409). For purposes of integrating mobile devices into workflow this was taken into consideration. The methodology implemented by Joyce (2014) consisted of defining an initial set of heuristics based on a literature review, surveys, and empirical tests which measured frequency and severity of issues.

Joyce, Lilley, Barker, and Jefferies (2014) did a study on heuristics for mobile devices based on Nielsen’s heuristics. In the study 11 heuristics were established. The authors have indicated that these heuristics have yet to be evaluated by Human Computer Interaction (HCI) experts and considers this to be the next step. These heuristics will be considered for this research since they are worth validating as part of a set of heuristics to be defined for workflow and mobile devices.

Barrera, Carrillo-Ramos, Florez-Valencia, Pavlich-Mariscal, and Mejia-Molina (2014) have stated that adaptation of user interfaces to different users and contexts is a common problem in information system development. Although several methods have been created which attempt to ensure a degree of usability, these methods focus mainly on the design stage. They do not adapt dynamically during execution. A solution to this is to integrate the design with adaptation at execution time to ensure that usability is preserved. Regarding workflow and mobile devices a dynamic adaptation analysis could be conducted in future studies to verify impact on workflow usability.

An option for the dynamic adaptation mentioned above by Barrera et al. (2014) can be found in Darlington, Field, and Hakim (2016). Regarding process efficiency, Darlington et al. (2016) have indicated that a framework based on user defined

constraints may assist in implementing workflow processes of an application. This is accomplished by granting users the ability of configuring constraints to prevent invalid options which may affect the solution's output. The framework could be beneficial for long term usability although Ellsworth et al. (2016), which focused on EHR systems have indicated that limited guidance exists regarding future usability studies.

Workflow processes require users to access, read, analyze, and compare multiple documents simultaneously. Chen et al. (2012) pointed out the existence of certain activities that take place while this occurs. Examples of these activities are annotating, skimming multiple papers, and switching between documents. These activities could challenge the usability of an EWDM system. New technologies and devices as presented by Chen et al. (2012) could assist in overcoming these challenges. Combining these with the automation or reengineering of manual processes may also help and lead to a more complete workflow solution integrating new devices.

Pandey (2013) conducted a case study which presented a prototype of a smartphone/tablet application for enterprise transaction banking. The challenge was to create it as a native application with user interface screens on the web. This was done to evaluate having "a single and uniform code base which helps reduce development costs and subsequent maintenance costs" (p. 294). It was noted that a performance tradeoff regarding interactivity for users existed.

Scott (2011) evaluated user perceptions of ECM systems and mentioned the importance of users' perceptions for the acceptance and benefit of an ECM. In a similar study, Petrie and Power (2012) conducted a usability study which focused on what users cared about on highly interactive websites. Petrie and Power identified over 900 usability

problems in six highly complex sites. The problems were categorized into sections such as: physical representation, content, information architecture, and interactivity. A new set of heuristics for these categories was defined to deal with these problems. Their study suggested that this set of heuristics is a useful tool for future website development and evaluation and should improve effectiveness. Although the study did not focus on workflow, the definition of a new set of heuristics served as a guideline for the purposes of defining a new set of usability heuristics for workflow.

Haber, Nacenta, and Carpendale (2014) conducted a study comparing paper vs. tablets in collaborating tasks and found that “paper is still overwhelmingly preferred as the tool of choice” (p. 94). Additionally it was noted that electronic devices such as tablets should not be interchanged with paper without the acknowledgement that group interaction may be affected depending on which tool (paper or tablet) is selected. It was found that tablets cannot be assumed to be a superior choice for collaborative tasks over paper in their findings. Haber et al. (2014) found that paper was preferred in collaboration scenarios although this may need to be addressed in the future by HCI professionals “as the adoption and acceptance of digital tools continues to grow and mature” (p. 95). Regarding workflow usability which involves collaborative task these findings were considered relevant.

Ahmed and Arif (2015) presented a usability study based on Nielsen (1995) on how to improve applications for Android devices. Suggestions were made for each of Nielsen’s heuristics. A similar approach was used for this research and is found in Appendix A.

A single interface solution for workflow was suggested by Gesing et al. (2014). The study focused on implementing a web browser based design (regarded as a dashboard) to eliminate the burden users have while learning diverse layouts. Gesing et al. (2014) suggested that interfaces that are intuitive promote and encourage extensive workflow use.

Heinicke et al. (2015) stated that the current EDM selection processes seem to lack consideration for usability. They conducted a study to evaluate usability of existing EDMs that lead to the selection of adopting one. The study produced over 70 usability criteria on which an EDM system could be evaluated. The criteria that was most commented on by participants had to do with the following concepts:

1) Intuitive interfaces – graphical representations of file structures
2) Searches – adequate information displayed in search results (document details)
3) Imports – visual feedback regarding completion
4) Workflow – interfaces that prioritize tasks in a graphical manner

The criteria presented by Heinicke et al. (2015) suggested quality improvements on processes that are often neglected for EDM systems. This was also discussed by Rolón, Chavira, Orozco, and Soto (2015) in a study based on evaluating business process models in healthcare. They indicated that workflow technology is an area of "continuous quality improvement" (p. 5604).

Unertl, Holden, and Lorenzi (2016) evaluated usability concepts regarding end-user adoption of solutions. They have suggested that usability is crucial for contextual factors of an implementation, and workflow is mentioned as one of the factors. Unertl et

al. (2016) has stated that based on the existing types of medical specialties “there are overwhelming number of workflows needed” (p. 49). The authors also have suggested that support and training are critical factors for adoption of a system since “users must have a clear understanding of the application and the feature that takes them through an effective workflow” (p. 53).

Mobile devices have changed the way enterprise solutions are implemented according to Cardoso et al. (2014). Nevertheless, the authors have stated that the integration of mobile devices in workflow systems has not progressed well for mobile users. Despite that in the past decade there has been substantial progress in EWDM systems, Cardoso et al. (2014) indicates that mobility was overlooked. Among their findings they have indicated that “new workflow paradigms for mobile devices can be inspired” (p. 547).

Duhm, Fleischmann, Schmidt, Hupperts, and Brandt (2016) conducted a research on how mobile devices can promote an EHR workflow. They indicate that research has suggested that devices connected to patient data may streamline a workflow solution for physicians. Devices such as tablets with patient information save time and facilitate the retrieval of data in clinical settings. Duhm et al. (2016) concurs with other studies by indicating that devices have not reached their full potential and that workflow training may be the reason. The authors conclude that there is solid evidence indicating that mobile devices may promote workflows by enhancing healthcare quality and efficiency. Nevertheless training as well as additional software enhancements are the key for devices such as tables to reach their full potential.

Dykes et al. (2015), who conducted a study that addresses the logistics needed when mobile devices are to be used in hospital care, have also recognized the challenges that exist when implementing mobile device into business processes. The authors have indicated that despite that mobile devices have been widely adopted and used, literature for implementing them in healthcare is limited.

Nielsen's 10 Applied to other domains

The 11 heuristics for mobile devices based on Nielsen's heuristics that were defined by Joyce et al. (2014) are:

1. Provide immediate notification of application status
2. Use a theme and consistent terms, as well as conventions and standards familiar to the user
3. Prevent errors when possible; Assist users should an error occur
4. Use a welcome mat for first-time users
5. Employ a simplistic, focused, glanceable, aesthetically pleasing, intuitive interface
6. Design a clear navigable path to task completion
7. Allow configuration options and shortcuts
8. Cater for diverse mobile environments
9. Facilitate effortless input
10. Make appropriate use of the camera and sensors
11. Use identifiable icons

For purposes of this research, many of the heuristics presented by Joyce et al. (2014), as well as other literature found were taken into account.

Also for mobile devices, the study for Android applications by Ahmed and Arif (2015) presented a table titled “Usability Heuristics Loopholes and Suggestions” (p. 171). A similar table was created for this research in Table A1. The purpose of Table A1 was to identify heuristics in the literature which may be compared to Nielsen’s 10. See Appendix A.

Herr, Baumgartner, and Gross (2016) have indicated that common standards for rating usability processes are limited. The ratings among experts often differ significantly. Nielsen (1994) used the following numerical scale to classify usability:

0 = not a problem

1 = cosmetic problem

2 = minor problem

3 = major problem

4 = usability catastrophe

In an effort to improve rating accuracy, Herr et al. (2016) have presented the following scale:

1. Frequency
2. Difficulty
3. Workflow impact (impacts efficiency)
4. Persistence
5. Frustration
6. Market impact (impacts adoption)
7. Fixing Effort

Herr et al. (2016) concluded that this scale is more accurate than Nielsen. Its focus on workflow and market impact, which could be translated to efficiency and adoption for purposes of this research, was used to support this study.

Mosweu, Bwalya, and Mutshewa (2016a) conducted a study which examined the adoption and usage of an EWDM system. A survey of of 53 participants was completed. Their study is directly aligned with EWDM adoption and therefore served as a foundation for this research. Their findings indicated by that negative attitudes towards computers, computer anxiety, complexity and incompatibility to current practices were the main reasons for an unwillingness to adopt and use an EWDM system. A clear example of this unwillingness was presented in the study where a participant mentioned that a manual system was preferred. A number of social influences were found to impact adoption of EWDM systems. Among the social influences mentioned were:

1. Only 45.2% indicated that influential individuals at their job thought an EWDM should be used.
2. Only 45.3% indicated that important people at their job thought an EWDM should be used.
3. Only 24.6% indicated that top management was helpful in using the system.

However, regarding efficiency a somewhat different scenario than the one for adoption appeared when various issues were addressed such as:

1. 86.8% agreed that an EWDM system would reduce time taken on their tasks.
2. 88.% agreed that with an EWDM their jobs would be easier.
3. 90.5% agreed that their job effectiveness would be enhanced.

Among the various findings, the authors recommend the following for an EWDM adoption and usage:

1. facilitating conditions are needed for the adoption
2. social influences such as top management have an impact on adoption
3. trainings should be given before implementing to address change and unwillingness
4. system use should be monitored and evaluated
5. the use of an implemented EWDM system should be compulsory

Mosweu et al. (2016a) is directly aligned with EWDM adoption and therefore is literature that served as a foundation for this research.

The grouping of heuristics by Hermawati and Lawson (2016) for specific domains was used to assist in defining usability heuristics for adoption and efficiency of an EWDM system as mentioned previously. The following themes have already been defined and mentioned previously in this paper: Workflow Performance, Workflow/user interaction and Workflow Support.

Workflow Related Solutions

According to Sun, Su, and Yang (2016), EWDM systems have also been referred to as office automation or Business Process Management Systems (BPM). Sun et al. (2016) define a business process as "an assembly of tasks performed by human participants or by computing and other devices to accomplish a business objective" (p. 3:4). In many of these systems data is distributed across database and file systems which may present certain challenges such as support on collaboration among multiple business processes. These challenges have led to the creation of new artifacts and frameworks to

assist in overcoming these types of issues. This study helps understanding how fundamental support may be in a workflow solution.

Another closely related topic to workflow and BPM, as noted by Lederer, Betz, Kurz, and Schmidt (2017) is digitalization. Digitalization, as noted by Lederer et al. (2017) represents “the idea of generating significant process innovations as well as innovative business models resulting in new workflows through the usage of modern technologies” (p. 1). The authors stress the important role Information Technology (IT) has in increasing the efficiency of workflows.

Liu, Fan, Wang, and Zhao (2017) have stated that regarding BPM implementations such as e-commerce, knowledge management, and supply chain management workflow has had an “increasingly widespread adoption” (p. 11). Liu et al. (2017) emphasize that an efficient workflow design is a key factor for success, and that the reuse of existing models can improve efficiency of business process designs. The authors present an interesting example using simple banking transactions, indicating how transferring funds and a credit payment application could be reused and combined to create a loan application process. Financial processes are commonly designed into workflow solutions, although there is limited workflow literature for this type of industry. Hyland Software for example, has been involved in the design of many banking and credit union workflow solutions which have increased adoption and efficiency for their clients. Loan applications are done online and are forwarded for approval. This reduces the amount of paper used and provides a more organized way of tracking the status of the application while expediting the approval or denial. The concept of reusing existing

processes presented by Liu et al. (2017) is worth looking into to enhance performance and efficiency in future workflow implementations especially with mobile devices.

The workflow model reuse presented by Liu et al. (2017) leads to another interesting workflow related topic: workflow regression testing. Makki, Landuyt, and Joosen (2016) was a study on the potential and challenges of having a workflow regression testing framework that would verify how a newer version of a workflow process executes compared to a previous version. Regarding support and quality assurance, having this type of regression tool could also enhance not only the efficiency of an implemented solution, but also assist in providing workflow support for the adoption of future business processes.

Summary

The literature review has been helpful in identifying a lack of a formal set of heuristics for workflow implementations based on Nielsen's 10. Although a limited amount of literature exists, there was sufficient literature to suggest that the problem statement presented in this research should be addressed. Related usability studies have been conducted for many domains. The methodology approach that previous studies have implemented was adapted to answer the research questions presented in this study.

Chapter 3

Methodology

Introduction

This chapter describes the approach and methodology that was used to conduct this research. As stated previously, the research questions for this study were:

RQ1: What usability heuristics must be taken into account for the adoption and efficiency of EWDM systems today?

RQ2: How will the new set of usability heuristics enhance adoption and efficiency in EWDM systems today?

Approach

The research was an exploratory research in nature, and the methodology was similar to Joyce (2014). The research consisted of 3 phases:

1) A new set of grouped usability heuristics based on literature review was proposed (see Figure 2).
2) As part of the data collection process, initially a pre-survey was conducted. After obtaining initial data a final survey was then conducted addressing participants on the new set of heuristics. This phase consisted of administering a Likert-scale survey to a population of the ECM consultants from Hyland Software. This was due to the availability of participants and of previous arrangements established with the company. Designers, users, and administrators of implemented EWDM systems were surveyed to evaluate whether the proposed usability heuristics apply to modern day workflow solutions. Survey responses were measured using a 7-

point scale ranging from 1 which indicated “Strongly Disagree” to 7 which indicated “Strongly Agree”.

