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MANAGERIAL IMPLICATIONS IN TECHNOLOGY INNOVATION

PART I: THE IMPORTANCE OF INNOVATION CULTURE IN DEVELOPING INNOVATIVE TECHNOLOGIES

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MANAGERIAL IMPLICATIONS IN TECHNOLOGY INNOVATION

PART I: THE IMPORTANCE OF INNOVATION CULTURE IN DEVELOPING INNOVATIVE TECHNOLOGIES

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Key Findings

- In the Republic of Armenia, innovation culture and its components are regarded as important factors in the process of developing innovative technologies.
- An attempt to detect specific patterns in assessment of such importance depending on individual and organizational characteristics did not uncover any significant differences across industries and respondents.
- Regardless of respondents' age, gender, education, experience, position in the organization, as well as industry, organization's active years in innovation or number of employees, the answers to questions about importance of innovation culture and its components were relatively uniform. Only a few statistically significant correlations were found, which however were quite low.
- The survey, conducted with the purpose of examining the importance of innovation culture and its components for the process of innovative technologies development among various businesses involved in technology innovation, proved to have a rather high reliability and internal consistency.

Technology innovation happens not only in large and advanced economies, but also in small and developing countries. One of them is the Republic of Armenia that has been involved in development of innovative technologies for many decades, before even gaining independence from the Soviet Union (Bonner, 1994). The authors have been observing an upsurge of innovative technological companies and informal teams in the recent years based both on various industry reports (e.g. Enterprise Incubator Foundation, 2018) and their own dealings with them. With this in mind, it was important to gather data on how various facets of technology innovation process management are viewed among such enterprises and groups, and whether these perceptions depend on various individual and corporate attributes. To accomplish this purpose, firstly, the focal facets (along with their components) were established using a literature review, which included: (i) innovation culture; (ii) enabling environment for innovative activities and R&D; (iii) research excellence and quality control; (iv) capabilities/knowledge of the personnel; (v) connection with markets/customers; and (vi) strategic collaboration. Secondly, a study on their perceived importance among Armenian technology innovation enterprises and teams was conducted, with subsequent analysis of the obtained data.

This write-up presents the results of the study on only one of the focal facets in management of the technology innovation process – the innovation culture.

The innovation culture in organizations is one of the key factors contributing to technological progress. An innovation culture is about encouraging creative, outside-the-box thinking among the employees, thus allowing innovation to happen in the corporate environment. An organizational culture that values innovation, where employees are encouraged to think differently, take calculated risks, and challenge the status quo, is one of the key components of an effective innovation system (Serrat, 2017). There are many scholarly studies and real-business evidences confirming that. A seven-year study pertinently titled "The Global Innovation 1000: Why Culture Is Key", concluded that successful companies have a culture that encourages innovation and accelerates its execution, ensuring that the innovation strategy is clearly articulated and communicated throughout the organization from the top all the way down to the lab bench (Jaruzelski et al., 2011). The most recent version of the Global Innovation 1000 study by Strategy& (Jaruzelski et al., 2018) again names company-wide cultural support for innovation as one of the six key characteristics that help companies achieve higher performance.

It is then no surprise that businesses, educational and R&D institutions, and other entities involved in technology development pay close attention to shaping and maintaining innovation culture. Moreover, it may even provide a competitive edge to an entire country. The success of Israel in achieving high levels of technology innovation is often attributed to the culture of innovation reigning in the country. As Shapiro contends, one of the reasons why the immigrant and multicultural nation of Israel continues to be a flourishing high-tech hub despite its location in an increasingly inhospitable region is the Israeli culture of creativity and innovation that encourages the free flow of ideas and collaboration among individuals with very different perspectives (Shapiro, 2013). The author also notes that in many ways, Israel's strong innovation culture runs parallel to that of America, sharing the unique view that entrepreneurial failure is an education rather than a badge of dishonor. Risk-taking in both of these nations is not punished, unlike in many other countries.

On the other hand, it is reasonable to expect that the wrong organizational culture will impede the innovation drive and development of innovative technologies in an organization. For example, risk-averse and bureaucratic cultures are among the factors that may act as barriers to innovation (Tan, 1998;

Agolla & Van Lill, 2016), and hierarchy culture is found to retard both in-bound and out-bound open innovation (Naqshbandi et al., 2015).

