

How Can Small and Medium Enterprises Maintain a Balance of Research and Development?

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Abstract The objective of this project is to gain a better understanding of how small and medium sized enterprises (SMEs) balance research and development (R&D) activities. We explore modern R&D tools and methodologies through literature research. These tools and methodologies are then aligned with “External Variables and Internal Conditions” as identified by Keizer et al. and a framework is created [1]. This framework is applied to a case study. The case study examines HECO, the Hawaiian Electric company, representing a small enterprise. The results of this analysis show that the proposed framework for understanding SME R&D programs is viable.

1 Introduction

Small and Medium Enterprises (SMEs) have played and continue to play significant roles in the growth, development and industrialization of many economies around the world. SMEs have been driving the U.S. economy in the last few decades, by providing jobs for over half of the nation’s private workforce. One article notes the following:

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Office of Advocacy funded data and research shows that small businesses represent 99.7 % of all firms, they create more than half of the private non-farm gross domestic product, and they create 60–80 % of the net new jobs [2].

Not only did industry funding for R&D grow rapidly in recent decades, but so did the numbers of R&D alliances, mergers and acquisitions, and patent licenses. Moreover, the share of R&D conducted by SMEs and business funding for university research increased significantly [3].

This suggests that SMEs have adopted “new models” of knowledge creation, management, and sharing that supplement more strategically oriented internal R&D activities with greater use of externally acquired technology.

We have to align these new models and tools with variables that can be considered as “possible predictors of innovation efforts” as defined by Keizer et al. [1]. Keizer’s paper conducted in depth research of the different variables impacting R&D in SME’s. They concluded that the variables could be classified as *external variables* and *internal conditions*. External variables refer to opportunities SME can take advantage of in regards to its environment, while internal conditions refers to the characteristics and policies of SMEs [1].

1.1 Objective of the Study

This report intends to explore the models and key business survival strategies, which have worked for SMEs. These strategies are listed below.

- Partnerships with Universities and other companies [4].
- Global teams [5].
- Open innovation [6].
- Licensing, Patents and trade secrets [4].
- Speed to Market [4].
- Corporate Entrepreneurship [7].
- Collaboration tools [5].
- Improved designs and processes [8].
- Platform based development [9].

By applying these variables and tools to the case study, we hope this report will lead to a better understanding of the way in which SMEs conduct research and development activities.

1.2 Challenges and Opportunities

The problems and challenges that SMEs contend with are enormous. For example, they have to deal with limited resources, inability to spread risk over a portfolio of new products, too many partners, problems in funding longer-term R&D, and

marketing issues [10]. Moreover, the unfair competition and government policy inconsistencies and bureaucracy increases these challenges and make it difficult for SMEs to innovate [11].

However, it is important to note that many SMEs are able to overcome these challenges. This should provide a basis for optimism that there is an opportunity and a way out.

Due to their relatively small/young environment, they enjoy a number of behavioral advantages over their larger counterparts. They have an interactive management style which makes internal communication more efficient so they can respond rapidly to external threats and opportunities. SMEs can make decisions and implement them faster. They can react more quickly to input from customers or challenges from competitors, and evolve their business models more rapidly [10].

Their smaller size makes smaller markets attractive to SMEs. This advantage allows SMEs to exploit new trends sooner when entry costs are still quite low. Moreover their focus lets them execute very effectively against larger, diversified firms. It was also found that SMEs attract more entrepreneurial R&D employees. All of these advantages lead to their strong licensing ability [12].

2 Background

A lot of research has been conducted recently to find out which factors contribute to innovation efforts by SMEs. These studies revealed that activities directed to innovation correlate with a number of variables. These variables were classified by Keizer et al. as **External Variables and Internal Conditions**. External variables refer to opportunities SMEs can seize from the environment. Internal variables refer to characteristics and policies of an SME [1].