3) Modifications of the grouped heuristics were made based on feedback from the pre-survey. This process assisted in providing an initial idea of what the answer to RQ1 would be. The modifications consisted of renaming Workflow Feedback to Workflow Support. The reasoning behind this is that system feedback questions did not seem impact adoption or efficiency significantly, while Workflow Support not only addressed issues of system feedback, but also addressed supporting resources more effectively. Workflow Support was found to be a more reliable theme than grouping of heuristics as Workflow Feedback.

A total of 32 participants responded to the survey which met the goal for this research. This number of participants is larger than the usability study conducted by Petrie and Power (2012) where 30 responses were received. Open-ended questions were also part of the survey. Quantitative and qualitative data was therefore available to categorize the results and provide an answer to RQ2. Participant demographic data was also collected during the survey for statistical analysis and is presented in Chapter 4. The specific demographic questions are listed in Appendix B.

Participants were informed that all questions on the Likert-scale survey should be answered considering the relevance of the adoption and efficiency factors of workflow implementations. The questions were based on the usability heuristics themes mentioned earlier.

Mosweu, Bwalya, and Mutshewa (2016b) conducted a study on adoption and use of workflow solutions. Their study concluded that factors such as technophobia, system

complexity, and incompatibility with other systems were some of the reasons for a low adoption as well as low usage of workflow solutions. The instrument used in their study was a Likert-scale survey which was evaluated for normality, correlation analysis, and validity tests. This instrument was used and slightly modified for this research. The survey questions presented for this research were:

Workflow performance survey questions

1. Using workflow would enhance my job effectiveness.
2. Using workflow in my job would enable me to accomplish tasks more quickly.
3. Using workflow will make my job easier to do since I will be more productive.
4. Using workflow will enable me to spend less time on routine tasks.
5. Performance is a critical factor to consider for adoption.
6. Performance critically affects efficiency.

Workflow user interaction survey questions

1. As a user, my interaction with workflow is clear and understandable.
2. I could develop skills needed to use a workflow solution, if user controls are provided.
3. Intuitive interfaces makes a workflow solution easy to use.
4. Intuitive interfaces makes a workflow solution easy to learn.
5. User Interaction is a critical factor to consider for adoption.
6. User Interaction critically affects efficiency.

Workflow Support survey questions

1. With useful documentation, l will have the necessary knowledge to use a workflow solution.
2. For workflow error management adequate resources are available.
3. Solution feedback is essential to avoid errors or difficulties.
4. Support critically affects efficiency.

To measure the impact efficiency has on adoption the following question was also on the survey:

1. Efficiency is a critical factor to consider for adoption.

General survey question

1. Which is more important for customers when they are considering to adopt a workflow solution? Performance, User Interaction, Support or Efficiency?
2. Which is more important for customers when evaluating efficiency of a workflow solution? Performance, User Interaction or Support?

Open-ended questions

Open-ended questions for qualitative purposes will include:

1. The proposed set of heuristics will significantly promote the adoption, and efficiency of an electronic workflow document management system. Answer “Yes”, “No”, or “Other” and briefly explain.
2. What additional heuristics should be added to the proposed set? Should any be removed? Briefly explain.

3. What factors do you consider increase efficiency and enhance adoption in present day workflow solutions? Briefly explain.
4. How will the proposed set of heuristics promote present day workflow adoption and efficiency? Briefly explain.

Figure 2 depicts the conceptual model for this study.

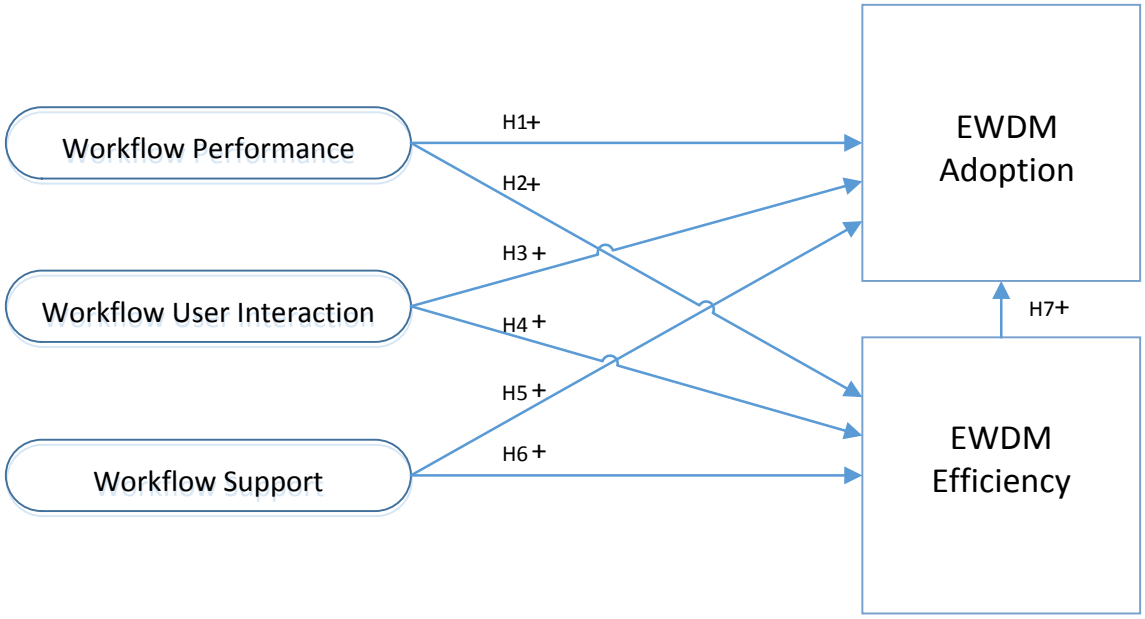


Figure 2: Conceptual Model

Hypotheses

The following are the main research hypotheses based on the proposed set of usability heuristics (Figure 2) for current workflow implementations:

H1: There will be a significant positive relationship between Workflow Performance and the adoption of EWDM systems.

H2: There will be a significant positive relationship between Workflow Performance and the efficiency of EWDM systems.

H3: There will be a significant positive relationship between Workflow User Interaction and the adoption of EWDM systems.

H4: There will be a significant positive relationship between Workflow User Interaction and the efficiency of EWDM systems.

H5: There will be a significant positive relationship between Workflow Support and the adoption of EWDM systems.

H6: There will be a significant positive relationship between Workflow Support and the efficiency of EWDM systems.

H7: There will be a significant positive relationship between EWDM Efficiency and EWDM adoption.

Individual models for each theme, and their hypothetical impact can be seen in Figures 3, 4 and 5.

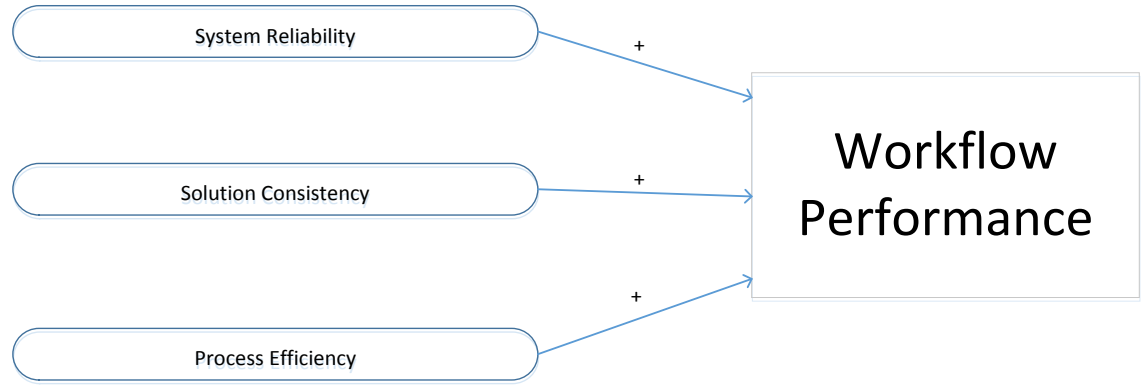


Figure 3: Significant Positive Relationships for Workflow Performance

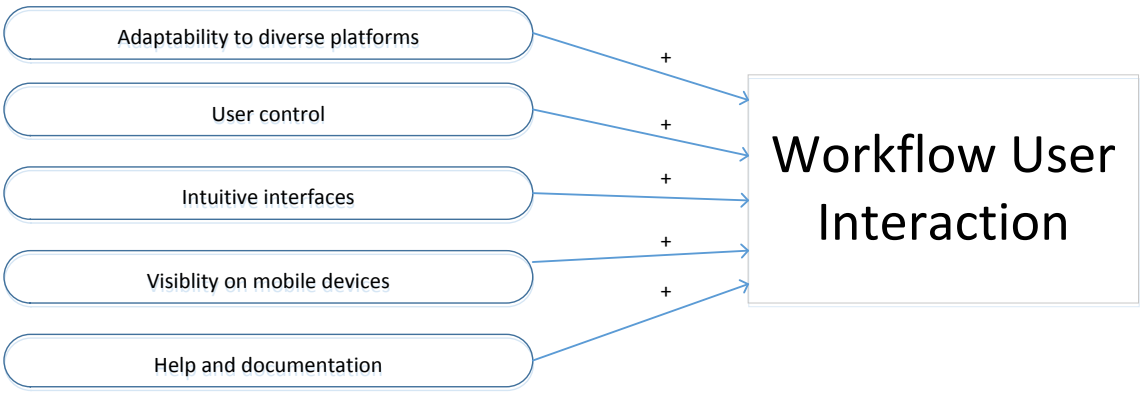


Figure 4: Significant Positive Relationships for Workflow User Interaction

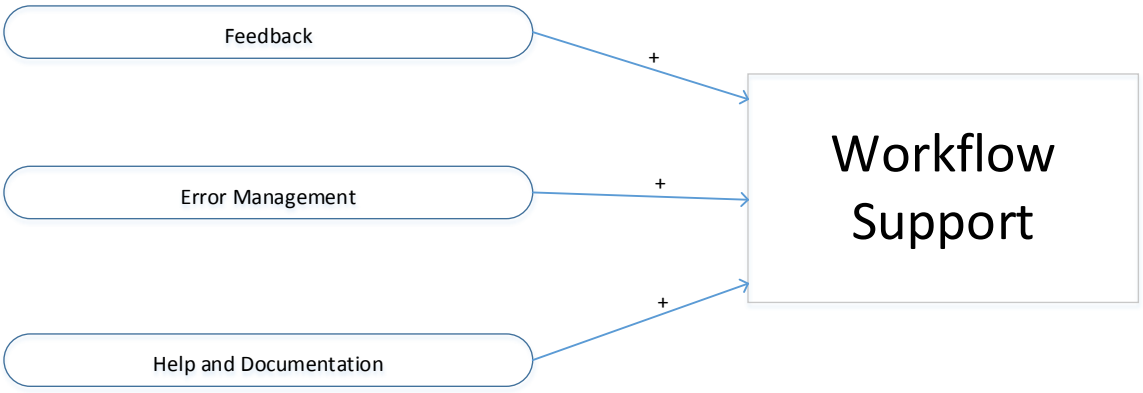


Figure 5: Significant Positive Relationships for Workflow Support

Data Analysis

A pre-survey was done prior to conducting the actual survey. The intention was to verify the validity of the survey instrument. An email was sent out to a total of 10 Hyland employees. Among the employees invited to the pre-survey were Managers, Team Leaders and Business Consultants of Hyland's Professional Services Group, who focus on providing workflow solutions worldwide. Seven responses were received.

Cronbach's Alpha was conducted on all questions of the Likert-scale using Statistical Package for Social Sciences® (SPSS), and a value of .665 was obtained (which

was less than the desired .70). This result could increase to .738 if an item regarding "feedback" was deleted. This led to modifying the question and renaming the Workflow Feedback theme to Workflow Support.

Cronbach's Alpha was also conducted on questions grouped by themes. The following results for the pre-survey were obtained.

- For the "performance" questions a Cronbach's Alpha of .600 was obtained with the possibility of deleting an item and obtaining a .722.
- For "user interaction" questions a .679 was obtained with the possibility of deleting an item and obtaining a .692.
- For questions regarding "feedback" (which was renamed to Support) a .313 with the possibility of a .513 by deleting a question was obtained. Although a .513 was still considered to be low, a possibility existed where an increased result may be obtained once renaming "feedback" to "support" and slightly modifying the focus of the theme questions. The focus of Workflow Feedback originally was on implementing alerts, notifications, help, and documentation. This theme was thought of being relevant in the design and development of a simple workflow application which had been proposed to be tested and evaluated by subject matter experts (SME's). Since this theme had such a low Cronbach's Alpha, it seemed to not be reliable or have a significant impact on either adoption or efficiency. For this reason the development of the proposed workflow application was therefore discarded. Nevertheless, this could be done in a future research study with a larger sample. The larger sample size may be

more adequate and lead to justifying the design and development of a test workflow application.

Factor Analysis tests were also conducted for the pre-survey results, but initially the following warning was provided by SPSS: "There are fewer than two cases, at least one of the variables has zero variance, there is only one variable in the analysis, or correlation coefficients could not be computed for all pairs of variables. No further statistics will be computed."

For samples of less than 300 participants, a Factor Anlysis may not be reliable according to Yong and Pearce (2013). Since there were only 7 participants in the pre-survey, this analysis was not considered reliable.

