Creative Knowledge Sharing For Superior Product Development: A Case Study

Poh Kiat Ng, Kian Siong Jee, Multimedia University, Melaka, Malaysia

---

ABSTRACT:

In order for Malaysian manufacturing firms to survive the modern dynamic changes in the existing market, a need has arisen to incorporate knowledge sharing practices with high levels of creativity in product development. With that in mind, this study aims to determine the effect of creative knowledge sharing on product development performance in a Malaysian semiconductor firm. A survey-based method was used to facilitate this study, where a total of 226 survey responses were collected back from the product development engineers of the firm. Using multivariate analyses, it was found that there are significant and positive relationships among knowledge sharing initiatives, creativity and product development performance. However, socialization and externalization initiatives were less dominant compared to combination and internalization initiatives since externalization can be time consuming and socialization captures tacit knowledge that can be overly subjective at times. In conclusion, in order to nurture creative knowledge sharing in product development, it would be beneficial for a firm to provide room for some socialization activities to enrich the idea generation among employees. This paper provides theoretical relevance that explains the mechanisms of knowledge sharing initiatives and creativity in a Malaysian semiconductor firm, with emphasis on the product development process.

Keywords: *Knowledge sharing, Engineering performance, Quality, Cross-functional teamwork.*

---

1. Introduction

In manufacturing firms, knowledge sharing initiatives are considered to be particularly important for product development that normally consist of highly coordinated activities among cross-functional team members (Reilly et al, 2002). Similarly, cross-functional teamwork also plays an essential role as an enabler of knowledge sharing initiatives (Love and Roper, 2009).

Cross-functional teams in product development groups are often used where the focus is on creativity and innovation (Huang and Newell, 2003). In this case, integration of knowledge (or information) from past product development projects may help these teams achieve higher levels of product development performance (Sherman et al, 2005).

Knowledge sharing has the potential to decrease the cost and time of acquiring essential information and has been proven to be an effective strategy planning tool for new product development (Calantone et al, 2003; Chen, 2005). However, the key interest among practitioners appears to be more on the mechanisms as to how product development teams

can improve their collaboration through knowledge sharing (Fernie et al, 2003). Also, identifying relevant important knowledge and utilizing it creatively may still be a challenge for many firms (Kasvi et al, 2003).

Therefore, the aim of this study is to investigate the role of creative knowledge sharing in achieving superior product development performance. The research is in a form of a case study conducted in a Malaysian semiconductor manufacturing firm. In this study, a total of 2000 product development engineers were surveyed, with their respective product development projects as the unit of analysis.

The variables used in this study were creativity, cost, time superiority and the knowledge sharing variables adopted from the SECI model of Nonaka and Takeuchi (1995). Based on the literature review of these variables, a research framework was also constructed.

A total of 226 survey responses were collected back and analysed using correlations and multiple linear regression analyses to validate the developed research framework. The research framework is represented by a combination of 6 hypotheses, which are discussed in the subsequent section.

2. Literature Review

In many large firms, technological knowledge appears to be distributed only among the individual specialists/experts, business units and locations (Grant, 1996; Meeuwesen and Berends, 2007). In view of this, firms tend to adopt knowledge sharing practices as their key strategies to manage their organizational knowledge for strategic advantage (Liebowitz, 1999).

According to Salmador and Bueno (2007), knowledge sharing may be strengthened through creativity. This study will therefore investigate the roles of creative knowledge sharing in enhancing product development in a Malaysian semiconductor firm. The following sections present the literature review on the variables involved which are knowledge sharing, creativity and product development.

2.1. Knowledge Sharing

Knowledge sharing is defined as a mindset which involves building on past experiences and creating new methods for exchanging knowledge (O'Dell et al, 1998). It is also an approach that creates value using a firm’s intangible assets, which can involve combinations of concepts in artificial intelligence, software engineering, organizational behaviour and information technology fields (Liebowitz, 1999).

One of the most common models used in knowledge sharing research is the SECI model which was developed by Nonaka and Takeuchi (1995). In this model, Nonaka and Takeuchi (1995) classifies the knowledge creation process into four elements; which are socialization, externalization, combination and internalization. The model is illustrated in Figure 1.

