

# **Education Nonprofit Organization**

A Hierarchical Decision Modeling Tool for State Engagement Choice

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#### **ABSTRACT**

Decision models can be useful in various industries. In this project, a hierarchical decision model (HDM) is employed to assist a nonprofit organization called "eKnow" that is concerned with improving high-speed internet access to American schools. When initially launched, eKnow's engagement decisions were based on immediate opportunities and educational or political connections in particular states. Now, after having already worked a number of states, decision criteria have matured. Over the winter of 2017/2018, eKnow is working to identify which which states to enter next. The purpose of this study was to assist eKnow in their effort by helping to identify and define the most relevant decision criteria and then to use those criteria in an HDM-based prioritization of five states by subject matter experts at eKnow. This result is then available to assist decision makers move forward.

Keywords: Hierarchical Design Model, Decision Making, Nonprofit Management Techniques, Broadband Internet Access, Digital Divide.

#### **INTRODUCTION**

The goal of bringing high-speed broadband access to schools is championed by a nonprofit organization that is the focus of this study. To preserve its anonymity it is called "eKnow" in this report. The mission of eKnow is to upgrade Internet access in every public school classroom in America so that every student has the opportunity to take advantage of the promise of digital learning. Currently, eKnow is engaged in increasing broadband access to millions of students. Their efforts are focused on engagement at both state and federal levels, providing policy, procurement, and technical support where they perceive it is needed most. The issue of building equality of access is important to eKnow. They endeavor to give every student the same opportunity to learn through digital tools. Broadband access, specifically, is important because most digital education efforts carry multimedia programs—which require high-speed download capabilities to play effectively. WIthout it, students face simpler and less rich, text-based learning modules [1].

> "The large and growing role of new media in the economy and society serves to highlight their important role in education, and especially in promoting educational equity. On the one hand, differential access to new media, broadly defined, can further amplify the already too large education inequities in American society. On the other hand, the effective deployment and use of technology in schools may help compensate for unequal access to technologies in the home environment, and thus help bridge educational and social gaps. [2]"

When initially launched, eKnow's engagement decisions were based on immediate opportunities and educational or political connections. Now, after having already worked in multiple states, decision criteria have matured. Over the winter of 2017/2018, eKnow is evaluating which states to enter next. There are several states they are confident to consult with while some fall to the bottom of their list. The goal of understanding which opportunities are best to select from the "fuzzy middle" is approached here. The purpose of this study was to assist eKnow in their efforts by helping to identify and define the most relevant decision-making criteria and then to use those criteria in a hierarchical decision model (HDM) to understand which states ranked highest from this subset for programmatic attention in the coming year.

The State Engagement Group of eKnow worked with the Portland State University (PSU) research team to identify and define specific decision criteria and then selected five states from the "fuzzy middle" for programming consideration. Using HDM, these criteria were evaluated by the members of eKnow's State Engagement Group through a pairwise comparison survey. This survey was provided via an emailed link to the HDM program hosted by PSU (and made available by the university's Department of Engineering and Technology Management) and allowed users to apportion priorities between pairs. Survey responses were used to apply weights to each criteria and then, in turn, a scoring of each of the five states in question.

While the primary purpose of the HDM effort was to assist eKnow with a decision-making need currently in front of them, a secondary benefit was that it also documented and communicated their collective choice. The organization can now consider to use the framework and criteria to guide future work. For the PSU research team, the opportunity to test-drive the HDM methodology and tool with a real-world partner and test study proved to be highly valuable.

#### **RESEARCH APPROACH**

The PSU research team followed a structured process in order to carry out tasks in a timely, effective manner. While any research effort requires some structure, the fact that this project involved collaboration with an external organization on an aggressive timeline underscored the need for a defined process. Specific tasks are identified below.

- Task 1: Conduct exploratory research and query eKnow to determine interest in participating in HDM research.
- Task 2: Continue preliminary research into publicly available information about eKnow's mission, vision, objectives, and activities.