These considerations imply that innovation culture can be regarded as one of the focal facets in technology innovation process and its management. It is then useful to determine the specific components that constitute innovation culture and that help shape and maintain it. To answer this question academic literature was reviewed and analyzed to identify practices of innovative enterprises and the direct experiences of the authors in managing companies involved in technology innovation. Innovation culture as a focal facet in technology innovation process management has been determined to have the components shown in the Table 1.

TABLE 1 Innovation Culture and its Components

Innovation Culture and its Components		Literature/Sources
1.	Innovation culture	Paisner, 2000; Jaruzelski et al., 2011; Harper, 2011; Naqshbandi et al., 2015; Agolla & Van Lill, 2016; Serrat, 2017; Shapiro, 2013; Jaruzelski et al., 2018; etc.
1.1.	Encouraging open, free and creative thinking	Amabile et al., 1996; McFadzean, 1998; Paisner, 2000; Robinson, 2013; Serrat, 2017; etc.
1.2.	Free exchange of ideas between individuals with different opinions	Post et al., 2009; Shapiro, 2013; Bergendahl & Magnusson, 2015; the authors' own managerial experiences.
1.3.	As little as possible imposition of formal, bureaucratic procedures on those who are involved in innovative initiatives and projects	Tan, 1998; Cordero et al., 2013; Lundstedt & Moss, 2013; Engberg & Altmann, 2015; Agolla & Van Lill, 2016; etc.
1.4.	Management's encouraging attitude towards risk-taking, and treating failures as lessons and source of knowledge, not reasons for dishonor or punishment	Tan, 1998; Tellis et al., 2009; Shapiro, 2013; Snediker, 2013; Hogan & Coote, 2014; etc.

Subsequently, innovation culture and its components mentioned above were included in a survey to determine their importance for managing development of innovative technologies, the details of which are provided below.

Methodology

The study of the importance of innovation culture was carried out within a wider research project of technology innovation process management problems in the Republic of Armenia. The five-phase methodology utilized during the research is presented below.

First, based on the review and analysis of theoretical and practical underpinnings of innovative organizations' management, the technology innovation process management's focal facets were identified. Second, further review of scholarly literature, interviews with individuals that have considerable experience in technology innovation and the authors' own experiences in the area served a basis to identify important practical components (sub-facets) for each of the above-mentioned focal facets. Third, a survey questionnaire was developed regarding the importance of each of the focal facets and their components in the management of the technology innovation process. Fourth, a survey was conducted among 107 respondents from 52 enterprises and teams in Armenia that were developing innovative technologies. Fifth, the data acquired through the survey were processed and statistically analyzed to determine the significance of the focal facets and their components in the management of the technology innovation process and to make useful conclusions based on the dependence between certain variables.

In the survey, the respondents were asked to assess the importance of the focal facets and their components on a five-point Likert scale, from 1 ("not important at all") to 5 ("very important").

The data acquired through the survey were processed and analyzed by MS Excel and PSPP software using the following methods/measures:

- distribution of the respondents and their organizations according to their demographics/characteristics to find out their possible interdependences with assessment variables;
- Cronbach's alpha to assess the internal consistency and reliability of the survey;
- the importance evaluation score sums and central tendency measures (the mean, median and mode values), which were used to determine the assessed importance of the focal facet and their components in the management of the technology innovation process;
- Yule's Q association and the Phi contingency coefficients to measure the association between the variables;
- Pearson's r and Spearman's ρ coefficients to determine the correlation between the variables.

Cronbach's alpha was used as an internal consistency estimate of reliability of the test scores. The value of Cronbach's alpha was 0.87, showing a good reliability of the observed variables ($0.8 \leq \alpha < 0.9$).

The total scores of importance assessments for the innovation culture's focal facet and its components were calculated. All assessment variables have quite high scores, the highest ones being for "encouraging open, free and creative thinking" and "free exchange of ideas between individuals with different opinions". The lowest score was 409, given to "as little as possible imposition of formal, bureaucratic procedures on those who are involved in innovative initiatives and projects". However, considering that the possible top score was 535, it is still quite high.

