CrashApp™ – Concurrent Multiple Stakeholder Evaluation of a DSR Artefact

Timothy M. Papp
University of South Florida, timpapp@comcast.net

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CrashApp™–Concurrent Multiple Stakeholder Evaluation of a DSR Artefact

by

Timothy M. Papp

A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Business Administration Muma College of Business University of South Florida

Major Professor: Alan R. Hevner, Ph.D. Matthew Mullarkey, Ph.D. Gert-Jan de Vreede, Ph.D. Carol Stoak Saunders, Ph.D.

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Keywords: Mobile applications, Usability, Efficacy, Design science research (DSR), ADR process model, Iterative intervention cycles

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ABSTRACT

The successful design, implementation, deployment, and use of mobile software applications is rare. While many mobile apps are developed, few succeed. This design science research project builds and evaluates CrashApp™, a mobile application that connects lawyers and clients before, during, and after car accidents. The effective, widespread use of this app depends on satisfying the needs of three groups of stakeholders – the end-users (clients), the owners (lawyers), and the software developers. The research objective is to investigate the key differences among the three stakeholder groups on evaluation criteria for mobile app success. Evaluation strategies and methods are selected to collect data that measures each group’s satisfaction with the constructed application artefact. Research contributions are the identification of multiple stakeholder groups and the ability to design rich evaluation strategies that provide measures of application success. Practice contributions are the design and development of a useful mobile app that provides needed services to the client and effective client connections for the law firm to interact with the clients. The project produced an instantiation of the design artefact CrashApp™ mobile application, which was evaluated with a naturalistic evaluation approach, including the following methods and techniques: focus groups, focused surveys, usability surveys, and real life tests and assessments.
1. INTRODUCTION AND BACKGROUND

In 2013, according to the National Highway Transportation Safety Administration (NHTRA), an estimated 5,687,000 motor vehicle accidents occurred in the United States; this number increases by approximately 2% per year on average. These crashes create business for several types of attorneys.

Currently, approximately 1,300,705 licensed and registered attorneys are in the United States (The Lawyer Statistical Report 2015). Unlike other industries that experienced severe revenue fluctuations over the past five years, personal injury law had a partially countercyclical nature. During the five years from 2011 to 2016, the personal Injury Lawyers and Attorneys industry grew at an average annual rate of 0.2% per year to $31.3 billion (Figure 1. below). Over the five years to 2016, the number of auto accidents in the United States rose at an annualized 1.0% to 5.6 million, bolstering demand for personal injury attorneys.

Looking forward to the five year period from 2016 through 2021, legal industry revenue is forecast to grow an annualized 1.0% to $32.9 billion. During this period, legal industry operators should benefit from an increase of revenue streams generated by structured settlements, or arrangements in which damages are paid over a period of time rather than all at once. (Figure 1)
In 2017, personal injury attorneys are projected to spend approximately $892 million in television advertising to attract the victims of auto accidents; the $892 million does not include any other form of advertising or all attorney advertising (only the top six areas of personal injury). This amount for television advertising represents a 68% increase in spending since 2008 (Figure 2). Overall, personal injury firms spent approximately $2 billion dollars on marketing costs.

Since the personal injury market is so large monetarily and the average small to medium-sized firm cannot compete with the marketing budgets of the large firms, smaller firms are natural stakeholders in other forms of marketing, such as mobile marketing. However, the time and resources required to develop a mobile application are monumental in comparison to the development of other applications. An industry leader in the application development field, Kivney, Inc., conducted a study in collaboration with research firm Ask Your Target Markey (AYTM), surveying 100 mobile designers to discover how long they expected it would take to build core front and backend components of an Android or iOS app (https://www.kinvey.com/how-long-to-build-an-app-infographic). (Figure 3) They averaged the responses and teamed with the designers at Visual.ly (Visually is a premium web content provider) to visualize the time required to develop each component of a Minimum Viable Product (MVP)
quality native mobile application, which is an application that has only the essential functions to test the application for developers and testers. They determined the average time to develop a version 1 of an application is approximately 18 weeks. Not included in the 18 week timeframe is the amount of time required to get the application approved for release by Apple and Google, which can easily take an additional 30 days.

Figure 3. Kivney – How Long it Takes to Build an App (www.kinvey.com/how-long-to-build-an-app-infographic)

1.1 MOTIVATION

Due to the time and money involved in developing a mobile application, attorneys in small to mid-sized firms are at a distinct disadvantage to larger firms in attracting new clients and maintaining former clients, especially with regards to personal injury cases. Attorneys, especially those in small to mid-size firms, are notoriously bad at marketing while drivers are incredibly bad at avoiding accidents.

To offset the weakness in marketing, larger firms have substantial marketing budgets to create strong brand recognition, so much so that after an accident, even if clients have used a small to medium-sized law firm in the past, they are more likely to seek the big firm with the brand recognition (and constant advertising) than return to the firm they know. Small to mid-sized firms
have large databases of current and former clients but limited, economically feasible opportunities to maintain relationships with those former clients. On average, it costs a business three to seven times more marketing dollars to attract a new client than to get follow-on work from a previous client (Daly, 2002). Therefore, it is imperative that small to mid-sized firms find a way to provide continued client communication so that they can continue to be top-of-mind with former clients to secure follow-on work.

This project proposed, the development of CrashApp™, is a mobile application artefact designed specifically as a conduit for attorneys to market directly to current and prospective clients and allows for application users to directly access their attorney, report information, call for emergency services or a tow truck from the scene of the accident. CrashApp™ meets the vital need of bridging the gap between attorneys and their driving clients to allow near instant communication between the two at the scene of an accident by providing drivers a mobile app to be installed on their smartphone. A key challenge in this development project is balancing the multiple stakeholder goals of the client driver and the attorney who handles any litigation arising from an accident.

The essential considerations in designing CrashApp™ are threefold, as it concerns three distinct but related parties: 1) the developer of the artefact who endeavors to create a functionally useful, effective, efficient artefact that works as designed, 2) small to mid-sized law firms (a firm of 15 or less attorneys on staff) who want to stay in touch with and grow their client-base, and 3) the potential end user/client who has been in an accident and needs a quick, efficient means of communicating the accident information to their attorney.

The artefact will be branded (re-provisioned) at the individual law firm level; the goal for the lawyer in using CrashApp™ is to be the first point of contact for drivers from the scene of the
accident. Due to the size of the target market of the mobile app, the cost of application development, and the need to have ready access to a client/customer, the need exists to understand how, when, and where customers want to be contacted as well as how they want to contact the attorney, if ever.

The problem for the client that could potentially be in an accident is multifaceted. If the client is in an accident and does not know what information is important to collect at the scene, he or she may miss data critical to the case, which could result in lower settlements. Clients currently have no easy way to quickly connect directly to an attorney at the time of the accident or need. If they reach out to the insurance company without contacting an attorney, the insurance company may pressure them to settle the case without attorney input. Furthermore, following an accident, the client is often injured or in a state of shock and may not be able to correctly assess injuries and feel very alone, afraid, and confused.

The challenges for the developer are also multi-faceted. As stated above, the development of a mobile application is a very expensive, lengthy process for the owners and developers alike, often taking as much as one year to get the first “beta” version release. Many larger mobile applications cost in excess of $1,000,000 to develop. As smart phones have continued to expand across the mobile phone world, the cost and time for development have increased exponentially.

1.2 RESEARCH QUESTIONS

This research project utilized the Design Science Research (DSR) and expanded Action Design Science (ADR) methods to conduct research and evaluation, which supports the developers, attorneys, and users of the artefact. The expanded ADR research methods emphasized constant iteration, testing, and collaboration in fashioning the design principles and features for this artefact. This project explored a functionally innovative, generally novel instantiation of a
mobile application. Specifically, the researcher worked in accordance with Gregor and Hevner’s (2013) research theory to develop additional design theory from this design science research through abstraction and reflection as the design concept was expanded and explored from concept to a fully functional artefact. Additionally, this project used slightly modified ADR research methods to develop substantive theory about bias(es) for or against the use of a particular mobile application artefact to contact an attorney in the context of an accident and the acceptance of the application for use as a marketing tool for a law firm. The study began with an emergent artefact design; the research team constantly evaluated the build as is it evolved from the original design.

The research goal of the study was to produce new knowledge for researchers and developers in the creation of such an artefact in order to advance design and evaluation theory in the DS discipline. From a DSR evaluation perspective, inductive and abductive reasoning (Fischer et al 2012) were used through an iterative cycle of ADR to generate and evaluate a set of Design Principles (Markus et al 2002). These new Design Principles created new knowledge of a specific artefact and formulated new design theory for these types of mobile application artefacts. A process for ADR should build on this work while integrating its principles into a comprehensive methodology for conducting Design Science Research.
2. RESEARCH METHODS

Walls et al (1992) found that design theory has a design product (the artefact) and a design method (means to create an innovative artefact). Good design theory is grounded in the relevance of a class of real problems facing practitioners (business need) and the rigor of a methodical exploration and adaptation of existing knowledge (applicable knowledge) (Hevner and Gregor, 2004). Good design theory results in new knowledge in the form of an innovative artefact and a means to generalize the artefact across a problem set (Mullarkey 2014). Research design science artefacts cannot be made sense of without considering the context in which they are to be used, the purpose(s) of the artefact, and the beneficiaries.

2.1 DESIGN SCIENCE RESEARCH (DSR)

When Information Sciences’ researchers started to develop an interest in Design Science Research in the early 1990s, agreement existed in prior research about the basic difference between Design Science and other paradigms, such as theory building and testing and interpretive research: “Whereas natural sciences and social sciences try to understand reality, design science attempts to create things that serve human purposes” (Simon 1996).

There are two sets of applicable design science literature. One revolves around issues of actually doing academic design work, i.e., design research. The second set addresses the meta-level of conducting research at a higher level of abstraction: it is research about design research (Id. pp. 48.). The research about design research literature is rich with ideas about how to conduct research. This literature, while not providing process models that can be applied directly to the problem of design science research, provides concepts from which processes can be inferred.
(Peffers et al 2007). IT artefacts are both instrumental and contextual. Hence, they are applied in organizational settings, personal settings, and other social contexts of relevance (Benbasat and Zmud 2003).

March and Smith (1995) identify two design processes and four design artefacts produced by design-science research in IS. The two processes are build and evaluate, which also are the two basic activities of Design Science. Building is the process of constructing an artefact for a specific purpose; evaluation is the process of determining how well the artefact performs (March and Smith 1995). An artefact is built identifying and anticipating potential needs while satisfying those needs appropriately and effectively. The design artefacts are constructs models, methods, and instantiations. Purposeful artefacts are built to address heretofore unsolved problems (Hevner et al 2004). Hevner and others make clear that the goal of design-science research is utility and a proposed solution (artefact) addresses important unsolved problems in unique or innovative ways or solves problems in more effective or efficient ways (Hevner et al 2004). March and Smith’s and Hevner et al.’s (2004) guidelines for design science research influence methodological choices within the design science research process. Table 1 (below) summarizes the seven guidelines.

Table 1. Design Science Research (DSR) Guidelines (Hevner et al 2004)

<table>
<thead>
<tr>
<th>Design-Science Research Guidelines</th>
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<tr>
<td>Guideline 1: Design as an Artifact</td>
<td>Design-science research must produce a viable artifact in the form of a construct, a model, a method, or an instantiation.</td>
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<tr>
<td>Guideline 2: Problem Relevance</td>
<td>The objective of design-science research is to develop technology-based solutions to important and relevant business problems.</td>
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<tr>
<td>Guideline 3: Design Evaluation</td>
<td>The utility, quality, and efficacy of a design artifact must be rigorously demonstrated via well-executed evaluation methods.</td>
</tr>
<tr>
<td>Guideline 4: Research Contributions</td>
<td>Effective design-science research must provide clear and verifiable contributions in the areas of the design artifact, design foundations, and/or design methodologies.</td>
</tr>
<tr>
<td>Guideline 5: Research Rigor</td>
<td>Design-science research relies upon the application of rigorous methods in both the construction and evaluation of the design artifact.</td>
</tr>
<tr>
<td>Guideline 6: Design as a Search Process</td>
<td>The search for an effective artifact requires utilizing available means to reach desired ends while satisfying laws in the problem environment.</td>
</tr>
<tr>
<td>Guideline 7: Communication of Research</td>
<td>Design-science research must be presented effectively both to technology-oriented as well as management-oriented audiences.</td>
</tr>
</tbody>
</table>
2.1.1 Guideline 1: Design as an Artefact  The result of design science research in Information Science is, by definition, a purposeful IT artefact created to address an important organizational problem. It must be described effectively, enabling its implementation and application in an appropriate domain (Hevner et al. 2004).

2.1.2 Guideline 2: Problem Relevance  The objective of research in information systems is to acquire knowledge and understanding that enable the development and implementation of technology-based solutions to heretofore unsolved, important business problems. Behavioral science approaches this goal through the development and justification of theories explaining or predicting phenomena that occur. Design science approaches this goal through the construction of innovative artefacts aimed at changing the phenomena that occur. Each must inform and challenge the other (Hevner et al. 2004).

2.1.3 Guideline 3: Design Evaluation  The utility, quality, and efficacy of a design artefact must be rigorously demonstrated via well executed evaluation methods. Evaluation is a crucial component of the research process (Hevner et al. 2004).

2.1.4 Guideline 4: Research Contributions Effective design science research must provide clear contributions in the areas of the design artefact, design construction knowledge (i.e., foundations), and/or design evaluation knowledge (i.e., methodologies). The ultimate assessment for any research is, “What are the new and interesting contributions?” Design science research holds the potential for three types of research contributions based on the novelty, generality, and significance of the designed artefact. One or more of these contributions must be found in a given research project (Hevner et al. 2004).

2.1.5 Guideline 5: Research Rigor  Rigor addresses the way in which research is conducted. Design science research requires the application of rigorous methods in both the
construction and evaluation of the designed artefact. In behavioral science research, rigor is often assessed by adherence to appropriate data collection and analysis techniques. Overemphasis on rigor in behavioral IS research often has resulted in a corresponding lowering of relevance (Lee 1999).

2.1.6 Guideline 6: Design as a Search Process  Design science is inherently iterative. The search for the best, or optimal, design is often intractable for realistic information systems problems. Heuristic search strategies produce feasible, good designs that can be implemented in the business environment (Hevner et al. 2004).

2.1.7 Guideline 7: Communication of Research  Design-science research must be presented both to technology-oriented as well as management-oriented audiences. Technology-oriented audiences need sufficient detail to enable the described artefact to be constructed (implemented) and used within an appropriate organizational context. This detail enables practitioners to take advantage of the benefits offered by the artefact and researchers to build a cumulative knowledge base for further extension and evaluation. It is also important for such audiences to understand the processes by which the artefact was constructed and evaluated. This understanding establishes repeatability of the research project and builds the knowledge base for further research extensions by design science researchers in IS (Hevner et al. 2004).

2.2 ACTION DESIGN RESEARCH  
Sein et al. define ADR research as a “method for generating prescriptive design knowledge through building and evaluating ensemble IT artifacts in an organizational setting. It deals with two seemingly disparate challenges: (1) addressing a problem situation encountered in a specific organizational setting by intervening and evaluating; and (2) constructing and evaluating an IT artifact that addresses the class of problems typified by the encountered situation” (2011). Since
ADR focuses on ensemble artefacts, it identifies the stages and principles ingrained in the process of problem formation for those artefacts. Figure 4 illustrates that process.

2.2.1 Stage 1: Problem Formation  
First stage is a problem perceived in practice or anticipated by researchers.

- **Principle 1: Practice-Inspired Research.** Emphasizes viewing field problems (as opposed to theoretical puzzles) as knowledge-creation opportunities.

- **Principle 2: Theory-Ingrained Artifact.** Emphasizes that the ensemble artifacts created and evaluated via ADR are informed by theories.

2.2.2 Stage 2: Building, Intervention, and Evaluation  
Problem framing and theoretical premises adopted in stage one.

- **Principle 3: Reciprocal Shaping.** Emphasizes the inseparable influences mutually exerted by the two domains: the IT artifact and the organizational context.

- **Principle 4: Mutually Influential Roles.** Points to the importance of mutual learning among the different project participants.
• **Principle 5: Authentic and Concurrent Evaluation.** Emphasizes a key characteristic of ADR: evaluation is not a separate stage of the research process that follows building.