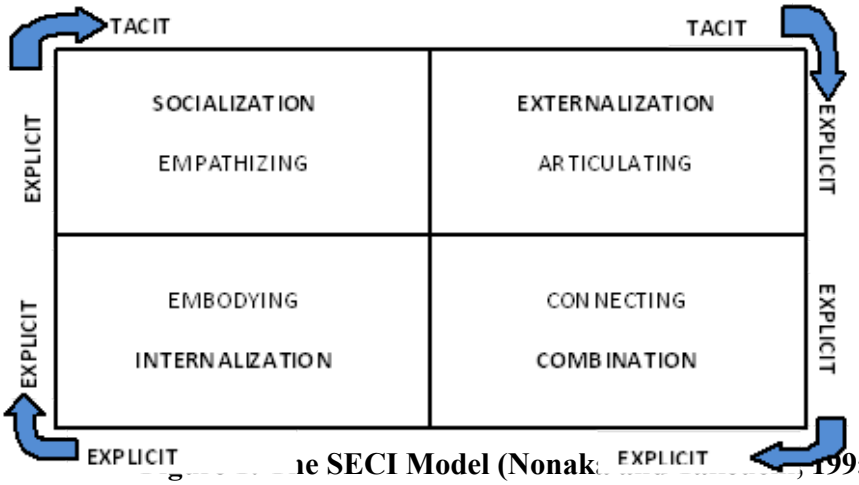

Figure 2.1: The SECI Model (Nonaka and Takeuchi, 1995, p. 72)

Socialization. Socialization can be defined as the act of sharing tacit knowledge through face-to-face communication or shared experience (Choi and Lee, 2002; Vaccaro et al, 2009). Socialization mechanisms such as multifunctional team meetings are able to gather individuals across departments (Lawson et al, 2009). However, tacit knowledge is from implicit learning, which is context-specific and difficult to communicate (Mittendorff et al, 2006). Taking into consideration both of these different views, the contribution of socialization mechanisms for improved product development performance appears to be subjective. Thus, the following hypothesis is proposed:

> ***H1: Socialization correlates with product development performance in a Malaysian semiconductor firm.***

Externalization. Externalization is defined as an act of converting tacit knowledge to explicit knowledge by developing concepts and models (Hoegl and Schulze, 2005). In externalization, tacit knowledge is converted to understandable and interpretable knowledge so that it can be conveniently used by others (Nonaka and Takeuchi, 1995; Choi and Lee, 2002; Li et al, 2009). However, externalization can sometimes be time consuming and difficult to support with the current information and communication technologies (Vaccaro et al, 2009). Consequently, it may be largely categorized in forms of face-to-face interactions or documentation. This will reflect strongly on the creativity and product development performance of a company. Thus, the following hypothesis is proposed:

> ***H2: Externalization correlates with product development performance in a Malaysian semiconductor firm.***

Combination. Combination is defined as an act of compiling externalized explicit knowledge to broader entities and concept systems (Nonaka and Takeuchi, 1995; Bolloju et al, 2002; Vaccaro et al, 2009). In combination, knowledge in explicit forms can be combined with the knowledge processed earlier during the externalization process to produce a more structured and organized form of knowledge (Linderman et al, 2004; Hoegl and Schulze, 2005; Li et al, 2009). However, it is still uncertain if this combination process can produce a more effective product development performance (Sapienza et al, 2004). Therefore, the following hypothesis is proposed:

H3: Combination correlates with product development performance in a Malaysian semiconductor firm.

Internalization. Internalization is defined as an act of understanding explicit knowledge when it transforms to tacit knowledge and becomes part of an individual's fundamental information (Nonaka and Takeuchi, 1995; Bolloju et al, 2002; Vaccaro et al, 2009). However, knowledge stickiness (which can be defined as unwillingness to share knowledge) may be a challenge for internalization initiatives when developing products turn out to be more costly than usual (Li and Hsieh, 2009). This drawback may restrict a company's progress in product development. Hence, the following hypothesis is proposed:

H4: Internalization correlates with product development performance in a Malaysian semiconductor firm.

2.2. Creativity

Creativity is defined as a skill that can generate and translate ideas and vision into a practical and new external reality (Goel and Singh, 1998). It is important in product development because the initial idea is almost never commercialized until after some substantial modification (Stevens et al, 1999). It is through the creativity of employees that concepts grow to be commercialized products (Garcia and Calantone, 2002).

