24th DAAAM International Symposium on Intelligent Manufacturing and Automation, 2013

# Thinking Styles and Product Development Project Types: How to Match Them?

Anja Orcik*, Petar Vrgovic, Zeljko Tekic

*Faculty of Technical Sciences, University of Novi Sad, Trg Dositeja Obradovica 6, 21000 Novi Sad, Serbia*

**Abstract**

Focusing on the characteristics of different thinking styles and different product development project types, we suggest that people should adapt their thinking strategies according to the challenge they face and choose a thinking style that is a best match for the type of project they are working on. Even though people can perform well in more than one thinking style, they can be more successful if they adequately choose the most appropriate one for solving the problem in front of them. Considering that different thinking styles have different ideas and conclusions as results, we propose how to match them to a specific product development project type that has a certain degree of change in the product as a deliverable. For further research, these findings open the possibility to define the most appropriate creative problem solving methods and techniques that spur and support a specific style of thinking.

## 1. Introduction

Product development has been defined as one of the riskiest, yet most important endeavours of the modern corporation [1]. To respond to the changing environment and stay competitive in long-term, companies need to provide quality, variety, novelty and functionality of products for their customers [2]. This requires constant improvement of existing products, as well as faster development of new ones. Focusing on the degree of change in the product, and the degree of change in the manufacturing process, Wheelwright and Clark [3] have defined five types of product development projects – research and development, breakthrough, platform, derivative, and alliances

---

* Corresponding author.
   *E-mail address:* a.orcik@uns.ac.rs

and partnership projects. Since these project types have very different deliverables, as solutions for the existing problems, they ask for distinct approaches to problem solving. One of promising ways to deal with this requirement is to match specific problems to the most appropriate thinking style to get the most effective result. "Thinking styles", "thinking modes" or "thinking strategies" are thinking preferences deeply rooted in physiological and neurological base of every person. According to Herrmann [4], there are four thinking styles which are organized in the four-quadrant whole brain metaphorical model. Considering that these thinking styles have different ideas and conclusions as results, it can be beneficial if they can be matched to different product development project types. That is the aim of this paper.

In section 2 we review the research focused on thinking styles, and give the description of four different thinking styles defined by Herrmann. In section 3 we deal with product development projects, as well as their types described by Wheelwright and Clark. We give the answer on the research question – how to match thinking styles to product development projects in section 4. To additionally explain why a specific thinking style is a best match for the specific type of project, we provide the example of the development of smart phones. In the conclusion we explain the significance of findings for further research.

## 2. Thinking styles

A big number of researches from many fields, spanning from neurology to psychology, have tried to identify thinking styles with variable success and variable results, depending on their perspective and basic assumptions. And, while it is not proven that the different thinking styles are morphologically specific in terms of anatomical lateralization [5]–[7], there are some theories and research that identify different thinking styles in terms of their specific outcomes and their usage. What we do know is that people often deviate from the performance that we consider "normative" on many reasoning tasks. That means that people sometimes reason differently than what is considered to be objectively correct: they assess probabilities incorrectly, they display confirmation bias, they overprotect their own opinions on others, they allow prior knowledge to become implicated in deductive reasoning and more [8]. Furthermore, people tend to evaluate their thinking efforts in the light of the thinking outcomes: they evaluate their thinking as better, decision making as more competent when the outcome was favourable than when it was unfavourable [9]. What this shows is that people's thinking strategies are not always entirely based on rational judgements; they are sometimes influenced by subjective factors inside the individual. Since we are able to distinguish objective from subjective, there is basis to divide thinking process in, at least, two categories: the thinking that is mainly automatic, largely unconscious and relatively undemanding of computational capacity (colloquially named as "intuitive") and the thinking that is mainly based on controlled processing (colloquially named as "rational") [8]. This division of thinking processes was confirmed and/or criticized by various scientists in the last few decades. For example, Epstein et al. have identified *Need for Cognition* and *Faith in Intuition* as two orthogonal factors that can be used as thinking strategies [10]; interestingly they have found that both factors determined heuristic thinking, at least to some extent. On the other hand, others have questioned this belief, asking for more solid arguments for statements of different thinking systems [11].

