HirePro: Aiding “Aging in Place” via Connecting Caregiver to Older Adults through Web Application

Vikas Jyoty

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HirePro: Aiding “Aging in Place” via Connecting Caregiver to Older Adults through Web Application

by

Vikas Jyoty

A report submitted to the graduate faculty in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

Major: Computer Science

Program of Study Committee:
Dr. Carl K. Chang
Dr. Simanta Mitra
Dr. Jin Tian

Iowa State University
Ames, Iowa
2019

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Abstract

Our innovation addresses three main problems. First, our innovation is addressing the concept of “aging in place”, or older adults living independently in their own home. Our innovation is focusing on this problem so that older adults will be able to live independently in their homes for a longer period and maintain autonomy, while ensuring a safe environment. Second, this product addresses the issues that service providers face in delivering high quality services and care to older adults, such as staffing and identifying care recipients in need. Third, family members often provide informal care for older adults. However, due to the demands of providing care, family members may be prone to experience burnout and strain, which increase the likelihood of elder abuse occurring in the home. Our innovation aims to address this problem through providing support and services that will aid family members and older adults, thereby decreasing the chance of elder abuse.

These problems are currently being solved by the availability and use of at-home care services. At-home care companies address these problems through providing services that help keep the older adult at home and assist the family members with managing care. However, these services do not commonly take a person-centered approach when selecting caregivers and care recipients. Additionally, this problem is also indirectly being addressed by older adults moving out of their homes and transitioning into long-term care facilities. This option is expensive, and the quality of care varies. Older adults often have a decline in their sense of independence when transitioning into long-term care facilities. Some moves into long-term care are made prematurely for older adults with low-care needs, which our innovation could potentially prevent in the home setting.

To solve these issues, we have built a web-based application that is specifically designed to be usable by older adults due to its simple design. This prototype demonstrates our idea of connecting service providing agencies to the customers through our optimized and senior friendly application. The prototype will be much superior to any other existing solution because it can be used directly by the senior adults.
Section I – Introduction

HirePro is a Software Ecosystem that is designed to help both the older adults and the caregiver to optimize cost and improve service quality. We help older adults by providing a web-based, simple to use graphical interface to request for services from caregiving agencies. Moreover, they have freedom to choose the caregiver they want to work with. Also, we provide an android app solution to the caregivers so that they can see all their tasks and optimize their time to maintain efficiency hence increase their productivity and income. Visualizing the need of HirePro and refining its prototype was a process spread across our various courses related to Gerontology.

a. Initial Idea - While taking course COM S 514 and COM S 590, we made multiple visits to senior care center and met many caregiver and resident older adults. During our interaction with them we realized, living at a senior living facility can be both expensive and lonely for an older adult. Therefore, there was a need of “Aging at Home”. To solve this problem, we came up with a system where the older adult can stay at home instead of a senior living facility and still get all the services, they need from the care giving agencies. This will help to reduce the cost and let adults stay at their homes for longer period.

b. Market Research - To test the feasibility/usability of the product we took our idea to NSF-ICORP program, which helps new start-ups in their initial phase. As a part of the program we talked to many entrepreneurs and business leader, who helped us to evaluate our idea and its potential market. We also interviewed around 25 caregiver and senior adults to understand their everyday needs and problems. All the research was used as business case for HirePro.

c. Product Prototype – After doing two months of market research we came up with HirePro. The main idea of the product was to connect caregivers to senior adults in a way that does not need intervention from any other person. Also, to make it simple enough so that a senior adult should be able to use it without any technical challenges. The prototype of HirePro consists of mainly three sub-products

a. Easy to use web interface for the senior adults by which they will be able to request all the services they need daily.

b. Web and Android App interface for the caregivers, that can be used by them in order to get information about all the request assign to them and schedule them in their day.

c. Web interface for the admin of the agency who can monitor the quality of the care being provided by their agency.
Table 1: Summary of requirements from customer

<table>
<thead>
<tr>
<th>Type of Interviewee</th>
<th>Average range</th>
<th>Needs/Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Senior Adults</td>
<td>65-90</td>
<td>Laundry, Pet Care, Grooming Services, Companionship, Medicine reminder, Meal Preparation, Dementia care, etc.</td>
</tr>
<tr>
<td>Care Givers</td>
<td>25-45</td>
<td>Client information, Address, Important information about care, Age of patient, Allergies and medical condition.</td>
</tr>
<tr>
<td>Admin/ Facility Owners</td>
<td>NA</td>
<td>Employee availability, Feedback, Task Management</td>
</tr>
</tbody>
</table>
Section II – Related work

