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Article

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MANAGEMENT | RESEARCH ARTICLE

Impact of T-shaped skill and top management support on innovation speed; the moderating role of technology uncertainty

Shabnam Hamdi^{1*}, Abu Daud Silong¹, Zoharah Binti Omar¹ and Roziah Mohd Rasdi¹

Abstract: This study examines the moderating role of technology uncertainty on the relationship between team contextual factors of top management support and T-shaped skills with innovation speed. For the purpose of this study, the data were collected from 227 new products from 147 biotechnology firms in Malaysia. The overall results confirmed the moderating effect of technology uncertainty on the relationship between T-shaped skills, as well as top management support with innovation speed. The results further confirmed that under the high technology uncertainty, this effect is higher in comparison to the low and medium uncertainty. This indicates that the effect of top management support and T-shaped skills on innovation speed improves when technology uncertainty increases. On the practical side, the report equips biotech firms with valuable insights to develop effective strategies.

Subjects: Human Resource Development; Human Resource Management; Management of Technology; Small Business Management

Keywords: T-shaped skills; top management support; innovation speed; technology uncertainty



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PUBLIC INTEREST STATEMENT

Speed is the rule of the day. Technology is evolving fast, and firms gain competitive advantage by adapting new technologies. This study guide firms to build a dynamic strategy using the common human resource management (HRM) processes and practices to invent new technologies. The data were collected from biotechnology industry. The findings show that quality of research and development (R&D) activities as well as management involvement are important factors to accelerate development of innovative technologies. In fact, the results imply that firms cannot succeed without management involvement and proper investment in R&D. In sum, HRM practices require continuous learning and development. The findings could help policy-makers of small and medium enterprises (SEMs) developing policies to better compete in marketplaces.

1. Introduction

In this fast-changing market environment everyone is pushing to be the first to market to gain competitive advantage and create values (Chen, Reilly, & Lynn, 2005). To become first to market and gain, firms are first required to build dynamic capabilities (Schiavone, 2011). These capabilities are more important for biotech industry due to the twisted regulatory and approval process that aim to ensure product safety, quality, and efficacy (Markman, Gianiodis, Phan, & Balkin, 2005).

In addition, the environmental dependencies are powerful forces that shape organizational strategies and capabilities. It enables competitive advantage through faster NPD (Carbonell & Rodriguez, 2006; Chen, 2013; Kessler & Chakrabarti, 1996). In fact, organizational performance and success depend on boosting teams' capabilities (Tripsas & Gavetti, 2000). The technology uncertainty and change also add to the product complexities and therefore call for enhancement of teams' capabilities to better deal with change and uncertainty (Brown, Bessant, & Lamming, 2013).

Biotechnology is one of the fastest growing industries. It enables social development and economic growth. Developing nations have put significant efforts on their biotech industry such as Malaysia. Malaysia's goal is to be the hub of biotechnology in the region. Aligned with its sustainable development initiative, the Malaysian government has launched a number biotech programs in 2005 onwards, including National Biotechnology Policy (NBP) and the Malaysian Biotechnology Corporation (BiotechCorp). The Biotech Master Plan (2005–2020) was also introduced to provide roadmap and milestone for biotechnology enrichment and NPD (The Ministry of Science, Technology and Innovation (MOSTI), 2010). To this view, and considering that Malaysia is already behind its plan, the biotech industry is required to recognize and adopt speed-based strategies to effectively optimize NPD cycle. To do so, there is a need for an exclusive study to investigate factors contributing to the speed-based strategy.

The concern here is the boundaries that slowdown the innovation speed. And as far as Malaysia is concerned, its biotech industry is dominant with newly established firms and SMEs, which lack necessary capabilities such as experiences, skills and resources to innovate and develop new products (MOSTI, 2010). Certainly, under such constraints, top management would be under considerable pressure to make appropriate speed-based decisions (Forbes, 2007). Besides the above criteria, staff-related capabilities, including skills and experiences play important role in new technology development (Martín-Rojas, García-Morales, & Bolívar-Ramos, 2013).

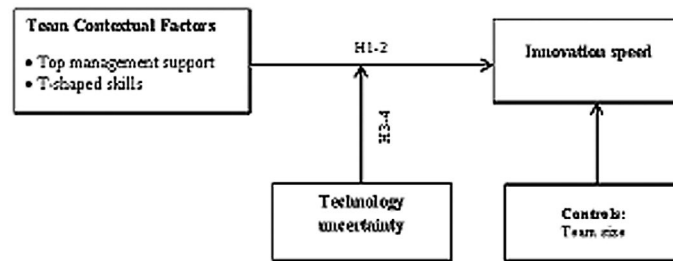
Moving beyond the existing literature, this study attempts to examine the moderating role of technology uncertainties in innovation speed in new product development within the Malaysian biotech industry. The current research has hypothesized the significant relationship between the top management support, as well as the T-shaped skills and innovation speed, under technology uncertainties.

2. Theoretical framework

The research framework of this study provides access to a range of topics in innovation and technology management that facilitates faster product development. For the purpose of this study innovation speed theory (Kessler & Chakrabarti, 1996) in conjunction with contingency theory was employed. Innovation speed framework (Kessler & Chakrabarti, 1996) provides concepts that need to be examined through sources of uncertainties. As stated by Scott (2006) the best way to organize a firm and its structure depends on the firm's environment. This in fact is the claim of contingency theory—there is no best way to make decision and lead a company; however the preferred action is contingent and depends upon the internal and external factors. The ongoing change in an environment drives uncertainties that influence organizational internal configuration and feature (Lawrence & Lorsch, 1967).