The question „which thinking style to use?“ is often asked when somebody stands in front of a challenge, but there is also an option to view these styles of thinking as complementary [12], using them together to fully benefit one's mind. Also, there are experimental evidence that thinking styles differ from the concept of intelligence in its standard measurements [13], which indicates that thinking styles cannot be observed as uniform tools for problem solving; rather they should be observed as approaches from different perspectives. Nevertheless, there are research that show dependence between job decisions and dominant thinking style [14], differing various thinking types that are frequently grouped in the two already mentioned categories: rational and intuitive [15]. This division of brain functions on "rational" and "intuitive" has served as basis for various thinking typologies. For example, Ned Herrmann has developed his Brain Dominance Instrument based on his theory of four thinking styles, activated by different regions of the human brain [16], [17]. This instrument is based on belief that parts of the brain (left and right hemisphere, cerebral and limbic brain) form a grid whose quadrants work on independent principles, resulting in different ideas and conclusions. In this paper, we will use this four quadrant classification, which will be observed not as an anatomical theory, but as a descriptive one. This classification, firstly based on the lateralization duality [4], identifies four different thinking styles, which can be applicable in our research problem. Herrmann named these

thinking styles as A, B, C and D, briefly described in the following section; this typology has been successfully used in relation to different thinking outcomes, mostly in business [18], [19] and engineering educational research [20], [21].

### 2.1. Herrmann's Brain Dominance Instrument

The A quadrant thinking style shows preference for analyzing, dissecting, figuring out, getting facts and solving problems logically. In making decisions, this quadrant relies on logic based on assumptions, perception, verbalization and precision. Here is the cornerstone of logical thinking and reasoning, making conclusions for the future and creating grounded theories.

The B quadrant thinking style is also verbal and linear, but is not so concerned about present facts as it is about past experiences and order. It rarely changes attitudes, trying to be conservative and trying to maintain status quo, being predictable and safe. This quadrant is best for getting things done when all the procedures and rules are known; it organizes and structures to make perfect sense of everything it sees.

The C quadrant thinking style can be looked at as the most sensitive and receptive one. Its perception of the outside world is based on emotions and feelings, and so are its thinking outcomes. The C quadrant perceives reality through subjective experience, achieving intuitive understanding for the outside world. It tries to reconcile and harmonize, by employing emotional involvement.

The D quadrant thinking style is highly imaginative and creative one, bearing no mind for facts and rules. Its designs are based on subjective perceptions which are frequently impersonal and without connections to others. The D quadrant often takes initiative in exploring hidden possibilities, synthesizing content in order to construct new concepts. However, its lack of boundaries makes it almost impossible for this quadrant to finalize projects and to meet any given deadlines. Also, its groundbreaking ideas are often not understood by the other quadrants and are sometimes difficult to put in practice directly.

## 3. Product Development Projects

For a company, growth opportunities exist through offering new or improved products to customers. Product development must be carefully managed to control time, resources and quality [22] and supported by project management techniques and tools.
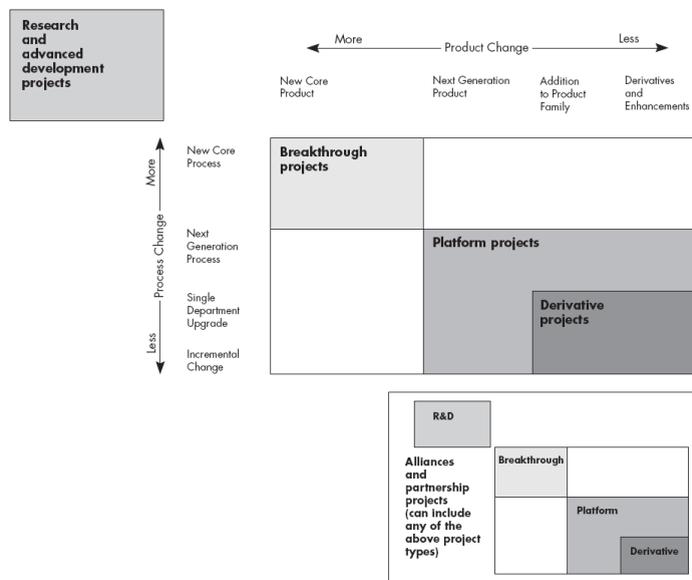


Fig. 1. Product development project types [3].