Summary

The approach and methodology for this research consisted initially of defining a list of heuristics and grouping them into themes. These heuristics were identified in a literature review and were based on usability issues found. A pre-survey was conducted with questions that were directly related to these usability issues. Cronbach's Alpha and Factor Analysis tests were conducted on the pre-survey which was later fine-tuned. The design and development of a simple workflow application to be evaluated by SME's was discarded due to the pre-survey results where Workflow Feedback was found to not have a reliable impact on adoption and efficiency. The Workflow Feedback theme was therefore modified and renamed to Workflow Support.

After concluding the pre-survey analysis described above, the actual survey was then conducted and Cronbach's Alpha, Factor Analysis and Regression tests were performed. The findings can be found in Chapter 4.

Chapter 4

Results

Introduction

The data collection process for this study began by designing and conducting a survey which was developed using Google Forms. The survey consisted of multiple choice questions, open-ended workflow related questions, a 7 point Likert-scale, and a section where participant demographic information was collected. The survey was emailed to a group of 41 workflow experts from Hyland Software. Thirty two responses were obtained. The Likert-scale results were evaluated for consistency and reliability using Cronbach's Alpha and Factor Analysis. It was based on the instrument used in Mosweu et al. (2016b) which was a study that focused on adoption and use of workflow solutions. The Likert-scale questions were modified for the survey and were previously detailed in Chapter 3. The Likert-scale items can be found in Appendix C.

An email indicating that the survey was available online was sent out December 18, 2016 (see Appendix D). The goal was to reach at least 30 respondents out of the possible 41 workflow experts. On January 20, 2017, a total of 32 participants had responded. This total represented a 78% response rate.

Instrument Validation

Descriptives

Due to a small amount of survey participants all responses were taken into account for this study. To enforce survey completeness all questions required a

participant response. The survey could not be submitted unless all questions had a valid response. Therefore there was no missing data nor incomplete responses.

Due to the fact that the identified themes (Workflow Performance, Workflow User Interaction, and Workflow Support) were the independent variables of this study, it was necessary to calculate an average score per participant based on the theme responses. The same calculation was done for the dependent variables EWDM Adoption and EWDM Efficiency, although EWDM Efficiency was also used as an independent variable impacting EWDM Adoption. This reasoning was all based on the Conceptual Model in Figure 2.

To amplify with an example of this process, if a participant's responses for the 4 questions on Workflow Performance were 5, 6, 5, and 7, an average of 5.75 was calculated. This value (for consistency with the Likert-scale) was rounded off to 6 and was assigned as the participant's response regarding Workflow Performance. This method would allow to evaluate the impact each theme had on EWDM Adoption and EWDM Efficiency. A spreadsheet was created in Excel to determine the averages and a screen-shot of the spreadsheet used in the calculation can be found in Appendix E. The rounded averages were then used as an SPSS dataset to begin regression analysis and can be found in Appendix F.

By conducting a visual inspection of the 32 average scores per theme, 4 possible response sets were identified as candidates for deletion. The response sets identified were for cases 16, 20, 28, and 32 (see response sets in Appendix F). A response set can be considered as an unengaged response where the participant simply provided the same answer on all questions. Due to the limited amount of participants and the uncertainty

that participants could be confirmed as unengaged, all response sets were included in the analysis.

Most relevant respondent descriptive statistics for this study are detailed in Table 1.

Table 1. Descriptives (N =32)

		Frequency	Percentage
Gender	Male	22	68.8%
	Female	10	31.2%
		Frequency	**Percentage**
Age	18-29	10	31.3%
	30-39	9	28.1%
	40-49	8	25%
	50 or over	5	15.6%
		Frequency	**Percentage**
Type of Industry – where respondents have most experience	Healthcare	7	21.9%
	Finance	1	3.1%
	Accounting	2	6.3%
	Other	22	68.7%
		Frequency	**Percentage**
Workflow Experience	1 to 5 yrs.	15	46.9%
	6 to 10 yrs.	10	31.3%
	Over 10 yrs.	7	21.8%

An interesting point regarding the type of industry where survey participants have most experience, is that most responded to have worked in industries other than healthcare, finance, and accounting. The survey did not prompt participants with a follow up question if it was answered as “other”. This may be something to follow up on in a future study. Healthcare is the second highest industry where the respondents have experience in with 22.9%. It was expected for healthcare to be high on the list according to the literature review.

Regression tests on EWDM Adoption and EWDM Efficiency were conducted and are explained in the Assumptions of Linear Regression section of this chapter. These tests are fundamental for this study since they should be helpful in predicting EWDM Adoption and EWDM Efficiency with a certain degree of accuracy based on the values of

the independent variables, as indicated by Terrell (2012). Additional regression tests were also conducted on gender and workflow years of experience. All results are detailed further below in this paper.

The additional regression tests by gender and years of experience were conducted since these may provide interesting insight on how Workflow Performance, Workflow User Interaction, and Workflow Support may impact EWDM Adoption and EWDM Efficiency. The years of experience tests in particular were considered relevant; with 46% of the respondents only having 1 to 5 years of experience with workflow and the remaining 53.1% having more than 5 years of experience, it would be interesting to evaluate if the independent variables may have a significant impact on dependent variables from a more experienced participant point of view.

Cronbach's Alpha

The instrument had previously been tested during the pre-survey for consistency and validity using Cronbach's Alpha. These results can be found in the Data Analysis section in Chapter 3. Nevertheless, a more thorough validation was conducted on the final survey results. Cronbach's Alpha, Factor Analysis and the Assumptions of Regression Analysis were also performed.

Regarding Cronbach's Alpha the following results were obtained from the final survey results:

- Workflow Performance = .925
- Workflow User Interaction = .899
- Workflow Support = .836
- Efficiency = .822

- For all question surveyed, an overall Cronbach's Alpha of .958 was obtained.

Based on these results, the instrument satisfied Cronbach's Alpha threshold of .70. According to Mertler and Vannatta (2013) a Cronbach's Alpha value must equal or greater than 0.7 to qualify as being reliable.

Factor Analysis

Factor Analysis tests were also performed. The conclusion reached was that due to the small sample size of 32, results were not reliable as noted by Yong and Pearce (2013). Although four components (Performance, User Interaction, Support and Efficiency) were identified as expected, the items did group together reliably on the SPSS Component Matrix. There were multiple instances of cross loading which is possible yet not the desirable. This may be an issue that could be verified in the future on a larger sample. The SPSS Component Matrix can be found in Appendix G.

Assumptions of Linear Regression

Williams, Grajales, and Kurkiewicz (2013) and Statistics Solutions (2017) concur that the assumptions of linear multiple regression are:

1. Zero conditional mean of errors – if violated it may be non-linear. A linear relationship should exist among the independent variables and the dependent variables. A visual inspection of a scatterplot can assist in defining the relationship.
2. Normal Distribution or errors - variables should be multivariate normal. A visual inspection of a histogram can assist in determining if a normal distribution exists.

3. Multi-collinearity – when a correlations has been identified between predictor values. Independent variables should be independent from each other. Four methods exist to verify multi-collinearity:
    a. Correlation Matrix – The correlation coefficients in Pearson's Bivariate Correlation matrix should be less than 1 among all independent variables as indicated by Mertler and Vannatta (2016).
    b. Tolerance (T) – measures the influence of an independent variable on all other independent variables. T should be greater than .1 for no or little multi-collinearity according to Mertler and Vannatta (2016).
    c. Variance Inflation Factor (VIF) – VIF should be less than 10 as noted in Mertler and Vannatta (2016).
    d. Condition Index – this index should be less than 10 for little or no multi-collinearity according to Statistics Solutions (2017).
4. Independence of errors – no auto-correlation. Residuals should be independent from each other. A Durbin-Watson generally suggests no auto-correlation when values are greater than 1.5 and less than 2.5 according to Statistics Solutions (2017).
5. Homoscedasticity – constant variance of errors. For each independent variable, the variance of error should be constant. A scatter plot will assist to check homoscedasticity as indicated by Statistics Solutions (2017).

Due to the small sample size of the survey, the assumptions of linear regression defined above were tested in the regression analysis performed for this research. The results of these test are presented in the next section of this chapter.

Quantitative Results

Introduction

Regression tests were conducted on adoption and efficiency. The assumptions of linear regression were evaluated for each regression test to support the instrument validity due to the unreliability of the Factor Analysis results (small sample size). All tests were done using SPSS. The regression results are presented in the following sections.

Regression tests on Adoption

Regression tests on Adoption (dependent variable) were conducted with the following independent variables:

1. Performance
2. User Interaction
3. Support
4. Efficiency

All variables and tests were configured in SPSS to test the Assumptions of Linear Regression. The results are detailed below:

Linear relationship

A visual inspection of a scatterplot output in SPSS, indicates a linear relationship among the independent and dependent variables producing the following a regression line: $y = -0.04+0.14(x)$. See Figure 6.

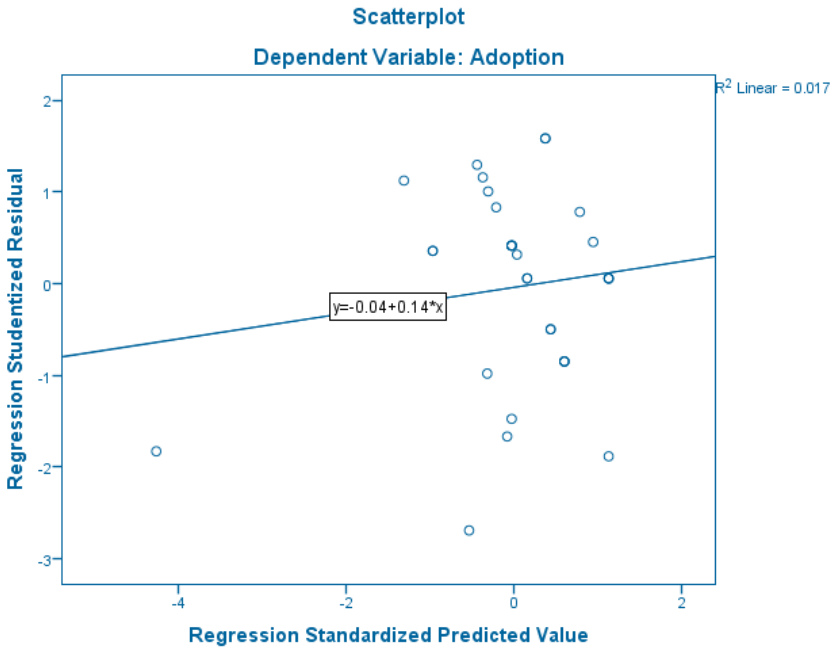


Figure 6: Scatterplot for Regression on Adoption

Multivariate normality

Although the visual inspection of the histogram (see Figure 7) suggests a normal distribution with negative skewness issues, a probability plot as indicated by Williams et al. (2013) can assist to verify if the assumption of normality has been met. If the residual dots cluster along the line, normality can be assumed according Mertler and Vannatta (2016). Figure 8 suggests that the assumption of normality has been met since the majority of the dots cluster along the line.

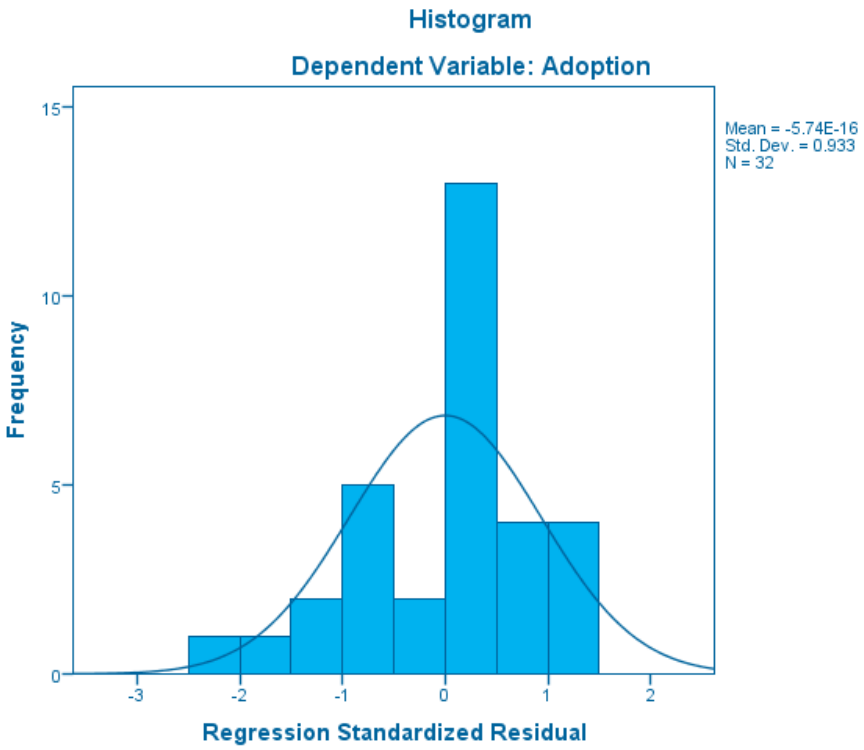


Figure 7: Histogram for Regression on Adoption

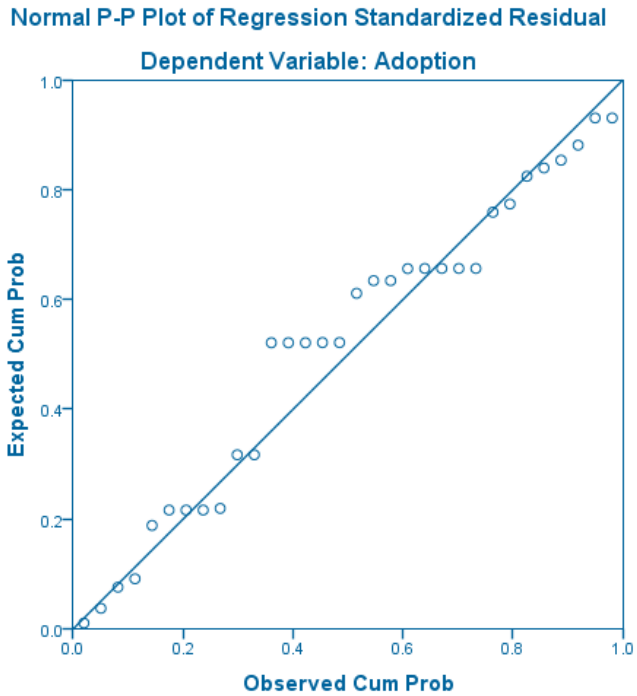


Figure 8: Normal P-Plot for Regression on Adoption

No or little multi-collinearity

As mentioned previously, there are four methods to identify no or little multi-collinearity. The correlation statistics tests of Tolerance and VIF for Adoption were evaluated and are displayed in Table 2.