Lawrence, Lorsch, and Garrison (1967) argued that the rate of change in an environment that drives uncertainty highly influence the internal configuration and feature of the firm. In harmony,

Figure 1. Conceptual framework.



Bahemia and Squire (2010) stressed that the implementation of open innovation at project level can no longer be determined by internal R&D, because it highly depends on numerous external factors and players. Authors cited in Lichtenthaler and Ernst (2009) indicating, firms that process innovation through obtaining knowledge from external sources (inbound strategy) and commercializing technology (outbound strategy) can gain and generate higher profit. The argument here is that NPD and firm performance depend on environmental uncertainties, which firm and its product projects are bound to engage. To this view, the following framework was designed based on sources of uncertainty and teams' contextual factors (Figure 1).

3. Literature review and hypotheses development

3.1. Top management support and innovation speed

Top management support is about the degree of senior managements' interest and involvement in the project (Larson & Gray, 2014). An outstanding product could not be developed without a true leadership. Actually, any perfect product/project has a leader who gives direction to ensure successful product development (Clark & Wheelwright, 1993). Occasionally, top managers do not clarify their support and involvement in the project. Often, they do not define the project plan or do not advise the team on their actions. These behaviors create an unsafe environment and demotivate the team, resulting in poor performance or failures (Kerzner, 2013).

The development of a new product/project may involve different departments and level of management. The middle management usually show interest on a segment of a project or one milestone, the first-line managers' however are mainly interested in a task or a work package that relates to their position (Larson & Gray, 2014). While top management has the higher authority with interest in overall project outcome. Senior managers can influence the project by providing resources such as manpower, engineering, manufacturing, and financial support (Griffin, 2011; Kessler & Chakrabarti, 1999). Top management's support can extend from providing facilities and resources to employment of skilled people and motivate the individuals who are involved in the project (Gupta & Wilemon, 1990). In other words, the product development life cycle will not get shorter unless top management is truly interested and supports the whole project (Atkinson, Crawford, & Ward, 2006). This top level support is necessary to transform and adopt technology friendly culture (Martín-Rojas et al., 2013). Such transformation should change both operational and strategic levels. At the heart of organizational strategy implementation, projects should receive top managements' support to deliver expected values (Cook, Heath, & Thompson, 2000). Executives are the ones with authority to support the project in time of difficulties and drive success through critical decision-making and change (Brown et al., 2013). As stated by Tripsas and Gavetti (2000) and McDonough (2000), top level support not only influences the smooth and faster development of products it also enables greater market experience and product commercialization.

H1: The top management support has positive effect on innovation speed.

Another critical issue is the uncertainties in technology which needs top management's attention. Undoubtedly, top management can reduce production and delivery timeliness (Griffin, 2011) through enabled communication and cooperation across departments as well as external organizations,

suppliers, and customers (Clark & Wheelwright, 1993). Further studies have also highlighted the vital role of top management in scoping and facilitating the project. A number of scholars confirmed that speeding up NPD process is the priority of senior managers in every industry (Cooper & Edgett, 2008; Swink, 2003). Thus, its support enables faster delivery of products to the market (Carbonell & Rodríguez-Escudero, 2009; Kessler & Chakrabarti, 1996; McDonough, 2000). Higher authorities are in better position to support organization in scanning, forecasting, assessing, and monitoring the environmental uncertainty and mitigating risks, and capturing opportunities. Finally, in an environment which is highly contingent, top management's support is a valuable weapon (Carbonell & Rodríguez-Escudero, 2009). Then:

H2: The effect of top management support on innovation speed will be stronger when technology uncertainty is high in comparison to the low and medium uncertainty.

3.2. T-shaped skills and innovation speed

Developing and marketing a product from its early stage to its commercialization requires technological know-how, and complementary resources and skills (Teece, 2009). This highlights the importance of structured and precise management coupled with the formation of technology management to create values from corporate entrepreneurship and learning processes to lead performance (Martín-Rojas, García-Morales, & García-Sánchez, 2011). According to Madhavan and Grover (1998) a team's intellectual ability is revealed in the T-shaped skills of its fellows and A-shaped skills of its leader.

Madhavan and Grover (1998) argued that the T-shaped skills bring depth factors (the vertical part of the "T") and wideness factors (the horizontal part of the "T"). Those with T-shaped skills retain both good knowledge of discipline and know how to cooperate with others to function as a team. Again, exploration focuses on gaining new knowledge aimed at innovation (Levinthal & March, 1993). Knowledge resulting from exploration is categorized as original, complex, divergent, and ambiguous, which is likely to be synergistic with T-shaped skills. In order to effectively interpret and utilize novel and unfamiliar knowledge, T-shaped skills are required. People with these skills have the ability to combine theoretical and practical knowledge and to sustain meaningful conversations with others (Madhavan and Grover, 1998). They are capable of expanding their ability across numerous areas, and develop systemic thinking skills (Lee & Choi, 2003). Hence, they can assist others to organize market and technical knowledge in a systemic way (Johannessen, Olsen, & Olaisen, 1999).

As mentioned earlier, in order to effectively interpret and utilize original and unfamiliar knowledge, T-shaped skills are needed. People with these skills can expand their ability and develop universal thinking skills (Lee & Choi, 2003). T-shaped skills provide a NPD team with a greater ability to comprehend a wide variety of new information and integrate newly created knowledge with previous knowledge. As a result, NPD teams are better able to correctly interpret extensive new knowledge and further apply it effectively to a new product and process. The results of several studies support the positive impact of T-shaped skill on innovation speed (Zhang & Yin, 2012). The combined knowledge, skills, and know-how group team is more important for complex innovation projects (Moorman & Miner, 1997). Hence:

H3: The T-shaped skill has positive effect on innovation speed.

