SMART® Boards: Implementing Technology for Innovation

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Abstract

Collaboration on campuses, whether business or collegiate, is essential to improving innovation across the street or across the globe. This paper will explore the use of Interactive White Boards (specifically SMART Boards) to connect faculty expertise, in-class experiences and real-world projects. The dynamics of collaboration and the ubiquity of information are stifling to some, yet stimulating to others. Why? What is the perception for satisfaction or dissatisfaction of collaborative technological tools in industry? In order to foster innovative power and to address collaboration in the 21st century, the use of dynamic toolsets such as SMART board technologies could be one consideration in industry and/or higher-education (Engineering Education). Specifically in this paper, the authors survey industry leading upper-level management groups using Interactive White Board (IWB) collaboration. The goal is to evaluate the impact of technology, perception of users, as well as ways to maximize the *how* (in business/industry and in colleges/universities) collaboration might improve success. Using a quantitative study, researchers attempted to determine whether disconnects for change are a derivative of technology and innovation. After all, the process of innovation be it locally or globally, is paramount to future successes. The team of experts within notes the paradigm of Pracademics – a cross between Practice and Academics - as one way to afford best practices within College-Industry (CI) collaboration and for innovation at-large between colleagues. Before addressing C-I, however, an understanding of how certain technological tools are chosen for progress-forward entities.

Introduction

Defining the term **innovation** provides the first basis to our study, as: "an innovation is something original, new, and important - in whatever field - that breaks in to (or obtains a foothold in) a market or society"[1]. The present study included twenty-five participants. Twenty-two of the participants are employed by global manufacturing companies located in the United States; company employers included the Subaru of Indiana Automotive (SIA), a notable worldwide car manufacturing company; the Wabash National Corporation (WNC), a leading internationally recognized trailer manufacturer; Cummins Inc. (CMI), a global corporation designing and distributing engines and power generation systems; and an internationally headquartered helicopter and industrial production entity from the Russian Federation. All 25 participants were senior-level managers or administrative decision-makers managing on a daily basis anywhere from 10 to 5000 people.

The survey-responses are included below as the total sample, counted within the cumulative data analysis. It is noted that after responding to the survey questions, some participants gave interesting commentary regarding SMART technology use in their local markets. For example, the Russian participants described various "culturally intelligent" aspects in using the same technologies in different countries and territories stating that local SMART Tech dealers often sell just the tools (SMART Interactive White Boards) without providing any appropriate ancillary services or even educating local customers to use the whole spectrum of features offered with IWBs. Thus, the connection between the dealer and a new customer often is

fractured in a few months. The same situation is observed in the USA as well, since American participants mentioned identical situations. Also, from a Russian cultural perspective, an innovation is a desire, a free creative (similar to art) working mindset. Thus, for many Russian top-business environments there is a recent almost trendy refusal of "bothersome" SMART technologies. Management prefers to employ large "writing walls" where meeting participants can express their thoughts freely without thinking of computer-related or challenging technologies and instead, rely on human interaction above and beyond the physical touch or newfangled digital 'inking' (SMART's patented technology) allowing the user to write over open applications, files, folders, websites - even over live-video streaming - or any other open window on a computer.

Background

Human nature is to either embrace change, or resist it. Organizations that embrace the change in technology will have a significant competitive advantage. IWB offers the ability to "write" on the board, share files or CAD drawings, record all sessions, use video streaming, and deliver content via the internet all within a large, interactive, touch screen surface in a secure environment. There exists literature suggesting that IWB brings innovation to an organization. The research method approach of our study considers the scientometrics (the quantitative study of science) within the relationship of collaboration - though a full quantitative analysis of science and technology is not the focal point of the survey study herein. Though the use of scientometrics, regarding collaboration, provides illuminating examples as when Northwestern researches found that "high-impact results" are more likely to come from collaborative teams rather than from a single scientist. This is an important revelation with regard to impact factors. As such, another corollary link to innovation is population. For economist Bryan Caplan posits, "more populous countries today produce many more scientific, technological, and cultural innovations than less populous countries"[1]. Indeed, another economist Michael Kremer's population-to-innovation analysis argues, "that technological growth should be proportional to population size" (Ibid). And yet, population density actually causes innovation to grow faster than population size. Indeed, 'Globalization' is critical, entrepreneurially, to succeeding in the worldwide economy (Wilson, M.D., et al, 2013). Moreover, entrepreneurs need to understand *Globalization* and that the evolution of the global economy has brought forth a competitive worldwide marketplace delivering the benefits of reduced labor costs and lower operating expenditures, which could directly affect the product that they are developing[3]. Understanding Globalization successful processes is important to both growth and innovation. The purpose of any project or organization is prosperity.

