Radio Assisted Identification Device: A Universal Card

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Abstract— George Mason University uses photo identification cards with magnetic stripes. This system contains multiple points of vulnerability for the campus community which could lead to identification theft. This problem may further result in unauthorized purchases and entries into buildings and dormitories. Security issues have become increasingly relevant on university campuses due to random occurrences of violent acts. When these situations occur it is imperative to quickly locate and respond to the problem. The current emergency system in use at George Mason utilizes twenty-seven call boxes scattered around campus to respond to requests for help; only fourteen of these function properly, so that responding to and locating the individual become both untimely and less accurate. With the current system the dining services on campus reach maximum capacity during peak hours of operation when mass numbers of students attempt to purchase meals in between classes. With limited amount of time for waiting in line, many students may be discouraged to purchase food which in turn causes the school to lose business.

A new identification device may be developed to help the performance in food services, decrease response in event of campus threat, and protect against identification theft. The smart identification card may allow authorized personnel to triangulate the position of a campus member upon activation of the card in emergency. Smart identification cards will also be able to smoothly handle campus purchase transactions, subsequently reducing the waiting and processing times per individual. This will lead to both a higher efficiency of service and a higher return of profit. These features shall be integrated into a functioning unit known as Radio Assisted Identification Device, henceforth known as RAID.

A system economic analysis is essential in determining if the device is sustainable, marketable, and have a desired usage in a campus environment. A comparative breakup of the existing system with the proposed RAID system shall be conducted in order to determine value of benefit vs. cost. A trade-off analysis is necessary in order to select a design alternative, whose component makeup gives the highest utility.

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I. Introduction

Universities across the nation in recent years have become vulnerable to violence such as the Virginia Tech University incident, where a student opened fire on his classmates killing thirty-three and wounding several others. This event led to the realization that campuses are not as secure as university personnel have assumed. Since this incident, universities have taken a closer look at campus security and have taken steps to prevent a repeat of this incident, one of them being George Mason University (GMU).

GMU is a special case with its ease of accessibility by multiple means of transportation that leave it vulnerable to various forms of crime on campus. Data from the 2008 Annual Security Report shows that Weapon Referrals have decreased over the past three years, but there has been a rise of reported Sex Offenses Forcible. With the current system in place, there may be no real way to solve this problem. In addition, GMU's current ID system uses magnetic stripe technology that was introduced many years ago. Although it is an efficient tool there are technological advances that can improve safety and ensure greater security of the students, staff, and faculty.

II. Problem Statement

The problem GMU is facing can be categorized into three parts: safety, security, and efficiency. GMU currently utilizes a magnetic stripe ID card system that provides easy access to resident and lecture halls, the ability to conduct transactions to purchase food, and other retail products on campus and as a form of identifying the individual. The ID card does provide a little security to the campus, but still leaves the campus community vulnerable to identity theft and a secure living and work area.

Also, to provide students, staff, faculty and visitors an alternate point of contact to university police, an emergency call box system was put in place. This system is lacking, due to the limited number of access points, having only fourteen operating units spread across the campus which provides less than 2% of coverage on its 700 acre campus.

A. Statement of need

As the number of students attending the University grows, the need for a safer educational environment grows as well. These concerns can be addressed with a new adaptable identification card. The University has a police force, but there is also a need for a localization device for members of the community in case of emergency. This addresses the issue of locating persons who are in need and reduces response time in reaching and assisting the user. There is also a need to optimize the on-campus transaction system in order to increase security against identity theft, as well improve traffic flow of dining services during peak hours.

B. Scope

The new ID system will be designed to apply to university settings only, GMU being considered as the pilot test. This will involve the entire campus including the parking lots, all the buildings and other university owned properties. Factors such as convenience, safety and cost vs. performance will be evaluated. More specifically, the system will focus on identification and localization of the card holder, and long range data transmission analysis. Environmental affects and visitors to the campus are outside of our scope.

II. Problem Approach

Our team conducted research into the functionalities that the current ID system provides. This was then used to add on particular functionalities that would be beneficial to the campus community. Based on these findings, the technology that could be used to meet the specifications of the functionality were decided based on the current trends in the technology market.

A. Requirements

Following meetings with different officials from the campus community the following top-level requirements were defined:

1. The ID System shall provide a method to complete transactions on campus.
2. The ID System shall provide communication for emergency response services.
3. The ID System shall be used as a form of identification.