Firms that encourage creativity tend to have more flexible working environments (Augusto and Coelho, 2009). An environment such as this will encourage a company to take more risks in new niche areas. Creativity is also required for the development of new products that are characterized by high levels of complexity (Kazanjian et al, 2000).

Creativity can be nurtured in a less structured environment where most employees have the satisfaction of a conducive work environment to come up with more creative work (Balbontin et al, 2000). Ill-informed interventions, however, may have a negative impact on creativity and the quality of the final product (Bonner et al, 2002). In addition, paying too much attention to operational concerns at a too early stage of a product development phase can restrict the potential conceptual flexibility and creativity of a team (Olson et al, 2001).

Decision-making in product development may depend on common sense and intuition which will require creativity even though organized management decision plans must still be prepared (Thiry, 2002). However, product development team members may be less motivated when dealing with more abstract tasks that require more creativity (Reilly et al, 2002). Thus, the following hypothesis is proposed:

H5: Creativity correlates with product development performance in a Malaysian semiconductor firm.

2.3. Product Development Performance

Product development performance is defined as the degree of success in commercialization which engages the whole supply chain (Customers, suppliers, distributors, engineers and marketing executives) (Iyer et al, 2006). Through product development performance, knowledge from various experts who have undergone the

necessary extensive training is required for design and new product development (Schmickl and Kieser, 2008). Product development performance deals with the objectives of the final product's creation and effects of it to end users (Pheng and Chuan, 2006).

To achieve successful product development performance, multidisciplinary processes are involved, where cross-functional teamwork is crucial for the growth of cost-effective products (Olson et al, 2001). Working on product development projects provides room for continuous improvement, knowledge generation, problem-solving and brainstorming activities (Zika-Viktorsson and Ingelgard, 2006). Therefore, efficient and collaborative teamwork also plays an important role in product development performance (Thamhain, 2004).

However, high failure rates in projects suggest that the management's knowledge in transforming ideas into commercialized products, is far from ideal, especially among highly innovative development projects (Bonner et al, 2002). This shows that companies need to effectively understand and manage risks associated with developing new products since there is a high probability of new product failure and large financial loss (Schmidt et al, 2009). Although the ability to rapidly introduce new products into the market has become a sustainable competitive advantage, it is still exceedingly complex and requires a wide variety of assets, resources and skills (Sen and Egelhoff, 2000).

The abovementioned issues show that in order for companies to survive and adapt to the dynamic changes in the current market, there is a need to integrate knowledge sharing with high levels of creativity in product development to expand a company's competency in developing highly complex and novel products. Therefore, the sixth and final hypothesis is proposed:

> ***H6: Creative knowledge sharing influences product development performance in a Malaysian semiconductor firm.***

Figure 2 presents the proposed hypothetical research framework of this study. The proposed framework suggests that superior product development performance can be attained if the four modes of knowledge conversion interact with creativity aspects in the spiral of knowledge creation in order to potentially trigger new spirals of knowledge creation. This proposition, however, will require further empirical validation. The following sections will discuss the methods to facilitate this gap.

