Enablers and Barriers to Remote Healthcare Technologies: 
A Stakeholder Analysis

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Abstract
Remote healthcare technologies provide a platform for efficient communication and effective long-term monitoring of patients. Studies have shown improved outcomes when remote monitoring tools were used for chronic illness management. While patients and physicians are the immediate users, they are not the only stakeholders influential in the design, use, and implementation of these systems. Other important stakeholders include insurance companies that pay for these technologies, an array of healthcare providers that aid physicians in patient care, and family members whose lives can be affected by changes in their loved ones’ care. Incorporating the needs of all stakeholders into system design presents a significant challenge. Patients generally need systems that are affordable and that are covered by their insurance. Regulatory agencies, on the other hand, require strict data security measures that could increase manufacturing costs and, in turn, costs to the patient. Based on a review of literature, this paper evaluates the enablers and barriers to the adoption of remote healthcare technologies and identifies and analyses the needs of the major stakeholder groups involved in integration of these technologies into the overall healthcare system. This analysis is then used to outline a systematic framework for the definition of system requirements.

Key Words
Remote healthcare technologies, remote patient monitoring, technology adoption, stakeholder analysis

1. Introduction
Technology for health applications has been rapidly advancing [1]. Studies have shown that the use of remote technologies in healthcare has the potential to enhance healthcare delivery and services, resulting in improved patient outcomes. For example, patients can use a mobile device to measure health metrics that are automatically transmitted to healthcare providers to support decision-making. Additionally, managing chronic illness with remote technologies could reduce patient wait times, improve patient involvement, strengthen family support in patient care, and reduce healthcare costs in the long-term [2]. These systems are typically designed and maintained by scientists and engineers, used by patients, monitored by medical staff, and paid for by insurance companies. For wide adoption of these systems, there should be a clear understanding of each of its key players. These key players, referred to as stakeholders, are groups of people who are affected by the system, either by contributing to the system, benefiting from its services, or losing from the system’s success. The design of such systems requires adequate knowledge of the specific characteristics and needs of the stakeholders involved. This is essential for strategic planning and tactical decision-making. Because the needs of all stakeholders are important to the system design and can vary dramatically across groups, it is important to identify the major stakeholders that contribute to the development and use of remote healthcare technologies and to understand their roles, interests, and power within the system.

Many different methods for stakeholder analysis exist, and each has its own strengths and weaknesses. The aim of this paper is to highlight stakeholder differences, needs and priorities that should be taken into account in designing remote healthcare technologies. In section 2, we identify the stakeholders’ economic interests in remote healthcare technology systems using Rechtin and Maier’s Four Whos. The Four Whos is a rubric that identifies stakeholders by
four roles; those who pay for, those who provide for, those who benefit from, and those who lose from the system’s economic success. The Four Whos illustrates that some stakeholder groups hold multiple roles in these systems, demonstrating complexity in stakeholder needs management. In the following section, a Power-Interest map is used to categorize stakeholders according to their level of power and interest in remote healthcare technology systems. Section 4 discusses conflicts that arise when stakeholder needs overlap but differ in power and interest. Potential solutions are proposed to manage stakeholder needs according to their power and interest level in the systems. By understanding the stakeholders in context of their power-interest conflicts, system designers can better manage stakeholder needs to guide the development of system requirements.

2. Characterizing Stakeholder Needs and Roles Using the Four Whos

Stakeholder needs vary widely across remote healthcare technology systems. The primary needs are to achieve a productive and efficient healthcare system and obtain financial satisfaction for all key players. This section describes the basic interests and needs of the primary stakeholders throughout the life cycle of remote healthcare technologies, from design to utilization. Six stakeholder groups that are largely affected by the system have been identified and classified into four roles using Rechtin and Maier’s Four Whos. Identifying stakeholders’ economic stakes in the system is important to ensuring the design of the system is tailored to meet the needs of the stakeholders [3]. The subsections below describe each stakeholder according to the Four Whos and how their needs are influenced by their role(s).