The respondents assessed quite highly the importance of innovation culture and all of its components in technology innovation. Median and mode values were either 4 ("rather important") or 5 ("very important") and coincided for all variables but one. Mean values ranged from 3.82 ("as little as possible imposition of formal, bureaucratic procedures") to 4.5 ("free exchange of ideas between individuals with different opinions").

Apparently, the variables selected for this study turned out to be highly regarded indeed by those involved in technology innovation. There are some small differences between assessment scores, with "as little as possible imposition of formal, bureaucratic procedures" considered slightly less important than the others (but still quite high in importance), while "encouraging open, free and creative thinking" and especially "free exchange of ideas between individuals with different opinions" scoring rather close to the maximum.

Further, the survey data were analyzed to determine if there is any association and correlation between the assessments of respondents and their demographics.

Since the nature of ICT businesses is quite different from those in other industries in terms of management peculiarities, speed and completeness of new product development before introduction to market, type of assets used and so on, it was decided to perform association analysis in order to determine if there is a link between the responses and respondent's industry. For this purpose Yule's Q association and the Phi contingency coefficients were used. The two binary variables required for such analysis were defined as follows: ICT and non-ICT; rated importance of ≤3 and ≥4. Both the Yule's Q association and the Phi contingency coefficients were computed for all five questions on innovation culture and its components. The letter designations for binary variables, response numbers and results of calculations are presented in Table 2. Numbering of the questions is the same as in Table 1.

TABLE 2 Yule's Q association and Phi contingency coefficients

	≤3	≥4	
ICT	a	b	a+b
Non-ICT	c	d	c+d
	a+c	b+d	a+b+c+d

	Question #				
Binaries	**1**	**1.1**	**1.2**	**1.3**	**1.4**
a	1	2	1	14	6
b	32	31	32	19	27
c	5	3	4	17	14
d	69	71	70	57	60
a+b+c+d	107	107	107	107	107
a+b	33	33	33	33	33
c+d	74	74	74	74	74
a+c	6	5	5	31	20
b+d	101	102	102	76	87
Yule's Q Coefficient of Association	-0.397	0.209	-0.293	0.424	-0.024
Phi Contingency Coefficient	-0.075	0.044	-0.052	0.198	-0.009

As the perfect correlation in Yule's Q association and Phi contingency coefficients is indicated by values of -1 or 1, the results suggest rather weak correlation between importance ratings and respondent's industry. Near-zero values were obtained for the question 1.4 (risk-taking), while the highest values for Q and Phi were only 0.42 and 0.198 respectively, obtained for the question 1.3 (free of formal procedures). It can be concluded that the respondents' perceived importance of innovation culture and its components depended very little on the industry where technology innovation happens. It has to be noted that this was not the case with some other focal facets and their components that were investigated within the framework of the wider research of technology innovation process management problems, of which this study is a part.

Correlation analysis for the acquired data was implemented using Pearson's r and Spearman's ρ coefficients. Wherever a respondent or organization characteristic was both expressed by a number and possible to meaningfully rank, both Pearson's r and Spearman's ρ were computed. If the characteristic was already in a form of ranking (e.g. education, position, etc.) then only Spearman's ρ was calculated. For the remaining, only Pearson's r was calculated. In addition, the statistical significances of the calculated Pearson's r and Spearman's ρ were checked using the p-values.

The obtained values of Pearson's r and Spearman's ρ along with their p-values are presented in Table 3.

TABLE 3 Pearson's r and Spearman's ρ coefficients with their corresponding p-values

