Title: A Critical Review of " The R&D Cycle: The influence of product and process R&D on Short-Term ROI"-4

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Abstract: A paper titled "The R&D Cycle: The influence of product and process R&D on Short-Term ROI" is critically reviewed in this individual report.

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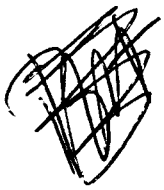

THE CRITICS ON R-7

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THE R&D CYCLE: THE INFLUENCE OF PRODUCT AND PROCESS R&D ON SHORT-TERM ROI

Jehiel Zif and Daniel McCarthy

CONCEPTS STUDIED FROM THE PAPER

In this paper, Zif and McCarthy (1) examine the relationship between R&D components: product and process and the profitability of the business in term of ROI. The relationship of total R&D (product/process) and short-term ROI also plays an important role in comparing profitability of business. The cyclical patterns of R&D product and process and investment are also examined in this paper to see this relationship.

The analysis of R&D is based on the phenomenon of the S-Curve of technology. Three stages are examined thoroughly. Stage I is called Efficiency Focus where R&D is aiming for increasing efficiency, quality and supply capability for a business. Stage II is called Innovation Focus in which businesses at this stage are more committed to compete through the innovation of the product. Lastly, Stage III, Extensive R&D Commitment, is when the businesses are more concentrated in process R&D so that they will be able to supply products at a competitive price.

The paper demonstrates that there is a relationship between product R&D and ROI. It also shows the positive impacts in each stage of R&D analysis. Improvements in one of the R&D components can be made in each stage in order to improve profitability in a business. For example, by improving process R&D in companies with extensive R&D in stage III and product R&D of companies in middle stages, profitability in ROI can be maximized.

METHODOLOGY

The authors (1) initially make the hypotheses about product and process R&D in business applications. The first hypothesis states that the different portions of product and process R&D will change as the percentage level of Total R&D/Rev increases. Second hypothesis states that different component in each stage will effect efficiency and profitability of a short-term ROI. To prove the validity of their hypotheses, they use literature from the past and graphs of cyclical relationship between ROI and R&D. The data are collected from the PIMS database of the Strategic Planning Institute. There is a total of 2018 strategic business units from PIMS examined in this paper.

To analyze the level of R&D intensity, 2018 industrial SBU's in the PIMS database are divided into ten groups of approximately equal size with increasing levels of total R&D/ Rev. Two methods are used to analyze the relationship. The first analysis is presented in the graph, emphasizing cyclical patterns. Second, to test the stability of the results, non parametric tests (chi- square) are performed. Based on the data, the cutoff points are selected to divide each stage of R&D intensity. Since there is no attempt to define the exact cutoff points, it is appropriate to derive these cutoff points from empirical data.

The results of this analysis is graphed according to the business types the 2018 companies are dealing with. The graphs, such as capital groups, components and raw or semi-finished materials, are plotted to see the similarity in product and process R&D cyclical graphs. They are used to prove that both hypotheses apply to many business types in general.

CONTRIBUTION OF THE PAPER TO THE LITERATURE

The first hypothesis is about the product and process R&D in an investment (R&D/Rev). As there is an increase in R&D investment, the portion of product R&D out of the total portion will increase and the portion of process R&D will decrease. This shows a company with extensive R&D/Rev will spend more in product than a company with the low level of total R&D/Rev.

The second hypothesis is about the relationship of R&D and short-term ROI. The application of this relationship can be useful to help a company make a decision in maximizing the efficiency of an investment. First, a company should determine which stage it is in by looking at its percentage level of R&D/ REV. Then, a decision can be made whether to invest more in product R&D or process R&D. The positive impact of the information in the table below is what a company should concentrate on in each stage.

The table summary:

Stage	R&D/REV	Name	Positive Impact
I	0.25-1 %	Efficiency Focus	Process R&D
II	1.0-3.0 %	Innovation Focus	Product R&D
II	>3.0 %	Extensive R&D	Process R&D

COMPARISON WITH OTHER RESEARCH PAPER IN THE FIELD.

a) What have the other researchers found that are related to this research?
Three other papers with similar topics are compared with this paper. First, Baker(2) discusses how automobile manufactures, GM and FORD, spend a portion of their revenue on R&D. Second, Wood (3) mentions that Eastman Chemical Co. has consolidated its R&D units into one operation to increase its coordination and quicken product development life cycle. The R&D investment is equal to 3% to 4 % of the company's total sales. Finally, O'Donnell (4) explores the R&D method used by Nabisco food company in its marketing and product R&D strategies by spending 5% of the total income on product R&D.

b) What are the findings of this paper that support, extend or refute the findings of other research?
These three research papers are discussing companies that spend more than 3% of the total revenue in product R&D. This is related to the first hypothesis in the paper, the

larger percentage of total revenue spent on R&D, larger portion of the revenue is used in product R&D than process R&D. All the companies discussed in these three research papers are concentrating on product R&D. I conclude that product R&D is more important than process R&D in companies that concentrate on developing their products.