Table 2: Collinearity Statistics on Adoption

Coefficients		
	Collinearity Statistics	
Model	Tolerance	VIF
Performance	.337	2.967
User Interaction	.374	2.672
Support	.414	2.414
Efficiency	.384	2.605

All Tolerance results are greater than .01 and the VIF results are less than 10. Therefore it can be suggested that no multi-collinearity exists.

A Pearson bivariate correlation test was also conducted to further validate and support the Tolerance and VIF results. This test indicates that factors are highly correlated if the Pearson Correlation (r) is larger than .90 according to Tabachnick and Fidell (2007). The highest value in Table 3 for a Pearson Correlation is a .851 which satisfies the threshold of not being larger than .90 and reconfirms the suggestion that no multi-collinearity exists.

Table 3. Pearson Correlation Matrix for Regression on Adoption

Correlations						
		Adoption	Performance	User Interaction	Support	Efficiency
Adoption	Pearson Correlation	1	.605	.750	.664	.851
Performance	Pearson Correlation	.605	1	.752	.686	.720
User Interaction	Pearson Correlation	.750	.752	1	.672	.678
Support	Pearson Correlation	.664	.686	.672	1	.704
Efficiency	Pearson Correlation	.851	.720	.678	.704	1

No auto-correlation

Durbin-Watson generally suggest no auto-correlation when values are greater than 1.5 and less than 2.5 according to Statistics Solutions (2017). The Durbin Watson test conducted in SPSS produced a 2.270 which indicates no auto-correlation. However, this test is not reliable for surveys due to the requirement of first order effects.

Homoscedasticity

A visual analysis of the scatter plot can be used to identify homoscedasticity. The way the dots are spread out in the scatter plot seem to suggest that homoscedasticity is not being violated and that the variances of the residuals are constant.

Hashimzade, Myles, and Black (2017) have indicated that the Breusch-Pagan test is a popular way to evaluate linear regression homoscedasticity. Although this test is not part of SPSS, macros exist online that can be imported into SPSS to do so. The macro used was developed by Daryanto (2013) and also includes the Koenker test. The execution produced the following results are presented in Table 4.

Table 4. Breusch-Pagan and Koenker on Adoption

	LM	Sig
Breusch-Pagan	4.064	.397
Koenker	4.536	.338

A Sig value less than .05 indicates homoscedasticity assumption has been violated according to the macro's output developed by Daryanto (2013).

Regression Analysis on Adoption

Hypotheses H1, H3, H5 and H7 respectively assume that Workflow Performance, Workflow User Interaction, Workflow Support, and EWDM Efficiency will have a

significant positive relationship with adoption. The regression on adoption test produced the following *p* value results in Table 5.

Table 5. Results for Regression Analysis on Adoption (N=32, df =4)

Independent Variables	(β)	Std. Error	Adoption
Intercept	-0.024	0.623	0.969
Performance	-0.288	0.155	0.073
User Interaction	0.478	0.154	0.004**
Support	0.066	0.150	0.665
Efficiency	0.712	0.137	0.000****
R-Square			0.804
Adjusted R-Squared			0.775
F			27.739
Prob. (F)			0.000
Hypotheses Supported?			H3: Yes; H7:Yes
Parameter estimates (*p)* are shown in each cell. * p<0.05; ** p<0.01; *** p<0.001; **** p<0.0001.			

A *p* value less than .05 is considered significant. According to the results, the only *p* values less than .05 are Workflow User Interaction and Efficiency. Therefore these results are significant. It can also be suggested that the relationship is a positive one based on the regression equation: y= a + b(x) where b is a positive value. The regression test on Adoption provided the following: y= -0.04+0.14(x). Based on these results it could be suggested that Workflow User Interaction and Efficiency have a significant positive relationship with EWDM adoption.

Regression test on Efficiency

Regression tests on Efficiency (dependent variable) were conducted with the following independent variables:

1. Performance
2. User Interaction
3. Support

All variables and tests were configured in SPSS to test the Assumptions of Linear Regression. The results are presented in the following sections.

Linear relationship

A visual inspection of a scatterplot output in SPSS, indicates a linear relationship among the independent and dependent variables producing the following a regression line: y = 0.01+2.13E-3(x). See Figure 9.

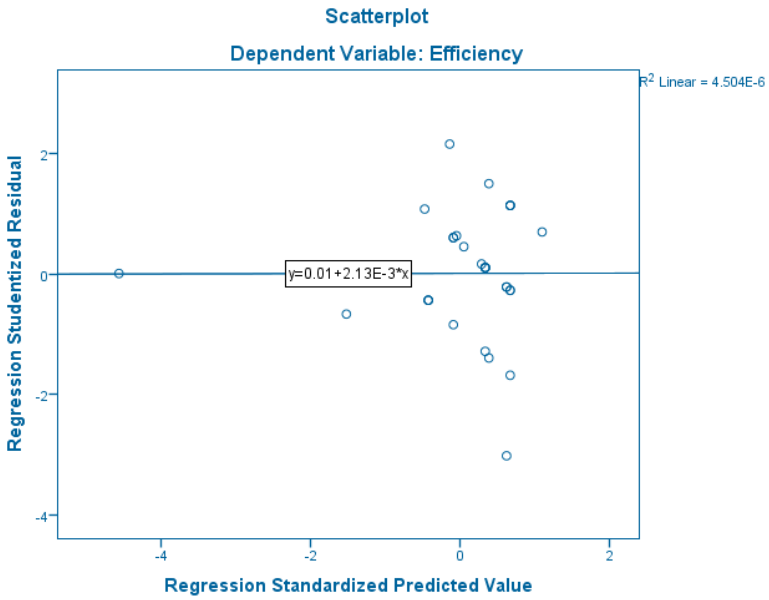


Figure 9: Scatterplot for Regression on Efficiency

Multivariate normality

Although the visual inspection of the histogram for Efficiency also suggests a normal distribution with negative skewness issues, the Normal P-Plot in Figure 10 suggests that the assumption of normality has been met since the majority of the dots cluster along the line.

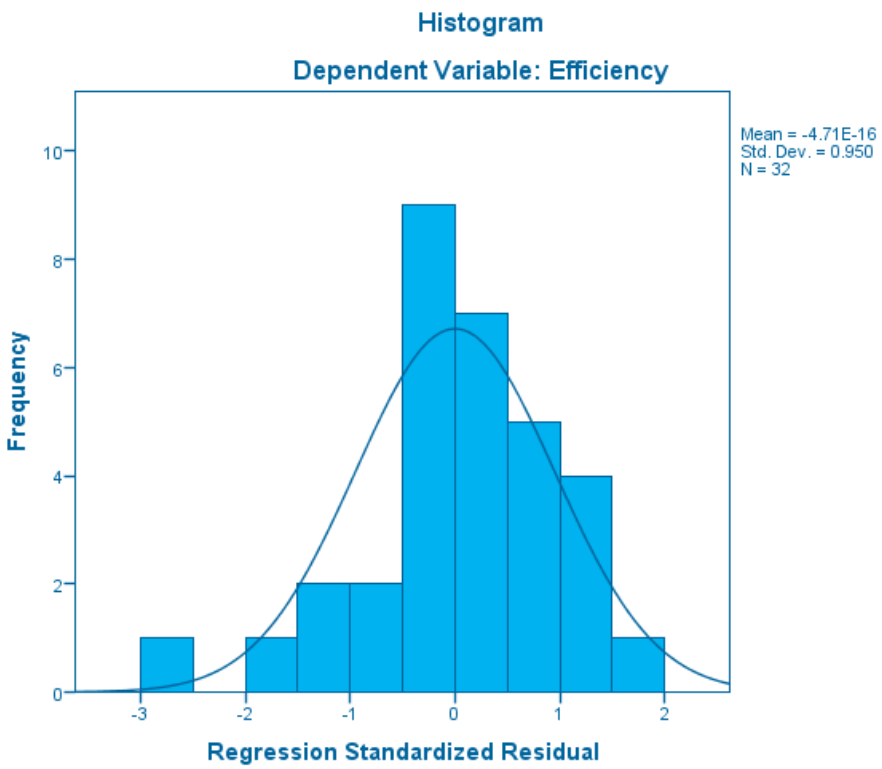


Figure 10: Histogram for Regression on Efficiency

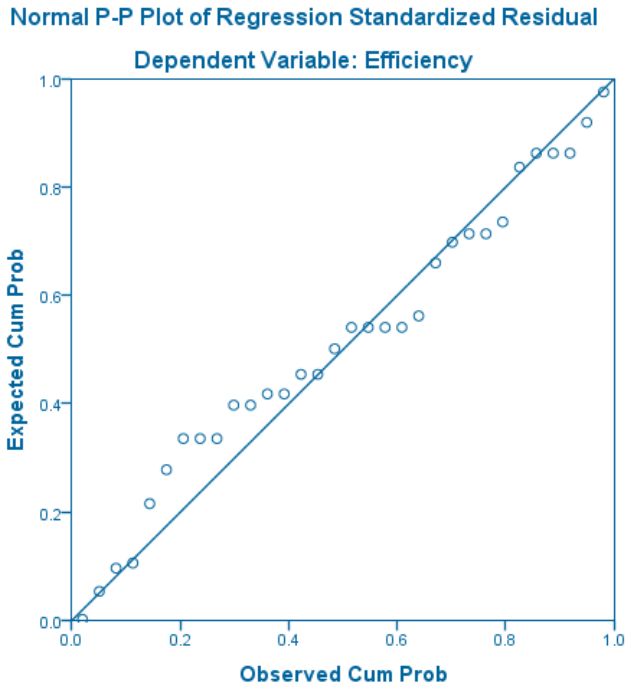


Figure 11: Normal P-Plot for Regression on Efficiency

No or little multi-collinearity

The correlation statistics tests of Tolerance and VIF for Efficiency are presented in Table 6.

Table 6. Collinearity Statistics on Efficiency

Coefficients		
	Collinearity Statistics	
Model	Tolerance	VIF
Performance	.375	2.665
User Interaction	.388	2.575
Support	.474	2.111

All Tolerance results are greater than .01 and the VIF results are less than 10. Therefore it can be suggested that no multi-collinearity exists.

The Pearson bivariate correlation tests are presented in Table 7 and also satisfy the threshold of not being larger than .90. This reconfirms the suggestion that no multi-collinearity exists.

Table 7. Pearson Correlation Matrix for Regression on Efficiency

		Adoption	Performance	User Interaction	Support
Efficiency	Pearson Correlation	1	.555	.622	.730
Performance	Pearson Correlation	.555	1	.752	.686
User Interaction	Pearson Correlation	.622	.752	1	.672
Support	Pearson Correlation	.730	.686	.672	1

No auto-correlation

The Durbin Watson test produced a 2.270 which indicates no auto-correlation. However, this test as mentioned previously is not reliable for surveys due to the requirement of first order effects.

Homoscedasticity

The way the dots are spread out in the scatter plot seem to suggest that homoscedasticity is not being violated and that the variances of the residuals are constant. The Breusch-Pagan and the Koenker tests were also conducted to reconfirm if homoscedasticity exists. The results of the tests are presented in Table 8.

Table 8. Breusch-Pagan and Koenker on Efficiency

	LM	Sig
Breusch-Pagan	5.270	.153
Koenker	3.056	.383

A Sig value less than .05 indicates homoscedasticity assumption has been violated according to the macro's output developed by Daryanto (2013).

Regression Analysis on Efficiency

Hypotheses H2, H4, and H6 respectively assume that Workflow Performance, Workflow User Interaction, and Workflow Support will have a significant positive relationship with Efficiency. The regression on Efficiency test produced the following *p* value results in Table 9.

Table 9. Results for Regression Analysis on Efficiency (N=32, df =3)

Independent Variables	**(β)**	**Std. Error**	**Efficiency**
Intercept	0.890	0.843	0.300
Performance	-0.039	0.199	0.845
User Interaction	0.269	0.205	0.201
Support	0.610	0.190	0.003**
R-Square			0.565
Adjusted R-Squared			0.518
F			12.120
Prob. (F)			0.000
Hypotheses Supported?			H6: Yes
Parameter estimates (*p)* are shown in each cell. * p<0.05; ** p<0.01; *** p<0.001; **** p<0.0001.			

According to the results, Workflow Support significantly impacts EWDM Efficiency since the value is less .05. The relationship is also a positive one based on the output regression equation of y= 0.01+2.13E(x). Based on these results it could be suggested that Workflow Support has a significant positive relationship with EWDM Efficiency.

Regression by Gender

Regression tests were conducted on Adoption and Efficiency by gender. The test for male responses produced the following regression line equation for Adoption: y=0.04 + 0.06(x). Significance levels are displayed in Table 10.