<table>
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<tr>
<th>Who Provides?</th>
<th>Who Pays?</th>
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<td>System designers, Healthcare providers</td>
<td>Patients, Healthcare providers, Insurance companies</td>
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<th>Who Benefits?</th>
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<tr>
<td>Patients, Family members, Healthcare providers, System designers, Policymakers. Insurance companies</td>
<td>Healthcare providers</td>
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Figure 1: Four Whos Matrix

2.1 Healthcare Providers

Healthcare providers (e.g. physicians, nurse practitioners, physician assistants, and registered nurses) are often referred to as frontline workers in healthcare delivery. Healthcare providers benefit from remote healthcare technology systems by obtaining detailed health data for more efficient communication, diagnosis, treatment, and patient management. Healthcare providers must also pay for the implementation and maintenance of the system. However, if patients do not successfully adopt the system, healthcare providers stand to lose a considerable amount of what was invested into implementing the system. As payers, their preferences are for systems that will not greatly increase their overhead costs and budget expenditures. Consequently, healthcare providers may require the patients or insurance companies to cover a portion of these costs. The use of a remote technology system in patient care can also lead to a reduction of patient visits with the healthcare provider. Because healthcare providers receive payments for each patient visit, this reduction poses a risk of decreased financial profit from in-person visits. As such, healthcare providers simultaneously benefit and lose from the economic success of the system.

2.2 Patients

Patients with chronic illnesses require daily disease management, even outside of the healthcare provider’s appointments. A rigorous monitoring regimen required in chronic illness management, such as diabetes and hypertension, can become overwhelming for patients to self-manage. However, successful implementation of the system can lead to improvements in the patient’s quality of care. Thus, for the system to be accepted and used by patients, it should meet patient concerns, preferences, and desired health outcomes [4]. Boyer et al. showed that that the stigma of ill health associated with home monitoring medical devices is a strong deterrent of remote technology adoption by patients, illustrating the effects of user preferences [5]. Furthermore, in some cases, a patient’s health
insurance policy may cover these systems in part or full, leaving patients to consider paying out-of-pocket for the systems. Consequently, patients become more concerned about affordability in addition to the health benefits.

2.3 Family Members
Family members can play a significant role as support systems for patients in health monitoring. This group of stakeholders are exclusively limited to family members of patients with chronic illnesses that offer support at home. Family members, while not possessing formal clinical training, are vital to patient management in cases where a patient is partly or wholly dependent on others for daily care. For example, in assessing the attitudes and behaviors of patients with diabetes, Daly et al. found that a large factor in self-management involved familial support [6]. With the ability to monitor their loved one’s health, family members can provide more accurate assistance in daily living. In current practice, family members may not have this additional information when caring for their loved one. As a result, family members can benefit from utilization of the system without much to lose because their interests in the system are not directly tied to their own health outcomes.

2.4 Insurance Companies
Insurance coverage is currently structured to reimburse costs associated with acute care, a branch of secondary healthcare addressing short-term treatment resulting from injury, episodes of illness, urgent care, or medical recovery [2]. These types of visits typically include charges for diagnostic tests, treatment procedures, medication prescribed, and/or hospital admissions. Insurance companies may pay out less if their patients adopt remote technologies designed to prevent acute events. This reduction in insurance payouts is highly beneficial for insurance companies. It will, however, require new costs to pay for the system, but the purpose of long-term patient management can mean more savings in the long-term at the cost of small upfront investments. Furthermore, because the insurance companies make payouts on a patient-to-patient basis, they do not necessarily incur large upfront costs to implement these systems. As such, the failure of these systems may not result in a loss for the insurance companies.

2.5 Policymakers
Policymakers produce guidelines that affect the design of remote healthcare technology systems. Policymakers need both providers and users of the system to comply with security, safety, and ethical protocols that are both effective and sustainable [7]. Regulating bodies specializing in remote health may be needed to supplement current regulating bodies to account for the unique challenges that arise with remote health technologies [7,8]. When remote systems are successfully implemented, its efficacy and safety reflects back onto the policymakers, validating their position as regulators of the system. Policymakers benefit from the successfully implemented remote system because it creates a standard for which other systems can be compared to, creating guidelines for similar system regulations.

2.6 System Designers and Device Manufacturers
Remote healthcare technology systems serve as bridges between patients and their care providers. As such, these technologies require a system of connectivity to send health information that healthcare providers can access and respond to with appropriate recommendations. The system designers and device manufacturers provide continuous maintenance and support of the system as it is in use. This service, is however, offset by profit from charging for the services. As providers of the system, this group is also positioned to benefit from future financial success as they gain a reputation as quality device manufacturers.