There are some existing solutions for providing necessary services to the older adults. But most of these services are either inefficient or expensive, that puts a lot of financial burden to the individual. In some cases, these costs are cover by Medicare but most of the time individuals end up paying for these services from their own retirement funds. In current time the various solutions available to an older adult are of following types.

a. **Assisted Living Facilities** - These facilities are either day care or fulltime residential facilities where the senior adults are assisted with their everyday chores and other medical needs. These facilities are good in terms of care provided but can be highly expensive. Some of the facilities can cost up to $9000/month. Hence not everyone is able to afford these. Also, staying from home and loved once can sometimes be worse for their health.

b. **Living with family** - Sometimes adults do live with their family members who can take care of them. This is affordable but not feasible all the time, as most families are nuclear families now. Also, longer time can exhaust both the care taker and older adult and they can feel burnt out.

c. **Caregivers from Platforms like Care.com** – In many cases seniors take help of platform like Care.com to hire independent care givers. This is a cheaper option but not reliable. There is no or minimal background checks and sometime the caregiver does not show up at work. Monetary transactions are also not supervised, hence can lead to abuse for either of the parties.

Table 2: Region wise assisted living cost approximation

<table>
<thead>
<tr>
<th>Care Type</th>
<th>National Average</th>
<th>Midwest</th>
<th>Northeast</th>
<th>South</th>
<th>West</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Independent Living</strong></td>
<td>$2,520</td>
<td>$2,362</td>
<td>$2,765</td>
<td>$2,687</td>
<td>$2,532</td>
</tr>
<tr>
<td>Communities that cater to seniors who are independent with few medical problems. Also known as retirement communities, retirement homes or senior housing. Typically includes room and board.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Assisted Living</strong></td>
<td>$3,823</td>
<td>$3,825</td>
<td>$4,315</td>
<td>$3,562</td>
<td>$3,771</td>
</tr>
<tr>
<td>A long-term care community that provides 24-hour personal care support services, meals and limited medical assistance.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Memory Care</strong></td>
<td>$4,848</td>
<td>$4,958</td>
<td>$5,779</td>
<td>$4,345</td>
<td>$4,787</td>
</tr>
<tr>
<td>In-depth dementia and Alzheimer's care within a secure environment. Provides 24-hour personal care support services, meals monitoring and limited medical assistance.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

As we can infer that the above-mentioned solutions have many disadvantages. Some of them are expensive and some are prone to be misused by either parties. Therefore, to solve these problems and find a more optimized way to connect both older adults and caregivers we proposed HirePro. Most important advantage of HirePro is that this application is designed for senior adults, compared to the solutions in today’s market, that are very complicated and need help in using them.
Section III – Methodology/ Architecture

a. Market Research/ Business Development at NSF-ICORPS

We started our research, about the problems the older people face, during our various courses in Gerontology. Our research became more focused during the course COM S 590. We formed a cross domain team of five members to perform research on “Aging in Place”. During our research we found the need of a software platform that can help older adults connect to caregivers and get services while staying at home. Therefore, in order to validate our idea for the software we took help from ISU Research park. Our team participated in a 4 weeklong training program called NSF-ICORP fall-2018, conducted by ISU and National science foundation. Our team was one of the few teams, out of many applications, that got selected for the program. During the training we were assigned tasks which involved interviewing potential customers and documenting their needs. We also learned and developed various types of business model for our product. Our progress was tracked each week and we created many important documents related to our business idea.

1. Week I- Important Milestones achieved and documents created during week I of training
   - Presented initial idea and status of the product to NSF-ICOPRS mentors’ panel. The panel consisted of people heading different start-ups and other senior members from industry and academia.
   - Created Quad chart for HirePro that tell about the problems and its proposed solutions.

