RHEST FRAMEWORK

Rural Health: Evaluation and Selection of Technology

University of Minnesota
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OVERVIEW

Recent advances in technology are generating new research efforts to improve the collective understanding of health outcomes in rural populations. There are multiple frameworks, methods, and guides for implementing health-related technology; however, there are few resources to guide researchers earlier in the process. The following framework will provide researchers a set of tools and resources to guide technology analysis and selection for rural health research. As the availability of health-related technology increases, a systematic approach toward an informed selection process will optimize research opportunities. The RHEST Framework includes information provided by researchers and service providers on rural health challenges, trends, and emerging technologies. Best-practice tools and methods from science and technology leaders have been adapted and included in the following process.

![Figure 1: High-level depiction of the RHEST Framework.](image)

**Drivers**

Minnesota has 30-40% of its population living in rural areas, depending on how rural is defined. The difficulties in improving rural health are significant. In many situations, such as stroke care, health outcomes are worse in rural than in urban areas, primarily due to reduced access to quality care. The awareness in the disparities in rural areas is becoming a focus for many organizations. In October 2019, Drs. Bruce Blazar, Director of the University of Minnesota Clinical and Translational Science Institute (CTSI), and Jakub Tolar, VP for Clinical Affairs, sent out a broad call-to-action:

*It is unconscionable that someone’s access to healthcare depends on their ZIP code. Yet, for many Minnesotans, that is a fact of life. They don’t receive the benefits of living near a large medical center with specialists and researchers who offer state-of-the-art therapies or clinical trials.*

In 2005, the National Institutes of Health took a giant step toward equalizing this disparity with the Clinical and Translational Science Awards. The program emphasizes smoothing the path of research from bench to bedside, by connecting research efforts, sharing best practices and solutions, and ‘engaging patients and communities in every phase of the translational process.’ This ties closely to our land-grant mission of improving the health of Minnesotans as we work to eliminate disparities caused by geography, economic status, and other factors.

Our own Clinical and Translational Science Institute (CTSI), in the second year of its current five-year award, brings tremendous advantages for researchers and trialists. It can help us learn and better understand what our communities want, need, and find missing in their current medical care. It offers resources available to help investigators at every level of experience.
Intended Audience
Version 1 of the guide is intended for any researcher considering the use of emerging technologies in their rural health research. The primary focus is for UMN researchers and is also broadly applicable for a Minnesota audience. Future versions will expand past the “research” focus and beyond Minnesota.

Framework Purpose
The guide will aide rural health researchers in:

1. **IDEATION**: Get started by exploring some resources early and identify potential research ideas using the “Ten Types of Innovation.” Generate a technology or research idea list. Even if you already have a specific technology selected, this section can expand your options in various categories.

2. **ANALYSIS**: Pare down the technology list. Select from various technology tools to guide evaluation and selection. Consider the research team’s capability, trends in technology and rural health, policy, and cost. Connect with various experts and available rural health resources for help.

3. **DECISION**: Make the final selection and use a systematic process to lay the foundation needed for advancing the research project through the next steps.

4. **RESOURCES**: The resource catalog is the simplest to access at any time, for any purpose. Use the list to rapidly connect to available experts, data sources, and services.

Value
This document is intended to provide a framework for researchers to follow when selecting appropriate technologies and connecting to available experts in support of their research in the rural health space. The guide can help generate new ideas, enable informed technology selection, strengthen the decision process, and allow connections with existing resources. Finally, the use of the tools will help prepare the foundation for a robust research proposal.

How to Use This Guide
The methods and information in this document can be used as a stepwise approach for those early in the process. Researchers who have begun taking steps to implement technologies in rural health research can still use sections and tools of this guide for further support. The guide contains four parts:

1. **IDEATION**: Get started by exploring some resources early and identify potential research ideas using the “Ten Types of Innovation.” Generate a technology or research idea list. Even if you already have a specific technology selected, this section can expand your options in various categories.

2. **ANALYSIS**: Pare down the technology list. Select from various technology tools to guide evaluation and selection. Consider the research team’s capability, trends in technology and rural health, policy, and cost. Connect with various experts and available rural health resources for help.

3. **DECISION**: Make the final selection and use a systematic process to lay the foundation needed for advancing the research project through the next steps.

4. **RESOURCES**: The resource catalog is the simplest to access at any time, for any purpose. Use the list to rapidly connect to available experts, data sources, and services.
1. IDEATION

A CLEAR PLACE TO BEGIN

Begin your journey by visiting the Rural Health Information Hub, or RHIIhub, located at [https://www.ruralhealthinfo.org/](https://www.ruralhealthinfo.org/).