Is there a cultural, managerial, or generative bias towards technological innovation? A Harvard study looked at the impact of research proxemics on collaboration and determined, proving a priori, "that just being in the same building as your collaborators makes your work better" (Ibid). In a previous pilot study, the authors determined the real disconnect with SMART IWBs is psychological over financial. Herein, we intend to investigate through linear regression and qualitative narrative whether the opportunity to collaborate with new toolsets potentially aids and translates to overall company innovation.

In a subsequent pilot study, despite cited and confirmed limitations of the findings, the research team determined that IWB features remain largely untapped or unclaimed in industry setting on account of psychological factors[10]. Also, that participant motivation increased after a SMART capabilities demonstration. These findings prompted further research statistically as uncovered below.

Finally, a notion for Pracademics (a portmanteau of Practical and Academic) is a teaching style emerging as a way of bridging disciplines of the academic and practical professional worlds. The pracademic often brings industry experience in dealing with uncertainty, ambiguous assignments, limited resources, and constant design constraint; translating such esoteric elements is both hard to teach and even trickier to assess but a pracademic often conveys through a combination of hands-on experiential lessons[9].

Like collaboration, pracademics intersect theory and research with coherent real-world practices. Stanford Researcher Curtis Carlson suggests that the only way to progress is "to learn the tools of innovation" and to go headfirst into knowledge-based and science-based sectors[7]. The new type of "thrivability" is rooted in technological innovation[6]. Indeed, integrating information and communication technology (ICT) is forging new paradigm shifts in collaboration that is at the heart of pedagogy and the educational experience inside and outside the classroom. As IWBs increase in industry, the effectiveness is likely, as in classrooms[4], the *how* entities adopt technology for high penetration and the *why* companies adapt (or often they do not forcing low penetration levels) over stagnation.

Methodology

The purpose of this study is to identify perception and satisfaction of industrial executive leaders and upper-level managers using new interactive technologies/equipment (specifically an IWB) for daily business activities. Using a quantitative design, the research analysis comprises a survey questionnaire following a 20-minute presentation of IWB features (including cost and an open question / answer session) and capabilities; the survey questions focused on satisfaction, perception, and probability of using SMART along with capturing certain demographic information. Prior to distributing the survey, all participants listened to a professional presentation from a SMART-dealer about the IWB features. Each presentation was approximately 20 minutes and the same for each group. After the presentation all participants were invited to use and try the IWB features from inking, to photo capturing, to iPad connecting, to remote video access sharing. The data collection occurred over a few months, on account of complicated scheduling challenges, between March thru December 2013.

A further aspect to the study will be the search for posterior probability. We anticipate further testing to determine that our hypothesis is true, after our survey test, using *sociometrics* (looking for certain fractions of relationships between variables) to coincide with the scientometrics as earlier mentioned. We hope to validate the discriminating power to our survey results in the near future through a grant. The full survey can be found in the Appendix at the end of the paper.

Results (Demographics and Survey)

Demographics

In upper-level industrial management the male population dominates. According to the data below (see Figure 1), about 76% of the participants were male and 16% females. The other 8% of participants did not report their gender.