In order to provide useful information about the required mix of projects in product development, Wheelwright and Clark defined five different types of projects in the company's project portfolio, focusing on the degree of change in the product, and the degree of change in the manufacturing process (Fig. 2) [3]. These five types of development projects are the following: (1) research and development, (2) breakthrough, (3) platform, (4) derivative, and (5) alliances and partnerships. Each project type has a different role, requires different levels and mixes of resources, and generates very different results. However, all project types are vital for the competitive advantage of a company.

### 3.1. Product development project types

*Research and development (R&D) projects* lie outside the boundaries of the main body of the map. They represent a precursor to product/service development projects, and have no relationship to the product change or process change of the main set of projects.

Product/service development projects are shown within the main body of the map. The majority of product/service development projects are initiated for commercial (external) or improvement (internal) deployment [23]. These projects are typically addressed by the breakthrough, platform and derivative project types that are defined by the amount of product and process change required to create the project deliverables. *Breakthrough projects* are at the high end of the development spectrum because they establish breakthrough or core products (e.g. the first cell phones, microwaves, television, digital photography, etc.) that differ fundamentally from previous generations. *Platform projects* refine and commercialize breakthrough products for mass market consumption. Platform projects refer to improvements in cost, quality, and performance across a range of dimensions. They provide a continuous transition between product generations, by offering moderately innovative products – platform products (e.g. new car models, next generation microprocessors, etc.). *Derivative projects* involve minor modifications or incremental product/process changes to existing platform products (e.g. hard drive size update, special edition car paint, whitening toothpaste, higher resolution camera, etc.). Derivative projects are usually short-term projects with low levels of resource commitment and risk [24]. Derivative products, as derivative project deliverables, are often used to extend a product's life to its end.

*Alliances and partnership projects* lie outside the boundaries of the main body of the map. They are undertaken as an agreement between two or more partners to share knowledge, resources and/or the risks [25], which could be beneficial to all parties involved (e.g. partnership between Nokia and Microsoft, Coca-Cola and McDonald's, consortium of companies that developed HDTV, etc.). While these projects can be formed to pursue any type of project - R&D, breakthrough, platform, or derivative, the amount and type of development resources and management attention can vary widely. Alliances and partnerships projects can be treated as different project types by the partnering companies, e.g. one partner can consider a project as a breakthrough while the other partner considers it as an R&D, platform or even a derivative project [3].

## 4. Matching thinking styles with product development project types

In this section we will match each of the four thinking styles described by Herrmann with different product development project types defined by Wheelwright and Clark. Thinking quadrants A, B, C and D will be connected to R&D, breakthrough, platform and derivative projects (Fig. 2). The fifth project type, alliances and partnership projects, will be left out, since they can be undertaken in order to pursue any of previously mentioned project types. To additionally explain why people should choose a specific thinking style as a best match for the type of project they are working on, we will offer the overview of smart phone development, from its roots to the variety of models.
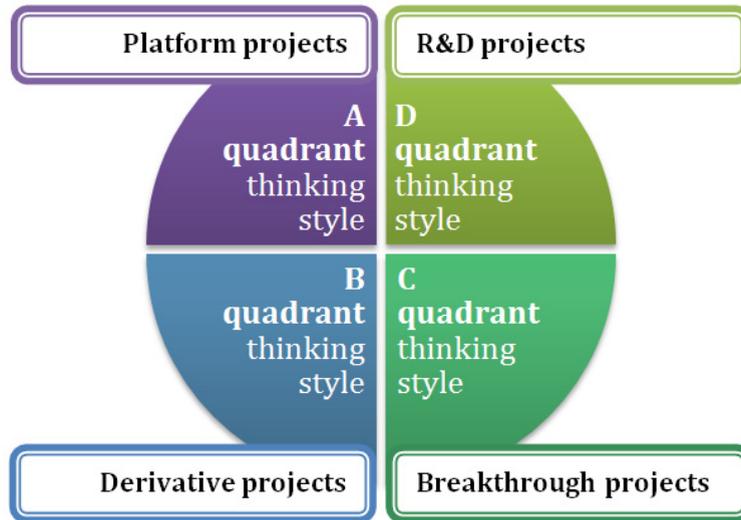
Fig. 2. Matching thinking styles with product development project types.

### 4.1. R&D projects and D quadrant thinking style

*R&D projects* are undertaken in order to create the know-how and know-why of new materials and technologies that eventually translate into commercial development [3]. These projects are focused on inventions and have concept of a new product as a result. They tend to establish new core products and new core processes that differ fundamentally from previous generations.