Duncan (1972) relates uncertainty with decision-making situation and defines uncertainty as the lack of information and skills regarding the environmental factors associated with a given decision-making situation. Lack or limited information results in absence of knowledge about the outcome of a specific decision in terms of organizational losses if the decisions were incorrect; and the inability to assign probabilities on the effect of a given factor on success or failure of a decision unit in performing its functions. This also leads the team to apply higher skills and expertise in high uncertainties of technology. As argued by Nilsson (1995) acceleration of a new product development highly depends on the team's high level of skills. This can lead to the establishment of a continuous

learning program to improve the speed of NPD (Patterson & Lightman, 1993). Considering the contingent environment of project and business, T-shaped skills are an important toolbox. Therefore:

H4: The positive effect of T-shaped skill on innovation speed will be stronger when technology uncertainty is high in comparison to the low and medium uncertainty.

4. Materials and methods

4.1. Subject and sampling

The desired data for the survey were gathered by a set of questionnaires over a period of months from a frame of 245 biotechnology firms across Malaysia in three different fields including health-care, agriculture, and industries. Altogether, 147 companies have participated from the entire 245 biotech companies. The response rate of 60% was significant to achieve valid generalization from the study (Ary, Jacobs, Razavieh, & Sorensen, 2009). Executive manager of each company has received the questionnaire. A 227 valid returned questionnaire was collected. For the purpose of this study, since the research aimed to investigate and provide insight on NPD speed, products were chosen as the most suitable unit of analysis (Kessler & Chakrabarti, 1996). Table 1 states the profile of the respondents and organizations. Respondents were the main persons who involved in developing the product such as CEO (18.4%), executive manager (18.4%), marketing manager (38.8%), project manager (10.2%), and R&D manager (14.3%). The respondents were asked to answer the questions based on the completed project/ product which they were most familiar with. Additionally, products were defined based on products that were fully completed and commercialized within the past three years. The shortest moment period was defined between the start time of the event and the moment of data collection to boost accuracy and reliability from the research (Meyer & Allen, 1997; Tatikonda & Rosenthal, 2000).

4.2. Measure

The questionnaire was adopted from previous researches. The pilot test was carried out using responses from 10 managers involved in NPD projects. Based on the feedback, the measures were refined to ensure their relevance to the context of the research. *Innovation speed* refers to the time effectiveness in process, completion/launch of a new product to the market and competition features. The six items, were borrowed from Goktan and Miles (2011) with $\alpha = .87$ and Kessler and Bierly (2002) with $\alpha = .68$ to operate innovation speed scale. *The top management support* was discussed previously by Cooper and Kleinschmidt (1995). It has four items and refers to the support given by top managers to facilitate a project. This factor was measured by four items adapted from previous studies. *T-shaped skills* refer to technical, social and practical abilities of research team members to facilitate a project. It describes the characteristics of the research team members for instance sociability and communication with others and making suggestion, wisdom, expertise, and specialization in their tasks and others. It was measured using four statements developed by Lee and Choi (2003). The technology uncertainty is about the rate of change and uncertainty in technology and range of ideas arise when a new product is launched by a firm. It was measured using five statements from the instrument developed by Jaworski and Kohli (1993). Item number three “we cater too many of the same customers as in the past” was reverse coded. These reflective and continuance variables were measured with 5 ordinal Likert scales from strongly agree = 1 to strongly disagree = 5. Some of the items were refined and adapted based on the survey (Table 2).

Table 1. Profile of sample

Position (%)	Employee member (%)	Field of organization (%)
CEO (18.4)	<20 (48.3)	Healthcare (51)
Executive manager (18.4)	21–49 (20.4)	Agriculture (16.3)
Marketing manager (38.8)	50–99 (17.7)	Industry (32)
Project manager (10.2)	100< (13.6)	
R&D manager (14.3)		

Table 2. Mean, construct reliability, and validity of the constructs

Construct measurement	Means	Construct Reliability	AVE
Innovation speed			
Speediness of the product development was satisfactory	3.78 (.65)	.865	.519
The product development process was short and efficient			
The product achieved in its scheduled time or behind schedule			
The duration of our innovation process gets shorter each time			
The product completed faster than similar past product in our organization			
The product completed faster than competitors in our industry			
Top management support			
Top management supported the project	3.6 (1.31)	.964	.870
Top management devoted a lot of time to the project			
Top management provided adequate resources to the project			
Top management created an enthusiastic atmosphere during the project process			
T-shaped skill			
Our project members were able to understand not only their own tasks but also others' tasks	3.8 (1.01)	.932	.775
Our project members were capable of performing own tasks effectively, and making suggestions about others' tasks			
Our project members could communicate well with their department members as well as other departments			
Our project members were specialized in their own part			
Technology uncertainty			
The technology is changing rapidly in our industry	3.16 (1.67)	.986	.934
It is very difficult to forecast the status of the technology for the next two to three years in our industry			
The technological developments are rather minor in our industry			
The technological changes provide big opportunities in our industry			
A large number of new product ideas have been made possible through the technological breakthroughs			

In order to enhance internal validity team size was considered as control variable (Kerlinger & Lee, 2000). Team size was measured by the number of R&D project team members (Sarin & McDermott, 2003).