Table 10. Results for Regression Analysis on Adoption - Male (N=22, df =4)

Independent Variables	**(β)**	**Std. Error**	**Adoption**
Intercept	-0.294	0.763	0.705
Performance	0.040	0.256	0.879
User Interaction	0.401	0.185	0.044*
Support	-0.201	0.290	0.498
Efficiency	0.761	0.225	0.004**
R-Square			0.824
Adjusted R-Squared			0.782
F			19.876
Prob. (F)			0.000
Hypotheses Supported?			H3: Yes; H7:Yes
Parameter estimates (*p)* are shown in each cell. * p<0.05; ** p<0.01; *** p<0.001; **** p<0.0001.			

The results for male responses suggest the same for regression on EWDM Adoption results where Workflow User Interaction and Efficiency have a significant positive relationship with EWDM Adoption.

The regression test for female responses produced the following regression line equation for Adoption: y= -0.01 + 0.03(x). Significance levels are displayed in Table 11.

Table 11. Results for Regression Analysis on Adoption - Female (N=10, df =4)

Independent Variables	(β)	Std. Error	Adoption
Intercept	0.825	1.544	0.616
Performance	-0.065	0.231	0.790
User Interaction	0.281	0.218	0.253
Support	0.293	0.187	0.177
Efficiency	0.356	0.172	0.093
R-Square			0.751
Adjusted R-Squared			0.552
F			3.774
Prob. (F)			0.089
Hypotheses Supported?			None
Parameter estimates (*p)* are shown in each cell. * p<0.05; ** p<0.01; *** p<0.001; **** p<0.0001.			

For females the results for regression on Adoption did not suggest that any of the independent variables impact Adoption. In this case, all *p* values are greater than .05. This presented a different outcome from all previous regression on Adoption tests.

Regarding Efficiency the results for male responses produced the following regression line equation for Efficiency: y=0.01 - 0.01(x). Significance levels are displayed in Table 12.

Table 12. Results for Regression Analysis on Efficiency - Male (N=22, df =3)

Independent Variables	(β)	Std. Error	Efficiency
Intercept	0.695	0.868	0.434
Performance	-0.327	0.290	0.274
User Interaction	0.403	0.197	0 055
Support	0.810	0.282	0.010*
R-Square			0.683
Adjusted R-Squared			0.631
F			12.955
Prob. (F)			0.000
Hypotheses Supported?			H6: Yes
Parameter estimates (*p)* are shown in each cell. * p<0.05; ** p<0.01; *** p<0.001; **** p<0.0001.			

In this case for males the regression test suggests that only Workflow Support significantly impacts EWDM Efficiency with a *p* value of .01. Nevertheless the relationship with EWDM Efficiency is a negative one.

For female responses the regression tests produced the following regression line equation for Efficiency: y=0.09 + 7.67E-3(x). Significance levels are displayed in Table 13.

Table 13. Results for Regression Analysis on Efficiency - Female (N=10, df =3)

Independent Variables	(β)	Std. Error	Efficiency
Intercept	-0.538	2.197	0.815
Performance	-0.255	0.378	0.526
User Interaction	0.390	0.324	0.273
Support	0.948	0.285	0.016*
R-Square			0.713
Adjusted R-Squared			0.569
F			4.958
Prob. (F)			0.046
Hypotheses Supported?			H6: Yes
Parameter estimates (*p)* are shown in each cell. * p<0.05; ** p<0.01; *** p<0.001; **** p<0.0001.			

Once again the regression test suggests that only Workflow Support significantly impacts EWDM Efficiency with a *p* value of .016 for females. The relationship with EWDM Efficiency is a positive one.

Regression tests by Years of Experience

Additional regression tests were also conducted on Adoption and Efficiency by years of experience. The regression test on Adoption for the 1 to 5 years of experience range produced the following regression line equation with a negative impact on Adoption: y= - 0.02 - 6.18E(x). Significance levels are displayed in Table 14.

Table 14. Results for Regression Analysis on Adoption for 1-5 yrs. Exp. (N=15, df =4)

Independent Variables	(β)	Std. Error	Adoption
Intercept	0.310	2.742	0.912
Performance	0.202	0.729	0.788
User Interaction	0.357	0.316	0.286
Support	0.023	0.316	0.943
Efficiency	0.357	0.221	0.137
R-Square			0.557
Adjusted R-Squared			0.380
F			3.146
Prob. (F)			0.064
Hypotheses Supported?			None
Parameter estimates (*p)* are shown in each cell. * p<0.05; ** p<0.01; *** p<0.001; **** p<0.0001.			

The results for 1 to 5 years of experience on Adoption did not suggest a significant impact on EWDM Adoption.

For 6 to 10 years of experience the regression test once again did not suggest that any of the independent variables impact Adoption. All *p* values are greater than .05 (see Table 15) just as it was calculated for the 1 to 5 year range. Nevertheless the results present a positive relationship with the following regression line equation: y = -0.06 + 0.08(x).

Table 15. Results for Regression Analysis on Adoption for 6-10 yrs. Exp. (N=10, df =4)

Independent Variables	(β)	Std. Error	Adoption
Intercept	0.222	7.384	0.977
Performance	-0.259	0.490	0.619
User Interaction	0.292	0.423	0.521
Support	0.300	0.635	0.656
Efficiency	0.601	0.529	0.308
R-Square			0.404
Adjusted R-Squared			-0.072
F			0.849
Prob. (F)			0.551
Hypotheses Supported?			None
Parameter estimates (*p)* are shown in each cell. * p<0.05; ** p<0.01; *** p<0.001; **** p<0.0001.			

For the 11 years and above range the regression test did not suggest that any of the independent variables impact Adoption. All *p* values are greater than .05 (see Table 16) just as it was calculated for the 1 to 5 year and the 6 to 10 year ranges. Nevertheless the results present a positive relationship with the following regression line equation: y = -0.06 + 0.08(x).

Table 16. Results for Regression Analysis on Adoption for 11+ yrs. Exp. (N=7, df =4)

Independent Variables	(β)	Std. Error	Adoption
Intercept	-0.48	1.310	0.974
Performance	-0.095	0.543	0.877
User Interaction	0.095	1.028	0.935
Support	-0.381	0.579	0.578
Efficiency	1.333	0.667	0.184
R-Square			0.974
Adjusted R-Squared			0.921
F			18.571
Prob. (F)			0.052
Hypotheses Supported?			None
Parameter estimates (*p)* are shown in each cell. * p<0.05; ** p<0.01; *** p<0.001; **** p<0.0001.			

On Efficiency the test on the 1 to 5 years of experience produced the following regression equation with a negative impact: y= - 2.93E-5 – 1.02E3(x). See Table 17.

Table 17. Results for Regression Analysis on Efficiency for 1-5 yrs. Exp. (N=15, df =3)

Independent Variables	(β)	Std. Error	Efficiency
Intercept	1.585	2.367	0.517
Performance	-0.732	0.594	0.244
User Interaction	0.707	0.274	0.025*
Support	0.707	0.274	0.025*
R-Square			0.634
Adjusted R-Squared			0.534
F			6.356
Prob. (F)			0.009
Hypotheses Supported?			H4: Yes; H6: Yes
Parameter estimates (*p)* are shown in each cell. * p<0.05; ** p<0.01; *** p<0.001; **** p<0.0001.			

The results for 1 to 5 years of experience suggest a significant impact on EWDM Efficiency for Workflow User Interaction and Workflow Support. The findings for Workflow Support concur with original regression tests on Efficiency. Nevertheless the relationship is not a positive one.

For 6 to 10 years of experience the regression test did not suggest that any of the independent variables impact Efficiency. All *p* values are greater than .05 (see Table 18), just as the results for the 1 to 5 year range. Nevertheless the results present a positive relationship with the following regression line equation: y = -0.02 - 0.01(x).

Table 18. Results for Regression Analysis on Efficiency for 6-10 yrs. Exp. (N=10, df =3)

Independent Variables	(β)	Std. Error	Efficiency
Intercept	1.833	4.625	0.706
Performance	-0.542	0.422	0.246
User Interaction	0.250	0.395	0.550
Support	1.000	0.559	0.124
R-Square			0.457
Adjusted R-Squared			0.185
F			1.680
Prob. (F)			0.269
Hypotheses Supported?			None
Parameter estimates (*p)* are shown in each cell: * p<0.05; ** p<0.01; *** p<0.001; **** p<0.0001.			

For the 11 years and above range the regression test did not suggest that any of the independent variables impact Efficiency. All *p* values are greater than .05 (see Table 19) just as the results for the 1 to 5 and the 6 to 10 year ranges. Nevertheless the results present a positive relationship with the following regression line equation: y = -0.06 + 0.08(x).

Table 19. Results for Regression Analysis on Efficiency for 11+ yrs. Exp. (N=7, df =3)

Independent Variables	(β)	Std. Error	Efficiency
Intercept	-1.107	2.066	0.629
Performance	-0.714	0.843	0.459
User Interaction	1.964	1.626	0.313
Support	-1.07	0.857	0.908
R-Square			0.854
Adjusted R-Squared			0.708
F			5.857
Prob. (F)			0.090
Hypotheses Supported?			None
Parameter estimates (*p)* are shown in each cell. * p<0.05; ** p<0.01; *** p<0.001; **** p<0.0001.			

Qualitative Results

Introduction

The survey also included a total of six questions where the participants could comment and provide their opinions regarding the proposed set of heuristics and other factors they considered to be relevant regarding to Adoption and Efficiency of a workflow implementation. These questions have been presented in Chapter 3 as the General survey questions and Open-ended questions.

General survey & Open-ended questions Assessment

Regarding the General survey questions the following responses and comments were collected:

Question 1: Which is more important for customers when they are considering to adopt a workflow solution? Performance, User Interaction, Support or Efficiency?

Assessment 1*:* Efficiency was found to be the most important factor with 64.3% of the respondents indicating so. All results are displayed in Table 20.

Table 20. Responses to Question 1

Variable	Percent of respondents
Performance	21.4%
User Interaction	14.3%
Support	0%
Efficiency	64.3%

The qualitative results support the regression analysis results. Findings suggest that Workflow User Interaction and Efficiency have a significant positive relationship with EWDM Adoption. Workflow Support impacted EWDM Efficiency but not EWDM Adoption which also is suggested by the results since it did not receive any responses.

Question 2: Which is more important for customers when evaluating efficiency of a workflow solution? Performance, User Interaction or Support?

Assessment 2*:* User interaction was found to be the most important factor with 64.3% of the respondents indicating so. Performance was the only other factor pointed out by participants as the most important factor with a 35.7%.

Question 3: The proposed set of heuristics will significantly promote the adoption, and efficiency of an electronic workflow document management system. Answer "Yes", "No", or "Other" and briefly explain.

Assessment 3*:*

A total of 31 participants answered "Yes" which is equal to 96.9%. Only 1 participant answered "Other" and commented "Yes, with additional heuristics".

Question 4: What additional heuristics should be added to the proposed set? Should any be removed? Briefly explain.

Assessment 4*:*

The complete list of responses can be found in Appendix H, nevertheless responses that were similar were categorized in Table 21.

Table 21. Categorized Responses for Question 4

Heuristic recommendations	Number of Responses	Percent
Training	5	16%
Simplicity/Ease of use	5	16%
Configurability/Added Functionality	4	13%
Reporting	3	9%
Processing Time	3	9%
Design	2	6%
Others	7	22%
No heuristics should be removed	3	9%
TOTAL	32	100%

Question 5: What factors do you consider increase efficiency and enhance adoption in present day workflow solutions? Briefly explain.

Assessment 5*:*

Findings suggests that Workflow User Interaction plays a very important role regarding EWDM Adoption. Approximately 50% (15 out of 32) of the respondents mentioned terms such as ease of use, simplicity, familiarity and user interfaces. Regarding EWDM Efficiency, responses were oriented around productivity. Respondents seem to concur that a good user interface will also enhance productivity.

Question 6: How will the proposed set of heuristics promote present day workflow adoption and efficiency? Briefly explain.

Assessment 6*:*

The responses suggest that the proposed set of heuristics will promote workflow adoption and efficiency in various ways. Simplicity, ease of use and enjoyable user interfaces seem to be factors the respondents consider to impact adoption. Below are a few examples of how the question was answered:

- “Making the workflow dynamic and easy to use is important, but more than anything I think user-understanding and adaptability is the most important. These

items will allow for a faster adoption of a process. No one likes to learn anything new right off the bat, but if they're only learning small things, such as one additional button to their existing process, it will be easier for them to adopt."

– Participant #9

- "Making solutions easy/enjoyable to use"

  – Participant #11

- "Intuitive Interface - people do not read documentation or the documentation will grow out of date. Simplicity is the best."

  – Participant #12

- "By having similar designs and consistency of feel on multiple devices will make it more enjoyable for users if they have to use separate devices like a PC and Mobile."

  – Participant #18

- "The more familiar applications and interfaces are to other popular, widely used business applications, will reduce user training needs and decrease the amount of time a user is up to speed and efficient with new applications."

  – Participant #19

Regarding efficiency, the participants seemed to base their responses on their experience in different industries. Concept such as processing time, processing volumes, error management, user satisfaction, confidence in the process, and return on investment (ROI) seemed to be related to adaptability, productivity, and efficiency. Below are a few examples of how the question was answered:

- “Hospitals are adopting this when a patient check in. Higher education uses workflow to make the process of an applicant fast and effective.”

  – Participant #4

- “Decrease in processing times and increase in processing volume”

  – Participant #6

- “Good ROI to the company, more precise process and less errors, better error handling and exceptions in a process, better way to get notify using alerts, timers, notifications etc. avoid lot of dependant”

  – Participant #8

- “This list is quite complete and will increase confidence that the workflow solution will operate efficiently.”

  – Participant #14

- “Users are much more likely to adopt a solution that proves to be more efficient. But even if the solution may be more efficient for some, but adding work for others, the solution overall may not be adopted well. Each user needs to be accounted for. Solution Owners and Champions must convey the importance of the solution and why changes are being made to the end users to help sell the solution.”