2.1 *External Variables*

2.1.1 Collaborations with Other Firms

SMEs can be integrated into the supply chains of large companies, using a technical- and business-skills mentoring approaches such as: partnerships with other firms, open innovation, and licensing.

2.1.2 Linkages with Knowledge Centers

This tool helps make SME's more competitive through consultation with universities, researchers, and technology centers.

2.1.3 Utilizing Financial Resources or Support Regulations

There are number of financial programs for SMEs, some of them are governmental funds, and some provide a number of different resources and opportunities for finding SMEs funding.

2.2 Internal Conditions

2.2.1 Strategy

There are different R&D strategies for SMEs, which allow them to compete with larger firms, like speed to market. SMEs take decisions faster and implement them more rapidly. They can react more quickly to input from customers or challenges from competitors, and evolve their business models more rapidly [12].

2.2.2 Structure

Efficient internal communication and interactive management style often represent the structure of SMEs. Their smaller size allows them to attract smaller markets. Their focus and business specialization lets them execute very effectively against larger, diversified firms [12].

2.2.3 Technology Policy

Through patents, Intellectual Properties, and Licensing, SMEs can be integrated into the supply chains of the large companies. Moreover, these policies are considered survival methodologies that allow SMEs to become a key player in the market.

2.2.4 Level of Education

Presence of qualified engineers and the number of PhDs and Masters researchers plays a key role in the development of the SMEs and the effectiveness of their research. Also, the degree of education of the founder/manager is an important factor in the progress and sustainability of the company [1].

2.2.5 Investments in R&D

Investment Policy is critical for SMEs. Unlike large firms, R&D investment is considered risky and controlled by many factors, such as: company's age and size, available funds, priority of the project, and relativity of the project to their main goal.

2.2.6 Geographical Location

This variable refers to the influence of location (Rural or urban location) on their collaboration with other firms, universities, and research labs, etc. Of course this depends on the enterprise's industry. The company should also explore the potential advantages and disadvantages of "Virtual and Global teams" for maximizing the impact of R&D investment.

We can take these external variables and internal conditions use them as a framework to help analyze our case study. For the case study we will look for evidence of this framework and identify how the SMEs are impacted.

3 Case Study

The goal of the following case study is to show how small and medium sized companies handle research, development and deployment of new and innovative products or concepts.

3.1 Case: *Hawaiian Electric Company*

3.1.1 Introduction

For the small company case study, the selected organization is actually a subset within a much larger company. Due to the nature of their work and the structure of the industry, this group functions very similarly to a small company and therefore met the criteria of the case study. The selected small company is the Renewable Energy Division that is part of one of the main Hawaiian utilities, Hawaiian Electric Company (HECO). Although the parent utility is a large organization, utilities have historically not functioned as R&D institutions. Therefore even though the renewable energy division is technically part of HECO, in many ways it runs like a small, semi-independent group. This includes the ways that they find sources of funding, develop industry and academia collaborations, and their portfolio development strategies. The interface with the larger utility mostly occurs once the technology or concept is ready for deployment. As such, the renewable energy division fills an RD&D role for the utility- research, development and deployment.

The source of information for the HECO Renewable Energy Case Study was interviews with the Director of the Renewable Energy Division. Research for the case study was conducted through a written questionnaire and phone interview. The study focused on the group's strategies for funding, developing collaborative relationships with external organizations and portfolio development. Many of the challenges, as well as the opportunities, found in the literature research are demonstrated in this case study.

3.1.2 Background

The utility industry does not historically have a reputation for being leaders in research and development activities. Due to strict regulations around system reliability, utilities are cautious to take on risk and make changes to the system. But as both the government and the public begin to demand more focus on fossil fuel alternatives and energy efficiency, the utilities are entering into a world that they have historically not participated in—research, development and deployment. HECO has been an active and leading player in the push towards upgrading and innovating both generation sources and distribution methods of the Hawaiian electric grid. The HECO Renewable Energy Division (referred to from here forward simply as “HECO”) provides an informative example of how utilities can begin to successfully enter and participate in R&D activities.