		QUESTION									
		1. Innovation culture		**1.1. Free thinking**		**1.2. Free exchange of ideas**		**1.3. Freedom from formalities**		**1.4. Risk-taking**	
Respondent Characteristic	Pearson's ***r*** or Spearman's ***ρ***	***r* or *ρ***	**p-value**	***r* or *ρ***	**p-value**	***r* or *ρ***	**p-value**	***r* or *ρ***	**p-value**	***r* or *ρ***	**p-value**
Age	Pearson's r	-0.053	0.59	-0.097	0.3191	-0.264*	0.006**	-0.069	0.4827	-0.304*	0.001**
	Spearman's ρ	-0.019	0.849	-0.054	0.581	-0.23*	0.017**	-0.066	0.5008	-0.23*	0.017**
Gender	Pearson's r	-0.163	0.094	-0.154	0.114	-0.113	0.245	-0.076	0.4341	-0.152	0.118
Education	Spearman's ρ	-0.189	0.052	-0.171	0.078	-0.202*	0.037**	-0.243*	0.0117*	-0.301*	0.002**
Experience in innovation	Pearson's r	-0.165	0.09	-0.205*	0.0344**	-0.372*	8E-05**	-0.084	0.389	-0.245*	0.011**
	Spearman's ρ	0.002	0.981	-0.179	0.0657	-0.282*	0.003**	-0.09	0.3554	-0.216*	0.025**
Position	Spearman's ρ	0.067	0.493	0.0343	0.7255	0.059	0.549	-0.001	0.9912	0.1	0.305
Industry	Spearman's ρ	0.061	0.535	0.0854	0.3815	-0.077	0.431	0.1443	0.1382	-0.032	0.744
Organization's active years	Pearson's r	-0.192	0.048	-0.172	0.076	-0.341*	3E-04**	-0.178	0.0668	-0.365*	1E-04**
	Spearman's ρ	-0.113	0.248	-0.112	0.249	-0.196*	0.043**	-0.227	0.0188	-0.297*	0.002**
Organization's # of employees	Pearson's r	0.022	0.821	-0.082	0.402	0.028	0.771	-0.059	0.5465	-0.097	0.318
	Spearman's ρ	0.071	0.47	0.0016	0.987	0.056	0.57	-0.078	0.4227	-0.134	0.168

Note: * r or ρ if $p \leq 0.05$; ** $p \leq 0.05$

It can be observed that no strong correlation was found between respondents' characteristics and importance assessments. Based on Table 3 the highest statistically significant correlations (at $\alpha = 0.05$ significance level, i.e. 95% confidence interval, with $df = n - 2 = 105$ degrees of freedom) were found between:

- age and importance ratings of free exchange of ideas, as well as risk-taking;
- education and importance ratings of free exchange of ideas, freedom from formalities, and risk-taking;
- experience in innovation and importance ratings of free/creative thinking, free exchange of ideas, and risk-taking;
- organization's active years in operation and importance ratings of free exchange of ideas, as well as risk-taking;

However, even these statistically significant correlations were quite low, ranging between 0.2 and 0.37, and all other correlations were both lower and statistically insignificant.

Managerial Implications

This study suggests that managers of technology innovation should pay attention and exert efforts to have a culture of innovation in their entities. In such efforts, it is important to stimulate open, free and creative thinking among their employees. This is likely to cause emergence of differing opinions among them. That is not only acceptable, but also useful for the process, provided that free exchange of ideas between them is encouraged, even if it may lead to some unpleasant altercations. At the same time, when it comes to acting upon these new and creative ideas, managers are advised to encourage taking reasonable risks and convey an understanding that failure is not a verdict, but something to learn lessons from and move on. Finally, although control and reporting are key aspects of any business, technology innovation managers must do their best to free the personnel working on technology development from the burden of formal and bureaucratic procedures as much as possible, so that they can concentrate on value-adding and creative activities.

Future Research

The study was conducted in the Republic of Armenia alone, and all respondents were Armenians, even though many of them studied or worked abroad, while some organizations were foreign-owned or regularly conducted business with foreign companies. Nevertheless, it is reasonable to assume the broad culture may have influenced the answers about innovation culture, since national differences in culture are known to affect how businesses are run and management decisions are made. The study could have benefitted from a more diverse pool of respondents from a greater number of countries. This could be an opportunity for future research, which may also involve a comparative analysis of approaches and importance ratings based on the nationality of the respondents in addition to the characteristics already used in this study. Therefore, a similar survey is planned to conduct in summer 2021 among companies in Southern California.