4.3. Validity and reliability

In order to assess validity of the instrument, unidimensionality of each variable, item-to-total correlation was estimated by inserting one construct at a time (Saxe & Weitz, 1982). All the item-to-total correlation were higher than .30. The reliability of the items to measure a construct is shown by their Alpha value between 0 and 1. The alpha of .8 or above for an item indicates high reliability coefficient, while the value of .7 is enough and acceptable (Sekaran & Bougie, 2010). The results of reliability test indicated an average Cronbach alpha coefficient higher than .08 (Table 1).

Additionally, Confirmatory Factor Analysis (CFA) is conducted to obtain discriminant and convergent validity, followed by goodness of fit for the proposed model. In order to avoid bias in single method testing, all three constructs with 17 underling observed variables were entered into a

Table 3. Correlation coefficient between variables

Items	Variables	1	2	3	4	5
1	Innovation speed	.86				
2	Top management support	.24**	.96			
3	T-shaped skill	.14*	.07	.93		
4	Technology uncertainty	-.18**	.07	.41**	.98	
5	Team size	-.06	.03	.03	.01	1

Notes: Cronbach alpha stand in diagonal line.

**Level of significance at $p < .01$.

measurement model (Hair, Black, Babin, & Anderson, 2010). All factors loaded perfectly with scores exceeded .5. The AVE (>.5) and construct reliability > .7 met the threshold values in accordance to the rule of thumb (Hair et al., 2010). As outlined in Table 2, the measurement model has achieved all criteria required for convergent validity. The results show that the model met all criteria of construct validity (Hair et al., 2010).

Prior to analysis, and in order to prevent multicollinearity problem in equations, as recommended by Aiken, West, and Reno (1991), T-shaped skill and top management support were mean-centered. Additionally, VIF < 10 and Tolerance values less than 1 confirmed that the multicollinearity was absent in the research.

Moreover, multicollinearity is also a problem if the correlations between variables are greater than .85 (Table 3). However, discriminant validity test and correlation matrix in this study, confirmed that variables uni-dimensionally explain their own constructs. Therefore, the entire hypothesized constructs of the study are unidimensionally valid and reliable for further analysis.

4.4. Common method bias

Common method biases are a serious problem in behavioral research (Conway & Lance, 2010; Podsakoff, MacKenzie, Lee, & Podsakoff, 2003). The reviews in the literature and the data collected in this research illustrated that self-report data bias is not an issue in this research. This is for the reasons that (1) NPD is not an emotion and feeling is not involved in NPD to mislead respondent's answer (Cote & Buckley, 1987), and (2) by collecting data from the best knowledgeable informant in each organization (Lynn, Abel, Valentine, & Wright, 1999). In addition, several statistical methods were employed to avoid common biases.

Harman's one-factor test was conducted as suggested by Podsakoff et al. (2003). Un-rotated factor analysis was examined to assess the variance of one-factor test loaded. A proper result from unrotated PCA (Tabachnick & Fidell, 2012) was generated. The eigenvalue range higher than 1.0 with first factor accounting for 31.40 of the total variance explained (80.64%) was the indicator of lack of common method bias in this study. Concern for this method arises when one general factor variance accounts for the majority of the components (Podsakoff et al., 2003). A confirmatory factor analysis in AMOS was also performed. In this technique, all factors are hypothesized to load as one factor in measurement model. The result of goodness of fit for one factor test with $\chi^2/df = 18.58$, $DF = 153$, $RMSE = .206$, $GFI = .41$, $CFI = .44$ in comparison with the measurement model with $\chi^2/df = 1.43$, $DF = 146$, $RMSE = .04$, $GFI = .91$, $CFI = .98$ revealed a badness of fit for one factor test. The overall results of the statistical assessments confirmed lack of common biases as a major problem in the study.

5. Findings of the study

5.1. Hierarchical moderated regression analysis

The Hierarchical moderated regression was utilized to determine the effect of top management support and T-shaped skill on innovation speed, as well as the moderating effect of technology

uncertainty. This method is increasingly used by scholars to test complex models using cross product terms (Carbonell & Escudero, 2010; Soane, Schubert, Lunn, & Pollard, 2015). Subsequently, the analysis was performed in four models. Team size was entered as control variable in the first model as an important factor in NPD (Henard & Szymanski, 2001).

Later, the main effects of top management support and T-shaped skill were entered into the Model 2, and, respectively, technology uncertainty in model 3. Finally, interaction terms were introduced into the model 4. Aligned with the acceptance of F test and interaction terms; the following analysis was conducted to test the hypothesis of the study. The results denoted that the top management support and T-shaped skill with 8% variance had effect on cycling time of NPD.

As shown in Table 4, the output of HMR in model 1, has revealed that team size is not important in the model. The results of model 2 shows that there is a positive main effect of top management support ($\beta = .24, p < .01$) on innovation speed. Vice versa, the main effect of T-shaped skill ($\beta = .12, p > .05$) on innovation speed was not significant. Then, H1 was supported, but H3 was rejected.