2.2.3 **Stage 3: Reflection and Learning** Moves conceptually from building a solution for a particular instance to applying that learning to a broader class of problems.

• **Principle 6: Guided Emergence.** Emphasizes that the ensemble artifact will reflect not only the preliminary design created by the researchers but also its ongoing shaping by organizational use, perspectives, and participants and by outcomes of authentic, concurrent evaluation.

2.2.4 **Stage 4: Formalization of Learning** The situated learning from an ADR project should be further developed into general solution concepts for a class of field problems.

• **Principle 7: Generalized Outcomes.** This ensemble represents a solution that addresses a problem.

The ADR efforts emphasize creating an innovative technological design at the outset, so the ADR Model accommodates our 3-cycle continuous, concurrent, build, intervention and evaluation of the instant artifact.

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Figure 5: Schema for IT - Build, Intervention and Evaluation
2.3 ELABORATED ACTION DESIGN RESEARCH (EADR)

The build activity involves the creation and implementation of the artefact, and the elaborated action design research adds an additional principle to the traditional ADR process called ADR Principle 8, “Abstraction,” which further supports different levels of abstraction.

Figure 6 below further elaborates on the activities and principles of the ADR intervention cycle and expands the ADR process model. ADR moves through multiple intervention cycles and stages of problem diagnosing, design, implementation, and evolution. Each intervention cycle contains at least one, and maybe more, DSR build and evaluation design cycles of an artefact.

Figure 6: The Elaborated Action Design Research (ADR) Cycle

Since the ADR efforts emphasize creating an innovative technological design at the outset, this project’s ADR Model accommodates our continuous, concurrent, build, intervention and evaluation (BIE) of the instant artefact. In elaborating on the ADR stages, Figure 6 provides an overview of the four-stage Elaborated ADR Process model applied to the problem domain.

The ADR cycle can be used as a generic template throughout the different stages in this extended ADR process model. The first of the four ADR stages is Diagnosis, wherein the researcher must understand the application project domain, including its strengths, weaknesses,
opportunities, and constraints while the practitioner must be aware of the existing knowledge base of research and practice that will inform the design and evolution of the artefact (Hevner & Mullarkey 2016). The second stage of the process model is the Design stage, which focuses on the identification and conceptualization of the proposed artefact. Design principles emerge through this iterative diagnosis process that helps to create the essentials of the artefact and solve the problem to be addressed by the problem environment. The third stage of the extended ADR process is Implementation, wherein real-life use and intervention provide for evaluations of effectiveness, efficiency, and usability of the artefact. Typical artefacts abstracted and evaluated in the ADR Implementation cycle include systems, algorithms, programs, databases, and processes (Hevner and Mullarkey 2016). The final stage of the extended ADR process is the Evolution stage as the problem environment changes and the artefact changes to meet those changes. This process of evolution requires problem re-Formation, technology advancements, design improvements and constant interventions continue to generate new knowledge for the researchers and practitioners (Hevner and Mullarkey, 2016).

![ADR Stages Diagram](Image)

Figure 7: The Elaborated ADR Process Model

Additionally for this project, within the four ADR stages (Diagnosis, Design, Implementation, Evolution) three more sub-stages were accomplished – Design BETA, Design
Improvement, and Design Evolution. These stages concentrated primarily on the actual design (UX and UI) of the artefact.

2.4 FRAMEWORK FOR EVALUATION IN DESIGN SCIENCE RESEARCH (FEDS)

Venable asserts, “In a sense, a DSR evaluation method has a paradigm similar to scientific paradigms, like positivism or interpretivism,” and “while there are different ways to characterize such paradigms, the prescriptive and functional nature of design science demands a distinction that is more practical and less philosophical” (2006).

According to Walls et al, “Artificial evaluation may be empirical or non-empirical (e.g., logical/rhetorical). It is nearly always positivist and reductionist, being used to test design hypotheses” (1992). However, interpretive techniques also may be used to attempt to better understand why an artefact works or does not. Even critical techniques may be used, but these generally supplement the main goal of proving or disproving the design theory and/or the utility of the DSR artefacts. The dominant scientific/rational paradigm brings the benefits of stronger scientific reliability in the form of better repeatability and falsifiability to artificial evaluation (Gummesson 1988).

Naturalistic evaluation explores the performance of a solution technology in its real environment, typically within an organization. By performing evaluation in a real environment (i.e., real people, real systems, and real settings, Sun and Kantor 2006), naturalistic evaluation embraces all of the complexities of human practice in real organizations.

In a 2014 paper, Venable explains the progression of evaluation:

Generally, evaluation progresses from a state of no evaluation having been conducted at the beginning towards a more comprehensive, rigorous state. The chronological progression through formative evaluations to more summative evaluation represents the purpose, peculiar to DSR, to rigorously consider the quality of the knowledge outcomes. The increasing use of more summative evaluations enables comparison of research outcomes with research expectations (testing the design theory). The chronological progress through artificial evaluations to more
naturalistic evaluations represents a similar, but subtly different purpose. The increasing use of more naturalistic evaluations improves the quality of the knowledge outcomes concerning the artefact’s effectiveness in real use, as the artefact increases in quality and the risks become low enough for real use by real users (2014)

“A planned trajectory of evaluations appropriate for the circumstances of a particular DSR project is an evaluation strategy” (Venable 2014). Since there are many types of evaluation strategies, scholars address how to select an appropriate one: “As a DSR thesis, a reasonably strong level of rigor is expected and the artefact developed is also expected to work and make a useful contribution…The pathway or trajectory sought and followed in a DSR project or program may differ according to the needs and resources available to the researcher” (Venable 2014). This process of evaluation functions allows the development of the artefact to flow from the beginning of the evaluation framework towards a comprehensive, final evaluation at the conclusion of the project.

The Framework for Evaluation in Design Science (FEDS) allows for four possible strategies, as shown in Figure 8 (above). The triangles illustrate where the evaluations might occur in each strategy employed. The number of triangles and their placement along any particular

![Figure 8: FEDS: A Framework for Evaluation in Design Science Research.](image-url)
strategy’s trajectory are illustrative only; they may (and should) vary according to the needs of a particular DSR project/program (Venable 2014). The strategies identified include:

2.4.1 Quick & Simple Strategy: Relatively little formative evaluation and progresses quickly to summative, more naturalistic evaluations. The evaluation trajectory of this strategy includes relatively few evaluation episodes (perhaps even only one summative evaluation at the end). This strategy is low cost and encourages quick project conclusion.

2.4.2 Human Risk & Effectiveness Strategy: Emphasizes formative evaluations early in the process, possibly with artificial, formative evaluations, but progresses quickly to more naturalistic formative evaluations. More summative evaluations are engaged near the end of this strategy, which focus on rigorous evaluation of the effectiveness of the artefact, that is, the utility of the artefact will continue to accrue even when the artefact is placed in operation.

2.4.3 Technical Risk & Efficacy Strategy: Emphasizes artificial formative evaluations iteratively early in the process, but progressively moves towards summative artificial evaluations. Artificial summative evaluations are used to rigorously determine efficacy of the artefact, that is, the utility/benefits derived from the use of the artefact are due to the artefact, not due to other factors. Near the end of this strategy, more naturalistic evaluations are engaged.

2.4.4 Purely Technical Strategy: Used when an artefact is purely technical, without human users, or planned deployment with users is so far removed from what is developed to make naturalistic evaluation irrelevant.

According to Venable’s theory, there are at least four possibly competing goals in designing the evaluation component of DSR. Some of the four goals are more relevant at different stages of a DSR project. The goals are: 1) rigor, which includes efficacy and effectiveness; 2) uncertainty and risk reduction, such as human social/use risks; 3) ethics, which addresses potential
risks to people, animals, organizations or the public; and 4) efficiency, which balances the goals of the evaluation versus the money available (Venable 2014).

2.5 FEDS Theory Choices Three primary stakeholders are in the design and development of the instant artefact, and all three require different evaluation strategies according to Venable’s FEDS guidance. Given the strategies and requirements of the stakeholders, the following FEDS strategies of evaluation were employed:

1. Developers – Technical Risk and Efficacy
2. Users – Quick and Simple
3. Attorneys – Human Risk and Effectiveness
3. ARTEFACT DEVELOPMENT STAGES

This study was guided by the Design Science Research (DSR) Framework, which informs the development of DSR artefacts, which, in turn, is informed by qualitative research in the form of surveys, focused surveys, and other testing for evaluation of the artefact’s usefulness, efficiency, efficacy, and completeness of purpose.

As a DSR artefact, CrashApp™ is a mobile tool that provides a “safety net” for people at the scene of an accident. The mobile application is designed to fill a void in the legal marketing field and provides a functional alternative for accident victims to collect data and have direct contact with their attorney at the scene of an accident. The artefact helps guide users through the process of reporting an accident to their attorney should they have one. The tone of the app is that of a helpful, friendly coach holding the users’ hands through a difficult time.

The artefact allows for quick alerts/texts to family members, a direct link to a law office, and guidelines for self-assessment. Unlike apps provided by insurance companies, the information collected in this artefact could be covered under attorney-client privilege. The value proposition for prospective users of the artefact is they are able to preload contact and insurance information, learn how to prepare for an accident, directly dial an attorney’s office, collect data at the scene, and contact police.

For the law firm, this platform allows a direct conduit to the client, allowing for mobile marketing campaigns (via regular push notifications) and frequent communication. The ability to communicate with clients regularly is crucial as it allows attorneys to maintain their relationships with their database of current and past clients. For attorneys who do not do a lot of personal injury
cases, this artefact could allow them to expand into a new, more lucrative line of law (e.g. a criminal attorney expanding into personal injury).

Since the artefact was built to address a previously identified yet unsolved problem, it was tested through an iterative series of design revisions to ensure its adaptability to changing technology and ease of use for the consumer. The design, build, and evaluation of the artefact continued through multiple iterations of the artefact until the artefact showed sufficient usability. Simulations with artificial data were tested to ensure the maximum assurance of data transfer and information safeguarding by creating “dummy” accounts and vigorously reporting and tracking the information exchange between the application, database management system, and the email confirmations generated by the database management system to the attorney. A descriptive design evaluation was not necessary as many other methods of evaluation were used.

The project followed a seven stage Elaborated ADR approach with multiple cycles of build, intervention and evaluation intended to create a mass market (law firm) consumer artefact where the first phase of design challenge corresponded to the problem Formation stage of the original ADR approach (Sein et al. 2011). The theorizing phases match the reflection and learning as well as the formalization of learning stages in ADR.

3.1 SOFTWARE DEVELOPMENT TEAM

Fundamental to any successful research project is the initial assembly of a team of individuals qualified to identify opportunities and potential problems and who are motivated to move the project through the many phases of development. The CrashApp™ team came together through the same type of process used to design, build, and implement the artefact. Multiple established software development firms (eight development firms in total ) were contacted and interviewed early in the problem formation phase and before the problem was fully developed.
None of those software development firms were willing to take time to fully develop the problem statement and identify salient research questions.

The researcher was forced to find an alternative source of software developers who would spend substantial time to develop the problem and research questions. Skilled master’s student level developers were found through the University of South Florida (USF) Practice Center. With the full help and support of the Practice Center Director, Clinton Daniels, eight graduating or recently graduated developers were interviewed; from those eight, three were chosen to be involved in the project. The initial three developers spent weeks working with the researcher on problem formation and research goals. The problem statement and research questions above came from the work with those three developers and the researcher. Two of the original software developers moved on from the project after six months and were replaced with two other developers who seamlessly picked up the project and moved it forward.

3.2. SOFTWARE TECHNOLOGIES

This section provides a brief summary of the software technologies employed to design and implement the mobile artefact. Figure 9 summarizes the flow through the technologies and platforms that compose the application. In this diagram, we highlight that (1) all transactions are initiated using a smart mobile phone once a user has registered and authenticated with the system; (2) this app is compatible with both Apple iPhone and Android devices; and (3) in order for the mobile app to exchange information with the rest of the system, it moves data inbound and outbound through a RESTful API that runs on an Amazon Web Service (AWS) Elastic Beanstalk (EBS) instance.
3.2.1 Rapid and Agile App Deployment  The requirements of the research project led the team to employ innovative strategies to meet multiple stakeholders’ needs using techniques of rapid application development and agile application deployment. The development team included domain experts (mid-market personal injury lawyers), several potential customers, IT enterprise professionals, academic researchers, and four programmers. The team spent considerable time and effort understanding the application context and stakeholder goals. The competitive environment was extensively researched to identify all existing applications in the solution domain and adjacent problem domains. While no clear competitor system was identified, this research effort led to a concise list of design principles and key features for the mobile app.

The CrashApp™ solution design supports a modern approach to rapid requirements change, open source technology, security controls, cloud-based storage and database management, and agile deployment with multi-mobile platform support. The innovative aspects of the technical design are summarized below.

3.2.2 Open Source Cross-Platform Development  The mobile app was designed to authenticate users, report motor vehicle accidents, maintain user profiles, and maintain lawyer profiles. Through the app, accidents are reported using captured photos of injuries or other required
evidence, witness information, damage information, and insurance information. The mobile app was designed using the “native” functionality of the iPhone and Android mobile operating systems. This was accomplished by developing the app using the open-source cross platform development software Xamarin. The advantage of using Xamarin to develop this artefact was it allowed the developers to code and compile using one language (C#) and compiler for all mobile platforms.

3.2.3 **Amazon Web Services (AWS) Elastic Beanstalk** AWS offers an automated process to deploy and scale web applications and services called Elastic Beanstalk (EBS). The app uses an AWS EBS Linux instance to host the Java application and RESTful API. The Java application running on AWS EBS is designed to handle communication between the RESTful API and other AWS services, such as Amazon RDS and Amazon S3.

3.2.4 **RESTful API** A RESTful API is developed and deployed to AWS EBS using the open source Jersey project. The open source Jersey RESTful API utilizes the Java Virtual Machine to handle http/https requests inbound and outbound throughout the app. The use of a RESTful API simplifies the communication between the mobile platform, the Java app hosted on Apache Tomcat, and AWS Services. For instance, the mobile app can collect images from the phone and stream them to AWS S3 via the RESTful API. Additionally, the mobile app can make requests to the AWS RDS instance by exchanging JSON strings via the RESTful API.

3.2.5 **Amazon Relational Database Service (RDS)** Amazon RDS is a scalable and relational database available in Amazon’s AWS cloud. The Oracle database engine was selected for this app due to its support for open source development and tight integration with Java applications. All of the app data are transacted, stored, and managed by the AWS RDS instance. JDBC drivers are used to securely communicate between the Java app hosted on the Apache Tomcat instance and the AWS RDS instance.
3.2.6 Amazon Simple Storage Service (S3) Amazon S3 is a secure, highly scalable cloud-based storage platform available in Amazon’s AWS cloud. The CrashApp™ uses Amazon S3 to store images captured by the mobile phone. The image files are streamed from the mobile app to the Amazon S3 storage volume via communication managed by the RESTful API hosted on the Apache Tomcat instance.

3.2.7 Security Controls Several layers of security are controlled by the app. Security is handled at all layers of the system to include the mobile app, Java app hosted on Tomcat Server in AWS EBS, AWS RDS instance, and AWS S3. The mobile application requires users to login using a username and password that must authenticate with the AWS RDS instance by passing a unique security key using an HTTPS request that combines a UserID with an AppID via the RESTful Service. The Java app hosted on the Tomcat Server in AWS EBS communicates with Amazon’s RDS and S3 using AWS Security best practices.

3.2.8 Application Management & System Administration The C# code developed in Xamarin is versioned and controlled for release in a secured GitHub repository. All Amazon Services, such as AWS Elastic Beanstalk, Amazon RDS, and Amazon S3, are administered and managed using the AWS Management Console. The use of Xamarin allows for code to be changed only once for a new requirement of the mobile app. Once the C# code was updated within Xamarin, the code was compiled for distribution on all supported mobile platforms.

3.2.9 Customization for Multiple Firms Upon completion of the “beta” version of the mobile app, the developers were faced with the challenge of how they might be able to re-provision the app with new customers. This required that the application be “branded” and “re-distributed” with a unique version for each customer. This unique version of the application binds an “ownership” between the owner and the attorney. In other words, the law firm owns its version of
the mobile application. The difficulty with this concept is there is no known way to easily re-provision a mobile app with subtle customized differences between customers without incorporating some type of manual process, creating a new version of the app and updating all the data for that unique version for that attorney consumer.