  – Participant #25

Summary

In this chapter an initial overview of the survey and the instrument’s validity was presented. A description of the sample size, survey completeness, and the analysis of the

response sets was provided and discussed, as was the data preparation of averaging scores for the regression tests on adoption and efficiency. Participant descriptive statistics such as gender, age, type of industry, and years of experienced using workflow were also presented and reviewed.

Regarding instrument validation, details on the Cronbach's Alpha and Factor Analysis tests were indicated as being the initial tools used as validation methods. The assumptions of linear regression were defined as an additional method of validating the instrument.

The results for the quantitative tests of this research were presented in this chapter. The main goal was to test regression on both Adoption and Efficiency. These were defined as the dependent variables in SPSS. Performance, User Interaction, Support, and Efficiency were defined as the independent variables. Due to the small number of participants the assumptions of linear regression (linearity, normality, no or little multi-collinearity, no autocorrelation and homoscedasticity) were evaluated to ensure the instrument's validity.

Once the assumptions of linear regression were completed, the significance and relationship of the independent variables with the dependent variables was evaluated. The results suggest that Workflow User Interaction and Efficiency have a significant impact on EWDM Adoption. The relationship was then evaluated based on the regression line equation and a positive relationship was found. These findings suggest that the null hypotheses for H3 and H7 may be rejected.

Regarding regression on Efficiency, the results suggest that Workflow Support has a significant positive relationship with EWDM Efficiency. Hence the null hypothesis for H6 may be rejected.

Regression tests were also conducted on Adoption and Efficiency by gender and years of experience. The regression results by male gender concur with the main regression test results. These display the same independent variables having a significant positive relationship with the dependent variables.

Years of experience was also evaluated using regression. Three ranges were accounted for (1 to 5 years, 6 to 10 years, and 11 or above). Results suggest that none of the ranges have a significant positive relationship on either EWDM Adoption or EWDM Efficiency. Although Workflow User Interaction and Workflow Support do display significant impact (*p* value = .025 in both cases) on EWDM Efficiency, the relationship between the variables is a negative one. The final results can be found in Appendix I.

This chapter also presented the responses to the general survey and open-ended questions. Responses suggest that the qualitative study of this research is closely aligned with the quantitative results. Efficiency was found to be the most important factor regarding Adoption with a 64.3% while User Interaction had 14.3%. These factors were also found to have significant positive relationships with Adoption as part of the quantitative study.

However, the responses regarding Efficiency do not suggest to be aligned with the quantitative study. Support was found to have a significant positive relationship with Efficiency, nevertheless it was not considered an important factor in the qualitative results. User Interaction was the factor found to be most important with 64.3% followed

by Performance with 35.7%. Support did not receive any participant responses indicating it impacted Efficiency.

Open-ended questions suggest the importance of simplicity, ease of use, and training. These were identified as common factors and participants seemed to mention them frequently. Participant experience in different industries was notable, as well as issues and situations that they seem to have encountered. This concurs with the demographic data collected where 46.9% of the participants indicated having more than 6 years of experience using workflow, 90.6% indicated having technical training or certifications, and 96.9% indicated having a Bachelor's degree or above.

Regarding their opinion on the proposed set of heuristics, 96.9% indicated that they agree that the proposed heuristics could enhance EWDM Adoption and increase EWDM Efficiency of workflow systems. Among the suggested heuristics that were mentioned as possible additions to the proposed set were concepts related to training, simplicity, configurability, reporting, processing, and allowing the user to add functionality.

Chapter 5

Conclusion

Introduction

The goal set for this research was to define an overarching set of usability heuristics which may serve as guidelines for the adoption and enhanced efficiency of present and future workflow solutions. The conclusions derived from this research are presented in this chapter as well as the limitations that were encountered. Recommendations pertinent to the findings and possible future research will also be presented and discussed.

Conclusions

This research addressed the problem of adoption of devices with workflow solutions which was indicated as not being successful by Cardoso et al. (2014). Although the authors stated that integrating mobile devices with workflow was suggested, mobility was found to have been overlooked regarding workflow implementations. Previously Alalwan and Weistroffer (2012) recognized that process efficiency is a critical factor for the adoption of document management systems.

The unsuccessful adoption of devices with workflow may have been based on a lack of intuitive interfaces which negatively affect the use of workflow solutions as noted by Gesing et al. (2014). In general terms, usability aspects were not being considered in document management systems according to Heinicke et al. (2015).

Therefore, this research focused on identifing the usability heuristics that could ensure the adoption and efficiency of a workflow implementation. A literature review was conducted and a proposed set of usability heuristics grouped by themes (Workflow

Performance, Workflow User Interaction, and Workflow Support) was the result (see Table A3 of Appendix A).

To validate the proposed set of usability heuristics a survey was conducted where quantitative and qualitative data was collected. The data analysis began with the validation of a 7 point Likert-scale using Cronbach's Alpha as a measure of reliability. The collected data was then evaluated accordingly. Regression analysis was the main test conducted on the quantitative data where the assumptions of linear regression were evaluated. General survey and open-ended questions were used for the qualitative data analysis. In some cases the qualitative data responses were grouped and categorized for evaluation purposes and used to support the quantitative findings.

The regression tests were conducted on the following variables defined and executed in SPSS:

1. Adoption – where Performance, User Interaction, Support and Efficiency were the independent variables (Table 5).
2. Efficiency – where Performance, User Interaction, and Support were the independent variables (Table 9).
3. Adoption by Gender – same independent variables, tested for Male and Female (Tables 10 and 11).
4. Efficiency by Gender – same independent variables, tested for Male and Female (Tables 12 and 13).
5. Adoption by Years of Experience – same independent variables tested on 3 ranges (Tables 14 through 16).

6. Efficiency by Years of Experience – same independent variables tested on 3 ranges (Tables 17 through 19).

Once all quantitative and qualitative analysis was complete, the goal of this research was focused on. In order to establish an overarching set of workflow usability heuristics for adoption and efficiency, the proposed set of usability heuristics in Figure 1 was modified to reflect the results. Table A3 was needed to accomplish this since the heuristics in this table were organized by theme. The research findings suggest that Workflow User Interaction and Efficiency have a significant positive relationship with EWDM Adoption. Regarding efficiency, the results suggest that Workflow Support has a significant positive relationship with EWDM Efficiency. Since the Workflow Performance usability heuristics identified in the literature review were not found to have a significant positive relationship with either EWDM Adoption or EWDM Efficiency, these heuristics were removed from the list.

The modified table with heuristics grouped into themes can be found in Table I5 of Appendix I, and the new proposed set of EWDM heuristics for Adoption and Efficiency are presented in Figure 12.

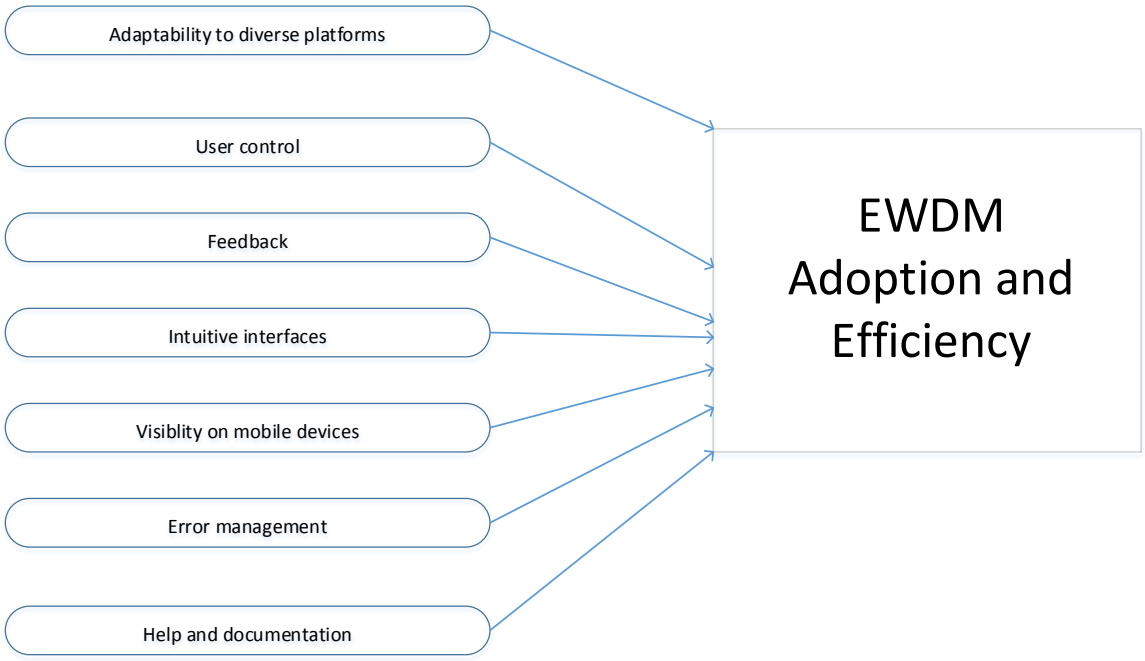


Figure 12: New Proposed set of EWDM Heuristics for Adoption and Efficiency

Limitations

This research had a few limitations that could be possibly be overcome in a future follow up study. One limitation was that a lack of literature exists regarding usability heuristics on EWDM solutions that focus on business processes. Although these solutions are becoming widely used worldwide, literature is limited.

A second limitation was that all survey participants were from a single company, which may be considered to be biased. A wider universe of participants could assist in overcoming this limitation.

The third and most important limitation encountered was the number of survey participants available. Out of a possible 41 participants from the Professional Services Group (PSG) at Hyland Software, only 32 responded. Although the goal was to reach 30

participants, if this number could increase, results from tests such as the Factor Analysis would be more reliable.

Recommendations

Future research could be conducted on a larger unbiased sample to expand on and corroborate findings. The study could evaluate different EWDM systems, focus on certain industries, and participants could be invited through professional social media sites such as LinkedIn.

Another option is to develop an application which could be tested on desktop, web, and mobile devices once a proposed set of heuristics is defined. The idea of incorporating SME's to test and validate the application based on the defined set of heuristics could also be done. Initially this was going to be part of this research but after the initial pre-survey findings and the small sample size, its relevance was questioned and so it was discarded.

Summary

The research findings presented in this chapter assist in accomplishing the main goal of this research. The study serves as a basis for identifying usability heuristics that may enhance adoption and increase efficiency of EWDM systems, despite the research limitations described herein. The findings answered the research questions and assisted in modifying a set of proposed workflow usability heuristics that significantly impact EWDM Adoption and EWDM Efficiency. The most important findings this study has identified are:

1. Workflow User Interaction and Efficiency are suggested as having a significant positive relationship with EWDM Adoption.
2. Workflow Support is suggested to have a significant positive relationship with EWDM Efficiency.

Literature regarding usability heuristics support these findings. Joyce et al. (2014) mentioned at least 3 heuristics for mobile devices that focus on user interaction, which was suggested to impact EWDM Adoption in this study. One of the heuristics mentioned by Joyce et al. (2014) indicated that a simple, focused, glanceable, intuitive, and aesthetically pleasing interface should be employed for mobile devices. Intuitive interfaces were also suggested for workflow implementations in this study, and findings suggest how significant user interaction is for workflow adoption with a *p* value of .004 (see Table 5). Workflow User Interaction should be as effortless as possible and easy to learn by implementing consistent and familiar interfaces. All of these characteristics were mentioned as usability heuristics for mobile devices by Joyce et al. (2014), and are also components of the Workflow User Interaction theme for this study. The relationship Workflow User Interaction has with EDWM Adoption is therefore understandable. An argument could be made that workflow adoption may be affected by how simple a solution is to use.

In this study Efficiency was based on obtaining results according to user effort and expectations such as keyboard short cuts, type ahead options and ease of use. This was also found to be significant for mobile devices. Ahmed and Arif (2015) suggested various usability heuristics for Android applications such as the functionality to type

ahead, redo actions, undo actions and ease of use for first time users. The authors considered all of these heuristics to make applications more usable, thus more efficient. According to the literature review and the research findings where Efficiency had a *p* value of .000 (see Table 5), an argument could be made that adoption may also be affected by the efficiency of the solution. Gesing et al. (2014) also suggested that an intuitive interface enhances using workflow solutions, hence workflow adoption.

Workflow Support heuristics related to alerts, feedback, help, and documentation were also considered for this study. Joyce et al. (2014) also mentioned that preventing and assisting with errors, such as offering a user advice on how to deal with an error and proceed, is suggested as a mobile application usability heuristic. As noted previously, the undo and redo actions suggested by Ahmed and Arif (2015), would also contribute to a more efficient workflow process by granting the user an opportunity to recover from a mistake made. Therefore it seems understandable to suggest how significant support is for workflow efficiency with a *p* value of .003 (see Table 9). An argument could be made that efficiency may be affected by the support provided by its solution.

Regarding the qualitative results, findings also suggest that Workflow User Interaction and Efficiency are important factors for EWDM Adoption. A total of 64.3% or the participants indicated that Efficiency was the most important factor for EWDM Adoption, while 14.3% chose User Interaction (see Table 20). For EDWM Efficiency, User Interaction was found to be the most important factor with 64.3% which indicated a difference from the quantitative results. Workflow Support was found to have a significant impact on EWDM Efficiency instead of User Interaction according to the regression analysis.

To conclude, the research findings suggest that user interaction and efficiency may contribute to the adoption of a workflow solution, and that support enhances its efficiency. These findings could be taken into consideration for future workflow implementations.