According to Table 4, the interaction effect of Technology uncertainty with top-management support ($\beta = .16, p < .01$) and T-shaped skills ($\beta = .53, p < .001$) on innovation was positively significant. The results revealed that moderation effect of technology uncertainty on these relations were obtained. The *post hoc* test also confirmed the existence of moderating effect of technology uncertainty. The moderating effect of top management support on innovation speed under subgroups of technology uncertainty was tested as suggested by Aiken et al. (1991). This effect positively enhances when technology uncertainty is high with $\beta = .25$, and $p < .001$. The effect of top management on innovation speed also increases under the medium level with $\beta = .12$, and $p < .001$. But, under low level of technology uncertainty, this effect was nonsignificant ($\beta = -.01, p > .05$). Figures 2 and 3 shows, respectively, the moderating effect of technology uncertainty on the relationship between top management support and T-shaped skills with innovation speed increases when technology uncertainty is high in opposed to the low and medium. Hence, H2 and H4 were supported.

Table 4. Hierarchical moderated regression analysis

Variables	Model 1	Model 2	Model 3	Model 4
Control variable				
Team size	.06 (.98)	.84 (1.3)	.086 (1.38)	.07 (1.31)
Independent variables				
Top management support		.24*** (3.73)	.25*** (4.11)	.16** (2.98)
T-shaped skill		.12 (1.89)	.25*** (3.70)	.66*** (7.31)
Moderators				
Technology uncertainty			-.31*** (-4.60)	-.39*** (-6.14)
Interaction effect				
Support \times TU				.16** (3.008)
Skill \times TU				.53*** (6.45)
R²	.004	.08	.16	.34
F value (d.f.)	.96 (1)	6.60 (3)	10.69 (3)	18.99
ΔR^2	.004	.07	.08	.18
F-change value (d.f.)	.969 (1)	9.37 (2)	21.17 (1)	30

Notes: T-value stands in bracket.

**Level of significance at $p < .01$ level.

***Level of significance at $p < .001$.

Figure 2. The moderating effect of technology uncertainty on relationship between top management support and innovation speed.

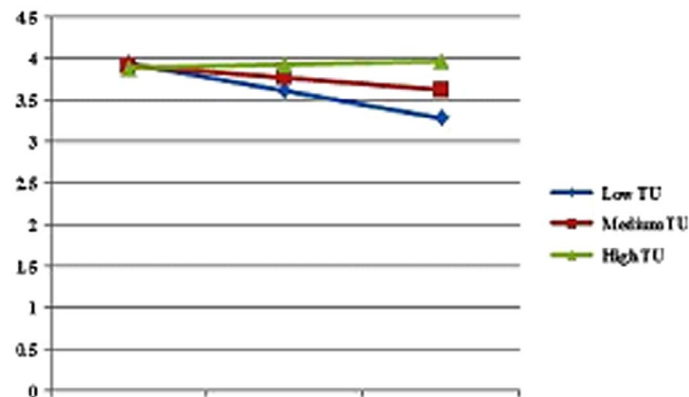
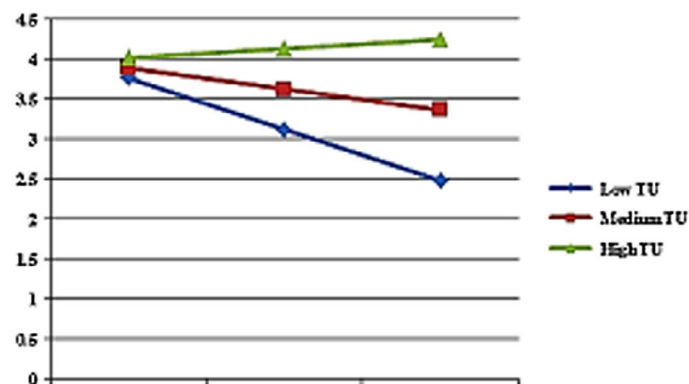


Figure 3. The moderating effect of technology uncertainty on relationship between T-shaped skill and innovation speed.



6. Discussion

This research has examined the effect of speed-based strategy, including top management support and T-shaped skills on innovation speed. The research has further proposed and assessed the moderating effect of technology uncertainties. The *post hoc* test was also applied to explore the effect of top management support and T-shaped skills on innovation speed under certain level of technology uncertainties.

6.1. Main effect of top management support on innovation speed

The results showed that top management's support is an important factor that facilitates innovation speed. This result is in harmony with some other studies that found the effect of top management support substantial (Brown et al., 2013; Carbonell & Rodríguez-Escudero, 2009). In other words, the completion of a project within the defined time highly depends on the level of top management's support. Top managers can facilitate successful NPD by encouraging and creating enthusiastic atmosphere to support a research team (Martín-Rojas et al., 2013).

6.2. Main effect of T-shaped skills on innovation speed

The main effect of T-shaped skills on innovation speed is negligible. Actually, the results revealed that these capabilities are less important for innovation speed in stable environment. T-shaped skills are referred to specialization in tasks and the ability of a team member to effectively communicate and suggest (Lee & Choi, 2003). This indicates that under the steady environment of less uncertainty, team members do not utilize their entire capabilities and expertise (Nystrom & Starbuck, 1984).

6.3. The moderating effect of technology uncertainty on the relationship between top management support and innovation speed

The result confirmed the effect of top management's support on innovation speed when technology uncertainty is moderated. In high technological uncertainty, this effect was more important for innovation speed. The deeper engagement and support of management is necessary to accelerate NPD in unknown situations. In contrary, in steady and low uncertainties, top management's support is less important to facilitate innovation speed. To this view, under the incremental and stable environment, top management support is less important in facilitating product speed (Carbonell & Rodríguez-Escudero, 2009; Rice, O'Connor, Peters, & Morone, 1998) and therefore, top managers can perceive a weaker support to accelerate products (Ireland, Hoskisson, & Hitt, 2011).