The development team concluded that it needed to design a system similar to an open-source content management system (CMS) for mobile phones. This process is similar to the way a CMS system, like WordPress, can rapidly develop websites, an open-source framework which could be developed to support the rapid development and deployment of mobile applications. The design would allow the artefact to leverage the capabilities of features such as a RESTful API and Amazon Web Services. This new framework would support the re-distribution or re-provisioning of the artefact using templates.

For instance, the developers investigated and recommended the Xamarin platform and Amazon Web Services (“AWS”) approaches. The output of these 12 weeks of iterative design cycles led to the implementation of the Beta version of CrashApp™ wireframe screens in the artefact and the first version of all User Interfaces (UI).

3.3 STAKEHOLDER EVALUATION STRATEGIES USED DURING EADR CYCLES

A review of the DSR literature reveals six purposes for the evaluation activity in DSR. First, one key purpose of evaluation in DSR is to determine how well a designed artefact or ensemble of artefacts achieves its expected environmental utility (an artefact’s main purpose) (Venable 2016). A second key purpose of evaluation is the confirmation of design theory in terms of the quality of the knowledge outcomes (Baskerville et al 2007, Kuechler and Vaishnavi 2012), that is, to provide evidence that the theory leads to some developed artefact useful for solving some problem or making some improvement. Third, evaluation also may be concerned with comparative
evaluation of the new artefact (or design theory) in comparison with other artefacts (or design theories) (Venable 2006) to determine whether the new artefact/design theory makes an improvement on the state of the art. The fourth purpose considers that utility is a complex, composite concept, which is composed of a number of different criteria beyond simple achievement of an artefact’s main purpose. Together with functionality, the utility, quality, and efficacy of a design artefact must be rigorously demonstrated via well-executed evaluation methods. According to Hevner et al, “Artefacts can be evaluated in terms of functionality, completeness, consistency, accuracy, performance, reliability, usability, fit with the organization, and other relevant quality attributes” (2004, p. 85). Fifth, an artefact may be evaluated “for other (undesirable) impacts” (Venable 2006), otherwise known as side effects. Sixth and finally, evaluation can further elaborate on the knowledge outcomes by discerning why an artefact works or not (Vaishnavi and Kuechler 2004).

The collection and analysis of data is imperative to show rigor in the research and usability, efficacy and efficiency for a DSR artefact. Multiple evaluation methods were employed for all stakeholders throughout the iterative development of this artefact and included Focus Groups, Mobile Acceptance Surveys, Focused Surveys, the System Usability Scale as well as FEDS (Framework for Evaluation in Design Science).

3.4 APPLICATION ARTEFACT EADR CYCLES

“The expanded ADR cycle incorporates the key activities and principles of the current ADR cycle with the key addition of the Artifact Creation activity as a generalization of the build activity” (Mullarkey and Hevner, 2016). Intervention, guided emergence, co-creation are at the center of the ADR cycle as fundamental to the conduct of each activity on any cycle. Every cycle
goes through a Problem Formulation, Artifact Creation, Evaluation, Reflection, Learning series of actions. (Figure 10)

There are multiple possible ADR entry points, and every project environment is different depending on multiple project factors. Any artefact can be abstracted – created and built – and evaluated in each cycle of any ADR stage (Mullarkey and Hevner 2015). Crashapp™ was created, built, and evaluated from the very beginning – the diagnosis stage – and evaluated through each successive stage of the project, meaning we entered with intervention cycles at the Problem Centered, Objective-Centered, Development-Centered, then Observation-Centered entry points of the Design, Implementation, and Evolution ADR stages. (Figure 11)
3.4.1 Diagnosis Stage Design Science Research is founded in the paradigm of practice inspired and theory ingrained definition, design, build, and evaluation of innovative artefacts in ways that add knowledge to research and practice (Hevner et al. 2004). The CrashApp™ team took a completely iterative approach to establish relevance in an environment with three distinct stakeholders: developers, attorneys, and their end users. Our observation early in the definition of the innovative CrashApp™ mobile artefact was that we were taking a problem-centered entry point in an Action Design Research (ADR) approach. (Sein et al. 2011, Mullarkey and Hevner 2015) Therefore, focus groups, focused surveys, mobile application acceptance surveys, application testing and analysis were employed to ensure the testing methodologies utilized were sound. Taking a concurrent, iterative, expanded ADR approach to the CrashApp™ by applying elaborated ADR Guidelines, rigorous testing was applied using surveys of those offered the artefact for download and used, or attempted, to register and use the artefact on their smartphones.

The CrashApp™ team entered the Diagnosis stage of ADR by analysing the environment of the three user groups and formulating the problem through a series of focus group interviews with five mid-market personal injury lawyers and several of their potential client customers. The developer attempted to create an artefact which performs a specific task, is novel, useful, effective, and efficient and works as intended with as few unintended consequences as possible. Building such an artefact demonstrated its feasibility and, once built, the artefact needed to be evaluated. The attorney/licensee was interested in the artefact as a marketing tool providing the means of staying in touch with current and former clients via regular “push notices.”

Additionally, the attorneys needed to be assured the application would work as designed i.e. they are properly notified when someone engages the artefact after having been in an accident.
Lastly, the end user will use the artefact in case of emergency. When the end user has an accident, he or she will engage the application to notify the attorney of the accident and share accident information, contact emergency responders, and possibly call a tow truck directly from the scene of the accident.

As the team iterated through its requirements diagnosis, the team defined and re-defined the needs of the artefact at two levels – the usability, efficacy, and efficiency of the application for the end users and the needs of the lawyers as stakeholders. The team also worked to refine the diagnosed artefact from the technical and developmental perspective. In addition, the team sought to understand and contribute knowledge created to the practical development of mobile artefacts and to the body of design science research on the definition, design, and deployment of mobile artefact applications.

In this stage, the attorneys led the first stage of the ADR process and identified their target audience and clients. The attorneys identified needs with their current client bases through a number of interactions, discussions, and related experience. The practitioners then researched the competitive landscape to (1) identify existing solutions, if any, and (2) build a business model for an entrant application into the marketplace. Finally, the practitioners met with the development team to describe the several critical objectives for a mobile application, including low cost, multi-platform, (semi) customizable, secure, user friendly, and enterprise ready. These objectives significantly influenced the definition of the requirements of the artefacts and the development team’s technical approach to the artefact’s progression into the next build, intervention, and evaluation ADR cycle. The outcome of that work is illustrated in Figure 12, and is the initial “map” of the workflow process, and guided the brainstorming session with developers.
Focus groups are a data collection method. Data is collected through a semi-structured group interview process. Focus groups are moderated by a group leader. Focus groups are generally used to collect data on a specific topic. Focus group methods emerged in the 1940s with the work of Merton and Fiske, who used focus groups to conduct audience studies (Asbury 1995).

Early in the artefact’s diagnosis cycle, a focus group interview was conducted with five mid-market personal injury attorneys. Researchers asked the attorneys the following questions: “Do you know precisely who your target audience is? And, who are your clients?” In this case, in
order to have a clear model of a typical user for the new application, we determined the typical user. (Figure 13)

![User Profile](image)

Figure 13: Typical user profile

The focus group attorneys also identified the needs of their current client bases through a series of interactions, discussions, and related experience. The researchers then researched the competitive landscape to (1) identify existing solutions, if any, and (2) build a business model for an entrant application into the marketplace. Finally, the practitioners met with the development team to describe several objectives for a mobile application, including low cost, multi-platform, (semi) customizable, secure, user friendly, and enterprise ready. These objectives significantly influenced the definition of the requirements of the mobile application and the development team’s technical approach to the system.

3.4.1.2 Mobile Acceptance Survey

Surveys are a common way of evaluating many systems. The developers employed a marketing-type online survey to help to narrow the focus of the proposed artefact. The researchers asked the focus group attorneys for the names and email addresses of 25 of their clients (five for each attorney) to participate in an initial marketing-type survey regarding their openness to downloading, registering, and using a mobile application from an attorney. The core questions identified at the outset of the application development process were determined to be critical to the artefact being considered for
development; this survey was intended to flesh out those issues. The survey questioned the likelihood of downloading the artefact, their willingness to register and use it, and their openness to accept push notices along with their initial inclination to refer the artefact to others.

The survey was a simple 10 question online survey distributed to 25 survey participants selected by the attorney stakeholders. All 25 participants responded to the survey. The development team secured the survey results from those potential end users of the artefact, and the results are discussed in Section 5.3, Mobile Marketing Acceptance Survey.

Table 2. Intervention Cycle 1

<table>
<thead>
<tr>
<th>Intervention Cycle 1: Problem-Centered Entry Point</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Problem Formation</strong> with attorney stakeholders and researchers, including introduction of problem statement, current state of marketing opportunities, desired outcome to address the theorized problem.</td>
</tr>
<tr>
<td><strong>Method of Intervention (Evaluation):</strong></td>
</tr>
<tr>
<td>• Focus Groups – 5 personal injury attorneys</td>
</tr>
<tr>
<td>• Mobile Acceptance Survey – 25 potential users (5 per focus attorney) were surveyed on openness to download, potential use and other issues.</td>
</tr>
<tr>
<td><strong>Artefact Creation:</strong></td>
</tr>
<tr>
<td>• Concept evolution</td>
</tr>
<tr>
<td>• Artefact model creation and development</td>
</tr>
<tr>
<td>• Development of future methods of evaluation</td>
</tr>
<tr>
<td><strong>Reflection:</strong></td>
</tr>
<tr>
<td>• Current technical solutions available</td>
</tr>
<tr>
<td>• Begin workflow mapping for UI and database management</td>
</tr>
<tr>
<td>• Commercial viability of proposed artefact</td>
</tr>
<tr>
<td><strong>Formalization of Learning:</strong></td>
</tr>
<tr>
<td>• Attorney – Typical user profile, successful artefact objectives defined</td>
</tr>
<tr>
<td>• Researcher – Basic user profile, initial technical requirements, basis for workflow mapping if UI</td>
</tr>
<tr>
<td>• Apparent willingness of users to download, register, and use the proposed artefact – acceptance of solution</td>
</tr>
</tbody>
</table>

3.4.2 Design Stage (ALPHA)    The project team then entered the Design stage of the elaborated ADR Process Model with a four-day brainstorming effort focused on the front-end design of the application and the development of a concept for a “minimally viable product”
(MVP). The MVP is the minimum number of functions to create a functioning model for effectively testing the artefact. No time was spent on the database or “backend” of the application other than to acknowledge a database of some sort would be required to handle data exchanged between the users and the system.

The first iteration of the artefact design focused on what the team surmised the app should look like for the attorney and client and the entire user workflow based on the information about the “normal” user of the artefact previously developed by the attorney focus group. A substantial amount of time was spent working on making the user experience (“UX”) thoughtful and intuitive. The illustration is the specific workflow developed for moving from one page to the next within the application and the basic user workflow through the entire artefact.

The workflow of the artefact was developed in columns following that particular process and over to the next column beginning with the average “users” definition and then that user’s anticipated needs at the time of an accident. The “awareness” column addressed the identification of the initial need for the application at the time of the accident and the developer’s addressing those needs leading to the workflow.

The “download,” “first run,” and “account creation” were all necessarily related to the initial download and registration within the application itself. Prompting for user information and registration upon first download saves the user time in case the application is needed in an emergency and is the overarching goal of the “be prepared” column. Everything to the right of the “Bang!” is application usage after an accident and prompts the user to take pictures, gather information, and upload all of it within the application. That information would be sent directly to the attorney portal and available for viewing and download by that attorney. Figure 14 is the
final whiteboard output from this four-day brainstorming session. It became the basis from which the artefact design would flow.

Figure 14: Whiteboard output from brainstorming workshop

3.4.2.1 Focused Survey – Usability  Approximately 70 users were requested to download and test the instantiation artefact; over the course of 10 days, approximately 60 users downloaded the artefact and tested it to varying degrees, including registering the application, reporting accidents, referring the app to friends function, and taking and importing photos and other data then uploading that data to the database. The developers monitored the database and REST service functions for potential problems. All functions and features of the
artefact were repeatedly tested for all stakeholders for initial download, installation, connectivity, database management functionality, and crash instances. Attorney practitioners tested the Lawyer Web Portal and the push notice function as well. An online survey was provided to all 60 users who downloaded and tested the artefacts functions and features. Forty three of the 60 users submitted input for that online survey, resulting in minor UI changes and additional artefact functions being added based on feedback.

3.4.2.2 System Usability Scale (“SUS”) A separate System Usability Scale (“SUS”) test also was administered to 15 users of the artefact. The System Usability Scale was invented by John Brooke (Brook, 1986) who created this ‘quick and dirty’ usability scale to evaluate practically any kind of system. The SUS has been tried and tested throughout almost 30 years of use and has proven to be a dependable method of evaluating the usability of systems compared to industry standards.

Quick to administer and cheap to start using, particularly online, the SUS is one of the most efficient ways of gathering statistically valid data and giving a clear, reasonably precise score to evaluate the system or artefact. Compared to other tests, the SUS is cheaper in that it is a short quiz that does not require a lot of resources to administer and is very useful if the researcher is constrained by budget but still needs good information fast. Furthermore, it is quicker to administer because the SUS template already exists. Rather than researching and designing a brand new study, a useable format has already been developed.
### Table 3. Intervention Cycle 2

#### Intervention Cycle 2: Problem-Centered Entry Point

<table>
<thead>
<tr>
<th>Evaluation of the basic artefact as designed and testing of usability, functionality, efficacy, and efficiency.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Method of Intervention (Evaluation):</strong></td>
</tr>
<tr>
<td>• Focused Surveys – many users downloaded and tested the artefact and completed an online survey</td>
</tr>
<tr>
<td>• System Usability Scale (SUS) – Users completed online survey regarding artefact acceptance and usability</td>
</tr>
<tr>
<td><strong>Artefact Creation:</strong></td>
</tr>
<tr>
<td>• Concept evolution</td>
</tr>
<tr>
<td>• Artefact model creation and development</td>
</tr>
<tr>
<td>• Development of future methods of evaluation</td>
</tr>
<tr>
<td><strong>Reflection:</strong></td>
</tr>
<tr>
<td>• Attorney – Affirmation of user willingness to download, register, use the artefact</td>
</tr>
<tr>
<td>• Developer – Acceptance of artefact, minor technical issues, improve user workflow, conformation of database management system usability/Portal</td>
</tr>
<tr>
<td>• Very high system usability ratings and user acceptance rate.</td>
</tr>
<tr>
<td><strong>Formalization of Learning:</strong></td>
</tr>
<tr>
<td>• Acceptance/rejection of artefact flow, technical viability/usability</td>
</tr>
<tr>
<td>• Expanded database management system/portal</td>
</tr>
</tbody>
</table>

### 3.4.3 DESIGN STAGE (BETA)

This iteration of the artefact’s design stage began to focus on how to build the artefact. This phase took an additional 12 weeks of close coordination between researchers, practitioners, and developers to produce a design document that incorporated all stakeholder input. Our observations during this stage of the design process were the developers frequently needed to “push back” on the functionality described by practitioners in order to offer design solutions that dramatically simplified the programming requirement and/or lowered the operational issues which might otherwise be associated with the artefact. This stage included the implementation and use of some of the specific technologies for the artefact which were discussed in Section 3.2 Software Technologies.
### Table 4. Intervention Cycle 3: Problem-Centered Entry Point

<table>
<thead>
<tr>
<th>Method of Intervention (Evaluation):</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Conversations with the Focus Group attorney stakeholders regarding workflow and design</td>
</tr>
<tr>
<td>• Constructive review of the design requirements</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Artefact Creation:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Design evolution</td>
</tr>
<tr>
<td>• Artefact development</td>
</tr>
<tr>
<td>• Planning for implementation of evaluation methods</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Reflection:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Attorney – Confirmation of artefact concept and design for the end users and attorneys</td>
</tr>
<tr>
<td>• Developer – Full acceptance of software technologies and planning for implementation of software technologies</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Formalization of Learning:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Acceptance of artefact flow, technical viability/usability, and technology solutions</td>
</tr>
<tr>
<td>• Begin build of database management system/portal</td>
</tr>
<tr>
<td>• Put all develops in place to begin actual build of artefact</td>
</tr>
</tbody>
</table>

#### 3.4.4 DESIGN IMPROVEMENTS STAGE

The next step of the development project (third iteration) was to create the proof concept and BETA version of the artefact with the wire frames (see a few examples below), prototype, and the User Interface (UI) experience for testing. Wireframes are mock-ups of your future mobile application’s interface; they become the blueprints of the mobile application. Wireframes show the structure of the mobile app and every part of its screens, demonstrate the features of the app to the client, represent the mobile application’s usability, and represent the user flow. (Figure 15)
When imagining the artefact, the developers and researcher tried to reflect every possible user interaction in wireframes. During the wire framing stage, developers and attorneys discussed all the features they wanted to incorporate in the artefact to give the artefact its greatest usability while keeping the artefact as efficient and effective and within its designed purpose. For example, in the construction stage, the attorneys were free to choose the sections of the application and their arrangement within the application. The developer’s task was to stay in tune with the attorney and the end users.