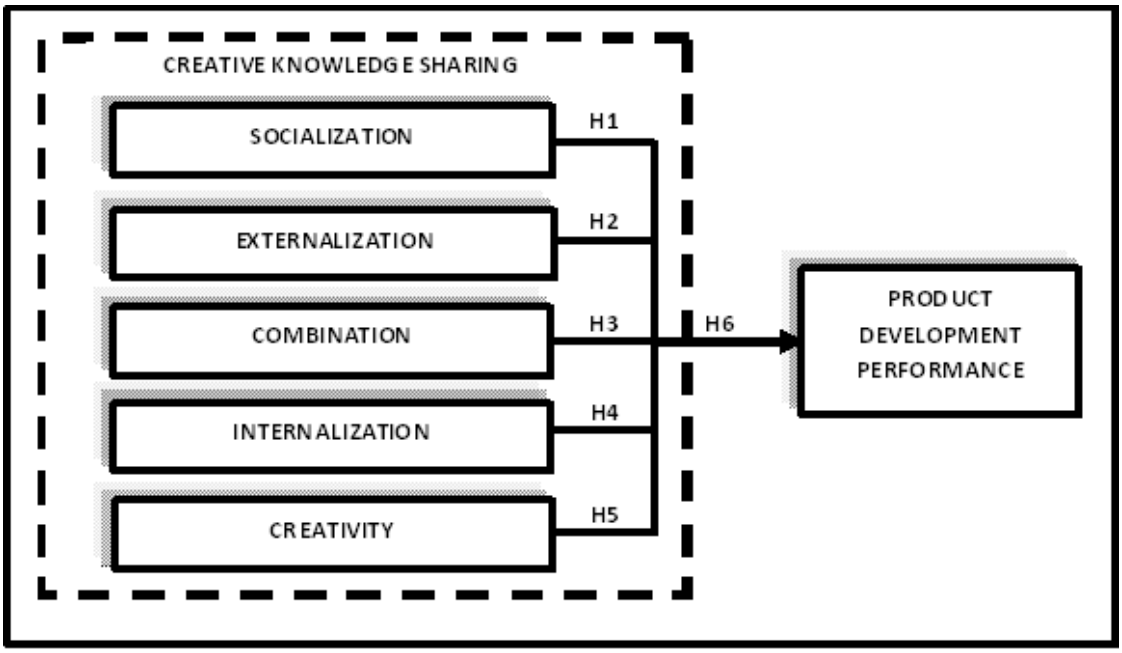

Figure 2: The Hypothetical Research Framework

3. Research Method

The firm chosen for this study was founded in 1999 in Malacca, Malaysia. This firm has about 43,000 employees worldwide, with 6000 of them involved in research and development. Other than in Malaysia, this firm also operates in Germany, Austria, France, Taiwan, Singapore and China.

Based on figures provided by this firm on projects in the last 2 years (since 2009), the firm had 3000 projects in total Due to the high turnover rates, re-assignments and resignations of project leaders, some projects were discontinued. A total of 2000 survey forms were handed out to all the product development managers and engineers in the firm.

As such, the unit of analysis for this study was the product development personnel's respective projects in the firm. Duration of 6 weeks was used to gather the data. The response attained was 226 usable surveys forms out of the 2000 surveys that were handed out, which produced a response rate of 11%. The data was analyzed using the SPSS 18, a quantitative application used for statistical analysis. The statistical methods employed were Pearson's correlations analysis and multiple linear regression.

4. Results

Pearson's correlation analysis is used to evaluate *H1*, *H2*, *H3*, *H4* and *H5*. The following tables present the results on the relationships among knowledge sharing, creativity and product development performance. Table 1 presents the correlation analysis used to evaluate *'H1: Socialization correlates with product development performance in a Malaysian semiconductor firm'*. The Pearson's correlation between socialization and product development performance is 0.504 with a *p* value of 0.000. Therefore, the relationship between socialization and product development performance is positive and significant. Hence, *H1* is not rejected.

Table 1: Socialization – Product Development Performance Correlation

Test	Output	Interpretation
Pearson's Correlation	0.504***	Positive Correlation
Sig. (2-tailed)	0.000	Significant

*significant at $p < 0.05$ level, **significant at $p < 0.01$ level, ***significant at $p < 0.001$ level

Table 2 presents the correlation analysis used to evaluate ***'H2: Externalization correlates with product development performance in a Malaysian semiconductor firm'***. The Pearson's correlation between externalization and product development performance is 0.497 with a *p* value of 0.000. Therefore, the relationship between externalization and product development performance is positive and significant. Hence, ***H2*** is not rejected.

Table 2: Externalization – Product Development Performance Correlation

Test	Output	Interpretation
Pearson's Correlation	0.497***	Positive Correlation
Sig. (2-tailed)	0.000	Significant

*significant at $p < 0.05$ level, **significant at $p < 0.01$ level, ***significant at $p < 0.001$ level

Table 3 presents the correlation analysis used to evaluate ***'H3: Combination correlates with product development performance in a Malaysian semiconductor firm'***. The Pearson's correlation between combination and product development performance is

0.586 with a *p* value of 0.000. Therefore, the relationship between combination and product development performance is positive and significant. Hence, ***H3*** is not rejected.

Table 3: Combination – Product Development Performance Correlation

Test	Output	Interpretation
Pearson's Correlation	0.586***	Positive Correlation
Sig. (2-tailed)	0.000	Significant

*significant at $p < 0.05$ level, **significant at $p < 0.01$ level, ***significant at $p < 0.001$ level

Table 4 displays the correlation analysis used to evaluate ***'H4: Internalization correlates with product development performance in a Malaysian semiconductor firm'***. The Pearson's correlation between internalization and product development performance is 0.549 with a *p* value of 0.000. Therefore, the relationship between internalization and product development performance is positive and significant. Hence, ***H4*** is not rejected.