B. Design Alternatives

1) **Provide Transaction Support**: This requirement has two sub requirements which are needed for students that live on campus. The ID must provide a method of entering buildings and provide a payment system utilizing the ID card for meal plans, as well as a debit card like system. To provide these functionalities, Short Range Radio Frequency ID tags were thought of as the best option. In order to enhance the level of security that the RFIDs can present, we then decided it would be best if the component worked when needed to reduce opportunities of vulnerability from external RFID integrators.

2) **Provide Emergency Response Services**: This requirement defines the need to provide a better form of contact in order to request and receive help in time of medical emergencies and requests of escort services. These services requires two points of functionality, a form of communication and localization to provide immediate access. To address the two parts of this requirement, the following components were taken into consideration as alternatives: Active Long Range RFID tags, GSM cell phone modems, Wi-Fi communication chips, GPS.

3) **Provide Form of Identification and Authentication**: To provide functionality for this requirement, a commonly method of authentication was thought of as a viable option, biometric fingerprinting.

Because all of these components require a power source, a rechargeable battery would be ideal to provide a source of energy for these components, In order to recharge, a Universal Serial Bus (USB) interface would provide the needed connection to recharge this battery.

C. Value Hierarchy

To find out the measures for the utility function students were asked to rate the features on the value hierarchy that the group developed. First, they were given a description of the device to be built. Then they were asked to rank each level of the hierarchy. The highest rank is 1 and decreases as the number gets bigger. At the top level they chose either performance or suitability. Under performance they ranked emergency response, biometrics, and transactions on a 1-3 scale. The same thing was done for suitability with durability, maintainability, reliability, and aesthetics as choices on a 1-4 scale. Under transactions, they ranked Building Entry Management, Financial Transactions, Network Authentication from 1-3. Aesthetics appeal was decided by weight or size.

D. Value Hierarchy

The weights were calculated by applying the Analytical Hierarchy Process (AHP) which is an approach for solving complex decisions. The method was done by structuring multiple choices criteria into a hierarchal structure with fundamental objective (goal) and means objective (sub-goals). AHP allows a better selection and determination of the overall ranking alternatives through the comparison alternatives and by normalizing the columns of the value matrix. The obtained weights are shown in Figure 1:

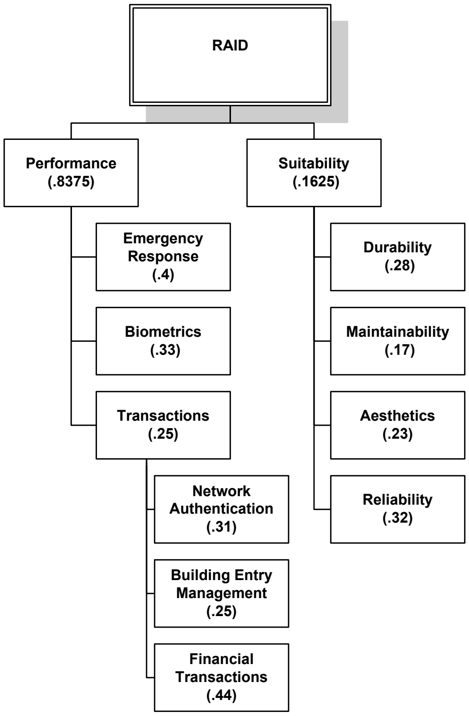


Figure 1 **Value Hierarchy showing weights derived from AHP & the survey**

III. Simulation and Analysis

A. Trade-off Analysis for triangulation and data transmission

In order to determine the best component which would allow it to localize an individual and send a distress signal so to the emergency call center so they can dispatch an emergency response official to the required location. A long range data transmission component is necessary which will allow the localization of the individual. Low price and the high utility is key to producing a quality and effective product.

In order to complete the trade off analysis, we used Logical Decisions® for Windows (LDW) and used the weights found from the analytic hierarchy process to determine the importance of the each performance measure for the components.

The measures used in order to determine the utility of the components were found by researching existing integrated circuits that are available in the current market. Weather Sivix chooses to purchase the components or develop their own will determine the final production cost of the product.

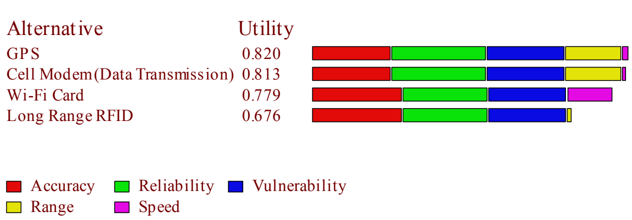


Figure 2 LDW results for localization components.