Also during this phase, the developers created additional upgraded wire frame mock-ups (Figure 16) as well as a non-working prototype for the attorney practitioners to review and provide input for the UI. Based on input from the attorney practitioners, the design and code were modified to create a simpler workflow for the end user. The attorney practitioners also provided input for database design and the Lawyer Web Portal yet to be fully designed. Based on that feedback and because of the unique nature of the database development using cutting edge technology, a provisional patent was filed to protect the re-provisioning process and overall dataflow process on the “backend” of the application.
Table 5. Intervention Cycle 4

<table>
<thead>
<tr>
<th>Intervention Cycle 4: Objective-Centered Entry Point</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Create the proof concept and BETA version of the artefact with the wire frames, prototype, and the User Interface (UI) experience for testing.</strong></td>
</tr>
</tbody>
</table>

**Method of Intervention (Evaluation):**
- Focused Surveys—many users downloaded and tested the artefact and completed an online survey
- System Usability Scale (SUS) – Users completed online survey regarding artefact acceptance and usability

**Artefact Creation:**
- Concept evolution
- Artefact model creation and development
- Development of future methods of evaluation

**Reflection:**
- Attorney – Affirmation of user willingness to download, register, use the artefact
- Developer – Acceptance of artefact, minor technical issues, improve user workflow, conformation of database management system usability/Portal
- Very high system usability ratings and user acceptance rate.

**Formalization of Learning:**
- Acceptance/rejection of artefact flow, technical viability/usability
- Expanded database management system/portal
3.4.5 EVOLUTION STAGE  

The continual iteration of the design project was to evaluate the application within and between the three stakeholder groups in the Evolution stage of the ADR process. The objective of this cycle was to initially evaluate the developed (MVP) artefact with user and attorney stakeholders in actual field tests. The evaluation was tracked and observed by the researchers, attorney, and developers and led to reflections and learnings which informed the next version of the artefact build. A re-provisioned version of the artefact was created to evaluate the challenges of that process for the developers insofar as the time needed to perform the task and understand the capabilities of the database and REST services. Additionally, the Lawyer Web Portal was tested for functionality and ease of use by the attorney practitioners.

<table>
<thead>
<tr>
<th>Intervention Cycle 5: Objective-Centered Entry Point</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Evaluation of the basic artefact as designed and testing of usability, functionality, efficacy, and efficiency.</strong></td>
</tr>
<tr>
<td><strong>Method of Intervention (Evaluation):</strong></td>
</tr>
<tr>
<td>• Developer testing of infrastructure software technologies</td>
</tr>
<tr>
<td>• System Usability Scale (SUS) – Users completed online survey regarding artefact acceptance and usability</td>
</tr>
<tr>
<td><strong>Artefact Creation:</strong></td>
</tr>
<tr>
<td>• Software technology evolution</td>
</tr>
<tr>
<td>• Artefact mockup evolution for User Interface (UI) and portal development</td>
</tr>
<tr>
<td>• Implementation of evaluation methods</td>
</tr>
<tr>
<td><strong>Reflection:</strong></td>
</tr>
<tr>
<td>• Attorney – Portal development issues identified and ease of use confirmed</td>
</tr>
<tr>
<td>• Developer – Further expansion of software technologies necessary and expansion to GitHub for cloud storage</td>
</tr>
<tr>
<td>• Very high system usability ratings and user acceptance rate.</td>
</tr>
<tr>
<td><strong>Formalization of Learning:</strong></td>
</tr>
<tr>
<td>• Push notices for the portal enhanced and further developed</td>
</tr>
<tr>
<td>• REST Services changed for faster data transfer</td>
</tr>
<tr>
<td>• New Wireframes developed for better user experience and workflow</td>
</tr>
</tbody>
</table>
As a part of the User Interface (UI), the usability of the artefact is a measure of how easy it is to use as a tool and how it performs those tasks deemed as necessary earlier in the process. The main purpose of functional design was to ensure that each feature prescribed by the client was implemented through an appropriate visual element and worked as planned. Wireframes were probably the most useful tools when dealing with the functional design for CrashApp. The high quality of a design is the competitive advantages that will help the artefact succeed in the market. To improve the artefact’s design, we used multiple surveys, iterations, and direct artefact testing to do a complete test of all functions and features of the artefact.

3.4.6 Surveys and Field Testing

Approximately 70 users were requested to download and test the instantiation artefact, and over the course of 10 days, approximately 60 users downloaded the artefact and tested it to varying degrees, including registering the application, reporting accidents, referring the app to friends function, and taking and importing photos and other data then uploading that data to the database. The developers monitored the database and REST service functions for potential problems. All functions and features of the artefact were repeatedly tested for all stakeholders for initial download, installation, connectivity, database management functionality, and crash instances. Attorney practitioners tested the Lawyer Web Portal and the push notice function as well.

An online survey was provided to all 60 users who downloaded and tested the artefacts functions and features. Forty three of the 60 users submitted input for the online survey, resulting in minor UI changes and additional artefact functions being added based on feedback. The results of this focused survey and their contribution to the overall development are discussed in Section 5.2, Focused Surveys.
Additionally, during this stage, the separate System Usability Scale Survey ("SUS") was given to 15 potential users of the artefact. A Likert Scale (Figure 17) was used, and the users of the application answered all questions and ranked each question from 1 to 5 based on how much they agreed with the statement provided. Five means they agreed completely while one means they disagreed vehemently.

![Figure 17: System Usability Survey Likert Scale](image)

The results of the survey are discussed in detail in Section 5.3, (get correct section) System Usability Scale.

### 3.4.7 IMPLEMENTATION STAGE

The artefact was deployed with all available learnings applied; the artefact is re-provisioning ready and is being sold on the open market. The resource dictionaries were updated to increase the speed of the artefact on the mobile device; the UI was again updated to the easiest possible workflow and additional improvements were made to the Lawyer Web Portal to allow push notices to be sent to a single mobile device in addition to every device (as necessary) in the database and to allow for the database to be exported in spreadsheet format.

### 3.4.8 EVOLUTION STAGE

After implementation, feedback was gathered from all stakeholders and the developers implemented multiple changes based on that feedback. The wireframes were updated and a message inbox was added to the artefact to manage incoming messages from the attorneys. Figure 18 reflects the Final wireframes and updates from this cycle. This was an ongoing process that included numerous intervention cycles as more users downloaded and registered the application. Additionally, the AWS service was updated to include
a data analytics package to monitor the artefact’s usage on the mobile phone in hopes of identifying “choke points” and to gather user usage data.

<table>
<thead>
<tr>
<th>Intervention Cycle 6: Development-Centered Entry Point</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Field (real-world) testing of the artefact with actual attorney users for evaluation of all functions and features of the entire artefact and system</strong></td>
</tr>
<tr>
<td><strong>Method of Intervention (Evaluation):</strong></td>
</tr>
<tr>
<td>• Real-world download and testing of the artefact by users</td>
</tr>
<tr>
<td>• Portal and database system testing by attorney stakeholder</td>
</tr>
<tr>
<td>• Focused Online Survey of real-world users of the artefact</td>
</tr>
<tr>
<td>• Follow-up with attorney Focus Group regarding Portal and database system use</td>
</tr>
<tr>
<td><strong>Artefact Creation:</strong></td>
</tr>
<tr>
<td>• UI Experience</td>
</tr>
<tr>
<td>• Portal and database system</td>
</tr>
<tr>
<td>• Future testing opportunities explored</td>
</tr>
<tr>
<td><strong>Reflection:</strong></td>
</tr>
<tr>
<td>• Attorney – Highly adaptive and responsive portal for push notices and database</td>
</tr>
<tr>
<td>• Developer – Very high user rating of artefact and system usability and data transfers from phones to/through database system</td>
</tr>
<tr>
<td>• User - Very high system usability ratings and user acceptance rate.</td>
</tr>
<tr>
<td><strong>Formalization of Learning:</strong></td>
</tr>
<tr>
<td>• Further UI updates for Wireframes and “dumbing down” of pictures and video for faster transfer or data to/through system</td>
</tr>
<tr>
<td>• Upgrade of push notice functions in the database management system/portal</td>
</tr>
<tr>
<td>• Conformation of system usability, efficacy, efficiently and fitness for its intended purpose</td>
</tr>
</tbody>
</table>
Figure 18: Final version of wireframes

Table 8. Intervention Cycle 7

<table>
<thead>
<tr>
<th>Intervention Cycle 7: Observation-Centered Entry Point</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Full Implementation of the artefact and all systems</strong></td>
</tr>
<tr>
<td><strong>Method of Intervention (Evaluation):</strong></td>
</tr>
<tr>
<td>- Further real-world use and testing with user and attorney stakeholders</td>
</tr>
<tr>
<td>- Data analytics data collection analysis</td>
</tr>
<tr>
<td><strong>Artefact Creation:</strong></td>
</tr>
<tr>
<td>- Wireframe updates</td>
</tr>
<tr>
<td>- Portal/database management system expansion for push notice software</td>
</tr>
<tr>
<td><strong>Reflection:</strong></td>
</tr>
<tr>
<td>- Attorney – Conformation of marketing value of artefact</td>
</tr>
<tr>
<td>- Developer – Usability, efficacy, efficiency, and fitness for its intended use confirmed</td>
</tr>
<tr>
<td><strong>Formalization of Learning:</strong></td>
</tr>
<tr>
<td>- Expansion of use and acceptance of artefact</td>
</tr>
</tbody>
</table>
4.0 ARTEFACT STAKEHOLDERS

Insofar as stakeholders in this project are concerned, we took the approach that, “A project stakeholder is any individual or an organization that is actively involved in a project, or whose interest might be affected (positively or negatively) as a result of project execution or completion” (Project Management Institute. 2004). This definition includes the developers even though there is some literature indicating that developers are not actual stakeholders (Ambler, 2012) but ancillary figures whose needs are to be considered and balanced but are somehow lesser. I disagree and approached this project with three equal stakeholders with equal, sometimes competing, needs and goals. Unfortunately, some projects are complete before the project team realizes that the artefact produced doesn’t meet any of the stakeholders’ actual needs.

This research study approached the development process for the artefact while having Design Science researchers work alongside the developers with the goal of shortening the development time and overall cost. The design problem of meeting the varying needs of developers, attorneys, and users forced me to design, build, and evaluate all three stakeholders separately but concurrently.

How do I effectively measure and scrutinize the success of a mobile application with multiple stakeholders? Recognizing the three stakeholder groups of clients, attorneys, and the developers as having unique and distinct measures of success I asked:

1. What are the critical factors for success of the artefact for the developers?
2. What are those critical success factors for attorneys?
3. What are the critical factors of success for users?
Once those success factors were determined I was left to determine the evaluation strategy and measurement tools which could best measure those critical factors.

4.1 DEVELOPER STAKEHOLDERS

The developers as stakeholders needed to marshal the design requirements, success factors for all stakeholders and manage the project as effectively as possible. The researchers kept the other stakeholders actively involved in the project and made them available to the developers throughout the project to manage their (the stakeholders) needs. Active stakeholder involvement helped to ensure the developers never lost touch of their own needs, as well – the artefact needed to be usable, effective, efficient, and functional.

4.1.1 Developer Stakeholder Needs Despite what could have been the changing needs of the other stakeholders, the needs of the developer’s really didn’t change throughout the project.

All of the developer goals are, or should be, measurable and testable. Utility and efficacy are “squishy” factors and don’t usually produce hard numbers until the artefact is in use for a period of time and further depends on the well-established goals of the other stakeholders.

4.1.2 Developer Stakeholder Artefact Requirements This artefact will exist in the real world so the developers had to keep that in mind when defining their critical factors for success (their requirements). So, also being mindful of the needs of the other stakeholders, developers defined their critical success factors as producing an artefact that is:

a) Usable;
b) Effective;
c) Efficient;
d) Functional; and,
e) Has efficacy/utility.
4.1.3 Developer Evaluation Methods & Strategies

Data provides insight but it’s only quantitative so it’s important to know how and why the data says what it does. In order to get as much information as possible, the developers started collecting and evaluating data from the other stakeholders very early in the project in addition to planning for iterative evaluation cycles throughout the development stages. Focus groups in the Problem Diagnosis Stage provided information about attorney stakeholder needs and their expectations of the artefact as well as their “typical” user. And, the Mobile Acceptance Survey provided the developers basic data on anticipated user needs for the artefact’s future utility in the Problem Formation Stage. In the Design Stage (BETA), a Focused Survey of test users of the artefact would provide a wealth of information about the artefact’s usability, effectiveness, efficiency, and functionality. And just before the Implementation Stage, the System Usability Scale (SUS) would provide the users’ perception of the pure usability of the artefact. Lastly, during the Implementation and Evolution Stages, I applied the Framework for Evaluation in Design Science (FEDS) Technical Risk and Efficacy strategy to provide a broad overall evaluation of the surveys and tests from formative to summative.

4.2 ATTORNEY STAKEHOLDER

The attorney stakeholders would be the “consumer” of the artefact as they are the stakeholders who will buy it to distribute to their current and former clients initially so their needs had to be identified early in the project and validated from problem diagnosis to evolution.

4.2.1 Attorney Stakeholder Needs

The attorney stakeholders were interested in the artefact as a marketing tool, providing them the means to staying in touch with current and former clients via regular “push notices” and a keep general marketing presence. Additionally, the attorneys need to be ensured the application would work as designed wherein they would be
properly notified when someone engages the artefact after having been in an accident. Lastly, the end user would use the artefact in case of emergency. When the user has an accident, he or she would engage the application to notify the attorney of the accident and share accident information, contact emergency responders, and possibly call a tow truck directly from the scene.

4.2.2 Attorney Stakeholder Artefact Requirements The attorney stakeholder requirements were relatively straightforward in that they wanted an artefact which would be functional, easy and convenient to download and use, and would encourage further (continued) use wherein the user stakeholder would accept push notices and show a willingness to refer the artefact to others in order to expand the attorney’s network of users thereby increasing the value of the marketing dollars being spent on the artefact.

4.2.3 Attorney Evaluation Methods & Strategies In the focus groups formed during the Problem Formation Stage, the attorneys identified their wants, needs and then critical success factors for the artefact. Those critical success factors were further verified by potential users in the Mobile Artefact Acceptance Survey.

Once the artefact was ready for a BETA testing, the artefact was provided to approximately seventy users for them to test the artefact’s functions and features and provide feedback via an online Focused Survey. Just before the Implementation Stage, a System Usability Scale (SUS) survey of those users was employed to validate the artefact’s acceptance/usability and all of those surveys and tests were applied against the Framework for Evaluation in Design Science (FEDS) Human Risk and Effectiveness strategy in the Implementation and Evolution Stages to ensure the rigor and veracity of the evaluations employed.
4.3 USER STAKEHOLDER

The end-user stakeholders are the people that will ultimately use the artefact and they will ultimately determine the success or failure of it. The user was the central focus of the project from the Problem Formation Stage (“who are your clients?”) through the Implementation Stage (“would you use this?” and “would you refer it?”). But user stakeholders have a different set of needs and expectations of an artefact than the other stakeholder and theirs are at once more simple and complex.

4.3.1 User Stakeholder Needs Usability is crucial to satisfy stakeholder needs. Users queried in the Problem Formation Stage expressed a willingness to use an application to notify their attorney should they get into an accident and further expressed a willingness to take pictures and gather information from the scene of an accident so the users need an artefact which will effectively capture pictures, data and other information to help document their case. They also wanted it to be innovative and simple to use.