Appendix A

Proposed heuristics for workflow usability

Table A1 provides references of workflow usability issues found in literature and are listed under the second column labeled Related EWDM Heuristics. These issues were evaluated as applicable to a corresponding heuristic in Nielsen (1995) under the first column labeled Nielsen's 10. In some cases, more than one issue was listed as relevant for supporting purposes.

Table A1. Related Heuristics for Workflow Usability based on Nielsen's 10

Nielsen's 10	Related EWDM Heuristics	Reference
Visibility of system status	Immediate feedback of real-time workflow status	Joyce et al. (2014)
Match between system and the real world	Workflow adaptability to realistic needs and environments	Grabenbauer, Fruhling, and Windle (2014)
User control and freedom	Ability to cancel, rollback, or exit tasks prior to completion	Ahmed and Arif (2015)
Consistency and standards	Consistent platforms and response times from diverse devices	Poulymenopoulou et al. (2014)
Error prevention	Errors are prevented when possible	Joyce et al. (2014)
Recognition rather than recall	Effortless input is facilitated Appropriate use of device functions	Joyce et al. (2014) Joyce et al. (2014)
Flexibility and efficiency of use	Adaptability to diverse user interfaces Satisfy diverse mobile environments	Joyce et al. (2014) Barrera et al. (2014)
Aesthetic and minimalist design	Intuitive interfaces to encourage workflow use	Gesing et al. (2014)
Help users recognize, diagnose, and recover from errors	Ability to validate communications from devices prior to actions	Ahmed and Arif (2015)
Help and documentation	Help is provided throughout the workflow stages	Joyce (2014)

Table A2 groups the issues that were presented previously into the new heuristics mentioned in Figure 1.

Table A2. Proposed List of Heuristics with Supporting Related Heuristics

Proposed Heuristic
Adaptability to diverse platforms
Workflow adaptability to realistic needs and environments
Adaptability to diverse user interfaces
Satisfy diverse mobile environments
System reliability
Immediate feedback of real-time workflow status
Solution consistency
Consistent platforms and response times from multiple devices
Process efficiency
Effortless input is facilitated
Appropriate use of device functions
User control
Ability to cancel, rollback, or exit tasks prior to completion
Feedback
Ability to validate communications from devices prior to actions
Intuitive interfaces
Intuitive interfaces promote adoption and efficiency
Visibility on mobile devices
Intuitive interfaces promote adoption and efficiency
Error management
Errors are prevented when possible
Help and documentation
Help is provided throughout the workflow stages

Table A3 groups the 10 new heuristics into three themes.

Table A3. Heuristics grouped into themes

Workflow Performance	**Workflow User interaction**	**Workflow Support**
System reliability	Adaptability to diverse platforms	System Feedback
Solution consistency	User control	Error management
Process Efficiency	Intuitive interfaces	Help and Documentation
	Visibility on mobile devices	

Appendix B

Demographics

1. Gender (male, female)
2. Age
3. Occupation
4. Type of industry (healthcare, finances, education)
5. Number of years in Information Systems (1-5, 6-10, 11-15 , over 15)
6. Years of experience with EWDM systems (1-5, 6-10, 11-15 , over 15)
7. Highest level of education completed and major (bachelor degree, master degree, doctoral degree)
8. Technical trainings or certifications

Appendix C

Pre-survey Likert-Scale
Strongly Disagree to Strongly Agree

Using workflow would enhance my job effectiveness.
Using workflow in my job would enable me to accomplish tasks more quickly.
Using workflow will make my job easier to do since I will be more productive.
Using workflow will enable me to spend less time on routine tasks.
Performance is a critical factor to consider for adoption.
Performance critically affects efficiency.
As a user my interaction with workflow is clear and understandable.
I could develop skills needed to use a workflow solution, if user controls are provided.
Intuitive interfaces makes a workflow solution easy to use.
Intuitive interfaces makes a workflow solution easy to learn.
User Interaction is a critical factor to consider for adoption.
User Interaction critically affects efficiency.
With useful documentation, I will have the necessary knowledge to use a workflow solution.
For workflow error management, adequate resources are available.
Solution feedback is essential to avoid errors or difficulties.
Support is a critical factor to consider for adoption.
Support critically affects efficiency.
Efficiency is a critical factor to consider for adoption.

Appendix D

Survey Email

Hello, PSGers!

As part of my graduate studies with Nova Southeastern University, I'm conducting a research study titled "Defining usability heuristics for adoption and efficiency of an electronic workflow document management system". Permission has been granted by PSG management to reach out to personnel and recruit participants for a simple survey. I currently need at least 30 participants who have at least 1 year of workflow experience as a consultant, or as a user. The survey will only take around 10 – 15 minutes of your time.

If you are willing to participate and are available to complete the survey, please view the attached Participant Letter prior to filling out the survey by clicking here or copying https://goo.gl/forms/pdFlmwreYgEa1GvM2 and pasting it to your browser.

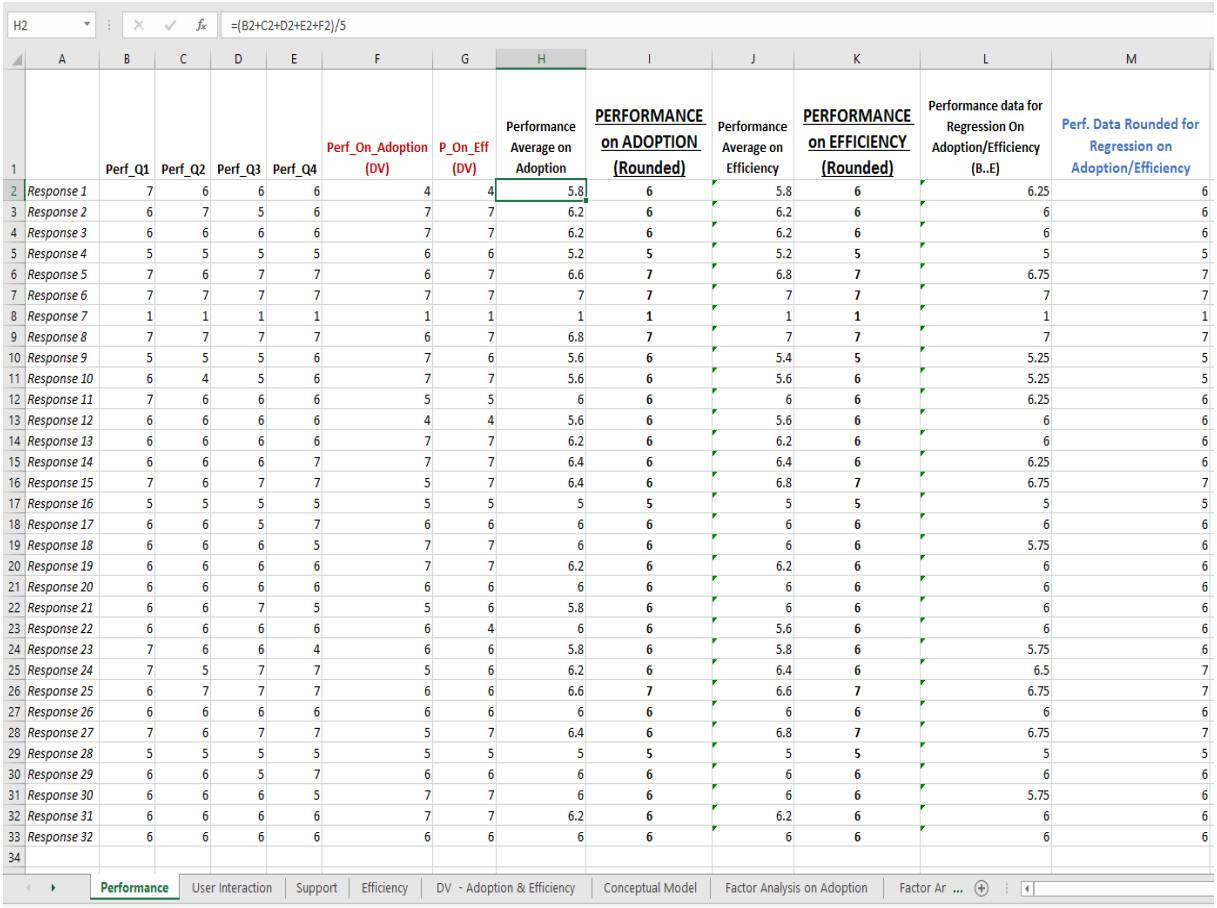
Any questions, please feel free to contact me…

Thank you for your support,

Steven Fuentes

Appendix E

Score Averages



H2 =(B2+C2+D2+E2+F2)/5

	A	B	C	D	E	F	G	H	I	J	K	L	M
1		Perf_Q1	Perf_Q2	Perf_Q3	Perf_Q4	Perf_On_Adoption (DV)	P_On_Eff (DV)	Performance Average on Adoption	PERFORMANCE on ADOPTION (Rounded)	Performance Average on Efficiency	PERFORMANCE on EFFICIENCY (Rounded)	Performance data for Regression On Adoption/Efficiency (B..E)	Perf. Data Rounded for Regression on Adoption/Efficiency
2	*Response 1*	7	6	6	6	4	4	5.8	6	5.8	6	6.25	6
3	*Response 2*	6	7	5	6	7	7	6.2	6	6.2	6	6	6
4	*Response 3*	6	6	6	6	7	7	6.2	6	6.2	6	6	6
5	*Response 4*	5	5	5	5	6	6	5.2	5	5.2	5	5	5
6	*Response 5*	7	6	7	7	6	7	6.6	7	6.8	7	6.75	7
7	*Response 6*	7	7	7	7	7	7	7	7	7	7	7	7
8	*Response 7*	1	1	1	1	1	1	1	1	1	1	1	1
9	*Response 8*	7	7	7	7	6	7	6.8	7	7	7	7	7
10	*Response 9*	5	5	5	6	7	6	5.6	6	5.4	5	5.25	5
11	*Response 10*	6	4	5	6	7	7	5.6	6	5.6	6	5.25	5
12	*Response 11*	7	6	6	6	5	5	6	6	6	6	6.25	6
13	*Response 12*	6	6	6	6	4	4	5.6	6	5.6	6	6	6
14	*Response 13*	6	6	6	6	7	7	6.2	6	6.2	6	6	6
15	*Response 14*	6	6	6	7	7	7	6.4	6	6.4	6	6.25	6
16	*Response 15*	7	6	7	7	5	7	6.4	6	6.8	7	6.75	7
17	*Response 16*	5	5	5	5	5	5	5	5	5	5	5	5
18	*Response 17*	6	6	5	7	6	6	6	6	6	6	6	6
19	*Response 18*	6	6	6	5	7	7	6	6	6	6	5.75	6
20	*Response 19*	6	6	6	6	7	7	6.2	6	6.2	6	6	6
21	*Response 20*	6	6	6	6	6	6	6	6	6	6	6	6
22	*Response 21*	6	6	7	5	5	6	5.8	6	6	6	6	6
23	*Response 22*	6	6	6	6	6	4	6	6	5.6	6	6	6
24	*Response 23*	7	6	6	4	6	6	5.8	6	5.8	6	5.75	6
25	*Response 24*	7	5	7	7	5	6	6.2	6	6.4	6	6.5	7
26	*Response 25*	6	7	7	7	6	6	6.6	7	6.6	7	6.75	7
27	*Response 26*	6	6	6	6	6	6	6	6	6	6	6	6
28	*Response 27*	7	6	7	7	5	7	6.4	6	6.8	7	6.75	7
29	*Response 28*	5	5	5	5	5	5	5	5	5	5	5	5
30	*Response 29*	6	6	5	7	6	6	6	6	6	6	6	6
31	*Response 30*	6	6	6	5	7	7	6	6	6	6	5.75	6
32	*Response 31*	6	6	6	6	7	7	6.2	6	6.2	6	6	6
33	*Response 32*	6	6	6	6	6	6	6	6	6	6	6	6
34													

Performance | User Interaction | Support | Efficiency | DV - Adoption & Efficiency | Conceptual Model | Factor Analysis on Adoption | Factor Ar ...

Appendix F

Participant average scores by theme

Table F1. Scores used for Regression on: Adoption

Participant #	Independent Variables				Dependent Variable
	Performance	User Interaction	Support	Efficiency	Adoption
1	6	7	5	5	5
2	6	6	7	6	6
3	6	7	6	7	7
4	5	5	6	6	6
5	7	6	5	6	6
6	7	7	5	7	7
7	1	2	1	1	1
8	7	7	6	5	4
9	5	6	6	5	6
10	5	6	6	7	7
11	6	6	6	6	5
12	6	5	4	5	5
13	6	6	6	6	6
14	6	6	5	7	6
15	7	7	6	6	6
16	5	5	5	5	5
17	6	6	5	7	6
18	6	7	5	6	7
19	6	7	6	7	7
20	6	6	6	6	6
21	6	7	6	7	6
22	6	7	6	6	6
23	6	7	6	6	6
24	7	5	6	7	5
25	7	6	6	6	6
26	6	6	6	6	6
27	7	7	6	6	6
28	5	5	5	5	5
29	6	6	5	7	6
30	6	7	5	6	7
31	6	7	6	7	7
32	6	6	6	6	6

Table F2. Scores used for Regression on: Efficiency

Participant #	Independent Variables			Dependent Variable
	Performance	User Interaction	Support	Efficiency
1	6	7	5	5
2	6	6	7	7
3	6	7	6	7
4	5	5	6	6
5	7	6	5	6
6	7	7	5	7
7	1	2	1	2
8	7	7	6	4
9	5	6	6	5
10	5	6	6	7
11	6	6	6	5
12	6	5	4	4
13	6	6	6	6
14	6	6	5	5
15	7	7	6	6
16	5	5	5	5
17	6	6	5	5
18	6	7	5	6
19	6	7	6	7
20	6	6	6	6
21	6	7	6	6
22	6	7	6	5
23	6	7	6	6
24	7	5	6	6
25	7	6	6	6
26	6	6	6	6
27	7	7	6	6
28	5	5	5	5
29	6	6	5	5
30	6	7	5	6
31	6	7	6	7
32	6	6	6	6

Appendix G

SPSS Factor Analysis - Component Matrix

Component Matrix[a]

	Component			
	1	2	3	4
UI_Q3	.887			
Perf_Q1	.878			
Eff_On_Adoption	.877			
S_On_Adoption	.864	.370		
UI_Q4	.852			
P_On_Eff	.850			
Perf_Q3	.836		.333	
Perf_Q2	.827			
Perf_On_Adoption	.774		-.342	.429
Perf_Q4	.770			
UI_Q2	.754	-.383	-.338	
S_Q3	.742			
UI_On_Adoption	.728	.470	-.325	
UI_Q1	.716			
S_Q1	.714			.477
UI_On_Eff	.648	.644		
S_On_Eff	.549	.533	.305	.344
S_Q2	.593		.702	

Extraction Method: Principal Component Analysis.

a. 4 components extracted.