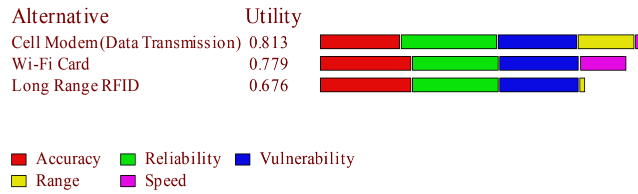


Figure 3 LDW results for long range data transmission components.

With LDW we were able to determine that using a GPS would provide the highest utility for localizing an individual at the time of an emergency. In order to deliver the information to emergency services the system would require another component because the GSM cell modem provides the next best utility and can provide the localization of the individual and transmitting the data, it was chosen as the best component for the two part job to contact emergency services.

B. Systems Economic Analysis

The economic analysis for this project is meant to determine the best alternative based on the cost, the utility, and it's resulting profit over time.

The initial investment cost for this product was estimated to equal $135,000 [Table 1].This low cost is due to an existing product which performs similar functionalities but on a larger scale. Therefore, taking the existing technology and tailoring it to the needs and functionalities for this system will result in lower costs.

Product Development Step	**Development Cost**
Board Design	$35,000
Board Manufacturing (3 Spins)	$10,500
Firmware	$25,000
Case Design	$10,000
Case Mold	$10,000
Certifications	$35,000

Table 1 Initial Investment for Product Development Break-down

The overall price threshold that GMU ID department has provided is a maximum of $20 per ID. Although the original intent was to determine the cost of production based on specific components and features, due to time constraints, a number of packages with preset components were priced. The following are the packages that were priced to their specifications, in addition, each package was provided with prices for different quantities ranging from 5-100,000 units, which were used to determine the production learning curve to approximate costs at various quantities. [9]

- **Basic Package:** active short range RFID, biometric reader, USB interface, analog screen and/or led feedback system, 2gb flash memory
- **Package One:** active short range RFID, active long range RFID, biometric reader, USB interface,

panic button, analog screen and/or led feedback system, 2gb flash memory

- **Package Two:** active short range RFID, GSM phone chip, biometric reader, USB interface, panic button, analog screen and/or led feedback system, 2gb flash memory
- **Package Three:** active short range RFID, Wi-Fi communications chip, biometric reader, USB interface, panic button, analog screen and/or led feedback system, 2gb flash memory
- **Package Four:** active short range RFID, GSM phone chip, speaker and microphone (for voice communication), biometric reader, USB interface, panic button, analog screen and/or led feedback system, 2gb flash memory.

Determining the learning curve for each of the packages for production costs the equation

$$e^{b*ln2} * 100 = Learning\ Curve\ [3].$$

Package Type	First Unit Cost	Learning Curve
Basic	$60	96%
Package 1	$80	96.5%
Package 2	$188	95%
Package 3	$162	95%
Package 4	$193	95%

Table 2 Individual Package based First Unit Cost and Learning Curve

Using package two for it's GSM phone chip we used the weights we had calculated earlier in the course of the project to determine the device's overall utility for all packages and the utility of the ID current system.