4.3.2 User Stakeholder Artefact Requirements Put simply, users care if the thing works as intended and everything after that is all secondary. For the users, once fitness for its intended purpose and usability are determined they wanted something easy and convenient to use, it should be innovative and visually appealing. The quality of the design and other factors all increase the overall satisfaction with the artefact but functionality and usability were the critical success factors.

4.3.3 User Evaluation Methods & Strategies Because the user stakeholder needs were first and foremost throughout the process, the methods of evaluating their needs and satisfaction were determined very early in the process. The Mobile Artefact Acceptance Survey was used to verify their desires even as the basic mapping and workflow was being conceived in
the Problem Formation Stage. During the Design (BETA) Stage, the users were provided the online Focused Survey which surveyed the users’ perception of usability, functionality and overall acceptance of the artefact as fit for its intended purpose. And the users were again surveyed about the system usability with a System Usability Scale (SUS) survey in the Implementation and Evolution Stage.

4.4 SUMMARY

The information in Table 9 represents the rigorous artefact stakeholder evaluation performed. It reflects the stakeholder evaluated, the method(s) of evaluation employed for that stakeholder, the imperative particular facet of the artefact measured, imperative objective tested, and the learning or outcome of those evaluations and in what stage that particular evaluation technique was employed. Many of the methods of evaluation employed crossed stakeholders while a few of the methods applied to only one set of stakeholders. For example, the Focus Surveys provided valuable information for all three of the project stakeholders.

Table 9. Evaluation Roadmap

<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Testing: Evaluation Methods</th>
<th>Success Criteria Tested</th>
<th>Results/Findings</th>
<th>Stage Employed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Developers</td>
<td>Focus Groups</td>
<td>Target audience</td>
<td>Identified Target Audience</td>
<td>Problem Formation</td>
</tr>
<tr>
<td></td>
<td>Focused Surveys</td>
<td>Intended Use</td>
<td>Validated intended Use</td>
<td>Design(BETA)</td>
</tr>
<tr>
<td></td>
<td>System Usability Scale (SUS)</td>
<td>Usability</td>
<td>Verified usability to a high degree of certainty</td>
<td>Implementation</td>
</tr>
<tr>
<td></td>
<td>FEDS:Technical Risk and Efficacy</td>
<td>Functionality</td>
<td>Validated application of functionality for intended purpose</td>
<td>Evolution</td>
</tr>
<tr>
<td></td>
<td>Mobile Artefact Acceptance Survey</td>
<td>Efficiency</td>
<td>Efficiency clearly produces the intended results</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Efficacy</td>
<td>Artefact clearly produces the intended results</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Use Across platforms</td>
<td>Verified use across all platforms tested</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Usability</td>
<td>Verified usability to a high degree of certainty</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Efficacy/Utility</td>
<td>Artefact clearly produces the intended results</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Willingness to download</td>
<td>Verified willingness to download the artefact</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Acceptance of push notices</td>
<td>Verified general acceptance of push notices</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Willingness to refer artefact</td>
<td>Relatively high certainty of referral of use</td>
<td></td>
</tr>
<tr>
<td>Users</td>
<td>Focused Surveys</td>
<td>Ease of Use</td>
<td>Found the artefact easy to use</td>
<td>Design(BETA)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Convenience of use</td>
<td>Found the artefact convenient to install/use</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Innovation</td>
<td>High quality of design</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Quality of design</td>
<td>Very visually appealing</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Visual appeal</td>
<td>Very high overall satisfaction with use/function</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Overall satisfaction</td>
<td>Rigorously verified artefact usability</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Usability</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>FEDS:Quick and Simple</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Attorneys</td>
<td>Focus Groups</td>
<td>Target Audience</td>
<td>Identified Target Audience</td>
<td>Problem Formation</td>
</tr>
<tr>
<td></td>
<td>Focused Surveys</td>
<td>Intended Use</td>
<td>Validated intended Use</td>
<td>Design(BETA)</td>
</tr>
<tr>
<td></td>
<td>User Functionality</td>
<td>All functions and functioned as designed and intended</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>User Data</td>
<td>Verified intended user pool</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Likelihood of future use</td>
<td>Verifed the artefact should be used in an emergency</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Push Notice acceptance</td>
<td>Majority of users received/accepted push notices</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
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<td>Willingness to refer artefact</td>
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<td>Mobile Artefact Acceptance Survey</td>
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<td>Verified general acceptance of push notices</td>
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<td>Willingness to refer artefact</td>
<td>Relatively high certainty of referral of use</td>
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<td>FEDS:Human Risk &amp; Effectiveness</td>
<td>Effectiveness</td>
<td>Preliminary data indicates the artefact is highly effective</td>
<td>Evolution</td>
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</table>
5.0 STAKEHOLDER EVALUATIONS AND RESULTS

Building an artefact such as this demonstrates its feasibility. According to Hevner, “Designing and testing an artefact as evaluation is a crucial element of the research process” (2004). IT artefacts can be evaluated in terms of usability, functionality, efficacy, efficiency, completeness, consistency, accuracy, performance, reliability, fit with the organization, and other relevant quality attributes. The software artefact for this study can be evaluated on nearly every term listed and is a novel use of the design science research paradigm; rigorous testing is possible at every level of implementation from design through communication of research contributions in various fields of study. However, the theory may fail in the actual, real time attempt to download, register, and use the artefact because of the time constraints of downloading the artefact as well as the entry of data into the artefact to make it fully functional and operational.

The results from some of the surveys and tests may be reflected in more than one section (as against more than one stakeholder) because they often bear on one or all of the stakeholder’s goals and critical success factors.

5.1 DEVELOPER STAKEHOLDER EVALUATION AND RESULTS

5.1.1 Focus Group Results - Developer The CrashApp™ team entered the Problem Formation Stage of ADR by analysing the environment of the three user groups and formulating the initial problem through a series of interviews with five mid-market personal injury lawyers and several of their potential client customers. The developer attempted to create an artefact that performs a specific task, is novel, innovative, useful, effective, and efficient, and works as intended with as few unintended consequences as possible for its intended audience.
5.1.2 Mobile Acceptance Survey Results - Developer The developers asked the attorney stakeholders for the names and email addresses of 25 of their clients (five for each attorney) to participate in an initial online survey entitled “Mobile Marketing Survey” to measure their openness to downloading, registering, and using a mobile application from an attorney. The core questions of use and acceptance were identified in the first stage of the artefact development process and, at that time, were determined to be critical to the artefact being considered for successful development and deployment.

A simple 10 question Mobile Marketing Survey was developed and distributed to the 25 survey participants; all 25 people responded to the survey, and the team secured the preliminary survey from those potential end users of the artefact. The questions tended towards validating the general notion that the researcher and developer were on the right path towards filling a previously unaddressed need for the attorneys and users.

5.1.3 Focused Surveys Results - Developer In order to measure, test, and evaluate whether or not the developers reached the intended target audience and whether that audience felt the artefact met the intended use, focused surveys were developed and provided to approximately 60 users. Over the course of 10 days, those 60 users downloaded the artefact and tested it to varying degrees, including registering the application, reporting accidents, referring the app to friends function, and taking and importing photos and other data then uploading that data to the database.

The developers monitored the database and REST service functions for potential problems. All functions and features of the artefact were tested for all stakeholders for initial download, installation, connectivity, database management functionality, and crash instances. Attorney practitioners tested the Lawyer Web Portal and the push notice functions, as well.
The online focus survey was provided to all 60 users who downloaded and tested the artefact’s functions and features. Forty-three of the 60 users submitted input for that online survey. Following the survey, the research team compared the results of the survey for the design specific questions related to the developer’s goals of designing an artefact (usability, efficacy, efficiency, and functionality). Additionally, the developers had to know the artefact would perform across various platforms (phones – iPhone, android and etc.); below, we address each of these factors individually. The questions and answers related directly to the developer stakeholder’s goals were as follows:

**Focused Survey Question 1.** “How would you describe the process of installing our mobile application?”

![Figure 19: Survey Results, Focused Survey Question 1](image1)

**Focused Survey Question 5.** “Did you find navigating around inside the mobile…?”

![Figure 20: Survey Results, Focused Survey Question 5](image2)
**Focused Survey Question 6.** “How convenient do you think the mobile application is to use?”

![Survey Results: Focused Survey Question 6](image)

**Focused Survey Question 9.** “Which of the following words would you use to describe the mobile application?”

![Survey Results: Focused Survey Question 9](image)

**Focused Survey Question 13.** “Did you have any technical issues with the mobile application during download and/or installation?”
**Figure 23: Survey Results, Focused Survey Question 13**

**Focused Survey Question 18.** “What type of phone did you use for the app download?”

![Chart showing phone types and their percentages](chart)

*Figure 24: Survey Results, Focused Survey Question 18*

**5.1.3.1 General Usability** Questions 1, 5, and 6 relate to the question of usability. Although there are clearly improvements to be made, 41 of the 43 users surveyed found the artefact either “extremely easy” or “moderately easy” to install with no one finding it difficult. Thirty-seven of the 43 users surveyed found the application either “extremely easy” or “moderately easy” to navigate inside the artefact while only two users found it moderately hard.
Question 5 relates directly to the “ease of use” question, which is extremely important for acceptance and adoption of the artefact. Thirty-eight of the 43 users surveyed identified the artefact as either “very convenient” or “moderately convenient” while none of the users found the use of the artefact inconvenient.

5.1.3.2 General Efficacy The Oxford dictionary defines Efficacy as “the ability to produce a desired or intended result.” Question 9 was specifically included in the survey to identify whether efficacy has been achieved by the developers. When users were surveyed to choose a word, or words, to describe the artefact, 26 of the 44 users chose all three of the words “high quality,” “useful,” and “innovative” while a number of others wrote “practical” in the “other” column.

5.1.3.3 General Efficiency The efficient operation of an artefact is crucial to acceptance and adoption, and questions 1, 5, 6, and 9 relate to the efficiency and a high rate of adoption of users. As discussed above, the users related that the artefact is easy to install, use, navigate within, and is useful for its intended purpose. However, a relatively high number of users identified technical issues with the artefact while using it. Specifically, a number of users identified problems with uploading the photos they had taken, which is a crucial function of the artefact.

5.1.3.4 General Functionality In its purest form, functionality is defined as “the quality of having a practical use: the quality of being functional” (“Functionality.” Merriam-Webster.com. Merriam-Webster, n.d. Web.). In the context of a system or artefact, functionality refers to the quality of being able to serve a purpose well; functionality is a crucial question to be asked of users for the developer stakeholders.

Questions 6 and 9 directly address the issue of perception of functionality as we have defined it. The results of both questions are identical in that both questions resulted in an average
rating of 8.56 out of a possible score of 10, indicating the users perceived the artefact highly functional for the purpose it was designed.

5.1.4 **System Usability Scale (SUS) Results** The System Usability Scale was invented by John Brooke who, in 1986, created this ‘quick and dirty’ usability scale to evaluate practically any kind of system (Brooke, 1986). The System Usability Scale is a Likert Scale which includes 10 questions and was provided to 15 users of the early version of the application. The users of the application answered the questions and ranked each question from 1 to 5, based on how much they agreed with the statement provided. A 5 means they agreed completely while a 1 means they disagreed vehemently.

Users will have ranked each of the 10 template questions above from 1 to 5, based on their level of agreement. The score is determined and equalized as follows:

- For each of the odd numbered questions, subtract 1 from the score.
- For each of the even numbered questions, subtract their value from 5.
- Take these new values which you have found and add up the total score. Then, multiply this number by 2.5.

According to John Brooke, the average System Usability Scale score is 68. If the score is under 68, then there are serious problems with the system usability that should be addressed. If the score is above 68, then it can be assumed the system is usable (John Brooke 1986). The results are reflected in Table 10.
Table 10. System Usability Scale Results

<table>
<thead>
<tr>
<th>Q1 - I think that would like to use this application had an accident</th>
<th>Q2 - I found the application unnecessary</th>
<th>Q3 - I thought the application was too much for the user to use</th>
<th>Q4 - I think that I would need the support of a technical person to be able to use this application.</th>
<th>Q5 - I think that I found the application well integrated.</th>
<th>Q6 - I thought there were too many functions in this application.</th>
<th>Q7 - I would imagine that other people would learn to use this application very easily.</th>
<th>Q8 - I found the application very manageable.</th>
<th>Q9 - I felt very confident using the application.</th>
<th>Q10 - I needed to have a lot of things before being able to get going with this application.</th>
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On a relative scale of 100, the survey resulted in a score of 97.267. A score of 68 or below would mean the artefact was found unusable and major revisions would have to be made before the next release or test. The results of the SUS reflect that the system is perceived as highly usable and the functions and features of the artefact are well integrated and highly likely to be usable, and used, by the intended audience.

### 5.1.5 FEDS: Technical Risk & Efficacy Results

According to Venable’s FEDS, “Naturalistic evaluation explores the performance of a solution technology in its real environment, typically within an organization. By performing evaluation in a real environment (i.e., real people, real systems, and real settings, Sun and Kantor 2006), naturalistic evaluation embraces all of the complexities of human practice in real organizations” (2014). As discussed in Section 2.4, Framework for Evaluation in Design Science Research (FEDS), Venable (2014) identifies at least six different purposes for the evaluation activity. They are (broadly): achievement of environmental utility, quality of knowledge outcomes, comparison to other artefacts, a complex, composite artefact, undesirable impacts, and knowledge outcome.
The Technical Risk & Efficacy evaluation strategy emphasizes artificial formative evaluations iteratively early in the process, but progressively moves towards rigorous, summative artificial evaluations (Venable 2014). These rigorous summative evaluations are used for determining efficacy of the artefact, “that is, the utility/benefits derived from the use of the artefact are due to the artefact, not due to other factors” (Venable 2014).

The focus groups, mobile artefact acceptance survey, focused surveys, and System Usability Scale all contribute to the efficacy/utility of the artefact.

5.1.5.1 Focus Groups Results as Applied to FEDS Early in the artefact’s concept design (Problem Formation), a focus group was established and an interview was conducted with five mid-market personal injury attorneys. The focus group attorneys identified the needs of their current client bases through a series of interactions, discussions, and related experience. The researchers then researched the competitive landscape to (1) identify existing solutions, if any, and (2) build a business model for an entrant application into the marketplace. Finally, the practitioners met with the development team to describe several objectives for a mobile application including, low cost, multi-platform, (semi) customizable, secure, user friendly, and enterprise ready.

5.1.5.2 Mobile Acceptance Survey Results as Applied to FEDS As discussed above, in Section 5.1.2, Mobile Artefact Acceptance Survey Results, the respondents appeared to show a very high perception of utility of the artefact even before the development.

5.1.5.3 Focused Surveys Results as Applied to FEDS The Focused Surveys, discussed in Sections 5.1.3, Focused Survey Results above, came late in the development process (Design(BETA)) and surveyed users who evaluated the artefact in a naturalistic environment (i.e. real use with real people with a high risk of failure). The results of the focused survey overwhelmingly showed that the user stakeholders found the artefact usable, effective, efficient,
and functional by all measures in the survey. Other properties, such as ease of use, time and effort required, and ease of learning of the artefact, were tested in the focused survey.

5.1.5.4 System Usability Survey (SUS) Results as Applied to FEDS

The System Usability Survey discussed in Section 5.1.4, System Usability Scale Results, also was administered to 15 users of the artefact after the Focused Surveys were administered, which was very late in the Design (Alpha) Stage. The purpose of the SUS was to test the artefact’s perception of usability in a real life setting with real users, like the focused surveys. On a relative scale of 100, the survey resulted in a score of 97.267. A score of 68 or below would mean the artefact was found unusable and major revisions would have to be made before the next release or test.

The formative and summative surveys and tests employed by the developers throughout the multi-cycle, multi-stakeholder design, build, and evaluation process were, as described above, initially formative in the form of initial interviews and basic surveys. As the iterative process continued into the second and third cycles (3rd, 4th, and 5th iterations), more summative surveys and technical surveys were performed in the form of focus surveys and System Usability Surveys.