The staff at the Center for Rural Health at the University of North Dakota maintain RHIIhub with the latest information on rural health issues, funding opportunities, state and federal data sources, case studies, news articles, and expert contact information.

For a primer on health information technology (HIT) in rural healthcare, be sure to visit RHIIhub’s HIT site at [https://www.ruralhealthinfo.org/topics/health-information-technology](https://www.ruralhealthinfo.org/topics/health-information-technology). You can even call or email for help finding information on available resources and referrals.

1-800-270-1898. [info@ruralhealthinfo.org](mailto:info@ruralhealthinfo.org)

RURAL HEALTH CHALLENGES

Be sure to explore and understand what the challenges are for achieving high-quality care in rural areas. Below are some examples:

- Access to quality care
- Low revenues leading to hospital and clinic closures
- Income disparities
- Medical history data sharing
- Lack of nurses in Minnesota schools
- Aging population
- Infrastructure for clinical trials
- Availability of medical specialists
- Discrete mental health care

RURAL AND URBAN DIVIDE IN MINNESOTA

It is necessary to understand the social divide between rural and urban communities. The RHIIhub lists several social determinants of health for rural Minnesota¹, including:

<table>
<thead>
<tr>
<th>Factor</th>
<th>Rural MN</th>
<th>Urban MN or MN-Wide</th>
</tr>
</thead>
<tbody>
<tr>
<td>2017 avg. per capita income</td>
<td>$44,350</td>
<td>$54,359 (MN-wide)</td>
</tr>
<tr>
<td>2017 Poverty rate</td>
<td>11.5%</td>
<td>8.9% (urban)</td>
</tr>
<tr>
<td>2013-2017 No high school diploma</td>
<td>9.0%</td>
<td>6.7% (urban)</td>
</tr>
<tr>
<td>2018 Unemployment</td>
<td>3.6%</td>
<td>2.7% (urban)</td>
</tr>
</tbody>
</table>

EMERGING TECH

Nearly every facet of daily life is impacted by technology. Rural health is no exception. One example is telehealth, which is now available in over 1,800 public schools with the reach of over 1 million students, primarily in rural areas.² Here are some examples of broad technology areas that are impacting rural health today:

- Telehealth
- Advanced imaging
- Digital health
- Artificial intelligence
- Data analytics
- Mobile phone applications
- Remote monitoring
- Robotics
TEN TYPES OF INNOVATION

Determine your rural research focus area based on your expertise and interest areas. It is common to consider a specific challenge or need related to healthcare access, condition, population, technology product, or service. Review the “Ten Types of Innovation” diagram below and consider how each innovation type may apply to a potential research area for rural health. For more information on this tool, see: https://doblin.com/ten-types.

Adapted from: Larry Keeley, Ryan Pikkel, Brian Quinn, and Helen Walters, Ten Types of Innovation: The Discipline of Building Breakthroughs (Hoboken, New Jersey: John Wiley & Sons, 2013).
TRENDS MATRIX

Looking at various trends can help to narrow down a focus area early in the process. Specifically consider rural health challenges, or other noteworthy trends, and various emerging technologies. Use the matrix below to gauge how these trends influence the advancement of the technologies. For more information on this tool, visit: https://www.boardofinnovation.com/tools/tech-trends-matrix/.

<table>
<thead>
<tr>
<th>Rapid Health (RH) Challenges (or other RH Trends)</th>
<th>Score ++</th>
<th>++ or 0</th>
<th>-</th>
<th>Strength</th>
<th>Tension</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 RH challenge / trend</td>
<td>+</td>
<td>-</td>
<td>++</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>2 RH challenge / trend</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>3 RH challenge / trend</td>
<td>++</td>
<td>+</td>
<td>0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>4 RH challenge / trend</td>
<td>+</td>
<td>-</td>
<td>++</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>5 RH challenge / trend</td>
<td>0</td>
<td>0</td>
<td>-</td>
<td>++</td>
<td>0</td>
</tr>
<tr>
<td>6 RH challenge / trend</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

**Score:**
- ++: Very high
- + : High
- - : Low
- -: Very low

**Strength (sum abs. values):**
- 6
- 6
- 7
- 5
- 7
- 3

**Tension (Strength minus Net):**
- 3
- 6
- 6
- 4
- 4

CHECK EXTERNAL RESOURCES

Explore various experts and data sources, as noted in Section 4 of this guide (pg. 12). Write down your list of ideas or technologies to use for rural health research. If you have a list of about ten or so, proceed to the next section to try some analysis tools to pare down the list.
2. **ANALYSIS**

Take your list of technologies from section 1 and apply them to any of the tools below. Refine the options and strengthen the justification for your research path.