3. Influence of Stakeholders with a Power-Interest Map
The Power-Interest map, shown in Figure 2, uses a quadrant system to categorize the stakeholders by their power/influence against their interest in remote healthcare technology system design and implementation [9]. The quadrants are differentiated with roman figures (I, II, III & IV) based on stakeholders’ importance to the system. They are further differentiated by color intensity, e.g. quadrants with the highest influence and interest are the darkest while those with lower influence and interest are lightest in intensity. Each stakeholder group is listed under only one of the quadrants and each quadrant identifies the best method of managing key players in that stakeholder group, i.e., those to manage closely, those to keep satisfied, those to monitor and those to show consideration. The arrows represent the directional influence of one stakeholder on another. For example, policymakers influence the system engineer’s design of systems that meet current patient safety and information security guidelines.
Quadrant I represents the high power-high interest group. As the primary users directly interacting with the system, patients, healthcare providers, and system designers fall within this quadrant. As reflected in the Four Whos, the system designers have a high interest in direct profit from the system, while patients and healthcare providers have a high interest in both improved health and financial outcomes as users and payers of the system. As usability/human factors engineering recommends, system design should center on the users, giving healthcare providers and patients high influence on the final design of the system. As such, the needs of patients and healthcare providers influence policymakers to ensure that system designers develop a system that satisfies end-user needs and adheres to their legal requirements. This group of stakeholders is the most influential to system adoption and should be fully involved in every stage of design [9]. As the needs of the players in this group are most likely to influence the design of the system, they require close management during the life cycle of the system.

Quadrant II represents the high power-low interest group. In this group are the policymakers who have limited interest because their benefit is restricted to validation in successful safety and financial regulation of these remote systems. They are, however, highly influential as they act as gatekeepers for devices cleared for safe medical use. Insurance companies are also included in this quadrant as they influence the type of medical services and costs covered on the patient's plan. Despite the limited interest in the detailed design of the system, these stakeholders’ roles in policy and health coverage afford them the power to affect the successful adoption of remote healthcare technology. Although engaging this group of stakeholders at every stage of the design may not be necessary, they should be consulted when addressing system safety, privacy measures, and financial costs to users of the system.

Quadrant III represents the low power-low interest group. In remote healthcare technology systems, the stakeholders with the most interest also have the most power, such as the patients and healthcare providers in Quadrant I. As a result, none of the six stakeholders identified here can be accurately categorized as those with low power-low interest that require simple monitoring. However, if stakeholders that fall into this category were to arise at a later time, they will be monitored throughout development but will have little power in affecting changes.

Quadrant IV reflects stakeholders with low power-high interest. This group has limited stake in the success or failure of the system compared to the stakeholders represented in Quadrants I and II. In the map, family members have high interest in the system. They stand to benefit from the system by creating an opportunity to better care for their loved ones with chronic illnesses. However, their interactions with the system are not the primary interactions system designers are accounting for, so they assert less influence on the design of the system in comparison to other stakeholder groups. These stakeholders should be shown consideration during system design and implementation stages.
The Power-Interest map is an effective tool to model relationships among stakeholder groups early in the design process. By understanding the influence and interest of each group, system designers can carefully prioritize their needs. Prioritizing and managing highly powerful stakeholders can prove challenging, especially in conflict situations. The following section discusses a subset of these conflicts and potential solutions.

4. Conflicts of Interest Among Stakeholders and Possible Solutions

As in any system involving multiple stakeholders, conflicts of interest are bound to arise. With remote healthcare technology systems, the most challenging conflicts are often those of a financial nature, typically involving the stakeholders in the high power-high interest group. These conflicts may act as barriers to the system design and its subsequent adoption if not resolved. The following sub-sections highlight a few of these potential conflicts and possible resolutions that may be implemented.

4.1 Stakeholder Conflicts of Interests

Healthcare providers have a vested interest and high influence in remote healthcare technologies. They should be managed closely as they pay for, provide for and benefit from remote healthcare technologies. Meeting their needs can be challenging, especially when they have conflicting interests with other high power-high interest stakeholders. As payers using the system for care management, healthcare providers may want to reduce potential economic losses by receiving cost reimbursements from insurance companies. Healthcare providers may preferentially stick to what they are used to if integrating remote healthcare technologies is perceived as a potential source of additional financial and time commitment. For patients, the ideal situation is to have complete coverage of their medical equipment by insurance companies. Likewise, insurance companies’ objective is to keep their costs low by rejecting or restricting coverage costs of healthcare providers and patients [10]. This leads to a conflict of interest between three high-power stakeholder groups that may create a barrier to the successful adoption of remote healthcare technology systems.