6.4. The moderating effect of technology uncertainty on the relationship between T-shaped skills and innovation speed

The findings confirmed that technology uncertainty has moderating effect on the relationship between T-shaped skill and innovation speed. The results showed that under the high technology uncertainty, the effect of T-shaped skills on innovation speed is significantly strong. While, in steady and low technology uncertainty, the T-shaped skills do not exhibit high impact on innovation speed. According to Gale and Sherry (2013), the skills and experience of team members is associated with the level of uncertainty in the project. There is a possible reason for this, in a steady environment, the team members do not show much interest to learn and grow their knowledge and skills (Nystrom & Starbuck, 1984), while in high uncertainties they tend to learn more. T-shaped skills are categorized as technical, social and practical abilities of research team members to facilitate a project (Lee & Choi, 2003), in which they tend to build a higher level of practical and technical abilities to achieve time and quality targets under high uncertainty condition.

7. Conclusion, implication and future research

This study is a trustworthy attempt to fill the gap and address practical issues around NPD speed in biotech industry in Malaysia. At the heart of the study, innovation speed theory in conjunction with a contingency theory was employed to develop research framework. Based on research questions, a series of hypotheses tested to draw results and meet research objectives. The research findings revealed the importance of human resource strategies and activities that builds organizational dynamic capabilities and enables firms to better deal with environmental uncertainties, change, and complexities.

In harmony with the previous findings, this study supports the role of top management support in high technology uncertainty. Similarly, the results add a fresh view with respect to the cognitive learning concepts of T-shaped skills on innovation speed when technology uncertainties moderated. The findings indicate that the subject of cognitive factors of skills play a key role in high technology uncertainties leading to a greater degree of innovation speed.

Additionally, this study confirms that top management's support is the key to project and NPD performance and success. However, top management's support is more vital under the high environmental uncertainties. The team may face greater challenges due to the increased uncertainties as the result of top management's ignorance or poor support. But the project team may face lower rate of challenges through top management's support, which is the key to control unknowns and mitigate risks. Therefore, the study suggests top management support as a strategic factor that can lead greater NPD success through minimized uncertainties, and minimized cycling time of NPD.

The results also find that the team capabilities in terms of skills and experience are important factors that help controlling uncertainties and time. The lower the skills and experience, the higher the uncertainties and time will be. Also, the more skilled and experienced the team is the better firm controls and manages the uncertainties and time. This leads the firm to build dynamic capabilities through routine processes and practices. In overall, these practices involve continuous learning and

development, release of existing skills, acquisition of new skills and employees, and establishment of relationship network to share knowledge, and integration of external knowledge.

The overall findings are expected to have significant impacts on biotechnology firms; especially the SMEs and newly established biotech companies, which intend to generate and localize new technologies. The study is expected to help biotech firms to develop effective strategies and prevent project and technology failures in preliminary paces.

This research has employed advanced methods to gather and further analyze data through appropriate techniques. Addressing the issues around NPD speed is important for both theoretical and practical reasons. Research on this issue is imperative as the competition in the marketplace becomes increasingly brutal. This study calls for a research stream to systematically examine the speed-based strategies in NPD. Considering the depth and complexity of the topic, there are rooms to explore and investigate speed-based strategies through other concepts.

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References

- Aiken, L. S., West, S. G., & Reno, R. R. (1991). *Multiple regression: Testing and interpreting interactions*. Thousand Oaks, CA: Sage.
- Ary, D., Jacobs, L. C., Razavieh, A., & Sorensen, C. (2009). *Introduction to research in education*. Belmont, CA: Wadsworth.
- Atkinson, R., Crawford, L., & Ward, S. (2006). Fundamental uncertainties in projects and the scope of project management. *International Journal of Project Management*, 24, 687–698. <http://dx.doi.org/10.1016/j.jiproman.2006.09.011>
- Bahemia, H., & Squire, B. (2010). A contingent perspective of open innovation in new product development projects. *International Journal of Innovation Management*, 14, 603–627. <http://dx.doi.org/10.1142/S1363919610002799>
- Brown, S., Bessant, J. R., & Lamming, R. (2013). *Strategic operations management* (3rd ed.). New York, NY: Routledge.
- Carbonell, P., & Escudero, A. I. R. (2010). The effect of market orientation on innovation speed and new product performance. *Journal of Business & Industrial Marketing*, 25, 501–513.
- Carbonell, P., & Rodriguez, A. I. (2006). The impact of market characteristics and innovation speed on perceptions of positional advantage and new product performance. *International Journal of Research in Marketing*, 23(1), 1–12. <http://dx.doi.org/10.1016/j.ijresmar.2006.01.002>
- Carbonell, P., & Rodríguez-Escudero, A. I. (2009). Relationships among team's organizational context, innovation speed, and technological uncertainty: An empirical analysis. *Journal of Engineering and Technology Management*, 26, 28–45. <http://dx.doi.org/10.1016/j.jengtecman.2009.03.005>
- Chen, J. (2013). *Innovation speed*. Encyclopedia of management theory. Thousand Oaks, CA: Sage.
- Chen, J., Reilly, R. R., & Lynn, G. S. (2005). The impacts of speed-to-market on new product success: The moderating effects of uncertainty. *Engineering Management IEEE Transactions on*, 52, 199–212.
- Clark, K. B., & Wheelwright, S. C. (1993). *Managing new product and process development: Text and cases*. New York, NY: Free Press.
- Conway, J. M., & Lance, C. E. (2010). What reviewers should expect from authors regarding common method bias in organizational research. *Journal of Business and Psychology*, 25, 325–334. doi:10.1007/s10869-010-9181-6
- Cook, C., Heath, F., & Thompson, R. L. (2000). A meta-analysis of response rates in web- or internet-based surveys. *Educational and Psychological Measurement*, 60, 821–836. <http://dx.doi.org/10.1177/00131640021970934>
- Cooper, R. G., & Edgett, S. J. (2008). Maximizing productivity in product innovation. *Research-Technology Management*, 51, 47–58.
- Cooper, R. G., & Kleinschmidt, E. J. (1995). New product performance: Keys to success, profitability & cycle time reduction. *Journal of Marketing Management*, 11, 315–337. <http://dx.doi.org/10.1080/0267257X.1995.9964347>
- Cote, J. A., & Buckley, M. R. (1987). Estimating trait, method, and error variance: Generalizing across 70 construct validation studies. *Journal of Marketing Research*, 315–318. doi:10.1080/10967494.2014.997906
- Duncan, R. B. (1972). Characteristics of organizational environments and perceived environmental uncertainty. *Administrative Science Quarterly*, 17, 313–327. <http://dx.doi.org/10.2307/2392145>
- Forbes, D. P. (2007). Reconsidering the strategic implications of decision comprehensiveness. *Academy of Management Review*, 32, 361–376. <http://dx.doi.org/10.5465/AMR.2007.24349585>
- Gale, A. W., & Sherry, A. H. (2013). *Understanding project uncertainty in safety-critical industries*. Paper presented at the PMI Global Congress Istanbul, Turkey.
- Goktan, A. B., & Miles, G. (2011). Innovation speed and radicalness: Are they inversely related? *Management Decision*, 49, 533–547. <http://dx.doi.org/10.1108/00251741111126477>