3.1.3 Collaboration with Other Firms, Universities and Knowledge Centers

Successful collaborations have been one of the biggest factors in HECO’s success. There are two benefits to the collaboration of R&D for utilities. The first is the more obvious one, which is the sharing of resources and ideas that can lead to stronger innovative efforts than either side could produce alone. This is especially key in the area of energy because the end users, the utilities, often are not doing their own development. This can result in both a stagnation of progress, as well as a disconnect between the developer and the user. But a collaboration between the utility, industry and academia helps tie the research abilities of academia with the development resources of industry with the deployment potential and end user needs of the utility. The added advantage of partnering with academia is that research for real world applications helps develop and train a future workforce already knowledgeable on the issues of the industry.

The other benefit of collaboration relates back to the structure of the funding resources. Most of HECO’s funding come from external sources that require strategic and creative approaches which necessitate partnerships with academia, research facilities and industry. Collaboration is often the key to winning grants and is often one of the intended outcomes of such programs. While researching the effect of government funded programs in Hungary, Inzelt comments “Throughout the world, policy programmes tend to call for collaboration and integration, and R&D and innovation policy programmes are important coordinating forces in the field of funded research and of supported innovation activities” [13]. Although government funded grants are sometimes intended to encourage these collaboration, the system is often so complicated that only experienced teams can successfully find partners, apply for, win the grants and then properly spend the money in qualified projects. HECO’s success in understanding this system and the type of relationships that are needed has been crucial in helping them become a successful and innovative player in the renewable energy field.

3.1.4 Utilizing Financial Resources or Support Regulations

As mentioned in the previous section, funding is a big issue for HECO. Since utilities historically haven't functioned as R&D organizations, they are not set up to support large research and development programs. This means that a R&D group like the Renewable Energy Group is often responsible for securing their own funding resources. But this is not a unique problem and finding funding is an issue most SMEs groups grapple with. The quest for funding can often be difficult and introduces additional risk to the program. The ability to successfully navigate the funding avenues can be the determining factor between small companies that have successful R&D programs and ones that do not.

In the case of HECO, much of their funding comes from grants but this does not come without its own set of challenges. The literature found that two of the challenges SMEs face are "problems in funding longer-term R&D" and "government policy inconsistencies and bureaucracy" [10, 11]. Both of these issues are clearly demonstrated in US federal grant programs for energy research, which often are short term. This makes it very difficult for groups to plan far in advance. This is a problem for most small R&D programs, but it is especially challenging for groups in the utility industry, which has historically been slow to change and requires significant testing before any modifications to the system can be made.

In addition to the constraints of the funding timelines, there seems to be some other disconnects between the funding sources and the funded programs. While researching factors impacting innovative research, Keizer et al. found a study concluding "only a very small number of SMEs seeking financial resources failed to succeed" [1]. This is perhaps a misleading statement because it does not necessarily account for all the small R&D groups that would like to apply for funding but have not successfully figured out a way to even enter the system. HECO has observed two main disconnects between the funding sources and the hopeful funding recipients. The first disconnect is in academia. The educational research groups are often able to get the funds, but they don't necessarily know the needs of the industry well enough to successfully use them. The second disconnect is industry, which knows what the research needs are but doesn't understand how to get the money or how to work within the stipulations of the grant. A successful R&D groups needs to understand three key areas- how to find the funds, how to apply for the funds and how to use the funds. This need for collaborative efforts and a broad range of skills sets is one of the reasons the previously discussed partnerships and collaborative efforts are so key in developing a successful program.

3.1.5 Strategy

HECO's strategy for project selection is a strong example of the impact of external variables. The main variables that effect HECO's program portfolio are need, funding, regulatory factors and public policy. Industry culture is another factor

since utilities are often risk adverse and more reactionary than proactive when it comes to change. The issue of public policy is a complicated one because it is influenced by its own set of external factors and is constantly changing. But when partnered with an accepted roadmap and aligned with the larger goals of the organization, it is possible to successfully move forward with project development and deployment.