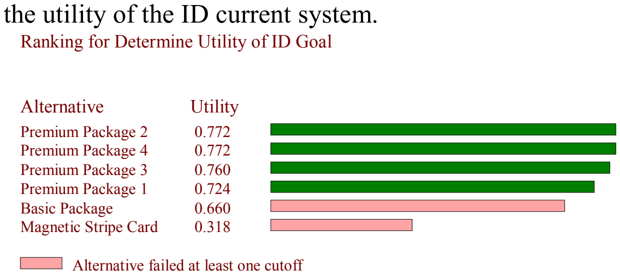


Figure 4 Utilities of complete package

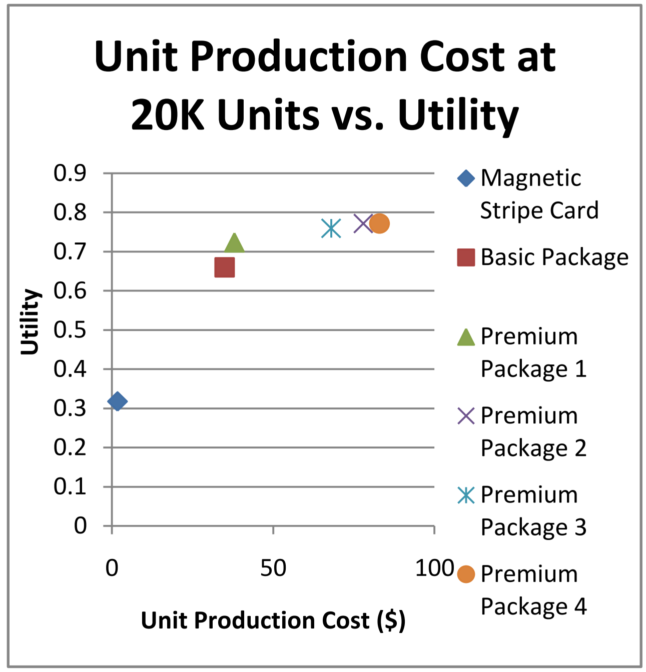


Figure 5 Production Cost vs. Utility at 20,000 units produced

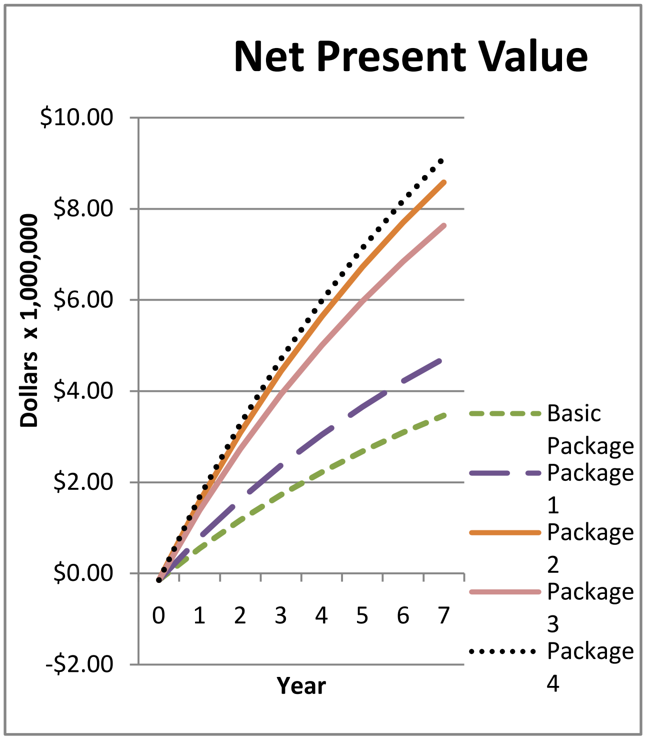
The package that comes closest to meeting GMU's price threshold is the Basic Package which has twice the utility of the current ID system, but costs almost 50 times to produce. Sivix provided Suggest Wholesale Price (SWP) rates. The multipliers are:
-SWP= 2*production cost.

C. Net present value Analysis

To determine the net value from the production and sales of the device that Sivix would produce if found financially feasible we used the following formula:

$$NPV = \frac{Net\ Profit}{(1+k+i)^n}$$
$$n = number\ of\ year$$
$$k = inflation\ rate$$
$$i = interest\ rate$$

The NPV was calculated over the course of seven years to determine the value of future sales and also to determine when the company would start to make a profit based on the sale price. If the device is sold at the wholesale price Sivix will be able to make a net profit of approximately $9,000,000.00 by the end of the seventh year.



IV. Conclusion

With the products that have been complied, the current system seems to be the best solution due to pricing but should be reviewed again sometime in the near future. The individual unit production cost per unit exceeds the price threshold suggested by the George Mason ID department. Even though the utility exceeds that of the current ID system, the benefit is not completely delivered by the product to have GMU invest in it. The reason for high cost on all of the products is because the components in most of the packages haven't reached a proper level on the learning curve which would allow the component to be acquired at a low cost.

In addition, the benefits of this device are outweighed by the cost for the acquisition and implementation of the system. Therefore this presents another reason why the RAID system is not feasible for university use.

V. Recommendations

Based on our conclusions, we recommend that the product be purchased at a lower rate but include a service charge in order to gain some profits after the acquisition price. The services could then be contracted to Sivix to maintain and monitor to ensure uptime for the system. This will also help to reduce the initial excessive price tag that may push possible customers away. This of course would only be true where the market exists.

Another recommendation that our group could make is to wait a few more years when the use of better and cheaper components will become available. This will allow better functionality for possibly a lower production cost.

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