- Task 3: Formally engage eKnow (via phone conference) to confirm scope, timeline, and expectations (of both eKnow and the PSU research team).
- Task 4: Explore additional research (literature review)
- Tasks 5 -7: Iterative tasks associated with model development and refinement
  - Task 5: Develop preliminary criteria
  - Task 6: Share criteria (and criteria definitions) with eKnow; request critical feedback
  - Task 7: Use eKnow's feedback to revise model and integrate eKnow's revised (i.e., validated) criteria into the model
- Task 8: Email eKnow subject matter experts link and directions to complete the pairwise comparison HDM survey tool.
- Task 9: Data gathering Following the completion of pair-wise comparisons, analyze data
- Task 10: Review results, share with eKnow, and get feedback from eKnow SMEs

Note: In order to produce the highest-value deliverable possible, the PSU research team coordinated the scope and timeline with eKnow early in the process. Knowing that the short time span of the academic term increased the risk of failure, the research team internally identified a firm date, February 27, 2017 (week 7 of 10) that would trigger a backup plan in case the eKnow experts did not complete answers to the HDM survey. As a contingency, the research team would complete the survey as proxies for the experts. While the model output would no longer be useful for eKnow's decision-making purposes, the output would still serve its educational purpose for the research team's academic endeavors.

# **LITERATURE REVIEW**

The mission statement of eKnow is broad in scope and and yet narrow enough to measure success and shift direction as progress is achieved: Improve access to the Internet in public school classrooms so that everyone can share in the promise of digital learning. Organizations change direction as they mature. As with most endeavors, experience leads to insights about the social, political, and economic environments in which they serve [3].

Decision making that draws from the expertise of individuals working towards the same goal enhances engagement with the larger mission. Companies and organizations whose members have a clear understanding of where the organization is headed and how their daily activities contribute to the success of the organization consistently outperform the competition [4]. This is also true in the nonprofit sector. Decision-making tools can help the decisionmaking process by identifying key activities that take place prior to a decision being made, identifying the human resources available to help, and promoting accountability. Sharing decision-making power among the right people can save time and yield better outcomes. The clarity that comes from an identifiable process may lead to better buy-in for the decisions that are made with a spirit of transparency. Non-profits in particular draw strongly from the engagement of team members with the mission and goals of an organization.

"Even though there are people who aren't involved, they're ecstatic just to know who is involved and what the decision-making process entails. "They feel more engaged just from understanding something that had been opaque to them before." Joyce McGee, Executive Director, the Justice Project, an advocacy nonprofit [5].

One example of the many decision-making process tools is **eRAPID**<sup>®</sup> (Recommend, Agree, Perform, Input, Decide), offered by Bain and Co. (see Figure 1 below)[6]. Organizations and teams of various sizes confronting various situations have effectively used this tool.



Figure 1: Decision- making process tool: eRAPID

It has been suggested that efficiency in decision making is directly tied to organizational effectiveness. Surveys have shown that confusion, disempowerment, and dissatisfaction can arise when staff are either not involved in decision making opportunities or do not understand them. Decision making can be either concentrated in the hands of a few, or distributed to larger groups or teams. Concentrated decision making may be appropriate at times, but allowing managers and staff to be heard is empowering to them as professionals [7].

However, there are challenges. How are different inputs and opinions handled? How are conflicts resolved between either the individuals contributing to a decision or between the way decision criteria are evaluated? Alignment with the objectives of the decision makers with organizational mission is important as well. The problem—the need and purpose for the decision—must be clearly stated. Then, the task is to identify the criteria and subcriteria, various stakeholders, expert opinion holders, and alternative actions to take. In any decision, there may be many intangible elements to consider, as well as quantifiable factors. One effective approach is to assign priorities to alternatives so that resources may be directed appropriately [8].

# **PROBLEM STATEMENT**

Simply stated, the question that eKnow identified for HDM treatment was:

#### Which state should receive eKnow's programming efforts next?

In adapting the HDM framework to this problem statement, other research questions developed as the work progressed:

- What criteria do nonprofits such as eKnow use to determine where to offer their services to advance program goals?
- How are those criteria evaluated and weighted?
- What factors lead to the decision and how is that affected by opportunities, risks, and liabilities?
- Can this decision process be modeled in a way that adds clarity and empirical justification in determining the path to take?
- What answers satisfy such criteria?