1. Gender

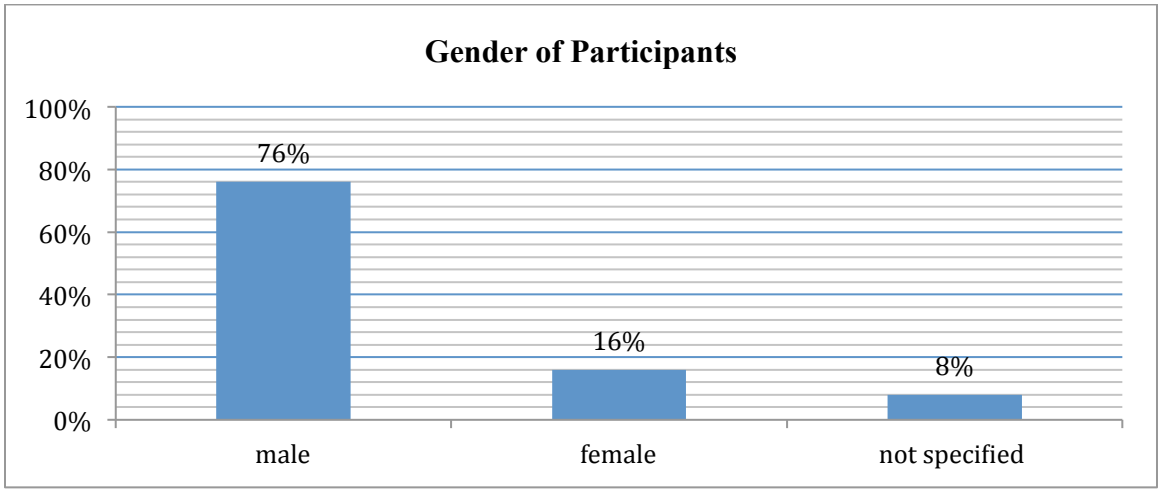

Figure 1. Reported gender of Participants

It should be noted that the majority of participants are recognized as a "young" generation. According to Figure 2, 28% of respondents reported their age in the category between 25-34 years old, 24% of respondents are in category 35-40 years old, and 32% of participants reported their age between 41-50 years old. Only 8% of participants are older than 50 years old.

2. Age Category

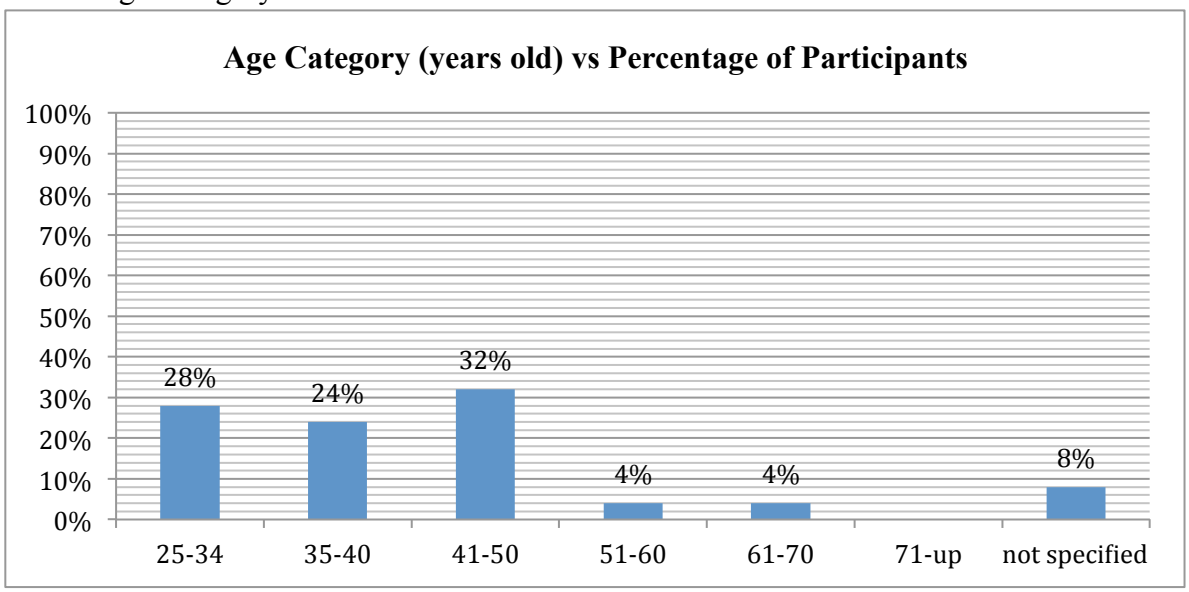

Figure 2. Reported Age of Participants

Responding to the question about educational background, over 88% of the survey participants claimed to have higher-educational degrees. According to Figure 3, 40% of participants obtained a Bachelors degree, 36% of respondents had a Masters degree, and 8% of participants held Doctoral degrees.