To develop a product that is new to the world, thinking should be based on vision and creativity of individuals, as well as on fundamental knowledge, detected flaws of existing products or growing customer requirements. Since this type of projects asks for exploring hidden possibilities and exceptional discovery, the *D quadrant thinking style* fits best in this case. The D quadrant is described as one that explores new and previously unknown, by taking initiative and relying on intuition. Since R&D projects cannot be based on previous experience, they ask for construction of new concepts and synthesis of different concepts, which is how the D quadrant works.

We will show the importance of D quadrant thinking style domination in R&D product development projects on the example of the development of smart phones. It started in 1970s when speech transfer dominates over the data transfer in mobile communication. Through R&D projects researchers conducted experiments based on already known concepts, connecting functions of a computer, with the focus on the Internet, and functions of a mobile phone. Envisioning the future and focusing on discovery, these researchers used creative, innovative, visionary and holistic thinking to synthesize and integrate these concepts, and invent new solutions. They saw all uncertainties and potential problems as possibilities. These researchers challenged the status quo, broke existing rules, caused change and took risks to develop the first concept of a smart phone with the integration of speech and data transfer. It was represented in 1992 and in addition to the functions of a mobile phone, it had a calendar, address book, calculator, email program, games, etc. [26].

### 4.2. Breakthrough projects and C quadrant thinking style

*Breakthrough projects* are focused on developing a solution that is better than the introduced one that overcomes its key problems and opens new opportunities. The invention that is created in R&D projects is passed to the development for implementation and conversion into breakthrough products. These products are introduced to the market, in order to test their value and acceptance by customers. To cope effectively with the uncertainty,

breakthrough projects call for intensive new knowledge exploration [24]. This requires looking for new possibilities, building up technology assets and bridging market demands in the long run.

This type of projects asks for application of an abstract concept into real-life environment. In order to achieve that, one must integrate and harmonize, which are features of the *C quadrant thinking* in Herrmann's typology. This quadrant performs by responding to changes while trying to soothe and resolve issues in conciliatory way. Internal experience is used to interpret external changes, which asks for good interpretation skills, needed to apply R&D ideas through breakthrough projects. The C quadrant perceives experience as reality, being interested in how ideas work in real-life conditions, while caring empathetically for the project outcomes.

In the example of smart phones development, the C quadrant thinking was important in breakthrough projects to develop and diffuse the idea of smart phones, communicate it to the market and build relationships with potential customers. The first smart phone was further developed and new improved concepts appeared in late 1990s. The first ones integrated functions of a mobile phone and a PDA (Personal Digital Assistant) device appear, e.g. Nokia 9000 Communicator (1996) and Ericsson R380 (2000). To develop a successful breakthrough product, it is necessary to be customer-oriented, to understand their feelings, and to be able to inspire them. Intuitive sensing of what people need and caring about customer values are crucial characteristics of the C quadrant thinking in breakthrough product development projects. Even though Nokia and Ericsson as mobile phone producers had the first smart phones with advanced functions on the market, competitors from other industries have optimized them for email usage. The additional value for customers was the QWERTY keyboard, computer keyboard adapted for smart phones, e.g. BlackBerry RIM 850 (1999) and PalmTreo (2003).

### 4.3. Platform projects and A quadrant thinking style

*Platform projects* are focused on integration and recombination of existing products that are developed inside one industry or value chain. Companies try to satisfy increasingly sophisticated customers' needs and rapidly improve their existing products, by decreasing costs, increasing quality and/or improving product performance [3]. Through platform projects existing products are reconfigured, changed and commercialized for mass market consumption. These projects call for significant information processing and moderate knowledge exploration [24].

The *A quadrant thinking style* is the most appropriate one for this type of projects. This quadrant is mostly considering facts, applying analysis and logic, so it forms its theories according to what is already present. This thinking style is concerned about efficacy, always trying to achieve the most with resources available. It is a master of logic and reason, always processing new information to form sense of reality. A quadrant's output is in the form of principles, formulas and conclusions about where to go next, which is a good basis for technical problem-solving.