- Griffin, R. W. (2011). *Management: Principles and practices* (10th ed.). Boston, MA: South-Western Cengage Learning.
- Gupta, A. K., & Wilemon, D. L. (1990). Accelerating the development of technology-based new products. *California Management Review*, 32, 24–44. <http://dx.doi.org/10.2307/41166603>
- Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2010). *Multivariate data analysis* (7th ed.). New York, NY: Pearson.
- Henard, D. H., & Szymanski, D. M. (2001). Why some new products are more successful than others. *Journal of Marketing Research*, 38, 362–375. <http://dx.doi.org/10.1509/jmkr.38.3.362.18861>
- Ireland, R. D., Hoskisson, R. E., & Hitt, M. A. (2011). *The management of strategy: Concepts and cases*. Boston, MA: South-Western Cengage Learning.
- Jaworski, B. J., & Kohli, A. K. (1993). Market orientation: Antecedents and consequences. *Journal of Marketing*, 57, 53–70. <http://dx.doi.org/10.2307/1251854>
- Johannessen, J. A., Olsen, B., & Olaisen, J. (1999). Aspects of innovation theory based on knowledge-management. *International Journal of Information Management*, 19, 121–139. [http://dx.doi.org/10.1016/S0268-4012\(99\)00004-3](http://dx.doi.org/10.1016/S0268-4012(99)00004-3)
- Kerlinger, F. N., & Lee, H. B. (2000). *Foundations of behavioral research*. Orlando, FL: Harcourt College.
- Kerzner, H. R. (2013). *Project management: A systems approach to planning, scheduling, and controlling*. Hoboken, NJ: Wiley.
- Kessler, E. H., & Bierly, P. E. (2002). Is faster really better? An empirical test of the implications of innovation speed. *IEEE Transactions on Engineering Management*, 49, 2–12. <http://dx.doi.org/10.1109/17.985742>
- Kessler, E. H., & Chakrabarti, A. K. (1996). Innovation speed: A conceptual model of context, antecedents, and outcomes. *Academy of Management Review*, 21, 1143–1191.
- Kessler, E. H., & Chakrabarti, A. K. (1999). Speeding up the pace of new product development. *Journal of Product Innovation Management*, 16, 231–247. [http://dx.doi.org/10.1016/S0737-6782\(98\)00048-4](http://dx.doi.org/10.1016/S0737-6782(98)00048-4)
- Larson, E. W., & Gray, C. F. (2014). *Project management: The managerial process*. Grandview Heights, OH: McGraw-Hill Education.
- Lawrence, P. R., & Lorsch, J. W. (1967). Differentiation and integration in complex organizations. *Administrative Science Quarterly*, 12(1), 1–47. <http://dx.doi.org/10.2307/2391211>
- Lawrence, P. R., Lorsch, J. W., & Garrison, J. S. (1967). *Organization and environment: Managing differentiation and integration*. Boston, MA: Division of Research, Graduate School of Business Administration, Harvard University.
- Lee, H., & Choi, B. (2003). Knowledge management enablers, processes, and organizational performance: An integrative view and empirical examination. *Journal of management information systems*, 20, 179–228.
- Levinthal, D. A., & March, J. G. (1993). The myopia of learning. *Strategic Management Journal*, 14, 95–112. [http://dx.doi.org/10.1002/\(ISSN\)1097-0266](http://dx.doi.org/10.1002/(ISSN)1097-0266)
- Lichtenthaler, U., & Ernst, H. (2009). Opening up the innovation process: The role of technology aggressiveness. *R&D Management*, 39, 38–54.
- Lynn, G. S., Abel, K. D., Valentine, W. S., & Wright, R. C. (1999). Key factors in increasing speed to market and improving new product success rates. *Industrial Marketing Management*, 28, 319–326. doi:10.1016/S0019-8501(98)00008-X
- Madhavan, R., & Grover, R. (1998). From embedded knowledge to embodied knowledge: New product development as knowledge management. *Journal of Marketing*, 62(4), 1–12. <http://dx.doi.org/10.2307/1252283>
- Markman, G. D., Gianiodis, P. T., Phan, P. H., & Balkin, D. B. (2005). Innovation speed: Transferring university technology to market. *Research Policy*, 34, 1058–1075. <http://dx.doi.org/10.1016/j.respol.2005.05.007>
- Martín-Rojas, R., García-Morales, V. J., & García-Sánchez, E. (2011). The influence on corporate entrepreneurship of technological variables. *Industrial Management & Data Systems*, 111, 984–1005.
- Martín-Rojas, R., García-Morales, V. J., & Bolívar-Ramos, M. T. (2013). Influence of technological support, skills and competencies, and learning on corporate entrepreneurship in European technology firms. *Technovation*, 33, 417–430. <http://dx.doi.org/10.1016/j.technovation.2013.08.002>