3. Educational Level

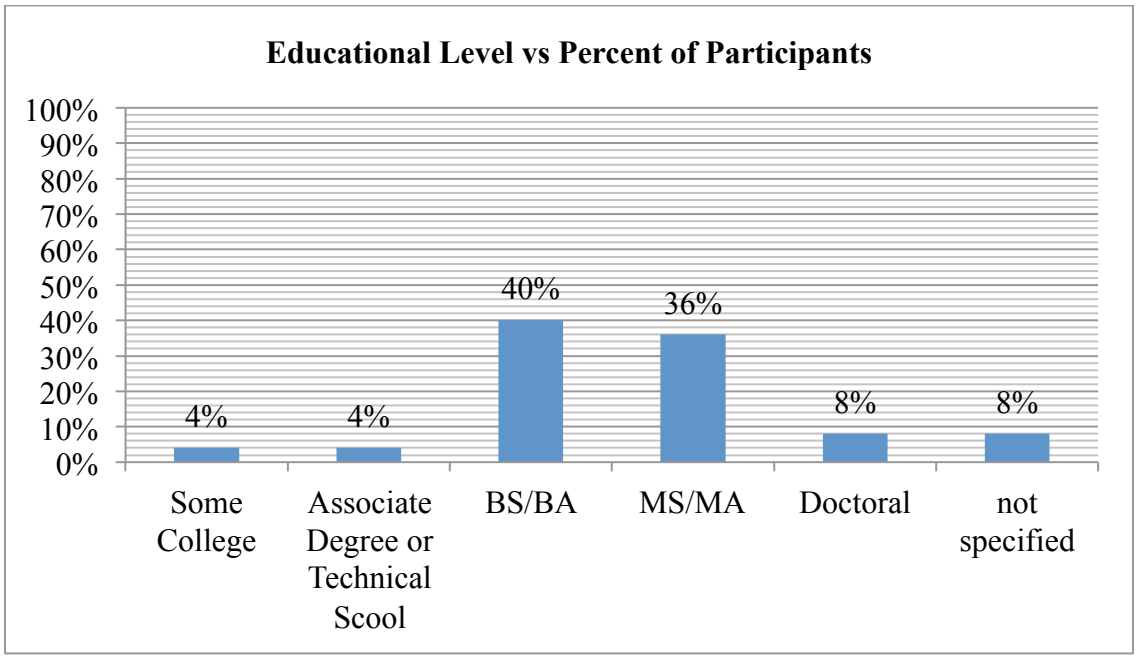

Figure 3. Educational Background of Participants

In the beginning of the survey, participants were asked to answer which technological tools are currently used during daily business meetings. According to Figure 4, the majority of respondents use traditional instruments (such as computers and projectors only).