**STRENGTH VS. VALUE**

Use this simple tool to compare each idea’s potential value to rural health and your capability to study or develop the plan further. **Tip:** For additional refinement of ideas, adjust the y-axis to a different measure, such as cost or technology proliferation.

<table>
<thead>
<tr>
<th>Capability to Study/Develop</th>
<th>Value to Rural Health</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>Medium</td>
</tr>
<tr>
<td>Tech. #1</td>
<td>Tech. #2</td>
</tr>
<tr>
<td>Tech. #6</td>
<td>Tech. #1</td>
</tr>
<tr>
<td>Tech. #7</td>
<td>Tech. #10</td>
</tr>
<tr>
<td>Tech. #8</td>
<td></td>
</tr>
<tr>
<td>Tech. #4</td>
<td></td>
</tr>
</tbody>
</table>

For example:

- **Tech. #1**
  - High Value
  - Strong Capability
- **Tech. #6**
  - Low Value
  - Capable Capability
- **Tech. #3**
  - Medium Value
  - Leading Capability

Adjust the y-axis to a different measure, such as cost or technology proliferation, to further refine the ideas.
HYPER CYCLE

Expert analysts often plot various technologies against a hype curve, based on the Gartner Hype Cycle. Gartner discovered that technologies typically follow a predictable pattern of early exaggerated interest before the noise dies down, and the technology eventually becomes reliable. One example is the 2020 digital health hype cycle below.

Search for existing hype cycles that list the technologies in which you are interested. If you cannot find a specific technology, carefully review existing literature to get a sense of the level of investment occurring in the technology, patents, and existing applications. Appropriately match your research idea with the state of the technology. For example, if you are developing some novel use of a new technology that will require several years of research and business partnerships, then it may be acceptable for the technology to appear earlier on the curve.

**Tip:** If you are expecting your research to have an immediate broad impact, you may want to focus on the items listed along the Path of Enlightenment or Plateau of Productivity, below. For additional information on this tool, see: https://www.cleverism.com/everything-need-know-gartner-hype-cycle/ and https://www.youtube.com/watch?v=2e416wjdKaY.

TECHNOLOGY READINESS LEVELS

Technology Readiness Levels (TRLs) provide a consistent way to determine the maturity status of technology products. NASA initially developed TRLs and they have also been used by the National Institutes of Health (NIH). The TRL scale operates from 1 to 9, where 1 is the least mature and 9 is fully in-use. The tool can also be useful in identifying appropriate technology funding for technologies ready to advance. Tier Seven provides a dynamic online biomedical TRL with examples of research activity for each level and specific TRL biomedical topic areas such as clinical interventions and medical informatics. Access the Tier Seven site here: https://tier7.us/trls/biomedical-trls/. See here for more information: https://www.youtube.com/watch?v=in4TnQZGYj4.

Sources: Thermometer Image from NASA TRLs, table adapted from the Department of Defense’s Technology Readiness Assessment (TRA) Deskbook: https://apps.dtic.mil/docs/citations/ADA524200.
POWER ASSET-TECHNOLOGY OPPORTUNITY MATRIX

When starting a research project, it helps to leverage the assets available to your organization. Modify the list of research and technology power assets to those that may impact your technology opportunities. Are you already well-positioned to advance your preferred technology opportunity, or is more work needed? Tip: In some cases, exploring additional partnerships or seeking outside expertise will be required.

<table>
<thead>
<tr>
<th>Item</th>
<th>Assets</th>
<th>Research &amp; Technology Power Asset (Examples)</th>
<th>Technology Opportunities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Faculty/Researchers</td>
<td>+ + + + +</td>
<td>Tech. Opportunity #1</td>
</tr>
<tr>
<td>2</td>
<td>Research partnerships</td>
<td>+ +</td>
<td>Tech. Opportunity #2</td>
</tr>
<tr>
<td>3</td>
<td>Corporate partnerships</td>
<td>+ +</td>
<td>Tech. Opportunity #3</td>
</tr>
<tr>
<td>4</td>
<td>Clinical partnerships</td>
<td>+ + + +</td>
<td>Tech. Opportunity #4</td>
</tr>
<tr>
<td>5</td>
<td>Data sources</td>
<td>+ + + +</td>
<td>Tech. Opportunity #5</td>
</tr>
<tr>
<td>6</td>
<td>Robotics expertise</td>
<td>+ + + +</td>
<td>Tech. Opportunity #6</td>
</tr>
<tr>
<td>7</td>
<td>Predictive analytics expertise</td>
<td>+ + + +</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Telehealth Research Center</td>
<td>+ +</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Rural Health Research Center</td>
<td>+ +</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Upper Midwest Agricultural Safety and Health Center (UMASH)</td>
<td>+ +</td>
<td></td>
</tr>
</tbody>
</table>