Table 4: Internalization – Product Development Performance Correlation

Test	Output	Interpretation
Pearson's Correlation	0.549***	Positive Correlation
Sig. (2-tailed)	0.000	Significant

*significant at $p < 0.05$ level, **significant at $p < 0.01$ level, ***significant at $p < 0.001$ level

Table 5 displays the correlation analysis used to evaluate ***'H5: Creativity correlates with product development performance in a Malaysian semiconductor firm'***. The Pearson's correlation between creativity and product development performance is 0.559 with a *p* value of 0.000. Therefore, the relationship between creativity and product development performance is positive and significant. Hence, ***H5*** is not rejected.

Table 5: Creativity – Product Development Performance Correlation

Test	Output	Interpretation
Pearson's Correlation	0.559***	Positive Correlation
Sig. (2-tailed)	0.000	Significant

*significant at $p < 0.05$ level, **significant at $p < 0.01$ level, ***significant at $p < 0.001$ level

A multiple linear regression using the stepwise method was conducted to evaluate '*H6: Creative knowledge sharing influences product development performance in a Malaysian semiconductor firm*'. Five independent variables (Socialization, externalization, combination, internalization and creativity) were tested for ***H6***. Using the formula provided by Tabachnick and Fidell (2001), the minimum sample size required would be 50 + (8 × 5) or 90 respondents. As such, the sample size criterion was met for this study.

Regression formulae are based on the assumption that residuals are normally distributed around the predicted dependent variable scores. For this study, normal probability plots were generated to test this. In the normal probability plots, since the points were in a

reasonably straight diagonal line from bottom left to top right, it can be confirmed that there were no major deviations from normality (Tabachnick and Fidell, 1996; Pallant, 2005). For the normality test, the measure of kurtosis and skewness values for the variables tested were within the prescribed |1.0| range (Tabachnick and Fidell, 1996). Having satisfied the assumptions for regression analysis, all of the four independent variables were regressed against creative product development and the results are summarized in Table 6.

Table 6: Multiple Linear Regression for Creative Knowledge Sharing – Product Development Performance

Creative Knowledge Sharing	*F*	*R*	R^2
(Constant)			
Socialization			
Externalization	94.801***	0.678	0.460
Combination			
Internalization			
Creativity			

(Notes: *p<0.05; **p<0.01; ***p<0.001; N=226; Durbin Watson = 1.653)

From Table 6, the results indicate that up to 46% of the variance in product development performance is explained by socialization, externalization, combination, internalization and creativity. A positive and significant correlation coefficient (R=0.678) was also obtained which supports the final hypothesis, ***H6***.

5. Discussion

From the analyses of ***H1***, ***H2***, ***H3***, ***H4*** and ***H5***, it is evident that the five selected independent variables (Namely; creativity, socialization, externalization, combination and internalization) have a positive and significant influence on product development. This finding is consistent with the fact that knowledge sharing helps to promote successful product development and generates significant value to a firm through its intangible assets (Liebowitz, 1999; Thamhain, 2004).

Also, it was found that the relationship between combination and product development performance is the strongest (R=0.586) among that of the other sub-variables. This may be due to the fact that this particular manufacturing firm has a proven organized documentation system of standards and processes. These standardized procedures allow the firm to easily and effectively utilise knowledge in established knowledge sharing techniques such as training, workshops and projects (Linderman et al, 2004; Li et al, 2009).

The externalization aspect however, appears to be the weakest among the four focused modes in relation to product development performance (R=0.497). One of the possible reasons is that this semiconductor firm employs highly sequential and systematic manufacturing processes that are not only extensive, but also complex. Thus, the tacit knowledge conversion process may be extremely time consuming and not feasible in such a complex condition (Vaccaro et al, 2009). The management and staff may therefore opt not to emphasize too much on converting tacit knowledge to enhance their product

development performance. Instead, it may appear to be more important for the firm to emphasize on existing problems in backend manufacturing processes.

In addition, the relationship between creativity and product development performance also appears to be relatively high (R=0.559) compared to that of externalization's relationship. This finding shows that this firm still strives to be creative in their product development processes apart from combining and externalizing them.