The motivation behind the interests of the stakeholders should also be considered. From the Four Whos, we see that insurance companies do not otherwise benefit from use of the system except for financial profit. The other two high power groups, however, stand to benefit more than just financially once the system is implemented. The interest of patients and healthcare providers goes beyond their ability to afford the system. Patients and healthcare providers gain by using remote healthcare to improve patient management and health outcomes. As users and payers of the system, patients and physicians are more likely to adopt a system that meets their needs both financially and in health benefits. Furthermore, patient needs may require flexible system designs. For example, the use of remote devices that are not perceived to be associated with the stigma of ill health may require more creative designs. This, in addition to satisfying end-user needs, may necessitate increased expenditure on the part of the system designers and, in turn, increase costs to insurance companies, healthcare providers, and patients. How, then, can a balance be achieved with such differences in motivation and interest?

4.2 Possible Solutions

A potential solution is to implement and coordinate cost-sharing between the three groups. Cost-sharing is a method of distributing costs across groups rather than placing the burden solely on one [10]. This method is an effective compromise among stakeholders, reducing the economic burden on any one group. Because it should be affordable for each group of stakeholders, it can be challenging to reach an acceptable agreement. Patients may want their share of the costs to be absorbed through co-payments that are already mandated by their coverage. Healthcare providers, on the other hand, may have higher costs associated with the maintenance of the systems. Since the patients and healthcare providers have more to gain from the system, insurance companies may want the distribution of costs to reflect distribution of benefits. If cost-sharing methods appeal to insurance companies in the early stages of implementation, healthcare providers and patients can use that time to demonstrate its effectiveness in improving health outcomes. By understanding that a healthier patient saves them money long-term, insurance companies may become more willing to increase their portion of cost-sharing as this becomes more evident over time.

The Power-Interest map shows that policymakers have a large influence on the system’s implementation and adoption with direct influence on two other high-power stakeholder groups. This group relies on evidence of improved health outcomes to influence coverage policies. For this reason, healthcare providers need frequent data points to support the claim of improved patient outcomes. However, it is common for patients to disregard their
healthcare provider’s recommendation due to the perception of an unmanageable number of tasks necessary for self-care [5]. Family members also require systems that are less intrusive and simple in management. It would be unwise for the system’s design to cater solely to healthcare providers’ needs, even if it is deemed necessary to achieve optimal health outcomes. Doing so can result in under-utilized systems that require retrofitting and redesign [7]. Fortunately, because each of the stakeholders in this group is interested in the patients’ improved health, it is likely that the needs of the groups can be uniformly balanced without sacrificing quality. An unintended consequence of the system’s success is a reduction in patient presence in care facilities. This may result in decreased revenue for the healthcare providers who stand to benefit financially from increased patient hospital visits and admissions. This seems counter-intuitive to their investment in the system and may cause some hesitation in the system adoption by healthcare providers. With sufficient cost reimbursement, through cost-sharing or complete reimbursement, healthcare providers may see the system as bringing adequate financial profit to make up for any perceived loss due to reduced patient visits. Furthermore, it should be emphasized that these systems are not intended to replace in-person visits. Rather, they are supplements to traditional visits to make effective use of limited time and manpower.

5. Conclusion
Stakeholder analyses provides critical insight about the individuals affected by the design and development of a system. Finding a workable balance among stakeholder conflicts is paramount to the successful design of remote healthcare technologies. Some stakeholders are more influential to the success and subsequent adoption of the system than others. Therefore, while all stakeholder needs are valid, the needs of the most influential may receive higher priority in conflict situations. Unresolved stakeholder conflicts may result in the design of systems with poor usability, which may lead to under-utilization and poor adoption of the system by end-users. After initial identification of key stakeholders through the Four Whos, the Power-Interest map highlighted the needs of each group by illustrating the influence and interest each stakeholder has in the design and implementation of the system. Understanding and anticipating these conflicts prior to system design can help mitigate potential redesigns or under-utilization. By analyzing the stakeholder needs and interests in the context of economic impact, power, and interest, it becomes easier to identify the challenges that could arise in designing remote healthcare technologies. Future work will utilize this framework in managing stakeholder needs in the development of requirements for the design of remote healthcare technologies.

References