- McDonough, E. F., III (2000). Investigation of factors contributing to the success of cross-functional teams. *Journal of Product Innovation Management*, 17, 221–235. <http://dx.doi.org/10.1111/1540-5885.1730221>
- Meyer, J. P., & Allen, N. J. (1997). *Commitment in the workplace: Theory, research, and application*. Thousand Oaks, CA: Sage.
- The Ministry of Science, Technology and Innovation (MOSTI). (2010). *Malaysian biotechnology statistical indicators 2010*. Putrajaya: Author.
- Moorman, C., & Miner, A. S. (1997). The impact of organizational memory on new product performance and creativity. *Journal of Marketing Research*, 34, 91–106. <http://dx.doi.org/10.2307/3152067>
- Nilsson, E. A. (1995). Innovating-by-doing: Skill innovation as a source of technological advance. *Journal of Economic Issues*, 33–46. <http://dx.doi.org/10.1080/00213624.1995.11505639>
- Nystrom, P. C., & Starbuck, W. H. (1984). To avoid organizational crises, unlearn. *Organizational Dynamics*, 12, 53–65. [http://dx.doi.org/10.1016/0090-2616\(84\)90011-1](http://dx.doi.org/10.1016/0090-2616(84)90011-1)
- Patterson, M. L., & Lightman, S. (1993). *Accelerating innovation: Improving the process of product development*. New York, NY: Van Nostrand Reinhold.
- Podsakoff, P. M., MacKenzie, S. B., Lee, J. Y., & Podsakoff, N. P. (2003). Common method biases in behavioral research: A critical review of the literature and recommended remedies. *Journal of applied psychology*, 88, 879. doi:10.1037/0021-9010.88.5.879
- Rice, M. P., O'Connor, G. C., Peters, L. S., & Morone, J. G. (1998). Managing discontinuous innovation. *Research Technology Management*, 41, 52–58.
- Sarin, S., & McDermott, C. (2003). The effect of team leader characteristics on learning, knowledge application, and performance of cross-functional new product development teams. *Decision Sciences*, 34, 707–739. <http://dx.doi.org/10.1111/dec.2003.34.issue-4>
- Saxe, R., & Weitz, B. A. (1982). The SOCO scale: A measure of the customer orientation of salespeople. *Journal of Marketing Research*, 19, 343–351. <http://dx.doi.org/10.2307/3151568>
- Schiavone, F. (2011). Strategic reactions to technology competition: A decision making model. *Management Decision*, 49, 801–809.
- Scott, W. R. (2006). *Organizations and organizing: Rational, natural and open systems perspectives*. New York, NY: Routledge, Taylor and Francis Group.
- Sekaran, U., & Bougie, R. (2010). *Research methods for business: A skill building approach* (5th ed.). Chichester, NJ: Wiley.
- Soane, E., Schubert, I., Lunn, R., & Pollard, S. (2015). The relationship between information processing style and information seeking, and its moderation by affect and perceived usefulness: Analysis vs. procrastination. *Personality and Individual Differences*, 72, 72–78. <http://dx.doi.org/10.1016/j.paid.2014.08.029>
- Swink, M. (2003). Completing projects on-time: How project acceleration affects new product development. *Journal of Engineering and Technology Management*, 20, 319–344. <http://dx.doi.org/10.1016/j.jengtecman.2003.08.002>

- Tabachnick, B. G., & Fidell, L. S. (2012). *Using multivariate statistics* (6th ed.). Boston, MA: Pearson Education.
- Tatikonda, M. V. & Rosenthal, S. R. (2000). Successful execution of product development projects: Balancing firmness and flexibility in the innovation process. *Journal of Operations Management*, 18(4), 401–425. doi:10.1016/S0272-6963(00)00028-0.
- Teece, D. J. (2009). *Dynamic capabilities and strategic management: Organizing for innovation and growth*. Oxford: Oxford University Press.
- Tripsas, M., & Gavetti, G. (2000). Capabilities, cognition, and inertia: Evidence from digital imaging. *Strategic Management Journal*, 21, 1147–1161.
[http://dx.doi.org/10.1002/\(ISSN\)1097-0266](http://dx.doi.org/10.1002/(ISSN)1097-0266)
- Zhang, M., & Yin, X. (2012). The effect of R&D alliances on the speed of innovation: Evidence from Chinese SMEs. *Physics Procedia*, 25, 1155–1161.
<http://dx.doi.org/10.1016/j.phpro.2012.03.213>



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