OTHER CONSIDERATIONS

Is your research idea going to help advance a Minnesota policy issue? Could current policy realities diminish the value of your research? Policy issues of interest in Minnesota include state Medicaid expansion, rising healthcare costs, health information availability, data privacy, insurance accessibility, primary care physician shortage, and mental healthcare access. If needed, check the Resources section for information on policy experts.

It is also essential to understand what cost factors are of importance to your research. Will insurance providers cover the technologies you are going to research? What about Medicaid and Medicare?
3. DECISION

Use the modified “Real-Win-Worth It (R-W-W),” and “probability of failure” tools to make a final decision on which technology opportunity to select for your rural health research. George S. Day describes both tools in detail in Harvard Business Review. If you have already decided upon a technology, jump to the research model canvas to strengthen your proposal for further vetting or funding opportunities.

MODIFIED “REAL-WIN-WORTH IT (R-W-W)”

If you have a new technology product to consider including in your research, try this modified tool based on George S. Day’s R-W-W. It is especially useful if you plan to commercialize a new product. Day’s tool has been used by well-known companies, such as 3M, to select and launch new products or new product lines. Too many “maybe” or “no” responses suggest more work is needed. For more information on this tool, visit: https://hbr.org/2007/12/is-it-real-can-we-win-is-it-worth-doing-managing-risk-and-reward-in-an-innovation-portfolio.
MODIFIED RISK MATRIX

Use the risk matrix to gauge the likelihood of failure for each of your technology product ideas. Note that the probability of failure goes up when the intended population and proposed technology are newer to the researcher. The matrix below was modified from George S. Day’s risk matrix\(^1\), for which he defines “failure” as missing the objectives used to justify the investment in a new product as a growth initiative for a company. In a research setting, it does not mean the research itself will fail, but rather that **there may be challenges for rapid technology proliferation.** The purpose of including the modified risk matrix as a tool here is to illustrate the importance of **collaboration between experts of relevant technology and research areas.** The risk matrix shows the probability of failure is lower when the right expertise is available. If additional knowledge is needed on a specific population, consider utilizing the University of Minnesota’s (UMN’s) Population Center for more data and the UMN Clinical and Translational Science Institute’s (CTSI’s) **Community Engagement Studio** to directly engage a community for feedback before launching your research study. For more information on this tool, visit: [https://www.aimcal.org/uploads/4/6/6/9/46695933/mcclure_tuesday_pres.pdf](https://www.aimcal.org/uploads/4/6/6/9/46695933/mcclure_tuesday_pres.pdf).

![Probability of failure](image)

**Expertise on the target population**
RESEARCH START-UP CANVAS

If you have used multiple tools within the framework, you should have plenty of information to make a final decision on a technology to advance research for rural health. To strengthen your proposal, consider the questions in the research start-up canvas, which is a modified concept from the Business Model Canvas designed by Alexander Osterwalder and Yves Pigneur. For more information on the Business Model Canvas, visit: https://www.businessmodelsinc.com/about-bmi/tools/business-model-canva/

4. RESOURCES

Part of the framework includes connecting with other researchers and experts. The following rural health resources are organized by category: Minnesota, national resources, and technology expertise. Note that while some contacts may overlap categories, each resource will only be listed one time. The list is not comprehensive.

MINNESOTA RESOURCES

Clinical and Translational Science Institute (CTSI)
Support for biomedical informatics, biostatistics, biospecimens, community engagement, multi-site studies, recruitment, and regulatory.
https://www.ctsi.umn.edu/
ctsi@umn.edu | 612-625-CTSI (2874)

Experts@Minnesota
Search for a UMN expert based on research output, grants, and other criteria
https://experts.umn.edu/

MN Community Measurement
Health care cost and quality data
https://mncm.org/
info@mncm.org | 612-455-2911
MN Department of Health Data, Statistics, and Legislation
Health diseases & conditions, environmental health, health care cost & quality, etc.
https://www.health.state.mn.us/data/651-201-5000