All these characteristics of the A quadrant thinking style necessary for platform product development projects we can show on the example of smart phones. With the development of powerful miniaturized processors, that process large amount of data in short time, breakthrough smart phones were completely adapted to continuous use of the Internet in full capacity. Critically analysing and carefully evaluating the existing models of smart phones, Apple developed the first iPhone in 2007. The product development team of this project was focused on outcomes, facts and how to make things work more efficiently, using logical, realistic and present-oriented thinking. The goal was not to create a product that is radically different, but to create a product with improved quality, better performances, as well as commercially and socially acceptable. As a smart phone that is user-friendly, with the first advanced multi-touch screen and virtual keyboard, it becomes a platform for the future models produced by Apple or copied by other companies.

### 4.4. Derivative projects and B quadrant thinking style

Through *derivative projects* companies can drive differentiation and growth of the product, by adding minor features and functionality to create greater variation and options [27]. Companies optimize their products and incrementally improve them to fit customers' needs and requirements. They exploit knowledge that already exists and do not introduce major modifications to their products. This optimizing process brings improvements, efficiency and excellence [26]. Derivative projects require only the extension of prior knowledge [28].

These projects are best supported with *B quadrant thinking style*, which is concentrated of routines, safekeeping and maintaining the status quo. While this quadrant resembles A quadrant being linear and verbal, it is different since it rejects ambiguity to a greater extent than A. The B quadrant does not create new formulas and hypotheses, it is only concerned about what has worked before and what will work again, based on previous knowledge. The B thinking mode tests A mode's ideas to the tiniest details, worrying about how they fit in what is known so far.

In the development of smart phones through derivative projects, team members have to pay attention on product details. To successfully manage these product development projects it is necessary to rely on the B quadrant thinking style, that is sequential, organized and action-oriented. Following iPhone design, new models of smart phones appear with predefined applications and functions (camera, MP3 player, etc.). The thinking focused on the improvements of these models is within the set boundaries, resists the change, keeping it save and predictable. There are so many smart phone models and their variants nowadays on the market, that fulfil the wishes, needs and requirements of customers. They maintain conventions and have only slight changes in design and technically conservative improvements. They maintain the functional status quo in comparison to the original models, e.g. LG Optimus L5 II Dual with floral design, HTC One mini designed by a fashion designer David Koma, etc.

## 5. Conclusion

Starting from different problems that project team members face in different product development projects, we have tried to suggest how to support and improve problem solving in different project types. Our solution is to favour certain thinking styles in delivering distinct product development project results. This does not mean that other thinking styles are not necessary or required in all project types, but it is beneficial to spur a specific thinking style and support its domination among the other ones in order to solve specific problems. In this paper we merged two well known frameworks: Wheelwright and Clark's types of product development projects and Ned Herrmann's thinking styles. Based on this it was possible to match different thinking styles to a specific product development project type and recognize that R&D projects would benefit from dominant D quadrant thinking style, breakthrough projects from dominant C quadrant thinking style, platform projects from dominant A quadrant thinking style, and derivative project from dominant B quadrant thinking style.

The established relations offer the ground for selecting and defining creative problem solving methods and techniques that can be used in specific product development project type and therefore for improving team problem solving tasks and overall efficiency. Based on results, creative problem solving methods and techniques can be matched to a specific project type depending on the expected result – whether it is just a slight or a significant change on the product, or whether it is an improved product platform or a product that is completely new to the world. Furthermore, the results can help in selecting external contributors, especially customers, based on their thinking style, in order to take the highest benefit from their involvement in product development projects.