The HECO Renewable Division has a roadmap that helps them determine which projects to focus on. In general their goal is “to sustainably and reliably bring on more renewable to the islands and advance the state of the industry” Their platforms look at new technology, improvement of the efficiency of existing technology and data collection to better model and develop the overall system.

3.1.6 Level of Education

In the case of HECO, the internal variable defined in the literature as “Level of Education” can perhaps be more broadly defined as caliber of employee. A well known factor in successful project management is that great programs attract great employees. Since the energy industry has not historically participated in much innovation, the push for exploration of new ways to produce, distribute and use energy has created an exciting environment that is helping attract talented people to the field. Since HECO has become one the leaders for renewable energy research among the US utilities, it has helped them to attract capable and motivated employees who are both excited and challenged by the innovative projects they are working on. Director Dora Nakafuji commented, “This is an exciting time to be working in the energy industry”.

3.1.7 Challenges

Most of the SME challenges that HECO faces tie back to funding in some way. From the list provided in [Sect. 1.3](#) of this paper, the SME challenges that apply to HECO are Limited Resources, Problems in Funding Longer-Term R&D and finally, Government Policy Inconsistencies and Bureaucracy. Although the government grant programs help initiate the formation of partnerships, the short life cycle of the grants are ironically counter-productive both in the collaborative relationships and the level of R&D that can be supported. A solid partnership can take 10, or even 20 years, to solidify but the funding programs are often five years or less. Therefore the issue of limited resources and government inconsistencies end up causing problems with funding longer term R&D programs.

Despite these challenges, HECO has been unusually successful in finding ways around them and could serve as a valuable learning tool for other US utilities hoping to advance their involvement with renewable energy and energy efficiency R&D programs.

3.1.8 Opportunities

Although being an SME has its challenges, there are also advantages to being a small organization and, when used properly, can provide unique opportunities. Of the advantages listed in Sect. 1.3, the three that are well demonstrated in the HECO case study are Rapid Response, Focus and Speed.

Focus is perhaps as much a product of the industry, as HECO's size. Their focus is on renewable energy technologies, improved resource forecasting and integration, improved distribution and allocation and smarter systems on all levels. This is obviously an extensive list and not necessarily a narrow focus, but since the regulatory forces on utilities have specific requirements around when and how changes can be implemented, HECO has at least some direction on where to focus their efforts. They work off of a living roadmap that focuses on five platforms of need.

One of HECO's biggest advantages is their size. In this case, although the parent utility is large compared to the Renewable Energy Division, it is in fact still considered a smaller utility. This has allowed them to be more nimble and adopt changes more easily than some of their larger sister utilities in other states. The flip side is that their victories don't always have as much widespread impact on the industry. In the future, HECO would like to continue using their small size as a chance to be a test bed for new solutions but also become an example of programs that can then be rolled out to larger utilities around the country.

3.1.9 Conclusions

HECO proved to be an interesting case study but not only because of their status as a small R&D organization. Their understanding of the R&D funding labyrinth in the renewable energy industry, as well as development and deployment in the utility industry, provided valuable insight into the weakness of the current system and ways that support of R&D programs could be improved in the future. The end conclusion was that the money is there, the needs are there and the brainpower is there for renewable energy research, development and deployment programs. But the hurdle that is left is figuring out a way to better connect the three so that these programs can really start to flourish.

4 Conclusion

The results of our research show that there are many variables involved in the development and long term survival of a successful SME R&D program. The variables, challenges and opportunities identified in the literature were easily correlated to the real world example, indicating that our proposed framework for analyzing SME R&D efforts is viable. Although both of the case study dealt with

companies that have been successful in managing R&D efforts, the ongoing struggles they face highlight the challenges than accompany the opportunities of managing a small or medium sized R&D program. But if done properly, it can produce a rewarding, exciting and successful program.

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