MN Design Center
Consulting using human-centered design, physical & service designs, public health service delivery design
https://designcenter.design.umn.edu/mdc@umn.edu

MN Population Center (MPC)
UMN-wide interdisciplinary cooperative for demographic research. Health, well-being, economic & demographic behavior, & human-environment interactions
https://www.pop.umn.edu/mpc@umn.edu 612-626-8375

MN Public Health Data Access Portal
Data on environmental issues, trends, geographic patterns and disparities.
https://data.web.health.state.mn.us/

MN Rural Health Association (MRHA)
Policy advocacy, engagement, education & collaboration
https://mrha.memberclicks.net/218-201-0098

Office of Rural Health & Primary Care (ORHPC)
Promotes access to quality health care, funding, publications, workforce data
https://www.health.state.mn.us/facilities/ruralhealth/health.orhpc@state.mn.us 615-201-3838

Upper Midwest Agricultural Safety and Health Center (UMASH)
Collaboration for research, education, & community engagement
http://umash.umn.edu/umashi@umn.edu 612-625-8836

NATIONAL RESOURCES

Agency for Healthcare Research and Quality (AHRQ)
Healthcare system safety and quality data, research funding
https://www.ahrq.gov/301-427-1104

CDC National Environmental Public Health Tracking Network
Data on environmental issues, trends, geographic patterns and disparities.
https://epitracking.cdc.gov/

General Social Survey Data Explorer
Societal change data since 1972
https://gssdataexplorer.norc.org/ GSSHelp@norc.org

Health Resources & Services Administration (HRSA) Federal Office of Rural Health Policy
Rural health policy, funding, hospital & community programs, & telehealth programs.

Health Resources & Services Administration (HRSA) Data Explorer
Supports access to health care in rural areas, training of health professionals, funding, etc.

National Bureau of Economic Research (NBER)
Conduct and share economic research
https://www.nber.org/info@nber.org 617-868-3900

National Organization of State Offices of Rural health (NOSORH)
Leadership development, advocacy, education, & partnership at national & state levels
https://nosorh.orghttps://www.powerofrural.org/888-391-7258
RHIHub
News, research, data, phone help
https://www.ruralhealthinfo.org/
info@ruralhealthinfo.org | 1-800-270-1898

State Health Access Data Assistance Center (SHADAC)
Data related to state and federal health policy, compare state data. Health coverage, affordability, and access data.
https://shadac.org/
http://statehealthcompare.shadac.org/
shadac@umn.edu | 612-624-4802

UMN Extension
Connections with greater Minnesota to advance scientific discoveries and education. Local and tribal relationships.
https://extension.umn.edu/
https://local.extension.umn.edu/local/
mnext@umn.edu | 612-624-1222

UMN Rural Health Research Center
Conducts policy-related research
https://rhrc.umn.edu/
rhrc@umn.edu | 612-626-8401

US Department of Agriculture (USDA)
National Institute of Food & Agriculture
Human health focus on nutrition, obesity, wellness, food science, and education. Data and funding.
https://nifa.usda.gov/
https://nifa.usda.gov/page/search-grant

Healthcare Information and Management Systems Society, Inc. (HIMSS)
Community of sharing and learning with searchable resources and events
https://www.himss.org/
312-664-4467

UMN Health Sciences Technology Development and Integrations
Develop web and mobile applications
https://it.umn.edu/service-details/health-sciences-development-integrations
bjs@umn.edu

UMN Health Informatics Services and Consulting
Data science, biomedical AI, machine learning, predictive modeling, secondary use of EHR data, clinical trials management, natural language processing, bioinformatics, & genomics
https://healthinformatics.umn.edu/
bmhi@umn.edu | 612-626-3348

UMN Computer Science & Engineering
Research areas in bioinformatics, robotics & AI, human computer interaction, data mining, databases, GIS, etc.
https://www.cs.umn.edu/research/research_areas
csdesk@umn.edu | 612-625-4002

UMN Technology Commercialization
Patents, licensing, start-up, IP management
https://research.umn.edu/units/techcomm
umotc@umn.edu | 612-624-0550

National Telehealth Technology Assessment Resource Center (TTAC)
Technology innovations, evaluation toolkits, events, and implementation technical assistance.
http://telehealthtechnology.org

TECHNOLOGY EXPERTISE

American Medical Informatics Association (AMIA)
Informatics healthcare community
https://www.amia.org/
301-657-1291

Great Plains Telehealth Resource & Assistance Center (gpTRAC)
Telehealth education and consultation
https://gptrak.org/
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