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Moderating effect of Technology Uncertainty on Relationship between Innovation Speed and Product Success: A Survey in Malaysian Biotechnology Industry

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Abstract
Time-based strategies are established based on speedy product development that leads to a greater result from market. To overcome the ongoing uncertainties in the market, we could add more knowledge to the literature on market strategies and new product success by studying the relationship between innovation speed and product success under different conditions of technology uncertainty. This research is a crosssectional quantitative survey research. A sampling frame of 101 biotech products was selected from small and medium Malaysian biotechnology enterprises and a self-administrated questionnaire was adopted from previous researches. Innovation speed is generally associated with new product success and technology uncertainty moderates this relation. Our findings indicate that innovation speed is less importance under low technology uncertainty for product success. Vice versa under high technology uncertainty, speedy development of a new product allows it to gain better results from the market and success the product. Based on the findings recommendations are forwarded, to biotech companies to develop and use the appropriate strategies.
Keywords: innovation speed, product success, technology uncertainty, market uncertainty

1. Introduction New product development (NPD) is the lifeblood of industries and organizations in today's competitive marketplace. Hence, industries have to bring new products to the market and consumers in the face of competition in order to survive. One way of achieving success is through fast and speedy product development process and to do this, organizations face some major challenges (Birnbaum-More, 1993). Being first to market provides organizations with unique positioning and gives them a competitive edge over their market rivals (Kessler & Bierly, 2002). Chen et al. (2005) stressed that time-based strategy has become an important tool to gain competitive advantages in this fast-changing market environment. Authors argue that the relationship between speed-to-market and new product success has become an issue of increasing concern and importance to researchers and practitioners. This relationship between the two (speed-to-market and product success) can lead to different conditions of uncertainties such as market uncertainty and technology uncertainty which would require further investigation and research (Chen et al., 2005).

In line with the above, the conceptual framework of the study (Figure 1) is based on the relation between innovation speed and product success when technology uncertainty is moderated. According to Chen et al. (2005), forecasting technology uncertainty warrants firms to make better decisions to overcome

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risks and failures. While the investigation on the, topic provides firms a greater understanding it may also lead to a faster response to market.

Biotechnology is one of the fast growing industries that is present in our daily lifestyle, it is chosen for the purpose of this study mainly because it is an emerging and fast-growing industry with high potential impact on social and economic development (Zucker et al., 2002), and secondly, this field of industry is considered to be one of the most research-based segments(Hine & Kapeleris, 2006) and science-led industry with R&D in today's competitive global market (Champion, 2001, Abbie, 2002).

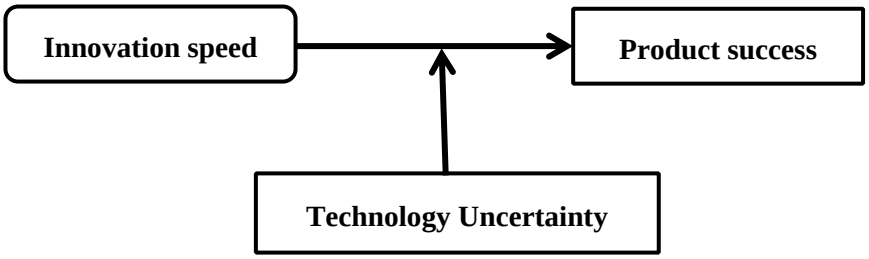

Figure 1: Conceptual Framework of the Study

2. Literature Review

Innovation Speed and Product Success

Innovation speed has been defined by Kessler and Chakrabarti (1996) as the time between initial discovery and commercialization. Innovation speed theory is fundamentally related to time (Markman et al., 2005). Historically, research on innovation and speed is grounded in two domains including economics and management (Markman et al., 2005). The economic theories examine innovation patterns across nations or industries (Dosi, 1988) while speed relates to the rate of diffusion of innovation throughout regions or populations (Rogers, 2010). Under the management theories innovation is examined within the context of processes and organizational structures and behaviors (Kessler & Chakrabarti, 1996). This study is interested in the relationship between innovation speed and NPD success and therefore is based on management perspective not economic domain.