However, Nabisco (4), when it was first developed, started to maximize the efficiency of process R&D. The company was in the first stage of short-term ROI period when it stated its first product. After its products were available in the market, this company moved into second stage in which product R&D is more essential. This is an example of the second hypothesis.

c) How does this paper differ from other researchers' work?
As far as the details are concerned, Zif and McCarthy(4) explain their paper clearly and completely, but study cases are not given in the paper. They explain their literature reviews, states hypotheses, describe the methods, explicate the results and then go into a conclusion. The other research papers first state their hypotheses and then support them by giving study cases of certain companies.

STRENGTHS AND WEAKNESSES OF THIS PAPER.

STRENGTHS. The authors support their hypotheses by summarizing the literature reviews. The literature research is very clear and compact. They explain the definitions of product and process R&D and how these R&D components play parts in every stage in short-term ROI.

Methods used in this research paper are considered practical. Data of many industrial businesses, including firms that produce raw materials, capital goods components and semifinished assemblies, are used to see the pattern of product and process R&D with total R&D/Rev. The chi-square used to see the relationship between the R&D and short-term ROI is also a very good method. Assumptions are also stated in this method. For example, the cutoff point in each stage is not going to be proven, it is stated that it is just derived from empirical data in the research.

The results are clearly illustrated in the graph. The graphs of many different businesses are also plotted to show the similarity in each hypothesis. This graph is self- explanatory and makes it easier to see the cyclical pattern when comparing with other types of businesses.

WEAKNESSES. The paper does not contain many examples and study cases. Study cases are helpful for readers to understand some complicated applications. The chi-square is a good method, but it is also very complicated. I think the procedure of how the methods are carried out is confusing. The definition of each category is not clearly understood. The numbers of the results are ambiguous. The initial numbers of product, process and revenue are not given in the tables. These are minor weaknesses in the paper. As far as graphs and concepts are concerned, they are very self- explanatory and easy to interpret.

CONCLUSION OF THE PAPER

The paper demonstrates a clear relationship between product and process R&D with short-term ROI. The discussion of each stage is also given in the conclusion. Each stage is related to the total R&D spending. In stage 1 and stage 3, process R&D has a positive correlation with short-term ROI and in stage 2, product R&D has a positive impact in short-term ROI. This means that in stage 2, product R&D is more effective to maximize profits and efficiency while in stage 1 and 3, process R&D can do the same thing.

The paper has a good conclusion and discussion. It discusses the results and explains the assumptions and limitations of the paper. Assumptions are made in this research due to the limitations of the components. For example, it is assumed that product and process are incompatible because when both of them are applied in one operating unit, effectiveness may not be realized in either. As a result, they become limited in scope. There is also limitation in breakdown of PIMS data. The breakdown into ten groups is approximate due to the unique data processing in PIMS system. Despite these limitations, the paper gives a clear examples of the relationship of product and process R&D and short-term ROI in engineering management areas.

ADEQUACY OF THE REFERENCES

The references are adequate for the paper. Zif and McCarthy have used many references in the literature reviews to support their definitions of the terms. The references give clear information about the meaning of R&D and short-term ROI and how they are going to be related.

If case studies are added in the paper to prove that this relationship can be applied in industrial business, paper (2) can be a good example. It explains what the product R&D is and gives methods that are implemented in a company to improve product R&D. Baker (2) mentions that GM spends more than 15% of their revenue in product R&D. The R&D division in GM, as an example, is trying to reduce fuel consumption and reduce hydrocarbon emissions by the order of magnitude during the 90's. Nabisco Food Company (4), is spending more than 4% of the total sale every year on product R&D and its mission is to meet changes in consumers trends: good , affordable and healthy food.

RESEARCHES FOR FURTHER STUDIES

I think one of the further studies required is to explore the dynamic nature of total R&D expenditures and the firm's ROI. Statistically significant relationship between these two areas need to be explored thoroughly in order to identify the profitability of a firm.

The competitive environment of business among high-tech industries is another variable that can be further analyzed. This area can affect behavior and performance of a company regarding the R&D budget.

A useful study can be made to see what happens to the ROI of firms as they change from one state to another. This study can include ideas about how they reach the transition and what they do before and after the transition. Another useful study is to examine the cutoff points in each stage. These points are not stable and could vary depending on the industrial, competitive and environmental conditions.

CONCLUSION

Overall, this paper explains new ideas in an easy-to-understand manner. It discusses the conclusion and explains the hypotheses in detail. The best improvement for this paper is to include some study cases that are easy to follow. Data used in this paper is very helpful, different varieties and sizes of companies are selected to prove that the hypotheses are relevant to various types of business. The authors also explain some limitations in the paper and explain some improvements that can be done for future research.

Lastly, I conclude that this paper explores important topics in engineering management and this paper can be used as a tool to make a decision in this area, especially when dealing with process and product R&D in short-term ROI.

Bibliography

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