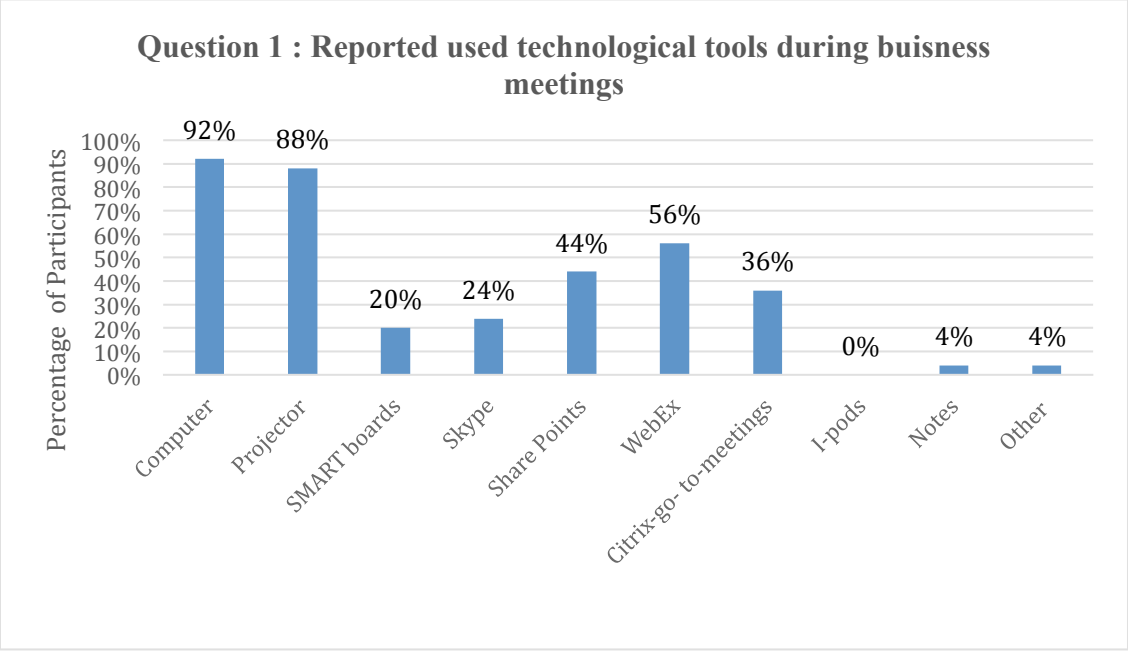

Figure 4. Technological Tools used in Business

The trend above indicates that older technology is used more often than newer technology. Moreover, innovative tools with advanced communication features are adopted slower. One of the reasons for poor adoption is the personal illiteracy or unawareness of the personal or personnel about extended features as well as the additional time and effort in learning new communication instruments. Only 20% of the participants reported to using a SMART Interactive White Board in industry sectors. This data contrasts with a previously reported and estimated 75% SMART penetration of the educational market sectors[5].

Survey Questions

The full version of the survey can be found at the end of this paper. The next five questions are related to the users' perception of the IWB using a 7-point Likert Scale. Figures 5 through 9 visualize participatory responses.

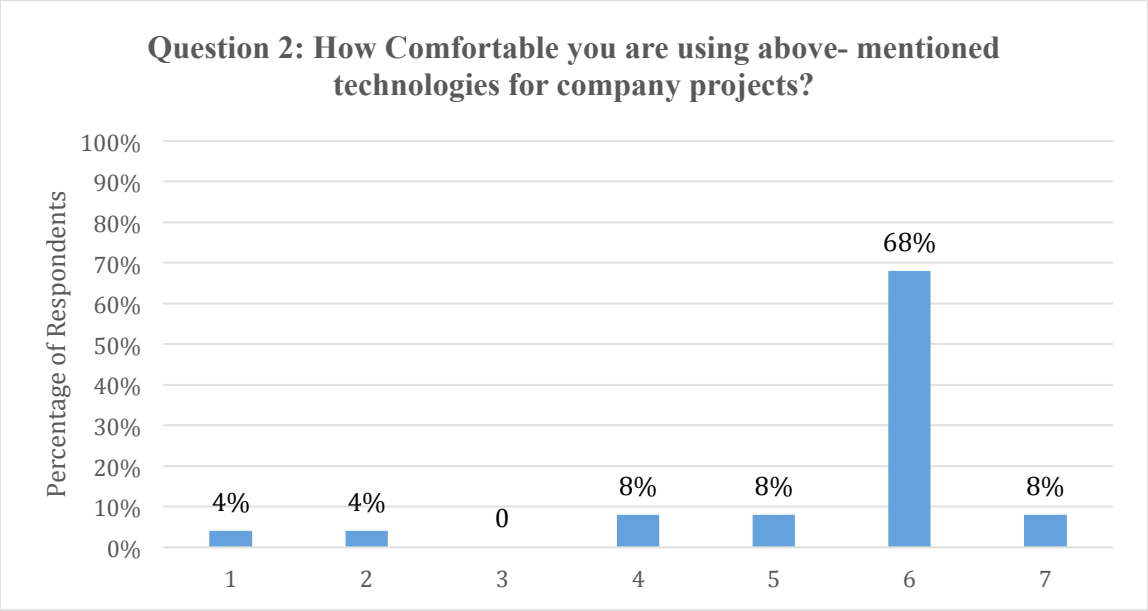

Figure 5. The level of personal self-confidence using technological tools for company needs