#### HDM MODELING FOR DECISION ANALYSIS

Decision analysis is a method of identifying the best option from a set of alternatives. Decision analysis can be applied to a wide-range of problems, and provides a disciplined approach for decision making, enabling decision-makers to better defend capital investment. A robust decision analysis in early stages of the life-cycle of a system or project can help avoid costly mistakes later in the life-cycle [9]. Furthermore, decision analysis is most critical and valuable when applied to decisions that are subjected to a high degree of ambiguity – such as conflicting goals, complex trade-offs, multiple stakeholders, or qualitative criteria [10].. Selecting the most effective analysis method or model greatly depends on the complexity of the outcomes and alternatives.

## **HISTORY AND DEVELOPMENT OF THE HDM**

The Hierarchical Decision Model (HDM) and the Analytical Hierarchy Process (AHP) were first used and developed Dr. Thomas L. Saaty in the early 1970's at the Arms Control and Disarmament Agency in Washington, D.C. The AHP offered a novel approach for decision analysis regarding complex funding trade-offs, and resource allocation within the US Department of Defense. Dr. Saaty has published eight books on HDM and AHP and taught at the University of Pittsburgh and the University of Pennsylvania. Dr. Saaty co-developed the software Super Decisions for creating HDM's using AHP [11]. The AHP is a decision analysis support methodology aiding in the solution of complex problems, using a hierarchical structure of goals, criteria, and alternatives. The AHP has been used in industry for decades [12].

Examples of HDM and AHP and its use in industry:

- Resource allocation for the Department of Defense
- Evaluation of technology investment
- Early detection of cancer
- Employee motivation
- Technology transfer
- Funding of R&D projects

The Hierarchical Decision Model (HDM) converts subjective judgments into relative priorities to model the best option selection from alternatives. The analytical engine of the model is the Analytical Hierarchy Process (AHP) through which pairwise comparisons of quantitative and qualitative criteria are derived into priority scales. The weighted priorities of the criteria serve as a basis for ranking the alternatives considered in the model [13].

# **CONSTRUCTING AN HDM**

The HDM is composed of clusters, nodes, and links. Figure 2 below is a diagram of the hierarchy structure. The goal node is <u>linked</u> to the criteria and subcriteria cluster of nodes that are considered in choosing a best option selection, in which each criterion is linked to each alternative [14].



Figure 2: General HDM Structure (Source: Ribeiero, Passos, Teixeira, 2012 [15])

#### **HDM STRUCTURE**

The PSU research team's final model hierarchy (developed after iterative consultations with eKnow) is shown in Figure 3 below, and includes the four levels: *mission, objective, target,* and *action*. Table 1 which follows, defines the criteria of each hierarchical level in more detail. An important concept to the model is the development and selection of the model's criteria for weighting. The criteria in the model may be subjective, thus it is critically important to understand the implications of criteria selection and methodology of the HDM. Criteria selection must be researched and validated since they are used to evaluate each alternative in the decision model. The selection criteria are prioritized by the experts based on a series of pairwise comparisons of relative importance.



Figure 3: eKnow HDM for States Engagement [16].

# **MODEL DEFINITIONS**

Decision making requires coherent definitions that can be shared between Subject Matter Experts (SMEs): in this case, eKnow experts and the PSU research team. Refining these definitions required back and forth communication similar to the Policy Delphi method, a structured review and comment exchange to draw forth ideas [17].

Increase Connectivity	Criteria	Sub-Criteria and Definitions		
	<b>Greatest Need:</b> Tackle the Greatest Need: Those states which most lack access	1 Students: Number of students in the state in districts not meeting 100 Kbps/student goal		
		2 Schools: Number of schools not connected to fiber		
		3 Service provider landscape: Is it competitive? Breakdown between incumbents and insurgents		
	Politically Important: Likelihood of success: Where the politics, leadership, organizational capacity etc. can align to support our work	4 Political landscape: No major budget or political drama, ideally Trifecta House, Senate, Gov political status		
		5 High-level champion exists who is willing to spend political capital to get this done		
		6 Organizational alignment: Do key agencies work well together? Do they like the governor? Legislative leaders?		
		7 Operational capacity: Does the state have broadband leaders/offices able to support communication, convening, advocacy?		
	Meet Unique Challenges: Unique needs and / or opportunities that eKnow may satisfy	8 Are there unique challenges that we are uniquely suited to help with? I.e. no good channel b/t districts/DoE?		