Appendix H

Answers to General and Open-ended questions

Question 4:

This may fall under another set, but management level buy-in. They are responsible for ensuring buy-in from the end users and training. I had a project with considerable turnover in project sponsors, and a lack of buy-in from the remaining project sponsors. The end users were improperly trained on the solution, and as a result, the solution was under utilized.
Follow up support could be of assistance to users.
Reporting
History. When you go to a doctor's apt and just to be able to retrieve your personal info and update is really huge and save time for the patient.
I should not add or remove any heuristics.
increases productivity or processing
Perfect analysis and design permits obtained a best efficient and performance.
design- add just relevant things.
Ability to be added onto -- Process should be able to have additional functionality added onto it to adapt to business growth/changes, User-Influenced Configuration -- Users have insight and opinions into the configuration of the workflow solution. Allowing users to have some control over the end-product will facilitate a likeness to the product and is more likely for them to adopt it easier.
Agile implementation including users along development path so they see the solution develop over time, and don't go from old instantly to new process.
Solution Adoption
Simplicity is the key to adoption.
User Training
Diverse platforms may not be a priority for many customers, most of which operate within a single, controlled platform.
Processing Time - Limiting lag time for tasks that require a large amount of processing
Tracking and reporting
Process path - users should be able to easily tell next steps
Shortest Path - Simplifying the workflow to require the least amount of clicks/touches
Online/In-person Admin and User Training
Configurability and ability to expand/build on solutions
UI, user control, and intuitiveness: Helping the user work more efficiently and independently.
Full feature set between platforms
Simplified presentation and ease of use make the solution more quickly adopted and provide a sense of control to the user.

Simplicity. Users like options and simplicity at the same time. It's a paradox but if a solution can do both of those things for the end users, they are happy.
Ease of use and taking away non value added tasks. Being able to automate something that a User now does not have to worry about spending time on in order for them to spend more time on value added tasks and making the right decisions quicker.
Processing Times
Ability to add functionality.
Productivity
Simplicity.
Configurability
User interaction always seems to be important.
Don't think any should be removed.

Question 5:

The biggest factor I've encountered is user interaction. A good UI, descriptive task descriptions, and succinct help text are all important.
Documentation and training increase adoption.
Understanding the core issues during discovery
See above.
The user must know the business process outside of what is workflow.
ease of use, increases in productivity
Design of solution is important and infrastructure over are going to implement.
Organizational structure, flexibility, cost, accessibility, Social - benefits and motivations
Help and documentation -- I think documentation is the most undervalued resource that is supplied with workflow solutions.
Increased user involvement in design and implementation.
User Interface - easy to use interfaces tend to increase productivity
Simplicity
Simplicity
Scalability, user control
Ease of interaction for the user is key for efficiency and adoption, because users need to feel comfortable with a workflow solution in order to want to use it regularly
End user buy-in from the get go
User experience, ease of use, performance, solution training, user involvement in implementation.
Automation, clear instructions

Familiar look and feel amongst applications
Ease of user interaction
UI - allows users to work independently
Accuracy of results for efficiency and being able to adapt to customer needs for adoption
Adaptability to user requirements
Simplicity for adoption. UI and Performance for efficiency.
Automation
System Processing
Ease of use should enhance adoption.
User interaction enhances productivity which should also enhance adoption and efficiency.
Ease of interaction with workflow processes which produce reliable results.
The ability to configure and adapt solutions to customer needs.
Customer satisfaction.
Performance, User interfaces and support

Question 6:

I believe that by raising awareness of the heuristics, we can improve as a consultant to provide a better solution. While I mentioned that the customer is important in adoption, the job starts and ends with the consultant who's building the solution, and managing the customer's expectations.
The solution will be well thought out and more easily adopted.
I think this set of criteria is the reason people purchase workflow and see the benefits in using the system.
Hospitals are adopting this when a patient check in. Higher education uses workflow to make the process of an applicant fast and effective.
Establishes a basis of communication and understanding between the parties.
Decrease in processing times and increase in processing volume
The end user has needed trained in solution and interaction with solution could be minimal. The workflow solution can be do the more business rules possible to obtain the best efficient
Good ROI to the company, more precise process and less errors, better error handling and exceptions in a process, better way to get notify using alerts, timers, notifications etc. avoid lot of dependant
making the workflow dynamic and easy to use is important, but more than anything I think user-understanding and adaptability is the most important. These items will allow for a faster adoption of a process. No one likes to learn anything new right off the bat, but if they're only learning small things, such as One additional button to their existing process, it will be easier for them to adopt.
Not sure what this question is asking.
Making solutions easy/enjoyable to use

Intuitive Interface - people do not read documentation or the documentation will grow out of date. Simplicity is the best.
.
This list is quite complete and will increase confidence that the workflow solution will operate efficiently.
The proposed set of heuristics encompass the needs of a modern technology user for any form of interaction with a process.
improved existing processed in a systemic manner
The proposed set definitely focuses on workflow once it is in the user's hands. There is a large focus on allowing the user to learn and use the system without external assistance.
By having similar designs and consistency of feel on multiple devices will make it more enjoyable for users if they have to use separate devices like a PC and Mobile.
The more familiar applications and interfaces are to other popular, widely used business applications, will reduce user training needs and decrease the amount of time a user is up to speed and efficient with new applications.
It will promote greater user acceptance and confidence in the workflow.
The proposed set allows users to access their workflow from multiple locations which promotes process up time. Also users will be able to utilize the workflow with limited external assistance increasing productivity.
I'll be able to do what I need to from virtually anywhere
Each of the listed heuristics offer the ability for the user to quickly adopt the solution and be provided insight into its operation.
It will allow implementers and customers of solutions to think about the product more holistically and with a focus on the most important aspects for their organization.
Users are much more likely to adopt a solution that proves to be more efficient. But even if the solution may be more efficient for some, but adding work for others, the solution overall may not be adopted well. Each user needs to be accounted for. Solution Owners and Champions must convey the importance of the solution and why changes are being made to the end users to help sell the solution.
It addresses many customer needs.
The proposed set seems to focus on customer requirements and needs.
It will promote ease of use.
I believe it will provide consistency on multiple platforms.
By promoting solution design.
Seems like the heuristics cover the most important factors.
Intuitive interfaces, reliability and consistency should help promote adoption and efficiency.

Appendix I

Summary of Qualitative Results

Table I1. Assumptions of Linear Regression Results

Assumptions	Validated	Tests
Adoption (DV)		
Linearity	Yes	Scatter Plot, Regression Line Equation
Normality	Yes	Histogram, Normal P-Plot
No Muti-collienarity	Yes	Pearson, Tolerance, VIF
No-Auto-correlation	Yes	Durbin Watson
Homoscedasticity	Yes	Breusch-Pagan, Koenker
Efficiency (DV)		
Linearity	Yes	Scatter Plot, Regression Line Equation
Normality	Yes	Histogram, Normal P-Plot
No Muti-collienarity	Yes	Pearson, Tolerance, VIF
No-Auto-correlation	Yes	Durbin Watson
Homoscedasticity	Yes	Breusch-Pagan, Koenker

DV = Dependent Variable

Table I2. Regression on Adoption and Efficiency Results

Regression	p	Significant Impact	Regression Line	Relationship	Reject Null for
Adoption (DV)			y= -0.04+0.14(x)	Positive	
Performance	.073				
User Interaction	.004	Yes			H3
Support	.665				
Efficiency	.000	Yes			H7
Efficiency (DV)			y = 0.01+2.13E-3(x)	Positive	
Performance	.845				
User Interaction	.201				
Support	.003	Yes			H6

DV = Dependent Variable

Findings:

1. Workflow User Interaction and Efficiency have a significant positive relationship with EWDM Adoption.
2. Workflow Support has a significant positive relationship with EWDM Efficiency

Interpretation:

1. User interaction and efficiency are the most important factors when considering to adopt a workflow solution.
2. Support is the most important factor when evaluating the efficiency of a workflow solution.

Table I3. Regression on Adoption and Efficiency by Gender Results

Regression	p	Significant Impact	Regression Line	Relationship	Reject Null for
Adoption (DV)			y=0.04 + 0.06(x)	Positive	
Male					
Performance	.879				
User Interaction	.044	Yes			H3
Support	.498				
Efficiency	.004	Yes			H7
Female			y=-0.01 + 0.03(x)	Positive	
Performance	.790				
User Interaction	.253				
Support	.177				
Efficiency	.093				
Efficiency (DV)			y=0.01 – 0.01(x)	Negative	
Male					
Performance	.274				
User Interaction	.055				
Support	.010	Yes			
Female			y=0.09 + 7.67E-3(x)	Positive	
Performance	.526				
User Interaction	.273				
Support	.016	Yes			H6

DV = Dependent Variable

Findings:

1. Workflow User Interaction and Efficiency have a significant positive relationship with EWDM Adoption based for Gender = Male
2. Workflow Support has a significant positive relationship with EWDM Efficiency for Gender = Female

Interpretation:

1. Same results for tests on all participants. Gender does not make a difference.

Table I4. Regression on Adoption and Efficiency by Years-Experience

Regression	p	Significant Impact	Regression Line	Relationship	Reject Null For
Adoption (DV)			y = - 0.02 - 6.18E(x)	Negative	
1 to 5 Years					
Performance	.788				
User Interaction	.286				
Support	.943				
Efficiency	.137				
6 to 10 Years			y = -0.06 + 0.08(x)	Positive	
Performance	.619				
User Interaction	.521				
Support	.656				
Efficiency	.308				
11 Years +			y = -0.06 + 0.08(x)	Positive	
Performance	.877				
User Interaction	.935				
Support	.578				
Efficiency	.184				
Efficiency (DV)					
1 to 5 Years			y= - 2.93E-5 – 1.02E3(x)	Negative	
Performance	.244				
User Interaction	.025	Yes			
Support	.025	Yes			
6 to 10 Years			y= -0.02 - 0.01(x)	Negative	
Performance	.246				
User Interaction	.550				
Support	.124				
11 Years +			y= -0.06 + 0.08(x)	Positive	
Performance	.459				
User Interaction	.313				
Support	.908				

DV = Dependent Variable

Findings:

1. No significant positive relationships with EWDM Adoption for any range of years of experience
2. No significant positive relationships with EWDM Efficiency for any range of years of experience

Interpretation:

1. Years of experience – although results are not the same, results per range were. This suggests similar responses regarding workflow across all ranges surveyed.

Table I5. Heuristics grouped into themes

Workflow User interaction	**Workflow Support**
Adaptability to diverse platforms	System Feedback
User control	Error management
Intuitive interfaces	Help and Documentation
Visibility on mobile devices	

Appendix J

IRB Approval

NOVA SOUTHEASTERN UNIVERSITY
Institutional Review Board

MEMORANDUM

To: **Steven Fuentes, MBA**
College of Engineering and Computing

From: **Ling Wang, Ph.D.,**
Center Representative, Institutional Review Board

Date: **October 25, 2016**

Re: **IRB #: 2016-502; Title, "Defining usability heuristics for the adoption and efficiency of an electronic workflow document management system"**

I have reviewed the above-referenced research protocol at the center level. Based on the information provided, I have determined that this study is exempt from further IRB review under **45 CFR 46.101(b) (Exempt Category 2)**. You may proceed with your study as described to the IRB. As principal investigator, you must adhere to the following requirements:

1) CONSENT: If recruitment procedures include consent forms, they must be obtained in such a manner that they are clearly understood by the subjects and the process affords subjects the opportunity to ask questions, obtain detailed answers from those directly involved in the research, and have sufficient time to consider their participation after they have been provided this information. The subjects must be given a copy of the signed consent document, and a copy must be placed in a secure file separate from de-identified participant information. Record of informed consent must be retained for a minimum of three years from the conclusion of the study.

2) ADVERSE EVENTS/UNANTICIPATED PROBLEMS: The principal investigator is required to notify the IRB chair and me (954-262-5369 and Ling Wang, Ph.D., respectively) of any adverse reactions or unanticipated events that may develop as a result of this study. Reactions or events may include, but are not limited to, injury, depression as a result of participation in the study, life-threatening situation, death, or loss of confidentiality/anonymity of subject. Approval may be withdrawn if the problem is serious.

3) AMENDMENTS: Any changes in the study (e.g., procedures, number or types of subjects, consent forms, investigators, etc.) must be approved by the IRB prior to implementation. Please be advised that changes in a study may require further review depending on the nature of the change. Please contact me with any questions regarding amendments or changes to your study.

The NSU IRB is in compliance with the requirements for the protection of human subjects prescribed in Part 46 of Title 45 of the Code of Federal Regulations (45 CFR 46) revised June 18, 1991.

Cc: **Maxine Cohen, Ph.D.**

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