Subsequently, the existing literature is the indicator of the contribution of innovation speed on new product development (NPD) success (Carbonell & Rodriguez, 2006, Chen et al., 2005, Calantone et al., 2003). Innovation speed is about speedy completion of NPD from the initial idea stage to first commercialization of the product (Kessler & Chakrabarti, 1996). Researchers have stressed that the success of new product and technology depends on how fast it moves from idea to commercialization (Abbie, 2002, Kessler & Chakrabarti, 1996).A study by Lynn and colleagues (Lynn et al., 1999) on a large number of products has confirmed the link between innovation speed and product success.

In line, a number of strategies exist with respect to speed. The time-based strategy is an approach that focuses on reducing the time required to plan, process and develop a product – speed on NPD, the firstmover strategy from the other hand is bound to reach the market before the competition – first to market (Chen et al., 2005). However, first to market is unlikely to happen without an effective time-based strategy that ensures speedy product development.

In today's fast paced market economy, first mover in the market gains more advantage with higher performance. Time is an important factor and NPD time reduction has become the key to success and firms that ignore this important rule may face business declines and challenges. Findings from studies reveal that innovation speed has a positive effect on project success and product performance. In other words, faster development of product will increase market share and return on investment (ROI) (Carbonell & Rodriguez, 2006). A study by Davis et al. (2002) on cycle time performance and context of strategy development provides

greater insight and confirms that fast movers in the market would enjoy significant improvement in organizational performance. Then:

Hypothesis 1: innovation speed is positively associated with product success.

Moderating Role of Technology Uncertainty

Uncertainty described by (Milliken, 1987) as the inability to predict the impact of environmental change and consequences involved in responses to change. Researchers including Sutcliffe and Zaheer (1998) have highlighted the importance and challenges involved in uncertainties which could be complex by nature. Authors have classified uncertainty sources to include "customers, suppliers, competitors, regulatory factors, union issues, technology and market". However, among all, technology and markets are the most-known uncertainties that organizations may face (Chen et al., 2005).

Technology uncertainty is due to the lack of required knowledge about the technological advancement that makes it difficult for firms to make accurate predictions (Sutcliffe & Zaheer, 1998). Technology uncertainty increases in a complex environment where technology is new or facing on-going changes (Chen et al., 2005). It have impact on both product development and product performance (Bstieler, 2005). In today's fast changing complex technological environment with high uncertainty, success depends on developing new knowledge in order to keep up with technology advancement (Chen et al., 2005). The moderating role of environmental uncertainty generally, and technology uncertainty specifically, has been examined by a number of researchers in previous studies (Tsai & Huang, 2008, Ignatius et al., 2012). In line with the above literature and approaches, we propose that:

Technological uncertainty refers to the degree of complex and radicalness of a technology and how fast it is changing (Tatikonda & Rosenthal, 2000). Technology uncertainty increases when a technology changes rapidly or is new (Moriarty & Kosnik, 1989). Uncertainty is the fundamental condition of entrepreneurial opportunity and profit (Knight, 2012, LeRoy & Singell, 1987). It is always present in the market and the industries would be more successful in selling new product and get potential profit by forecasting technology uncertainties; otherwise they will fail and loose the market (Gupta & Souder, 1998, Calantone et al., 1997).

The findings of a study by Chen et al. (2005) illustrate that when new products are delivered to a familiar, stable, and predictable marketplace, customers may not only require product newness, but also other criteria, such as product price and quality, hence, speed might not be very important. However, when new products must be delivered to an unfamiliar and turbulent marketplace, fast product development captures new customers and meets targeted customer needs. In short, speed-to-market is less important under conditions of low market uncertainty. Therefore:

Hypothesis 2: Innovation speed will be more strongly related to product success under high than low technology uncertainty.

3. Methodology

Sampling

The population frame consisted of 240 Malaysian biotechnology firms, most of which have less than 50 employees (BIOTECHCORP, 2010). Valid 101 questionnaires have returned from the firms. This number of sample size is proper to run multivariate analysis as suggested by the scholars (Tabachnick & Fidell, 2012, Schumacker & Lomax, 2010). Each product was considered as one unit of analysis. NPD projects were selected based on the products which are already completed and in the market within the past three years. The respondents mostly were in position of Chief Executive Officer (CEO, 37.7%), executive manager (21%), sales manager (34%) and the rest of them were in the position of R&D officer and project managers in three fields of biotech industry that includes healthcare (51.1%), agriculture (23.9%), and industry (27%) with less than 50 employees.