**Table 1: Decision Criteria Definitions** 

# **DATA GATHERING ISSUES**

As noted above, the research team identified a deadline for survey responses from the eKnow experts. If by February 27, 2017, the surveys had not been completed, then the research team would complete the surveys as

proxy experts. While the end-results would no longer offer any value to eKnow, this contingency plan would still provide the research team with an opportunity to gain the intended educational experience of the assignment. By February 27, 2017, survey responses had not been received from eKnow so members of the PSU research team completed the survey. Within days of the research team completing the surveys, the eKnow team submitted their survey responses. Unfortunately, three of four of the eKnow survey responses were not complete—all three stopped at the evaluation of political criteria. The research team finished the incomplete eKnow surveys in order to add to the research team's responses. Consequently, the survey results (submitted by eKnow and completed by the PSU research team) are insufficient to inform eKnow's decision making needs through the application of the HDM process. The description of results below represents a conveyance of findings, with an understanding that it is not intended to serve eKnow's needs, but rather those of the research team's purely academic requirements pursued in the spirit of learning how to utilize HDM and interpret the model's output.

## **PROJECT RESULTS AND ANALYSIS**

The results from the HDM "Objective Level" indicated (with a score of 0.53) that the primary objective should be a focus on numbers: tackle the greatest need. The second highest scoring objective is "meet unique challenges" defined as utilizing eKnow's ability to provide a specialized skill (*e.g.*, consulting).

Increase Connectivity	State #1 Michigan	State #2 Louisiana	State #3 Alaska	State #4 Idaho	State #5 New Jersey	Inconsistency
eKnow Expert 1	0.4	0.23	0.13	0.08	0.15	0.15
Alexis Wittman	0.35	0.14	0.1	0.18	0.22	0.2
eKnow Expert 2	0.24	0.12	0.37	0.12	0.15	0.03
Eric Arzola	0.31	0.16	0.12	0.14	0.26	0.02
eKnow Expert 3	0.28	0.14	0.27	0.17	0.15	0.09
eKnow Expert 4	0.4	0.15	0.18	0.07	0.2	0.11
John Bauer	0.25	0.11	0.21	0.2	0.23	0.13
Joshua Binus	0.28	0.19	0.14	0.14	0.24	0.01
Shivani purwar	0.18	0.21	0.23	0.21	0.17	0.01
Mean	0.3	0.16	0.19	0.15	0.2	
Minimum	0.18	0.11	0.1	0.07	0.15	
Maximum	0.4	0.23	0.37	0.21	0.26	
Std. Deviation	0.07	0.04	0.08	0.05	0.04	
Disagreement					/	0.056

Figure 4: Averaged Normalized Rankings from Surveyed Experts

The mean scores of the five states, using data from all available SMEs (again, scored from the PSU team), indicate Michigan as the preferred state to target, followed by New Jersey, Alaska, Louisiana, and Idaho. The research team recognizes that the responses from at least four of the experts should be discarded because of high inconsistency (greater than 0.1), but has maintained the complete set for simplicity of discussion given other limitations of the data set previously discussed.

When these states are examined in light of information related to broadband access available through eKnow, each state has unique characteristics that may affect consideration as a next choice. Michigan has the largest absolute number of students without minimum connectivity with New Jersey following second. Alaska has a lower number of students without minimum connectivity, owing to lower population overall, but has the highest relative proportion (98 percent) of school districts that are not maximizing broadband services for their budgets. This potential for improvement is also compelling. Louisiana has a large number of students and districts that need help, while Idaho falls in the middle range of students and districts needing assistance (figure 5).



Figure 5: Optimal Selection and Ranking of Alternatives

#### **LIMITATIONS**

As a result of the incomplete and partially inconsistent set of responses from the eKnow SMEs, the HDM results described above are not valid in their current state to inform eKnow's decisionmaking needs. The HDM tool itself provided an effective framework to approach the defined problem. However, the compressed timeframe of the academic term coupled with limited availability from the eKnow SMEs led to insufficient opportunities for further criteria validation and refinement of SME responses. The following "Lessons Learned" section provides more discussion about improvements for this project and lessons for other research groups that may work with external organizations.