5.2 USER STAKEHOLDER EVALUATION AND RESULTS

Although the users, and the user experience, was considered first and foremost throughout the project, testing of actual users could only be performed when the artefact was in Design (BETA) Stage.

5.2.1 Focused Surveys Results – User

In addition to the survey questions 1, 5, 6, 9, 13, and 18, which addressed developer desired outcomes, questions were related to the user’s perception of usability and functionality. Ease of use, convenience of use, innovation, quality of design, visual appeal, and overall satisfaction with the artefact all communicate usability and
functionality for the user stakeholder. Four user specific questions and answers are reflective of the user stakeholder’s goals and were as follows:

**Focused Survey Question 6.** “How convenient do you think the mobile application is to use?”

![Survey Results, Focused Survey Question 6](image)

**Focused Survey Question 9.** “Which of the following words would you use to describe the mobile application?”

![Survey Results, Focused Survey Question 9](image)

**Focused Survey Question 14.** “How likely is it that you would recommend this mobile application to a friend, family member, or colleague?”

(Scale of 1 to 10 – 10 being most likely)
Focused Survey Question 15. “Overall, how satisfied would you say you are with the mobile application?”

Score 1 to 10 (10 being the most likely)

5.2.4 Use across Platforms - User

Many types of smart phones are being used in our target market, and a mobile application must function across as many of those smartphone platforms as possible. This is important because as many users as possible need to be able to download and use the artefact. The survey found that the application was used across at least six different smartphone platforms.
5.2.5 FEDS: Quick and Simple Strategy Results

As discussed in Section 2.4, Framework for Evaluation in Design Science Research (FEDS), the Quick and Simple Strategy suggests relatively little formative evaluation and moves quickly to summative, more naturalistic evaluations, meaning the evaluations come late in the artefact development process and the evaluation trajectory of this strategy includes relatively few evaluations – possibly only one evaluation. This strategy is low cost and encourages quick project conclusion (Venable 2014).

5.2.5.1 Focused Surveys – Usability Results

The Focused Surveys came late in the development process (Design (BETA Stage) and surveyed users who evaluated the artefact in a naturalistic environment (i.e. real use with real people with a high risk of failure). The results of the focused survey showed overwhelmingly that the user stakeholders found the artefact usable, effective, efficient, and functional by all measures in the survey. Other properties, such as ease of use, time and effort required, and ease of learning of the artefact, were tested in the focused survey.

The FEDS evaluation strategy requires a “rigorous collection and analysis of the perceived utility from the stakeholders” (Venable 2014); the data collected and reflected herein shows a
strong statement of utility by putting the artefact through a real test with real people and collected ample data to support that assertion.

5.2.5.2 System Usability Survey (SUS) Results The System Usability Scale, was administered to 15 users of the artefact after the Focused Surveys were administered, which was very late in the development process (Iteration 5). The purpose of the SUS was to test the artefact’s perception of usability in a real life setting with real users, like the focused surveys. On a relative scale of 100, the survey resulted in a score of 97.267. A score of 68 or below would mean the artefact was found unusable and major revisions would have to be made before the next release or test.

Again, this FEDS strategy requires collection and analysis of data to show usability, and the researchers used real users in a real life setting to as completely and efficiently as possible provide feedback on the artefact’s usability.

5.3 ATTORNEY STAKEHOLDER EVALUATION AND RESULTS

5.3.1 Focus Group Results The attorney stakeholders are interested in the artefact as a marketing tool, providing the means of staying in touch with current and former clients via regular “push notices” and a general marketing presence. Additionally, the attorneys need to be ensured the application would work as designed wherein they would be properly notified when someone engages the artefact after having been in an accident. Lastly, the end user would use the artefact in case of emergency. When the user has an accident, he or she would engage the application to notify the attorney of the accident and share accident information, contact emergency responders, and possibly call a tow truck directly from the scene.
The focus group sessions provided valuable information to create a working outline of why the artefact was being developed and for what type of user. However, those criteria could only be validated after a working artefact was developed and used by a test group of user stakeholders.

5.3.2 Mobile Acceptance Survey Results  For the attorneys, the core value propositions of the design and development of this artefact were captured with the following questions: would the end users download, register, and use the artefact in an accident? And, would the attorney stakeholders be able to effectively use the push notices as a marketing tool to maintain and generate firm loyalty and growth?

Of the 25 people surveyed, nearly all (20 out of 25) said they were “likely” or “very likely” to download the artefact from their attorney, and two said they probably would not download it, which is an 80% acceptance rate for download. And, 22 of the 25 respondents said they would register, giving their name, address, and other contact information to the firm upon registration if it took less than five minutes; the other three said they did not know if they would or not, but one of those three said that if they downloaded the artefact, they would register it. However, only 17 of the 25 were sure they would use the application if they were in an accident while another seven said they were unsure if they would use it or not with two stating they would use it if they remembered they had it on their phone. Only one of the respondents said they would likely not use the artefact.

Insofar as push notices and updates are concerned, 19 of the 25 people surveyed thought that updates and other information being sent via push notices would be helpful and would welcome them while seven said they were not sure the notices would be helpful; no one indicated that the notices would be offensive or unhelpful. Of the seven who were not sure, three indicated
that it would depend on the type of notice being sent as to whether or not they would find them helpful.

Whether or not the users will recommend the artefact to family, friends and colleagues is an important question with regard to perceived utility, and 24 of the 25 respondents said they were “moderately likely,” “very likely,” or “extremely likely” to refer the artefact, which appears to show a very high perception of utility of the artefact even before the development.

*Mobile Acceptance Survey Question 1.* “After reading the CrashApp™ description, how likely would you be to download the application?”

![Figure 30: Survey Results, Mobile Acceptance Survey Question 1](image)

*Mobile Acceptance Survey Question 3.* “If it took less than five (5) minutes to register the application, would you register?”

![Figure 31: Survey Results, Mobile Acceptance Survey Question 3](image)

*Mobile Acceptance Survey Question 5.* “How likely are you to use the application after an accident or event requiring the help of an attorney?”
Mobile Acceptance Survey Question 7. “Do you think updates and other notices sent to your smart phone would be helpful?“

Mobile Acceptance Survey Question 9. “How likely are you to recommend this product to your friends and colleagues?“
5.3.3 **Focused Survey Results**  Specific focus survey questions related to the attorney stakeholders were asked as well as the questions and responses addressed above. Usability, target audience verification, acceptance of the artefact, and receipt and acceptance of push notices were measured. Additionally, attorneys needed to know the likelihood of future user, willingness to download, and the user’s willingness to refer the artefact to others in order to broaden their network. The specific questions and responses from the users which related directly to the attorney goals are as follows:

*Focused Survey Question 8.* “If you received the push notices, did you find them intrusive in any way?”
Of the 25 people (in the response to this survey) who affirmed they received push notices, only three found them intrusive. However, of the 43 users who responded to the questionnaire, 26 of the 43 recalled getting push notices, which is only slightly more than 50%.

Focused Survey Question 9. “Which of the following words would you use to describe the mobile application?”

![Survey Results, Focused Survey Question 9](Image)

Focused Survey Question 10. “If you had an accident, how likely is it that you would use the mobile application?”

Score of 1 to 10 (10 being the most likely)

![Survey Results, Focused Survey Question 10](Image)
**Focused Survey Question 14.** “How likely is it that you would recommend this mobile application to a friend, family member, or colleague?”

(Scale of 1 to 10 – 10 being most likely)

The survey indicated an average rating of 8.21 out of a possible score of 10, indicating the users would be far more likely than not to recommend the artefact’s use.

Of the respondents to the focus survey, the greater proportion was women (58%). The original focus group survey identified the “average” client of the attorney as a 40+ year old woman so this was a validation of the original focus group’s work.

**Focused Survey Question 19.** “Have you ever been involved in a motor vehicle accident?”
One of the more relatively surprising survey results came from the follow question regarding accident history of respondents. Eighty-eight percent of the respondents reported having been in a motor vehicle accident. This factor was not identified or anticipated in the focus groups or at any other time in the process of building the artefact, yet it seems validate the original proposition that there is a clear need for this type of artefact.

5.3.4 **FEDS: Human Risk & Effectiveness Strategy Results**  
Like Technical Risk and Efficacy Strategy, Human Risk and Effectiveness Strategy emphasizes formative evaluations early in the process, with artificial, formative evaluations, but progresses to more naturalistic formative evaluations fairly quickly. More summative evaluations are engaged near the end of this strategy. “Efficacy and effectiveness exist on a continuum. Generalizability depends largely on the viewpoint of the observer and the condition under investigation” (Gartlehner G, Hansen RA, Nissman D, et al. 2006). Effectiveness is therefore pragmatic. Which leads to the question, is the artefact useful and will it continue to be useful and relevant?

The evaluations in this strategy focus on “rigorous evaluation of the effectiveness of the artefact, that is, that the utility of the artefact will continue to accrue even when the artefact is placed in operation” (Venable 2014). These included the focused surveys and system usability scale.

As discussed above in the focused survey and SUS sections, the survey respondents overwhelming found the artefact has utility, is innovative, relevant, and functional. They also found the artefact effective for its intended purpose, but the ongoing effectiveness and relevancy are difficult to determine in such a short period and with the small sample size in all of the surveys and tests. However, the users of the artefact, through the end of this research, indicated it is
effective and the innovative design lends itself to continued evolution; therefore, benefits should continue to accrue as more users are added.
6. DISCUSSION

This study was guided by the Information Science Research Framework, which informs the development of DSR artefacts, which in turn, is informed by qualitative research in the form of surveys, focused surveys, and other testing for evaluation of the artefact’s usefulness, efficiency, efficacy, and completeness of purpose. The Framework for Evaluation in DSR (FEDS) and the elaborated ADR process model were instrumental in completing this lengthy, challenging real-world project. The ADR approach employed in this research is similar to other ADR approaches taken in prior research projects; however, this research extended those ADR models by using constant iteration and evaluation then entering the research at every point in the process to apply the knowledge for the next iteration further, which extends the ADR process model. The research goal of the study was to produce new knowledge for researchers and developers in the creation of such an artefact in order to advance design and evaluation theory in the DS discipline. And, we have achieved our stated goals.

6.1 APPROACH TO MULTI-STAKEHOLDER EVALUATION

The approach to the multi-stakeholder ADR intervention and evaluation process was developed in the problem formation stage and carried through the entire study. Guided by Hevner et al.’s DSR Guidelines, in the problem formation stage, the three stakeholders were identified and their varying critical measures of success defined: 1) the developer of the artefact who endeavored to create a functionally useful, effective, efficient artefact that works as designed, 2) small to mid-sized law firms (a firm of 15 or less attorneys on staff) who wanted to stay in touch with and grow
their client-base and 3) the potential end user/client who has been in an accident and needs a quick, efficient means of communicating the accident information to their attorney.

The elaborated ADR process allows for multiple points of entry at any stage of research; in the problem formation stage, the developers collaborated with the attorneys to intervene and evaluate the findings from the attorney focus group then applied the findings (formalization of learning) to reformulate the problem. An intervention cycle was again applied using a mobile acceptance survey, and those findings were applied to the workflow map (figure 8) before going forward into the design stage (ALPHA cycle).

Because of the open format and constant discussion, brainstorming was overtly iterative. As discussed in Section 3.22, the project team undertook a four-day brainstorming session, endeavoring to develop the front-end (user facing) of the artefact. The knowledge gained from the prior iterations in problem formation stage underpinned the application workflow goals for the user. After that four-day session, the workflow was summarized in Figure 9 and that outline became the architecture guide from which the artefact design would flow.

The implementation cycle again went back to the developer stakeholders and attorney stakeholders to work out what was wanted versus what was possible technologically. This was necessarily another entry point for evaluation to ensure potential operational issues could be minimized and the specific technology to be employed could be utilized.

Rapid and agile deployment of the artefact required the developers to employ innovative, cutting edge technologies. Developer and attorney stakeholders, programmers, and potential users along with technology experts spent considerable time reviewing the available options for the actual development of the artefact. Having found no system completely suitable, Figure 10 summarizes the Information System Flow finally selected by all stakeholders.
Figure 11 reflects the beginning and process of the Design Improvements cycle(s) and the application of learning within that cycle. The developers entered the design improvements stage; as wireframe mockups were developed and proof of concept/BETA version of the artefact was developed, the attorney stakeholders were free to choose to move the application flow and rearrange sections of workflow if necessary. Applying the information gained from this intervention cycle, upgraded mockups were created (Figure 12), and a database system and web portal were designed to collect data from the user interface with the application.

All stakeholders were involved in the Design Evolution stage and, as discussed in Section 3.51, a development-centered entry point was established and two intervention cycles were performed. Focused surveys and field testing were employed to gather information on all facets of the artefact design from user experience (UI) and database management capabilities (web portal) to re-provisioning capabilities. Multiple Implementation stage intervention cycles were employed with each cycle, providing new learning for the next iterative cycle and ADR stage. Figure 16 reflects the learnings and implementation of the latest version of the wireframes within the artefact.

6.2 CONDUCT OF STAKEHOLDER EVALUATION

The actual conduct of the evaluations for each stakeholder took many forms (e.g. focus groups, focused surveys, usability testing) dependent on the stakeholder and their defined needs. The researcher evaluated throughout the development of the artefact and intervened at every ADR stage. At every stage, multiple evaluations were performed, which significantly increased the learning process and knowledge contributions, thereby creating a more effective, efficient artefact.

To provide validity for the artefact development testing, we used many different types of evaluation techniques and tools for the different stakeholders. By applying the ADR process to a mobile artefact with multiple stakeholders, we endeavored to define critical success factors for
each stakeholder and define which criteria were important to define success for each stakeholder then measure those criteria by designing an evaluation strategy to analyze those criteria. In evaluating the design theory employed, we provided quality knowledge outcomes.

6.2.1 Attorney Stakeholders The actual conduct of evaluation for the attorney stakeholders began with focus groups to formulate our solution to a heretofore unaddressed problem and diagnose it through direct feedback. In our project, a substantial amount of time was spent diagnosing a problem that would inform both research and practice as outlined by Baskerville and Myers (2004).

The attorney stakeholder’s critical goals were further evaluated using focused surveys and the System Usability Scale (SUS) of actual users. The SUS and focused surveys, discussed in Sections 4.21 and 4.22, evaluated usability of both the application and database/lawyer portal, providing important real-life interventions to show efficacy and effectiveness as well as overall acceptance of the technology in situ.

As discussed in Section 5.8, The Framework for Evaluation in Design Science Research (FEDS), Human Risk and Effectiveness strategy was applied to the overall evaluation of the artefact as it applied to the attorney stakeholders in so far as utility, fitness for a particular function, innovation, and relevance. The results of the naturalistic and formative evaluations, like focused surveys and the SUS, employed at different entry points in the ADR process suggest the artefact will continue to be useful and relevant.

6.2.2 User Stakeholders The focus of the artefact, from the problem Formation stage (Problem Diagnosis) and throughout the project, remained steadfastly on the end user, usability, and their experience (UI) with the artefact. The Focus Group Survey, Section 4.11, the Mobile Artefact Acceptance Survey, Section 4.12, and the SUS, Section 4.22, evaluations were all used
to test the user stakeholder experience and satisfaction, and they represent the rigorous user stakeholder evaluation of this project.

The success criteria for the user stakeholder were defined very early in the problem formation stage of the ADR project. The following questions were asked: Would the user download and register the artefact? Would the user actually use the application in an emergency? Would the user accept the push notices coming directly from attorneys? The evaluation strategy we employed in this research clearly indicates that we tested, measured, and analyzed those criteria. When we applied the FEDS - Quick & Simple Strategy criteria to our various evaluations, we moved very quickly from artificial to summative evaluations with more than a few evaluation episodes applied at various stages of our ADR process, which increased the quality of our knowledge as well as finding the artefact efficient and effective in real use.

6.2.3 Developer Stakeholders  The developers were guided by the DSR, ADR, and EADR guidelines discussed in Section 2, Research Background. Because of the time and money invoiced with mobile application development, the developers had to balance all stakeholder goals and were guided by their critical success criteria expressed in the Problem Formation stage. The evaluation strategy for the developers required us to intervene in every ADR stage to ensure each build, implement, and evaluation cycle balanced the needs and goals of the other stakeholders as well as our own. Creating an innovative, novel artefact which has utility, efficiency, and functions for its intended use required rigorous evaluation and testing.