## References

[1] R. G. Cooper, *Winning at New Products*, 3rd Editio. New York: Addison Wesley, 2001.
[2] J. R. Turner, *The Handbook of Project-based Management: Leading Strategic Change in Organizations*. Mcgraw-hill, 2008.
[3] S. C. Wheelwright and K. B. Clark, "Creating project plans to focus product development.," *Harv. Bus. Rev.*, vol. 70, no. 2, pp. 70–82, 1992.
[4] N. Herrmann, "The Creative Brain," *Train. Dev. J.*, vol. 35, no. 10, p. 11, Oct. 1981.
[5] J. B. Gasen and J. F. Morecroft, "Hemispheric Lateralization and Programming Ability," *J. Educ. Comput. Res.*, vol. 6, no. 1, pp. 17–27, 1990
[6] T. Hines, "Left Brain/Right Brain Mythology and Implications for Management and Training," *Acad. Manag. Rev.*, vol. 12, no. 4, pp. 600–606, Oct. 1987.
[7] V. Leung, "The Whole Brain Scientist," *Sci. Creat. Q.*, no. 8, 2013.
[8] K. E. Stanovich and R. F. West, "Individual differences in reasoning: Implications for the rationality debate?," *Behav. Brain Sci.*, vol. 23, no. 05, pp. 645–665, 2000.
[9] J. Baron and J. C. Hershey, "Outcome bias in decision evaluation," *J. Pers. Soc. Psychol.*, vol. 54, pp. 569–579, 1988.
[10] S. Epstein, R. Pacini, V. Denes-Raj, and H. Heier, "Individual differences in intuitive–experiential and analytical–rational thinking styles.," *Journal of Personality and Social Psychology*, vol. 71, no. 2. American Psychological Association, US, pp. 390–405, 1996.
[11] S. E. Newstead, "Are there two different types of thinking?," *Behav. Brain Sci.*, vol. 23, no. 05, pp. 690–691, 2000.
[12] D. Frisch, "The tao of thinking," *Behav. Brain Sci.*, vol. 23, no. 05, pp. 672–673, 2000.
[13] S. J. Handley, S. E. Newstead, and H. Wright, "Rational and experiential thinking: A study of the REI," in in *International perspectives on individual differences: Vol. 1. Cognitive styles*, R. J. Riding and S. G. Rayner, Eds. 2000, pp. 97–113.

[14] I. H. Amzat, "Brain hemisphere characteristics of some Malaysian university managers in relation to their decision styles: A measurement model," *Procedia - Soc. Behav. Sci.*, vol. 15, no. 0, pp. 3971–3979, 2011.

[15] C. Akinci and E. Sadler-Smith, "Intuition in Management Research: A Historical Review," *Int. J. Manag. Rev.*, vol. 14, no. 1, pp. 104–122, Mar. 2012.

[16] N. Herrmann, *Applied Creative Thinking*. Charlotte, NC: Herrmann International, 1986.

[17] N. Herrmann, "The Creative Brain*," *J. Creat. Behav.*, vol. 25, no. 4, pp. 275–295, 1991.

[18] J. E. Amadi-Echendu, "Thinking styles of technical knowledge workers in the systems of innovation paradigm," *Technol. Forecast. Soc. Change*, vol. 74, no. 8, pp. 1204–1214, Oct. 2007.

[19] J. C. Huefner, H. K. Hunt, and P. B. Robinson, "A comparison of four scales predicting entrepreneurship," *Acad. Entrep. J.*, vol. 1, no. 2, pp. 56–80, 1996.

[20] M. Lumsdaine and E. Lumsdaine, "Thinking Preferences of Engineering Students: Implications for Curriculum Restructuring," *J. Eng. Educ.*, vol. 84, no. 2, pp. 193–204, Apr. 1995.

[21] H. Kashefi, Z. Ismail, and Y. M. Yusof, "Supporting Engineering Students' Thinking and Creative Problem Solving through Blended Learning," *Procedia - Soc. Behav. Sci.*, vol. 56, no. Ictlhe, pp. 117–125, Oct. 2012.

[22] B. Barkley, *Project Management in New Product Development*. Mcgraw-hill, 2007.

[23] A. J. Poli, M. Shenar, "Strategic Focus: Why We Do Projects.," in *Portland International Center for Management of Engineering and Technology - PICMET 2007 Proceedings*, 2007, pp. 2080–2088.

[24] J. Zhang, A. Di Benedetto, and S. Hoenig, "Product development strategy, product innovation performance, and the mediating role of knowledge utilization: evidence from subsidiaries in China," *J. Int. Mark.*, vol. 17, no. 2, pp. 42–58, 2009.

[25] P. Trott, *Innovation Management and New Product Development*. Financial Times Prentice Hall, 2008.

[26] Z. Tekic, "Knowledge Platform - Concept, Conditions of the Emergence and Models," University of Novi Sad, 2012.

[27] P. Kotler, K. L. Keller, and P. H. Cunningham, *Marketing Management*. Toronto: Pearson-Prentice Hall, 2006.

[28] R. G. Kleinschmidt, E.J., Cooper, "The Impact of Product Innovativeness on Performance," *J. Prod. Innov. Manag.*, vol. 8, no. 4, pp. 240–251, 1991 .