Although it may prove to be a challenge for some product development members at first (Reilly et al, 2002), it is still evident that nurturing creativity is important for knowledge creation and flourishing product development performance (Liu et al, 2005). One of the suggestions for this firm is to have a more flexible environment so that employees can have a conducive atmosphere to enhance their creative and inventive endeavours (Balbontin et al, 2000).

Upon using stepwise multiple linear regression to evaluate ***H6***, it was found that the relationship between all the sub-variables of creative knowledge sharing and product development performance appear to be also positively correlated (R=0.678). In addition to that, the model is significant as indicated by the ANOVA results of F (5, 221) = 94.801, p<0.001.

This finding indicates a relatively stronger relationship with product development performance as compared to the individual correlations of ***H1*** to ***H5***. This is consistent with the contingency theory, which suggests that there is no best, near to best or consistently effective method to manage an firm (Galbraith, 1973). It is likely that the fraction of total effectiveness from knowledge sharing practices and creativity in product development is muddied by the initiatives such as total quality management or concurrent engineering approaches.

6. Conclusion

In this study, it was found that the roles of combination and creativity factors in product development performance were the strongest in the firm among the other sub-variables. This was most likely due to the company's efficient traceability systems, documentation processes and standards.

Apart from that, socialization and externalization proved to be the weakest influences among the four modes of knowledge sharing. This may be because externalization activities are comparatively more time consuming. Also, socialization activities capture tacit knowledge which is cognitive and subjective. However, in order to nurture knowledge sharing and creativity in product development, it would benefit the firm if more opportunities for socialization activities were provided to enrich the idea generation among employees and subsequently offer a more conducive environment for creativity development.

The firm may also need to identify various means such as coffee klatches or brown bag sessions in order to promote socialization and externalization activities that can enrich the shared information among employees. Overall, socialization and externalization are not to be taken lightly, much less ignored in product development.

Also, since externalization activities often tend to remain largely in face-to-face interactions, the company can actually invest in various communication facilities that facilitate face-to-face meetings or social interactions. The usage of social media networks such as Facebook or Twitter should also be encouraged to promote a less structured and stressful environment, which in turn encourages creativity development.

The limitation in this study is the sampling method employed which limits the generalizing of this study beyond the context of this firm. Due to time and budgetary constraints, this study took on a case study approach in which it was only conducted within a large Malaysian semiconductor company. As such, the findings of this study needs to be interpreted within this context and cannot be generalized to other electronics companies in Malaysia. Apart from that, a simultaneous modelling analysis in this study is not possible because the variables cannot be simultaneously tested against each other. This limits the possibility of discovering more relations among the dependent and independent variables.

In addressing the above, it is suggested as a future method, to conduct the study in as many electronics companies in Malaysia as possible. This certainly would allow generalizing the findings and hypotheses put forward in this study. Another suggestion is to conduct in-depth qualitative studies in each technology cluster or business unit of this company to further examine its organizational context for more in depth understanding on the role of knowledge sharing and creativity in product development. Also, observations could be employed to shed more light on this phenomenon. In addition to that, instead of using respondent-reported knowledge sharing and creativity development scales, it would be good if researchers are able to use empirical data from the company's records e.g. sales performance, customer satisfaction, development cost etc.

In addition, a structural equation modelling (SEM) approach using a combination of statistical data and qualitative causal assumptions can be used in order to test and estimate causal relationships. AMOS software can be utilized for this analysis. Using this approach, the variables for this study are capable of being tested simultaneously instead of the conventional method where they are linearly tested with only one variable against another.

All in all, this study empirical evidence to suggest that creative knowledge sharing influences product development performance in a Malaysian semiconductor manufacturing firm. In this study, socialization and externalization factors are found to be often overlooked in product development and deserve serious attention towards the progress and eventual success of product development projects.

7. References

Augusto, M. and Coelho, F. (2009), Market orientation and new-to-the-world products: Exploring the moderating effects of innovativeness, competitive strength, and environmental forces, Industrial Marketing Management, 38(1), 94-108.

Balbontin, A., Yazdani, B. B., Cooper, R. and Souder, W. E. (2000), New product development practices in American and British firms, Technovation, 20(5), 257-274.

Bolloju, N., Khalifa, M. and Turban, E. (2002), Integrating knowledge management into enterprise environments for the next generation decision support, Decision Support

Systems, 33(2), 163-176.