The current study has collected data from different field of biotechnology industry, then analysis of variance has carried out from several companies from different industries, tests for between- group differences in any of the constructs included in this study were undertaken. Analysis of variance procedures and post-hoc Tukey multiple-comparison tests reveal that there were no significant between-group differences with the averages of innovation speed, product success and technological uncertainty at 95% significance level.

Table 1: Sample Characteristics

Field of industries%		Position of respondent%		Cost of products%	
		CEO	37.7	≤ 25000.00	26.7
Healthcare	50.5	**Executive Manager**	21.0	25001.00 - 50000.00	34.7
Agriculture	22.8	**Sales manager**	34.0	50001.00 - 100000.00	19.8
Industry	26.7	**R&D officer**	3.3	100001.00≤	18.8
		Project Managers	4.0		

Measurement

The measurement of the constructs of the study was based on research objectives. All items were adopted from previous researches. The questionnaire was tested with 10 product managers. The inappropriate items were modified and replaced with other items to ensure the validity and reliability of the constructs. The respondent has been requested to fill the questionnaire on the base of the products which is already completed and in the market.

Innovation speed consisted of 3 items were adapted from Kessler and Bierly (2002) and 4 items from Goktan and Miles (2011). It has been operationalized as the efficient developing process a product to reach to the market on the schedule time. Product success with 6 items was adopted from (Lynn, 1998, Lynn et al., 2000). It is measured base on whether the product met financial, competitiveness and market expectations. Technological uncertainty was measured with 5 items adapted from Jaworski and Kohli (1993). Technology uncertainty is operationalized as whether the technology is changing quickly in the industry. All questions are asked employing a 5-point Likert scale, from 1=strongly disagree to 5= strongly agree. All the items were measured in order to hypothesis the effect of innovation speed on product success in different conditions of technology uncertainty. Technology Uncertainties have been categories in their median in two levels as low, high. The median is the best measure of center to apply in a skewed distribution (Cohen et al., 2013).

Table 2: List of Adopted questionnares

	items	Variables	Items in previous research
Innovation speed	1	The product achieved in its scheduled time or behind schedule.	(Kessler & Bierly, 2002, Hult et al., 2002)
	2	The product completed faster than similar past product in our organization.	
	3	The product completed faster than competitors in our industry.	
	4	The duration of our innovation process gets shorter each time.	
	5	Speediness of the product development was satisfactory.	
	6	The product development process was short and efficient.	
	1	Overall, the product met or exceeded sales expectations.	(Lynn et al., 2000, Lynn, 1998)
	2	The product met or exceeded profit expectations.	
	3	The product met or exceeded return on investment (ROI) expectation	

Product success	4	The product met or exceeded overall senior management's expectations.	
	5	The product market met or exceeded share expectations.	
	6	The product met or exceeded customers' expectations.	
Technology uncertainty	1	The technology is changing rapidly in our industry.	(Jaworski & Kohli, 1993)
	2	It is very difficult to forecast the status of the technology for the next two to three years in our industry	
	3	The technological developments are rather minor in our industry.	
	4	The technological changes provide big opportunities in our industry.	
	5	A large number of new product ideas have been made possible through the technological breakthroughs.	

As a preliminary step to data analysis, statistical information was examined in several areas. Preliminary testing has been performed to ensure no serious violation of the assumptions of normality, linearity, outliers, multicolinearity and homogeneity of variance. Skewness and Kurtosis less than ±2 indicated to normal distribution of data (Schumacker & Lomax, 2010). The variance inflation factor (VIF) <10 shows that there is not concern about multicoliearity assumption of the data (Ho, 2006). As suggested by Aiken and West (1991), to remove any concern about multicolinearity violation in creating interaction effect, innovation speed and technology uncertainty were mean centered. Descriptive statistics method has been used to describe the profile of the respondents and variables of the survey (Table1).