As discussed in Section 4, Evaluation Methods Employed During Design, the Focus Groups, Mobile Acceptance Surveys, Focused Surveys, and SUS all provided formalized learning for the developers with each of them being applied at different entry points in the ADR process. For example, the workflow map (Figure 8), which was a result of the focus groups’ feedback,
provided the technical approach to be employed into the build cycle of the artefact. The SUS and Focused Surveys provided technical feedback for ease of use, acceptance, functionality, and utility of the artefact, which informed the Implementation and Evolution stages of development for the developers.

6.3 INNOVATIVE APPROACH TO MOBILE APPLICATION DEVELOPMENT

The research provides an innovative approach to an entirely new mobile artefact to address a previously unaddressed problem. When this research began, there was not another mobile application like it on the market in the United States. Using the ADR Model, the developers created a practice-inspired, functionally innovative artefact that provides new knowledge for the design of new mobile artefacts. Additionally, the evaluation cycles within the model could function as a guide for future development, informing both practice and research.

Figure 10 summarized the flow through the technologies and platforms that compose the application. In that diagram, we highlighted that (1) all transactions are initiated using a smart mobile phone once a user registered and authenticated with the system; (2) this artefact is compatible with Apple iPhone and Android devices; and (3) in order for the artefact to exchange information with the rest of the system, it moves data inbound and outbound through a RESTful API that runs on an Amazon Web Service (AWS) Elastic Beanstalk (EBS) instance. The CrashApp™ solution design supports a modern approach to rapid requirements change, open source technology, security controls, cloud-based storage and database management, and agile deployment with multi-mobile platform support. The innovative aspects of the technical design are:

- **Open Source Cross-Platform Development.** Accomplished by developing the app using the open-source cross platform development software Xamarin. Using Xamarin
to develop this Artefact allowed the developers to code and compile using one language (C#) and compiler for all mobile platforms.

- **Amazon Web Services (AWS) Elastic Beanstalk.** AWS offers an automated process to deploy and scale web applications and services called Elastic Beanstalk (EBS). The artefact uses an AWS EBS Linux instance to host the Java application and RESTful API. The Java application running on AWS EBS is designed to handle communication between the RESTful API and other AWS services, such as Amazon RDS and Amazon S3. This design approach was implemented by the developers to allow for rapid development changes and secure communications between the mobile platform and AWS services.

- **RESTful API.** A RESTful API is developed and deployed to AWS EBS using the open source Jersey project. The open source Jersey RESTful API utilizes the Java Virtual Machine to handle http/https requests inbound and outbound throughout the artefact. The use of a RESTful API simplifies the communication between the mobile platform, the Java app hosted on Apache Tomcat, and AWS Services.

- **Amazon Relational Database Service (RDS).** Amazon RDS is a scalable and relational database available in Amazon’s AWS cloud. The Oracle database engine was selected for this artefact due to its support for open source development and tight integration with Java applications.

- **Amazon Simple Storage Service (S3).** Amazon S3 is a secure, highly scalable cloud-based storage platform available in Amazon’s AWS cloud. The artefact uses Amazon S3 to store images captured by the mobile phone. This design technique was chosen to
simplify the movement, management, and control of images captured by the mobile phone that are required for secure permanent storage.

- The developers investigated and recommended the Xamarin platform and Amazon Web Services (“AWS”) approaches. The key to both was the ability of the developers to listen to the needs of three stakeholders and research creative, elegant, low cost solutions to the design of the artefact that flowed efficiently and functioned effectively.

6.4 ELABORATED ADR (EADR)

There are multiple possible ADR entry points, and every project environment is different depending on multiple factors. Any artefact can be abstracted – created and built – and evaluated in each cycle of any ADR stage (Mullarkey and Hevner 2015). Crashapp™ was created, built, and evaluated from the very beginning – the diagnosis stage – and evaluated through each successive stage of the project, meaning we entered the intervention cycles at the Problem Centered entry point of the Design, Implementation, and Evolution ADR stages because we questioned our reasoning for the artefact to solve a particular identified need. (Figure 19)

![Figure 40: The ADR Process Model with Research Entry Points](image)

The CrashApp™ team performed two Diagnosis intervention cycles and one Design intervention cycle to develop the artefact for law firms before moving to the Implementation cycle.
The learnings from each stage informed our progression to the next stage and moved our intervention entry point from Problem-centered to Objective-centered to Development and then Observation.

What became clear during each BIE (Build, Intervention and Evaluation) intervention cycle was the learnings quickly could be applied to the artefact and pushed back to the stakeholders for additional feedback, which created a new BIE intervention cycle, which then could be evaluated for additional learning and so on, implementing changes throughout the progression to create a leaner, more efficient and usable artefact. Through the use of the Elaborated ADR model, communication between and amongst stakeholders was made more effective, and the knowledge gained could be quickly pushed back into the process.

Taken in their entirely, those tests and surveys rigorously tested efficacy and utility, which include achievement of environmental utility, quality of knowledge outcomes, comparison to other artefacts, a complex, composite artefact, undesirable impacts, and knowledge outcome.

6.5 **POINT(S) OF ENTRY IN THIS ADR PROJECT**

The Build activity in the ADR process involves the creation and implementation of the artefact (Mullarkey and Hevner 2015). The point of entry for intervention into one stage or another of an ADR project is determined by the researcher, the project goals, and necessity. “Where to start?” and “When to intervene?” are serious questions to be addressed in the Build, Implement and Evaluate (BIE) cycles. In the instant case, the research team initially took a Problem-Centered entry point in the ADR process to better understand and formulate a plan for addressing our premise that the need exists for this type of artefact (Problem).

This project was not just another ADR project. Intervening at the Problem stage enabled the researcher to gather information and apply learnings to the artefact early and throughout the
entire project. Additionally, entry at the Problem formation stage encouraged a well-defined process of intervention cycles as the project moved from stage to stage. Being able to apply learning from each intervention gave developers insight and the project momentum with a solid structure to introduce important changes and updates as the project moved forward.

An ADR project does not generally move in a straight line through the stages from Diagnosis to Design to Implementation and Evolution; this project was no exception. The project team moved back and forth between ADR stages seamlessly and as intervention feedback (learnings) dictated. Being able to move with agility between the stages of the project evolution was both critical and proved instrumental to the success of the development team.

The artefact, the subject of this research, was not bound by the confines of the study because it was going to be a real-world artefact in the end, no matter the outcome of the research. Knowing the artefact would see a commercial release freed the researcher to push intervention cycles and evaluation into the process in order to gather feedback for the stakeholders.

6.6 DESIGN SCIENCE RESEARCH (DSR)

This study was guided by the Information Science Research Framework, which informs the development of DSR artefacts, which, in turn, is informed by qualitative research in the form of surveys, focused surveys, and other testing for evaluation of the artefact’s usefulness, efficiency, efficacy, and completeness of purpose.

According to Hevner et al, “The goal of DSR is utility and that a proposed solution (artefact) addresses important unsolved problems in unique or innovative ways or solves problems in more effective or efficient ways” (2004). This artefact was built to address a heretofore identified yet unsolved problem; it was tested through an iterative series of design revisions to ensure its adaptability to changing technology and ease of use for the user stakeholders.
The design, build, and evaluation of the artefact continued through multiple iterations of the artefact until the artefact showed sufficient usability, functionality, efficiency, efficacy, and fitness for its intended purpose. Simulations with artificial data were tested to ensure the maximum assurance of data transfer and information safeguarding by creating “dummy” accounts and vigorously reporting and tracking the information exchange between the application, database management system, and the email confirmations generated by the database management system to the attorney stakeholder.

The researcher in the project never lost sight of the DSR guidelines throughout this process.

1. **Design as an Artefact** - The artefact created in this project is a purposeful artefact created to address an important, heretofore, unaddressed problem. The artefact has been described effectively from the concept through implementation and is in the appropriate domain.

2. **Problem Relevance** - The artefact solution developed addresses an important business problem for small to mid-sized firms in that it creates an innovative opportunity to put marketing material directly into clients’ hands and allows the end user to collect data and contact their attorney directly from the scene of any accident. Knowledge was acquired and the application will change the phenomena currently occurring in the legal marketing industry.

3. **Design Evaluation** – Utility, quality, efficacy, efficiency, functionality, and usability of design were rigorously tested and all were demonstrated to be valid. Focus groups, formative and summative focused surveys, system usability testing as well as the FEDS evaluation strategies were all employed throughout the design, build, and implementation of the artefact, and rigorous evaluation was demonstrated from beginning to end.

4. **Research Contributions** – The ultimate assessment for any research is, “What are the interesting contributions?” The design and construction of the artefact adds knowledge to the
existing research, and the timing and methods of evaluation will add to existing evaluation knowledge. The artefact is novel, unique, innovative, and functional according to the real-life users of the artefact during the implementation stage and holds potential for all three of the types of research contributions required to be found in a DSR project.

5. **Research Rigor** – The way research is conducted addresses rigor in DSR. Application of rigorous methods of evaluation and construction are required in a DSR project; the selection and application of the various theories and methods of evaluation for this project were particularly selected from the existing knowledge in the field. Focus groups, focuses surveys, and other evaluation methods employed throughout this DSR project are normal techniques used by researchers in the field and are well documented throughout.

6. **Design is a Search Process** – The process of development for this artefact was wholly and entirely iterative. From the very beginning of the project, the processes were scrutinized and evaluated and changes were implemented and cycled back through, evaluated, and tested again in a completely iterative manner. The stakeholders were engaged throughout the entire process and every cycle involved them as necessary for their input. The results produced a great, functional artefact that is already being implemented in the business environment.

7. **Communication of Research** – This research project resulted in a real-world technology driven artefact already being sold on the market, and the process for the development of the artefact is an integral part of the commercial viability of the application in that market. As technology improves, understanding of this research will grow. I believe, through this research, we have developed a repeatable project that adds to the knowledge base for other design science researchers.
7. RESEARCH CONTRIBUTIONS, LIMITATIONS, AND FUTURE RESEARCH

The findings in this paper represent the full application of the DSR, ADR, and EADR stages and intervention cycles within those paradigms. These research theories were not applied to an abstract concept, method, or model but to an actual, real-life artefact conceived, designed, and developed from beginning to end with full intervention cycles introduced into each stage of the project. The researcher tried to generate knowledge that could be applied to a general class of problems. Perceptibly, impactful changes were introduced at each ADR cycle based on goals formulated and confirmed through evaluation cycles in the prior stages. At no time were ‘abstract’ or theoretical changes introduced to the next stage of development because interventions were introduced and evaluated, and input from each iterative cycle produced a fuller, richer artefact instantiation than the last.

The project which became the subject of this paper benefitted from being conceived while researching the ADR body of research. This fact may well be a limitation of its application to future ADR projects because most projects already will have begun and the problem Formation stage well under way or passed before intervention and evaluation cycles can be introduced. However, that is not a limitation on the introduction of intervention cycles, just a limitation on where to begin such cycles, contributes to ADR research and is the first real test of the Elaborated ADR model

7.1 RESEARCH CONTRIBUTIONS

One of the key contributions to the ADR Process model research provided by this project designing and executing different evaluation strategies for the three different stakeholder groups
was the main research goal. The lengthy, detailed documentation of the project from problem formation to evolution, illustrates how many intervention entry points and cycles are possible and how they may be introduced at nearly any level of abstraction, depending on the project or activity goals.

Each stage of the project development had different goals and affected different stakeholders more or less directly and the intervention cycles introduced at every level of the ADR project the team could better understand the implication of changes being introduced from one stage to the next. The interventions were both planned and spontaneous from one intervention cycle to the next like the initial Focus Groups and the Mobile Acceptance Survey performed in the Diagnosis stage for developer and attorney stakeholders. Those findings were evaluated and applied in problem formation and used to develop the initial workflow map which then guided the artefact’s overall user experience (UI).

The use of Focus Groups very early in the concept’s development was vital to validate the perception of the need for such an artifact in the attorney marketing field. Identifying the willingness to download, register and use such an artefact was seemingly demonstrated by the findings of the Mobile Marketing Acceptance Survey completed by potential user stakeholders. Without that calculated intervention cycle, the researcher and developer would be essentially making educated guesses at possible solutions then hoping those guesses were correct.

Using surveys of various stakeholders was a vital approach throughout this project. Attorneys, developers, and users were routinely surveyed, both formally and informally, by the developers and researchers. Intervention cycles during the Design stage of development were imperative as technology was being introduced and applied to the learnings from prior stages in order to meet the needs and goals of each stakeholder. Usability for attorney and user stakeholders
was a critical priority and the Focused Surveys and System Usability Scale were imperative evaluation tools at Objective-Centered entry points for Design (Alpha) and Design (BETA) phases of development. Those evaluation tools provided very quick, simple feedback on functions and the progress of development for all three stakeholders during the “meaty” part of the project. Those strategies reinforced the belief that the developers and researcher were on the right trajectory for a successful product.

Development-Centered interventions were designed to further enhancements and improved software technology deployment and were reinforced by the evaluation strategies employed during the Design and into the Implementation stages, which was well into the project near the artefact’s commercial release. Feedback from user and attorney stakeholders during those evaluations became the “sharpening of the stick” relatively speaking because they were narrowly focused to provide the best user experience both for the attorney stakeholder in the Portal/Database management system and the end user stakeholder.

Additionally, this is the first actual use (as far as this researcher knows) of the Elaborated ADR (EADR) model introduced by Mullarkey and Hevner (2016). This EADR model of using various ADR entry points expands the basic ADR Model by specifically identifying iterative intervention points at various stages throughout the ADR project in order to test, gather feedback then apply the learnings from that feedback going forward. The belief being that an evaluative/learning cycle intentionally inserted at multi points in a projects design will create a better, more efficient and effective outcome.

7.2 LIMITATIONS

Generalizing results outside of the area being researched using the ADR and DSR Models is always a limiting factor with the theories – the focus is always on one problem at a time.
Concentration on the problem in front of the researcher is good for the researcher and the problem being studied, but the results are hard to extrapolate to the broader population of problems, no matter how many intervention cycles performed through every stage. The ADR Model, and DSR more specifically, is relatively new and would certainly benefit from new research into additional applications as well as the application of new evaluation techniques to be employed within and between intervention and ADR cycles and how to generalize the findings to the larger population of IS problem sets.

The key limitation with this research is that artefact was designed, built, and evaluated in a very specific application environment. Thus, the results may not be applicable to other application environments. This project was limited in size and scope and was not sprawling across many locations and/or researchers and at no time was it applied to any other project other than this artefact’s development. The focus group sizes were small as were the survey sizes and test groups of users. The interventions were nonetheless as thorough as possible and the surveys were scientifically developed to elicit the most effective feedback from users and attorneys.

Additionally, the researcher is an attorney who knows the personal injury market and this may have skewed the initial development in one direction or another thus affecting who was chosen for focus groups and the initial development trajectory. The users were selected from a small group of users selected to use and test the artefact and were not completely random users picked from an anonymous large pool of potential users, which also could have swayed the survey outcomes in one way or another. Again, however, many intervention cycles were performed by the researcher in an attempt to limit any biases which may have existed in the pool of attorney stakeholders and users.
7.3 FUTURE RESEARCH

Despite the smaller scope of this project, I firmly believe this project extends and complements recent research by Mullarkey et al (2013), Mullarkey and Hevner (2016), Sein et al (2011), and others before them; additionally, future ADR and EADR researchers can use this research as an exemplar of how to define clear project goals, introduce intervention cycles at every stage of development, and implement those changes (learnings) into the next stage of ADR process.

Future research should be performed with the Elaborated ADR Model to fully illuminate its viability in more efficiently and effectively designing and building systems, theories, and instantiations of artefacts. Its intentional, methodical use could very well revolutionize systems development and bring down costs and development time. That future research could include more fully developed Problem Formation in each iteration and more fully document the formalized learning moving from one ADR stage to the next.

Because of the nature of the software technologies applied to this project, it is has made it easier to develop other types of artefacts utilizing the same process. I have already developed a version of the artefact called, “Fleet” for use by companies to manage their employee accidents while driving company vehicles and it’s already out on the market being sold. Additionally, a smaller version of the artefact was created, a “Crashpp Lite” if you will, which is a smaller, simpler version of the artefact for attorneys who are aware of the need to have a mobile application presence but can’t or won’t spend the money required to buy CrashApp Pro.
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Appendix 1: Mobile Acceptance Survey

Mobile Marketing Survey 1

<table>
<thead>
<tr>
<th>Completed Responses</th>
<th>Partial Responses</th>
<th>Survey Visits</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>0</td>
<td>26</td>
</tr>
</tbody>
</table>

Q1

After reading the CrashApp™ description, how likely would you be to download the application?