<table>
<thead>
<tr>
<th>Problem</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>People who get assistance from caregivers while remaining in their own homes have needs that change over time</td>
<td>A senior friendly website and android app, where residents can request services and caregivers can manage requests for services.</td>
</tr>
<tr>
<td>Residents need to communicate needs to caregivers</td>
<td></td>
</tr>
<tr>
<td>Caregivers need to manage many residents and services at a time</td>
<td></td>
</tr>
<tr>
<td>Assistance needs to be quick and efficient</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Technology</th>
<th>Measures of Success</th>
</tr>
</thead>
<tbody>
<tr>
<td>Web/App development tools</td>
<td>Both senior adults and caregivers find the software useful</td>
</tr>
<tr>
<td>Hosting service</td>
<td>Senior users are able to use product without any help.</td>
</tr>
<tr>
<td>Web server</td>
<td>Caregivers are able to get all information without talking to agency directly.</td>
</tr>
<tr>
<td>Database</td>
<td></td>
</tr>
<tr>
<td>UI design inputs</td>
<td></td>
</tr>
</tbody>
</table>
2. **Week II** - Important Milestones achieved and documents created during week II of training

- Created Refined Business Thesis for HirePro describing the problem and proposed solution.
- Started with customer interview process and completed 1 interview with a senior adult about her requirements from caregivers.
- Identified the Legal and liability issues related to the product that can lead to a legal action against the company or the service providers.
- Created the **Business Model Canvas** for HirePro that tell about the major components of business e.g. value proposition, customer base and other key activities. The detailed business model canvas is shown in figure below.

### Business Model Canvas

<table>
<thead>
<tr>
<th>Key Partners</th>
<th>Key Activities</th>
<th>Value Proposition</th>
<th>Customer Relationship</th>
<th>Customer Segments</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Iowa State University</td>
<td>- App prototype</td>
<td>- Aids aging in place</td>
<td>- Communicate through app/website</td>
<td>- Older adults aging in place</td>
</tr>
<tr>
<td>- At-home service providers</td>
<td>- Communication platform creation: connecting direct care workers and users</td>
<td>- Relief of informal caregiver burden</td>
<td>- Communicate over the phone</td>
<td>- People with disabilities</td>
</tr>
<tr>
<td>- Direct care workers</td>
<td>- Implementing platform with at-home service providers</td>
<td>- Widens the customer pool for at-home service providers</td>
<td>- Reliable service</td>
<td>- Formal caregivers (i.e., direct care professionals)</td>
</tr>
<tr>
<td>- Hospices</td>
<td>- Providing training about the system</td>
<td>- Gives more autonomy to direct care workers; more control over schedule and services performed</td>
<td>- Build a trusting relationship between customers and direct care workers</td>
<td>- Informal caregivers</td>
</tr>
<tr>
<td>- Physicians and providers (e.g., physical therapists)</td>
<td><strong>Key Resources</strong></td>
<td></td>
<td></td>
<td>- At-home service providers</td>
</tr>
<tr>
<td></td>
<td>- Gerontology students/faculty bring key knowledge about customer segment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Technology department students/faculty skills: can build app and website in-house</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Iowa State Office of Intellectual Property and Technology Transfer</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cost Structure</th>
<th>Revenue Streams</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Marketing costs</td>
<td>- Ads on website/app</td>
</tr>
<tr>
<td></td>
<td>- Complicated health care cost reimbursements to think about Medicare/Medicaid</td>
</tr>
<tr>
<td></td>
<td>- Charge at-home service providers a fee to use our service</td>
</tr>
<tr>
<td></td>
<td>- Charge for app usage</td>
</tr>
</tbody>
</table>
3. Week III - Important Milestones achieved and documents created during week III of training
   - By week III we completed 14 interviews among both the caregivers and older adults. After these interviews we had better idea about the needs of customers therefore, we updated the business model canvas.
   - We also identified various segments of potential customers and demonstrated that using **Pallet Diagram** as shown in below figure.

   ![Pallet Diagram for Customer Identification](image)

4. Week IV - Important Milestones achieved and documents created during week IV of training
   - By end of the training we completed all 20 interviews required by ICORPS program to pass and be eligible for $3000 NSF seed funds for further customer discovery.
   - Shortlisted few conferences and tradeshows where we can meet potential business partners and get more ideas about developing our product.
   - We also engaged our team with Aging 2.0, an organization that helps start-ups to build products for aging population.
   - We also get to know about some venture grants and pitching competitions where can participate.
b. User Interface

HirePro is a cloud-based application hosted on Amazon AWS EC2 instance. Most other application which are currently in the market are standard web application which are not so easy to be used by a senior adult. These applications need either a family member or another technologically sound adult to user them and place a request. On the other hand, HirePro has a senior friendly user interface with big icons and many pictures to make it easier for the users. Some of the important USPs of HirePro can be listed as below.

a. **Big Icons for better visibility** – HirePro UI use big fonts and icons for identifying them easily, even for a person with weak eye-sight. Big icons help in the fact that a senior adult using the website are more responsive towards picture than just the text. They also remember their choices in the future hence making the process easier next time.

b. **Precise and minimal information** – each screen of HirePro has very minimal but important information to make it less confusing for any older customer or less technical person. Less information on a screen decrease the visitors drop off rate from any webpage.

c. **Less number of clicks** – Efforts required to make a request on HirePro is much lesser than any other caregivers’ application. Just three clicks are enough getting your request into the system. Hence make it much easier for seniors to use this.

d. **Feedback system**- We have also planned to introduce a feedback system that will be important factor in improving the service quality.