Bonner, J. M., Ruekert, R. W. and Walker, O. C. (2002), Upper management control of new product development projects and project performance, Journal of Product Innovation Management, 19(3), 233-245.

Calantone, R., Garcia, R. and Droge, C. (2003), The Effects of Environmental Turbulence on New Product Development Strategy Planning, Journal of Product Innovation Management, 20(2), 90-103.

Chen, P. C. (2005), On-Demand Knowledge Management Blueprint., Wu-Nan Culture Enterprise, Taipei.

Choi, B. and Lee, H. (2002), Knowledge management strategy and its link to knowledge creation process, Expert Systems with Applications, 23, 173-187.

Fernie, S., Green, S. D., Weller, S. J. and Newcombe, R. (2003), Knowledge sharing: context, confusion and controversy, International Journal of Project Management, 21(3), 177-187.

Galbraith, J. R. (1973), Designing Complex Organizations, Addison-Wesley, Boston, Massachusetts.

Garcia, R. and Calantone, R. (2002), A critical look at technological innovation typology and innovativeness terminology: A literature review, Journal of Product Innovation Management, 19(2), 110-132.

Goel, P. S. and Singh, N. (1998), Creativity and innovation in durable product development, Computers & Industrial Engineering, 35(1-2), 5-8.

Grant, R. M. (1996), Toward a knowledge-based theory of the firm, Strategic Management Journal, 17(Winter Special Issue), 109-122.

Hoegl, M. and Schulze, A. (2005), How to support knowledge creation in new product development: An Investigation of knowledge management methods, European Management Journal, 23(3), 263-273.

Huang, J. C. and Newell, S. (2003), Knowledge integration processes and dynamics within the context of cross-functional projects, International Journal of Project Management, 21(3), 167-176.

Iyer, G. R., LaPlaca, P. J. and Sharma, A. (2006), Innovation and new product introductions in emerging markets: Strategic recommendations for the Indian market, Industrial Marketing Management, 35, 373-382.

Kasvi, J. J. J., Vartiainen, M. and Hailikari, M. (2003), Managing knowledge and knowledge competences in projects and project organisations, International Journal of Project Management, 21(8), 571-582.

Kazanjian, R. K., Drazin, R. and Glynn, M. A. (2000), Creativity and technological learning: The roles of organization architecture and crisis in large-scale projects, Journal

of Engineering and Technology Management, 17(3-4), 273-298.

Lawson, B., Petersen, K. J., Cousins, P. D. and Handfield, R. B. (2009), Knowledge sharing in interorganizational product development teams: The effect of formal and informal socialization mechanisms, Journal of Product Innovation Management, 26(2), 156-172.

Li, C.-Y. and Hsieh, C.-T. (2009), The impact of knowledge stickiness on knowledge transfer implementation, internalization, and satisfaction for multinational corporations, International Journal of Information Management, 29(6), 425-435.

Li, Y.-H., Huang, J.-W. and Tsai, M.-T. (2009), Entrepreneurial orientation and firm performance: The role of knowledge creation process, Industrial Marketing Management, 38(4), 440–449.

Liebowitz, J. (1999), Key ingredients to the success of an organization's knowledge management strategy, Knowledge and Process Management, 6(1), 37–40.

Linderman, K., Schroeder, R. G., Zaheer, S., Liedtke, C. and Choo, A. S. (2004), Integrating quality management practices with knowledge creation processes, Journal of Operations Management, 22(6), 589–607.

Liu, P.-L., Chen, W.-C. and Tsai, C.-H. (2005), An empirical study on the correlation between the knowledge management method and new product development strategy on product performance in Taiwan's industries, Technovation, 25(6), 637–644.

Love, J. H. and Roper, S. (2009), Organizing innovation: Complementarities between cross-functional teams, Technovation, 29(3), 192-203.

Meeuwesen, B. and Berends, H. (2007), Creating communities of practices to manage technological knowledge: An evaluation study at Rolls-Royce, European Journal of Innovation Management, 10(3), 333-347.

Mittendorff, K., Geijsel, F., Hoeve, A., Laat, M. d. and Nieuwenhuis, L. (2006), Communities of practice as stimulating forces for collective learning, Journal of Workplace Learning, 18(5), 298-312.