References

Amabile, T. M., Conti, R., Coon, H., Lazenby, J., & Herron, M. (1996). Assessing the work environment for creativity. *Academy of Management Journal*, *39*, 1154-1185. doi: 10.5465/256995

Agolla, J. E., & Van Lill, J.B. (2016). An empirical investigation into innovation drivers and barriers in public sector organisations. *International Journal of Innovation Science*, *8*, 404-422. doi: 10.1108/IJIS-06-2016-0006

Bergendahl, M., & Magnusson, M. (2015). Creating Ideas for Innovation. *Creativity and Innovation Management*, *24*, 87-101. doi: 10.1111/caim.12097

Bonner, R. (1994, April 27). Business Technology: Thriving in What Was the Soviet Silicon Valley. *The New York Times*. Retrieved from http://www.nytimes.com/1994/04/27/business/business-technology-thriving-in-what-was-the-soviet-silicon-valley.html

Cordero, R., Farris, G., & DiTomaso, N. (2013). Weekly, technical and administrative work hours: Relationships to the extent R&D professionals innovate and help manage the innovation process. *Journal of High Technology Management Research*, *24*, 64-75. doi: 10.1016/j.hitech.2013.02.002

Engberg, R., & Altmann, P. (2015). Regulation and Technology Innovation: A Comparison of Stated and Formal Regulatory Barriers throughout the Technology Innovation Process. *Journal of Technology Management & Innovation*, *10*, 85-91. doi: 10.4067/S0718-27242015000300010

Enterprise Incubator Foundation (2018, December). State of the Industry Report: Information and Telecommunication Technologies Sector in Armenia. Retrieved from http://www.eif.am/files/2329/Armenian-IT-Industry-Report-/2018-ICT-Industry-Report_Eng_v3.pdf

Harper, S. C. (2011). *The Ever-evolving Enterprise: Guidelines for Creating Your Company's Future*, Oxford: ABC-CLIO.

Hogan, S. J., & Coote, L.V. (2014). Organizational culture, innovation, and performance: A test of Schein's model. *Journal of Business Research*, *67*, 1609-1621. doi: 10.1016/j.jbusres.2013.09.007

Jaruzelski, B., Loehr, J., & Holman, R. (2011). The Global Innovation 1000: Why Culture Is Key. *Strategy and Business*, *65*, 1-17.

Jaruzelski, B., Chwalik, R., & Goehle, B. (2018). The Global Innovation 1000: What the Top Innovators Get Right. *Strategy and Business*, *93*, pp. 1-36.

McFadzean, E. (1998). The Creativity Continuum: Towards a Classification of Creative Problem Solving Techniques. *Creativity and Innovation Management*, *7*, 131-139. doi: 10.1111/1467-8691.00101

Naqshbandi, M. M., Kaur, S., & Ma, P. (2015). What organizational culture types enable and retard open innovation? *Quality & Quantity*, *49*, 2123-2144. doi: 10.1007/s11135-014-0097-5

Paisner, M. B. (1999). *Sustaining the family business: An insider's guide to managing across generations*. New York: Basic Books.

Post, C., De Lia, E., DiTomaso, N., Tirpak, T. M., & Borwankar, R. (2009). Capitalizing on Thought Diversity for Innovation. *Research Technology Management*, *52*, *No. 6*, 14-25. doi: 10.1080/08956308.2009.11657596

Robinson, A. (2013). *Exceptional Creativity in Science and Technology: Individuals, Institutions, and Innovations*. West Conshohocken, PA: Templeton Press

Shapiro, G. (2013). What Are The Secrets Behind Israel's Growing Innovative Edge? *Forbes*, 7 November.

Snediker, D. K. (2013). Innovation Management in a Contract Research and Development Corporation. In S. B. Lundstedt, & T. H. Moss (Eds.), *Managing Innovation and Change* (pp. 23-34). Dordrecht, Netherlands: Springer Science & Business Media.

Serrat, O. (2017). Harnessing Creativity and Innovation in the Workplace. In O. Serrat (Ed.), *Knowledge Solutions* (pp. 47-71), Singapore: Springer.

Tellis, G. J., Prabhu, J. C., & Chandy, R. K. (2009). Radical innovation across nations: The preeminence of corporate culture. *Journal of Marketing*, *1*, 3-23. doi: 10.1509/jmkg.73.1.3

Tan, G. (1998). Managing Creativity in Organizations: A Total System Approach. *Creativity and Innovation Management*, *7*, 23-31. doi: 10.1111/1467-8691.00082