![Figure 2: Icons for selecting a service](image)
c. Architecture

HirePro is hosted on Amazon AWS EC2 instance. Hosting on AWS makes it scale easily when there is high traffic on the server. The code base is written in Microsoft stack with SQL Server as database and C# as scripting language. We also use Microsoft Entity Framework 6 to make the application faster to develop and easy to maintain. The UI is built in HTML 5 and jQuery as the front-end scripting language. Also, we have built an android version of app for the caregivers to access the request data on the go.

Figure 3: HirePro system architecture

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d. Layers of HirePro Application

1. **Database** – HirePro uses Microsoft SQL Server 2017 express edition for storing data. It’s a free version of SQL Server with storage limit of 10 GB. The purpose for choosing MSSQL Server instead of other popular databases like MYSQL or Oracle is because of its compatibility with the EF 6 framework.

To make most use of Entity Framework one should have a good knowledge of ER Diagrams and should be able to create a good ER architecture for their system. HirePro has a complicated database design consisting of twelve database tables related to each other with foreign and primary keys constraints. The detailed diagram of the Entity Relationship is given below.
Figure 4: Entity Relationship Diagrams of HirePro
2. **Entity Framework 6 (Data Access Layer)** – To connect to the database and do the necessary CRUD operations we use Entity Framework 6 by Microsoft. It helps you to access database without writing any SQL query or stored procedure. It uses Object Model of database and can access tables in the database like a class or list. Using this abstraction, the development time for the application decreases by a huge percentage. Moreover, in many scenarios it has better performance and error management than the normal an ADO.Net call to a stored procedure.

3. **Server-Side Scripting and Business logic** – Most of the server-side code is written in Microsoft C# and ASP.NET 4.5. We also use LINQ 3 in order to manipulate data obtained through Entity Framework and convert it into lists and data tables.

For user authentication we use Microsoft ASP.NET Identity Framework. It gives us a ready to use authentication mechanism with multiple option. We have choice to use third party app login, username-password combination or two factor authentications.

The complete code base follow MVC 5 architecture pattern where the request is always made to a class called controller, which fetches data from the models and then binds it to the view in order to render the HTML response.

![MVC 5 architecture of HirePro](image)

4. **Web Server** – HirePro is hosted on Microsoft IIS 7 application server. The sever has eight connection pools to access database. Having large number of connection pool is useful in serving the client request faster as server can make parallel connections to the database. We have also enabled the server to support GZIP compression technique to minimize the size of its response to any HTTP request made by clients.

<table>
<thead>
<tr>
<th>Table 3: Recommended hardware and Software requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPU</td>
</tr>
</tbody>
</table>
5. User Interface

a. Web Interface – Web interface uses HTML 5 to render the content on the user’s browser. The various media like text, image and videos all being server with HTML 5 components. The UI scripting language is mainly jQuery and JavaScript. These scripting languages are used to validate forms and make ajax calls to server APIs as well. Designing the UI is done using technologies like CSS 3 and Bootstrap 3.

b. Mobile Browsers – Similar to Desktop version the Mobile version also uses HTML 5 as its main browser scripting language and JavaScript, jQuery for its client-side logic. Also, Bootstrap and CSS as its design technologies. Most of the code for the web and mobile version are same and they use responsive design elements to support both the versions. HTML pages are designed using Grid 960 designing system to dynamically resize the pages in both desktop and mobile screens.

c. Android – The android app uses java language and is built on Google’s Android Studio platform. It is supported for all android versions from 5.0 and above. This app uses the same database to fetch and update the data as the web counterpart application.

d. Senior friendly design – Every page of HirePro app is designed to be used by senior adults. Hence the design of each page contains very simple elements with minimal information. Also, it used big fonts and bigger icons for people of weak eyesight. In order to place a service request, a user only follow three steps. Login activity is one-time and then it keeps the user logged in for the next 30 days. It Also give an option to just call the agency and converse over phone if they are not comfortable using the app.
Section IV – Results/ User Testing

HirePro has been designed for the senior adults to make it easier for them to request care service while staying at home. We solved this problem by providing an easy to use web application to the senior adults. Also, we help caregivers to access all the requests on the go by using our android app. To prove the efficiency of the system, we tried HirePro with few test users. These users were in both the caregiver and care receiving categories. In these user testing scenarios, we notice their behaviors and documented them.