Answered: 25  Skipped: 0

![Pie chart showing response distribution]

<table>
<thead>
<tr>
<th>Response</th>
<th>Response Percent</th>
<th>Response Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extremely Likely</td>
<td>32.0%</td>
<td>8</td>
</tr>
<tr>
<td>Very Likely</td>
<td>48.0%</td>
<td>12</td>
</tr>
<tr>
<td>Maybe</td>
<td>12.0%</td>
<td>3</td>
</tr>
<tr>
<td>Probably Not</td>
<td>8.0%</td>
<td>2</td>
</tr>
<tr>
<td>Not at All</td>
<td>0.0%</td>
<td>0</td>
</tr>
</tbody>
</table>

Q2

If Probably not or Not at all, Why Not?

Answered: 2  Skipped: 23

1. Don’t know that I would remember to use it
2. I’m not religious
Appendix 1: Mobile Acceptance Survey

Q3

If it took less than five (5) minutes to register they application, would you register?

Answered: 25  Skipped: 0

![Pie chart showing 88% Yes, 4% No, and 8% Not Sure]

<table>
<thead>
<tr>
<th>Response</th>
<th>Response Percent</th>
<th>Response Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>88.0%</td>
<td>22</td>
</tr>
<tr>
<td>No</td>
<td>0.0%</td>
<td>0</td>
</tr>
<tr>
<td>Not Sure</td>
<td>12.0%</td>
<td>3</td>
</tr>
</tbody>
</table>

Q4

If No or Not Sure, Why?

Answered: 1  Skipped: 24

1. If I downloaded it I would register
Appendix 1: Mobile Acceptance Survey

Q5

How likely are you to use the application after an accident or event requiring the help of an attorney?

Answered: 25  Skipped: 0

<table>
<thead>
<tr>
<th>Response</th>
<th>Response Percent</th>
<th>Response Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extremely Likely</td>
<td>24.0%</td>
<td>6</td>
</tr>
<tr>
<td>Very Likely</td>
<td>44.0%</td>
<td>11</td>
</tr>
<tr>
<td>Maybe</td>
<td>28.0%</td>
<td>7</td>
</tr>
<tr>
<td>Probably Not</td>
<td>4.0%</td>
<td>1</td>
</tr>
<tr>
<td>Not at All</td>
<td>0.0%</td>
<td>0</td>
</tr>
</tbody>
</table>

Q6

If Probably not or Not at all, Why Not?

Answered: 3  Skipped: 22

1. If I remembered I had
2. If I remembered
3. would call the insurance company
Appendix 1: Mobile Acceptance Survey

Q7

Do you think update, and other notices sent to your smart phone, would be helpful?

Answered: 25  Skipped: 0

<table>
<thead>
<tr>
<th>Response</th>
<th>Response Percent</th>
<th>Response Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>78.0%</td>
<td>19</td>
</tr>
<tr>
<td>No</td>
<td>0.0%</td>
<td>0</td>
</tr>
<tr>
<td>Not Sure</td>
<td>24.0%</td>
<td>6</td>
</tr>
</tbody>
</table>

Q8

If No or Not Sure, Why?

Answered: 3  Skipped: 22

1. depends on the notices
2. depends on the notices
3. depends on the notices
Appendix 1: Mobile Acceptance Survey

Q9

How likely are you to recommend this product to your friends and colleagues?

Answered: 25  Skipped: 0

<table>
<thead>
<tr>
<th>Response</th>
<th>Response Percent</th>
<th>Response Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extremely Likely</td>
<td>24.0%</td>
<td>6</td>
</tr>
<tr>
<td>Very Likely</td>
<td>48.0%</td>
<td>12</td>
</tr>
<tr>
<td>Moderately Likely</td>
<td>24.0%</td>
<td>6</td>
</tr>
<tr>
<td>Not so Likely</td>
<td>4.0%</td>
<td>1</td>
</tr>
<tr>
<td>Not at all Likely</td>
<td>0.0%</td>
<td>0</td>
</tr>
</tbody>
</table>

Q10

What additional features do you think would be helpful to the end user?

Answered: 5  Skipped: 20

1. Call an ambulance
2. Ambulance, tow truck calling
3. I don't know that I would remember to use it
4. Seems like a great idea!
5. Seems like a good idea
Appendix 2: Focused Survey

Q1: How would you describe the process of installing our mobile application?*

- Extremely easy: 39
- Moderately easy: 2
- Neither easy nor difficult: 2
- Moderately difficult: 0
- Difficult: 0

Answered: 43
Unanswered: 0
Appendix 2: Focused Survey

Once downloaded, did you think the length of time it took to register the mobile application was reasonable?

- **Answered**: 43
- **Unanswered**: 0

<table>
<thead>
<tr>
<th>Choice</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Took a reasonable amount of time</td>
<td>42</td>
</tr>
<tr>
<td>Took a little too much time</td>
<td>1</td>
</tr>
<tr>
<td>Took way too much time</td>
<td>0</td>
</tr>
</tbody>
</table>
Appendix 2: Focused Survey

Q3: Did you use any of the following functions and features of the mobile application?*

- Registration: 35
- Report an accident: 25
- Took pictures (from within the app): 21
- Imported pictures (to the app): 9
- Uploaded photos: 16
Appendix 2: Focused Survey

- Logged into Facebook from the app: 6
- Viewed the Firm Page: 24
- Added Emergency Contacts: 12
- Refer to Friends: 4
Appendix 2: Focused Survey

Did you find the application visually appealing?*

<table>
<thead>
<tr>
<th>Choice</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extremely appealing</td>
<td>16</td>
</tr>
<tr>
<td>Moderately appealing</td>
<td>23</td>
</tr>
<tr>
<td>Neither appealing nor unappealing</td>
<td>4</td>
</tr>
<tr>
<td>Moderately unappealing</td>
<td>0</td>
</tr>
<tr>
<td>Extremely unappealing</td>
<td>0</td>
</tr>
</tbody>
</table>
Appendix 2: Focused Survey

Q5 Did you find navigating around inside the mobile application?*

<table>
<thead>
<tr>
<th>Choice</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extremely easy</td>
<td>23</td>
</tr>
<tr>
<td>Moderately easy</td>
<td>14</td>
</tr>
<tr>
<td>Neither easy nor hard</td>
<td>4</td>
</tr>
<tr>
<td>Moderately hard</td>
<td>2</td>
</tr>
<tr>
<td>Extremely hard</td>
<td>0</td>
</tr>
</tbody>
</table>

Answered 43
Unanswered 0
Appendix 2: Focused Survey

Q6: How convenient do you think the mobile application is to use?*

- Very convenient: 30
- Moderately convenient: 8
- Neither convenient nor inconvenient: 5
- Moderately inconvenient: 0
- Very inconvenient: 0

Answered: 43
Unanswered: 0
Appendix 2: Focused Survey

Did you get any of the push notices which were sent?*

<table>
<thead>
<tr>
<th>Choice</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>26</td>
</tr>
<tr>
<td>No</td>
<td>17</td>
</tr>
</tbody>
</table>

Answered 43
Unanswered 0
Appendix 2: Focused Survey

Q8
If you received a push notice, did you find it intrusive in any way?*

- Yes: 3
- No: 22
- Didn’t receive any push notices: 18

Answered: 43
Unanswered: 0
Appendix 2: Focused Survey

Which of the following words would you use to describe the mobile application? Select all that apply.*

- High quality: 18
- Innovative: 26
- Unique: 23
- Useful: 31
- Impractical: 0

Answered: 43
Unanswered: 0
Appendix 2: Focused Survey

Q10
If you had an accident, how likely is it that you would use the mobile application?*

<table>
<thead>
<tr>
<th>Choice</th>
<th>Total</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scoring</td>
<td>351</td>
<td>8.16</td>
</tr>
</tbody>
</table>

Answered 43
Unanswered 0
Appendix 2: Focused Survey

If you had an accident, how well do you think our mobile application would meet your needs?*

<table>
<thead>
<tr>
<th>Choice</th>
<th>Total</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scoring</td>
<td>368</td>
<td>8.56</td>
</tr>
</tbody>
</table>

Answered 43
Unanswered 0
Appendix 2: Focused Survey

Q12: If you think you are not likely to use the mobile application, why not?*

- Do not need an app like this: 2
- Do not want an app like this: 0
- There are other/better competing apps available: 1
- No reason - don't know: 5

Answered: 43
Unanswered: 0
## Appendix 2: Focused Survey

<table>
<thead>
<tr>
<th>Option</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>N/A - would use it</td>
<td>24</td>
</tr>
<tr>
<td>Other</td>
<td>13</td>
</tr>
</tbody>
</table>
Appendix 2: Focused Survey

Q13
Did you have any technical issues with the mobile application during download and/or installation?*
IF Yes, please describe the problem below.

MULTIPLE CHOICE

Answered
43

Unanswered
0

Choice
Yes
No
Total
11
32

74.4%
25.6%
Appendix 2: Focused Survey

Q14: How likely is it that you would recommend this mobile application to a friend, family or colleague?*

<table>
<thead>
<tr>
<th>Choice</th>
<th>Total</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scoring</td>
<td>353</td>
<td>8.21</td>
</tr>
</tbody>
</table>

Answered: 43
Unanswered: 0
Appendix 2: Focused Survey

Q15: Overall, how satisfied would you say you are with the mobile application?*

**SCORING**

- Answered: 43
- Unanswered: 0

100%

<table>
<thead>
<tr>
<th>Choice</th>
<th>Total</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scoring</td>
<td>365</td>
<td>8.49</td>
</tr>
</tbody>
</table>

115
Appendix 2: Focused Survey

What would make you more likely to use our mobile application? (Not a required answer but if there is a specific issue please identify it below)

Q16

ESSAY

April 6, 2017 1:11 AM
This is a recommendation to add a confirmation before allowing people to call 911, attorney, etc

March 30, 2017 4:06 PM
If the touch screen functionality worked properly.

March 24, 2017 7:08 PM
Where you going to send information of some type?

March 24, 2017 1:29 PM
I think if the app worked quickly, it could be extremely useful. The ease of navigation is good.

March 24, 2017 12:26 PM
I'd use it now because it's already on my phone app and easy to use in case of an accident.
Appendix 2: Focused Survey

What changes, if any, do you think would most improve your experience with the mobile application? (Not required but if you have a suggestion please list it below)*

April 6, 2017 1:11 AM
The confirmation step before calling... perhaps, information about the other party.

March 31, 2017 10:38 AM
I ran into issues when I was trying to upload pictures. I tried uploading pictures using android OS.

March 30, 2017 4:06 PM
Getting to the incident report/uploading images was a bit slow. Prefer uploading picture of insuran

March 28, 2017 8:22 PM
Question is stated as not required but an answer is required before continuing.

March 27, 2017 7:19 PM
This questions states that a response is not required however you cannot proceed without responding.
Appendix 2: Focused Survey

What type of phone did you use for the app download?*

**Multiple Choice**

- **Answered**: 43
- **Unanswered**: 0

<table>
<thead>
<tr>
<th>Choice</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Apple - Iphone 7</td>
<td>10</td>
</tr>
<tr>
<td>Apple - Iphone 6 (or 6S)</td>
<td>18</td>
</tr>
<tr>
<td>Apple - Iphone 5 or older</td>
<td>1</td>
</tr>
<tr>
<td>Samsung - Galaxy S7</td>
<td>6</td>
</tr>
<tr>
<td>Samsung - Galaxy S6</td>
<td>1</td>
</tr>
<tr>
<td>Samsung - Galaxy S5 or older</td>
<td>3</td>
</tr>
</tbody>
</table>
Appendix 2: Focused Survey

Q19: Have you ever been involved in a motor vehicle accident?

- **Yes**: 38
- **No**: 5

Answered: 43
Unanswered: 0

Choice | Total
--- | ---
Yes | 38
No | 5
Appendix 2: Focused Survey

What is your gender?

- Male: 18
- Female: 25

Answered: 43
Unanswered: 0
Appendix 3: System Usability Scale Survey

Q1: I think that I would like to use this application if I had an accident.*

<table>
<thead>
<tr>
<th>Choice</th>
<th>Total</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rate 1 to 5</td>
<td>73</td>
<td>4.87</td>
</tr>
</tbody>
</table>

Answered: 15
Unanswered: 0

100%
Appendix 3: System Usability Scale Survey

Q2: I found the application unnecessarily complex.

SCORING

Answered: 15
Unanswered: 0

100%

<table>
<thead>
<tr>
<th>Choice</th>
<th>Total</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rate 1 to 5</td>
<td>16</td>
<td>1.07</td>
</tr>
</tbody>
</table>
Appendix 3: System Usability Scale Survey

Q3
I thought the application was easy to use.*

<table>
<thead>
<tr>
<th>Choice</th>
<th>Total</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rate 1 to 5</td>
<td>73</td>
<td>4.87</td>
</tr>
</tbody>
</table>

Answered 15
Unanswered 0
Appendix 3: System Usability Scale Survey

Q4: I think that I would need the support of a technical person to be able to use this application.*

<table>
<thead>
<tr>
<th>Choice</th>
<th>Total</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rate 1 to 5</td>
<td>16</td>
<td>1.07</td>
</tr>
</tbody>
</table>

Answered: 15
Unanswered: 0
Appendix 3: System Usability Scale Survey

**Question 5 (Q5)**

I found the various functions in this application were well integrated.

**Scoring**

<table>
<thead>
<tr>
<th>Choice</th>
<th>Total</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rate 1 to 5</td>
<td>73</td>
<td>4.87</td>
</tr>
</tbody>
</table>

**Answers**

- Answered: 15
- Unanswered: 0

100% of the responses were answered.
Appendix 3: System Usability Scale Survey

Q6: I thought there was too much inconsistency in this application.

SCORING

<table>
<thead>
<tr>
<th>Choice</th>
<th>Total</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rate 1 to 5</td>
<td>15</td>
<td>1</td>
</tr>
</tbody>
</table>

Answered 15
Unanswered 0

100%
### Appendix 3: System Usability Scale Survey

**Q7**

> I would imagine that most people would learn to use this application very quickly.

**SCORING**

- **Answered**: 15
- **Unanswered**: 0

100%

<table>
<thead>
<tr>
<th>Choice</th>
<th>Total</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rate 1 to 5</td>
<td>72</td>
<td>4.8</td>
</tr>
</tbody>
</table>
Appendix 3: System Usability Scale Survey

Q8: I found the application very cumbersome to use.*

<table>
<thead>
<tr>
<th>Choice</th>
<th>Total</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rate 1 to 5</td>
<td>15</td>
<td>1</td>
</tr>
</tbody>
</table>

Answered: 15
Unanswered: 0

100%
Appendix 3: System Usability Scale Survey

I felt very confident using the application.*

<table>
<thead>
<tr>
<th>Choice</th>
<th>Total</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rate 1 to 5</td>
<td>71</td>
<td>4.73</td>
</tr>
</tbody>
</table>

Answered: 15
Unanswered: 0
Appendix 3: System Usability Scale Survey

Q10: I needed to learn a lot of things before I could get going with this application.*

<table>
<thead>
<tr>
<th>Choice</th>
<th>Total</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rate 1 to 5</td>
<td>15</td>
<td>1</td>
</tr>
</tbody>
</table>

Answered 15
Unanswered 0
Appendix 4: A Framework for Evaluation in Design Science Research, John Venable et al

Examples of possible generic artefact properties

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Adapting levels of granularity</td>
<td>Adapting context, input, process, and product</td>
<td>Adapting criteria as design goals</td>
<td>Adapting both rationality and understanding</td>
</tr>
<tr>
<td>(1) Whether the individual item was retrieved</td>
<td>(2) Whether the task-at-hand was completed, and</td>
<td>(3) Whether the completed task had a valuable impact on the goals-at-hand</td>
<td></td>
</tr>
<tr>
<td>Input: Strategy</td>
<td>Product: Outcomes and side effects</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Process: Work plan</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Product: Outcomes and side effects</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>