Nonaka, I. and Takeuchi, H. (1995), The Knowledge-Creating Company: How Japanese Companies Create the Dynamics of Innovation, Oxford University Press, New York.

O'Dell, C. S., Essaides, N. and Ostro, N. (1998), If Only We Knew What We Know: The Transfer Of Internal Knowledge And Best Practice, Free Press, New York.

Olson, E. M., Walker, O. C., Ruekert, R. W. and Bonner, J. M. (2001), Patterns of cooperation during new product development among marketing, operations and R&D: Implications for project performance, Journal of Product Innovation Management, 18(4), 258-271.

Pallant, J. (2005), SPSS survival manual: A step by step guide to data analysis using SPSS Allen & Unwin, NSW.

Pheng, L. S. and Chuan, Q. T. (2006), Environmental factors and work performance of project managers in the construction industry, International Journal of Project Management, 24(1), 24–37.

Reilly, R. R., Lynn, G. S. and Aronson, Z. H. (2002), The role of personality in new product development team performance, Journal of Engineering Technology Management, 19(1), 39-58.

Salmador, M. P. and Bueno, E. (2007), Knowledge creation in strategy-making: Implications for theory and practice, European Journal of Innovation Management, 10(3), 367-390.

Sapienza, H. J., Parhankangas, A. and Autio, E. (2004), Knowledge relatedness and post-spin-off growth, Journal of Business Venturing, 19(10), 809–829.

Schmickl, C. and Kieser, A. (2008), How much do specialists have to learn from each other when they jointly develop radical product innovations?, Research Policy, 37(3), 473-491.

Schmidt, J. B., Sarangee, K. R. and Montoya, M. M. (2009), Exploring new product development project review practices, Journal of Product Innovation Management, 26(5), 520-535.

Sen, F. K. and Egelhoff, W. G. (2000), Innovative capabilities of a firm and the use of technical alliances, IEEE Transactions on Engineering Management, 47(2), 174-183.

Sherman, J. D., Berkowitz, D. and Souder, W. E. (2005), New Product Development Performance and the Interaction of Cross-Functional Integration and Knowledge Management, Journal of Product Innovation Management, 22(5), 399-411.

Stevens, G., Burley, J. and Divine, R. (1999), Creativity + Business discipline = Higher profits faster from new product development, Journal of Product Innovation Management, 16(5), 455-468.

Tabachnick, B. G. and Fidell, L. S. (1996), Using Multivariate Statistics, HarperCollins College Publishers, New York.

Tabachnick, B. G. and Fidell, L. S. (2001), Using Multivariate Statistics Allyn and Bacon, Boston.

Thamhain, H. J. (2004), Linkages of project environment to performance: Lessons for team leadership, International Journal of Project Management, 22(7), 533-544.

Thiry, M. (2002), Combining value and project management into an effective programme management model, International Journal of Project Management, 20(3), 221-227.

Vaccaro, A., Veloso, F. and Brusoni, S. (2009), The impact of virtual technologies on knowledge-based processes: An empirical study, Research Policy, 38(8), 1278–1287.

Zika-Viktorsson, A. and Ingelgard, A. (2006), Reflecting activities in product developing teams: Conditions for improved project management processes, Research in Engineering

Design, 17(2), 103-111.

About the Authors:

Poh Kiat Ng is a Lecturer at the Faculty of Engineering and Technology, Multimedia University, Melaka Campus, Malaysia. He is also a PhD candidate at the Technical University of Malaysia. His research interests are in the areas of knowledge management, ergonomics, biomechanics, quality management, engineering education and manufacturing management.

Poh Kiat Ng, Faculty of Engineering and Technology, Multimedia University, Jalan Ayer Keroh Lama, Bukit Beruang, 75450 Melaka, Malaysia; Email: pkng@mmu.edu.my; Tel: +606-2523044.

Kian Siong Jee is a Lecturer and PhD candidate at the Faculty of Engineering and Technology, Multimedia University, Melaka Campus, Malaysia. His research interests are in the areas of manufacturing technology, manufacturing systems, manufacturing management, materials engineering, maintenance engineering, green technology, quality management, engineering education and knowledge management.

Kian Siong Jee, Faculty of Engineering and Technology, Multimedia University, Jalan Ayer Keroh Lama, Bukit Beruang, 75450 Melaka, Malaysia; Email: ksjee@mmu.edu.my; Tel: +606-2523099.