# **LESSONS LEARNED**

Having the opportunity to field test an HDM-focused process with a real-world partner offered the PSU research team significant educational opportunities. Having the opportunity to fail in the collective effort to provide eKnow with high-value decision-making support similarly offered a valuable opportunity to learn from mistakes to be better prepared to facilitate similar projects in the future. Some key lessons learned include:

Establish a clean line of communication with direct contact with the SMEs, if possible. Follow-up conference calls at key points in the study would have provided opportunities to clarify the process and the survey.

- The established line of communication was primarily conducted with one employee of eKnow. While that contact was knowledgeable and engaged, the PSU research team should have scheduled at least one larger team-to-team phone conference.
- A team-to-team engagement would have provided an opportunity to make some personal connection with each of the SMEs that were ultimately confronted with the burden of completing the pairwise comparison survey. More importantly, it would have allowed the PSU research team an opportunity to provide context to the eKnow team and given them an opportunity to ask questions directly. Instead, the single eKnow point of contact (who had even less experience with HDM) was left to communicate on his own. Without engaging anyone else involved from eKnow, the research team was not able to know how well they understood what was being asked of them—or what this project might do *for* them.

Limit the number of criteria or, break out different member SMEs into groups to simplify the individual contributions. The SMEs did not finish the pair-wise comparisons; there seemed to be too many.

- The first part of this problem is associated with a mistake made in asking the same SMEs to conduct pairwise comparisons on two levels in the hierarchy. The research team should have either had different SMEs address different layers or had the conducted survey in phases with perhaps a week between them.
- The second part of this problem was that the third level had more than five elements. While having more than five elements in the hierarchy does not necessarily lead to failure, when coupled with having too many levels or comparisons to evaluate and a limited understanding of the model, the task can become boring, repetitive, and meaningless.

In a formal consulting experience, laying the groundwork to develop criteria and definitions, confirm the model, and execute the study would require early buy-in from the top-level management. The aggressive deadline stemming from the academic term and the travel schedules of eKnow SMEs constrained the research team's ability to resolve incomplete surveys.

- With more time in a formal consultant-client relationship, the PSU research team would have continued to work with the eKnow group in order to drive toward a successful project completion.
- The next step would have involved a context-setting question and answer opportunity for all SMEs along with discussion about allocating survey components among particular SMEs. Through such dialogue, the SMEs would have appropriate context for what they were doing and why.

Expect important business decisions to involve a degree of proprietary knowledge; some reassurance of confidentiality will help projects move more smoothly.

• As the project progressed, and especially after eKnow expanded the range of political criteria, the need for formal reassurance of confidentiality grew. Ultimately, the PSU research team members each signed non-disclosure agreements (NDAs) for eKnow, but by then, the project was at an end.

Key observation: the SMEs all stopped answering their pairwise comparisons once they got to the political criteria. Did these questions amplify their concerns over confidentiality to the point that they no longer felt comfortable answering the questions? The key lesson here is to resolve confidentiality concerns at the *start* of a project, so the client can engage with greater confidence.

# **CONCLUSION**

Decision making requires quality information, insight, inspiration, and analysis. A decision is only as good as the input made towards it. In non-profit organizations where resources like time and personnel can be limited, the challenge is to utilize expertise and deep knowledge that is embedded within the organization at all levels. Although the quantitative analysis provided by this HDM cannot be used directly to support the very real decision which eKnow must make in the next period of their expansion, the light put on the process through this investigation may help. The literature review reveals that in nonprofit organizations in particular, participation with decision making helps staff at all levels feel more engaged and empowered within their larger mission.

In efforts to to improve the way children learn, the U.S. education sector lags behind the technology, business, medicine, and even sports sectors in its ability to employ new ideas, methods, and technologies. Catching up is not easy, but state-level developments can serve as role models for other states notwithstanding the unique circumstances and characteristics of each. The goal of achieving an equity of educational internet access nationally is admirable, and with such efforts as this nonprofit offers -- obtainable. The possibility of new technologies to match new educational methods in development means that the role of technology management will continue to be important in meeting educational goals. Decision making is one aspect of technology management.

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