The consistency of the items was measured by Cronbach coefficients alpha. All items indicated to cronbach alpha greater than 0.70(Cronbach, 1951; Hair et al., 2010, Raza & Hanif, 2013; Ali & Raza, 2015), which indicates good reliability. Total-item-correlation lower than 0.35 should be eliminated. The scores of total item correlation for this study shows the scores higher than 0.35(Saxe & Weitz, 1982)

Table 3: Descriptive Statistics and Pearson Correlation among Variables

	Variables	MEAN	S.D	Skewness	Kurtisus	1	2	3
1	Product success	3.81	0.64	-.26	-.631	(0.905)		
2	Innovation speed	3.74	0.68	-.294	0.298	0.435**	(0.872)	
3	Technology uncertainty	3.77	0.732	- 1.306	1.023	0.367*	0.205**	(0.804)

Note: Correlation is significant at the 0.01 level (2-tailed)**, significant at the 0.05 level (2-tailed)* *. Values on the diagonal are Cronbach's alphas>0.7 (Cronbach, 1951, Hair et al., 2010). Skewness and kurtosis<2 (Schumacker & Lomax, 2004)

4. Findings

We adopted Moderated hierarchical regression analysis (Anderson, 1986) and follow procedure suggested by Aiken and West (1991). We sequentially entered the variables in different blocks. The main effects of innovation speed were added in Block 1. In Block 2, main effects of technology uncertainty were entered. Finally, interaction effect of innovation speed and technology uncertainty was added in model3. The whole

procedures to examine moderator suggested by Aiken (1991), indicated that the moderating effect is obtained (Block 3).

Table 3: Results of the Moderated Hierarchical regression analysis

Independent variable	**Block1**	**Block 2**	**Block3**
Independent variable			
Innovation speed	.43**	.376	.378
Moderators		.29**	.178
Technology uncertainty			
Interaction effect			-.26**
Innovation speed× TU			
R_2	.18	.27	.33
Overal *F*	23.12	18.10	15.77
Adjusted R^2	.181	.255	.31
Change in R^2	.189	.08	.06
***F* change** 23.12 10.80 8.39			

Notes: Shown are standardized betas.***p<0.01*

Subsequently, the post hoc test (Figure 1) was perform to examine the level of technology uncertainty on relationship between innovation speed and product success. The results illustrated to significant negative effect of low technology uncertainty on relationship between innovation speed and product success. However, high technology uncertainty has significant positive effect on relationship between innovation speed and product successes. It means that when technology is easy to forecast and not changing rapidly in the industry, speed is less important to success the product at the market. However, innovation speed is more important to product success in high technology uncertainty. The result also supported H2.

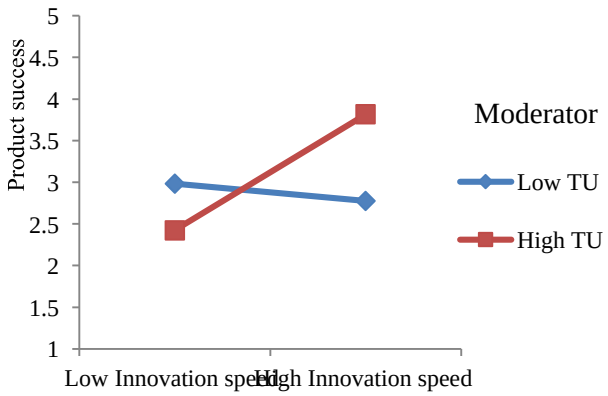

Figure 1: Effect of innovation speed on product success under high and low technology uncertainty

5. Discussion, Conclusion and Managerial Implication

In a study of 101 biotech products in different field of healthcare, industry and agriculture, we have examined the relationship between innovation speed and new product success (NPS) under different conditions of technology uncertainty. Our results indicate that there is negative relationship between innovation speed and new product success under low uncertainty. It means that in low technology uncertainty condition, speed in developing a new product is less important for success of a product in the market. From the other hands, the study confirms positive effect of high uncertainty on relationship between innovation speed and product success. It indicates that speed significantly improves the success of a product in high technology uncertainty environment. The results are quite similar to the findings of Chen et al. (2005) and Christensen (1992). However, our results are contrary with Kessler and Chakrabarti (1996) and Kessler and Bierly (2002) who found that innovation speed and new product success have higher positive association under low condition of uncertainty.

Findings are expected to help executives and managers in their policies and business strategies through effective alignment of their vision and strategies with the new product development. Such policy may adopt and implement innovation speed as an important part of their R&D to ensure successful delivery of the new project to the market. This study should also help managers to find answers for their questions in an environment facing low or high technological uncertainties.

The research results is expected to have significant implications on the biotechnology industry including SEMs as well as existing and newly established biotech companies in Malaysia especially those are intending to generate and localize the technology. The findings lead to a general discussion on speed-based factors that provide a brief description about the necessary assessments of NPD in order to prevent technology failure in preliminary stages.