<table>
<thead>
<tr>
<th>Test cases</th>
<th>User response</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Registration process</td>
<td>Registration needs many information from the user like address, phone, geolocation etc. Hence was difficult for senior adults to do it on their own.</td>
<td>Since it has to be done just once and a caregiver can do it for them so we classified it as a minor problem.</td>
</tr>
<tr>
<td>Requesting a service</td>
<td>Most of the older adults were able to request a service on their own. Some had problems in navigating backwards.</td>
<td>We should not use browser back. Instead, we can provide a custom back or restart button. Navigation can be made more useful.</td>
</tr>
<tr>
<td>Tracking a request</td>
<td>Some senior adults had some difficulties in tracking the request once it is placed. Billing and payment can be complicated to them.</td>
<td>Monetary transaction can be done on a monthly basis or if it is happening through Medicare/Medicaid then some closer relative can assist them with payments.</td>
</tr>
</tbody>
</table>
Table 6: User Acceptance Test summary when used by senior Caregivers.

<table>
<thead>
<tr>
<th>Test cases</th>
<th>User response</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Notification about new task</td>
<td>Caregivers were happy about the information provided by the app. They were</td>
<td>App is more useful than the manual process of communication about all the</td>
</tr>
<tr>
<td></td>
<td>able to know the address and contact information of the clients on their phone.</td>
<td>services a caregiver has to perform.</td>
</tr>
<tr>
<td>Managing Schedule</td>
<td>Helps in planning their day as they get all their tasks for the day first</td>
<td>A calendar view might me more useful.</td>
</tr>
<tr>
<td></td>
<td>thing in the morning.</td>
<td></td>
</tr>
</tbody>
</table>
Section V – Future work

HirePro has been developed as a prototype to test its usability with senior adults. It has mature screens design that lets senior adults select services and caregivers. However, there are some aspects that need to be improved in order to make it market ready. We have summarized few important features that need to be finished before its commercial can be started.

1. During the UAT by senior adults, some found it difficult to navigate between different screens. Specially the back functionality was not very intuitive for them. This led us to believe that navigation can be optimized further to make it easier.
2. While selecting a service an option of time selection should also be present. User should be able to specify when a caregiver comes to their house.
3. Caregiver has to open and look in the app to find out about any new tasks being assigned to them. Instead, the Android app should have a notification feature to let the caregiver instantly know if any new events has happened.
4. Time scheduling through a calendar like tool can be of great help for the caregiver to plan their day.
5. We should also introduce a system to provide feedback about the services rendered by the caregiver. Feedback system is an important part of the process. It helps to maintain the quality of the service being provide and if there is any kind of abuse happening to any party.
Acknowledgements

I would like to thank Dr. Carl K. Chang, Dr. Simanta Mitra and Dr Jin Tian for being a part of my advisory committee and their constant support throughout the project.

I would like to thank Dr. Carl K. Chang, Dr. Jennifer Margrett for leading us during four weeks of ICORPs training. Also, I am thankful to Hannah Dannewitz, Lauren Stratton, Yongan Liao and Rotem Arieli for being my team members in HirePro project.

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**Appendix I**

**Interview Questions for Customer Discovery**

1. You seem very independent, living in your own home and being actively involved in the community, how have maintained independence as you age?
   - E.g., family, community activities, physical activity, involvement
2. Do you currently use any type of services?
3. Have you considered in-home services for the future?
   - Other types of services?
4. What are 3 important things will you look for most while choosing a Home Care Service?
5. What are 3 important things will you look for while choosing a Day Care Home?
6. What are the other challenges you face every day, staying at home, which you wish technology can solve?
7. Explain website idea
   a. Reaction/thoughts
   b. Would you consider using this in the future?
   c. Would you let a family member/caregiver use this for you or help you with it?
   d. What challenges may this bring?
   e. Changes they would suggest
   f. Would you use this in an app form?