Sixty-eight (68%) percent of respondents reported that in most cases they are confident using technological tools and believed that those tools are effective for the organization. About 16% of the respondents stated that they use technologies only when it is required, or are hesitant to use new computer-related instruments. Eight percent (8%) expressed their general dissatisfaction; despite another 8% of respondents who reported an extreme self-confidence in using those tools.

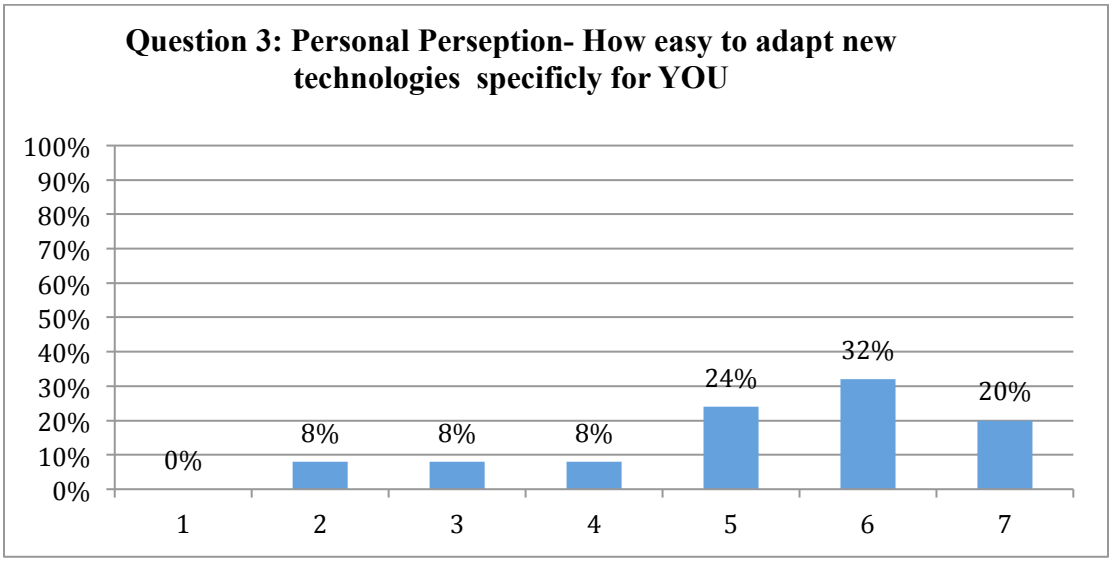

Figure 6. “Easiness” to adapt new technologies

Responding to the next question of “how easy is it to adopt new technologies?” for a specific person, there is a sweeping shift in responses – moving from left (hesitant) gradually to the right (extreme comfort). The peak of 32% of responses reported that adaption of new technologies is

not a problem for them. Twenty-four (24%) of participants said that they do not have major problems to employ new tools, but still feel hesitant and sometimes obligated to do so. The other 20% of survey-responders stated their high proficiency for any new technological instruments. But on the other hand, a total of 24% (scales 2-3-4) reported that adaption of new tools is difficult for them, or they expressed the "neutral" state.

As above-mentioned, before distributing the survey, all participants experienced a 20 minute presentation / participation demonstration about IWB features conducted by the local SMART-dealer Value Added Reseller (VAR). The next question (Figure 7) presents satisfaction of participants after the presentation. Basically, participants reported whether they like the SMART product (IWB). The vast majority of participants (scales 5-6-7), in total 83% of respondents, liked the presentation and expressed their interest in learning more about the IWB offering.

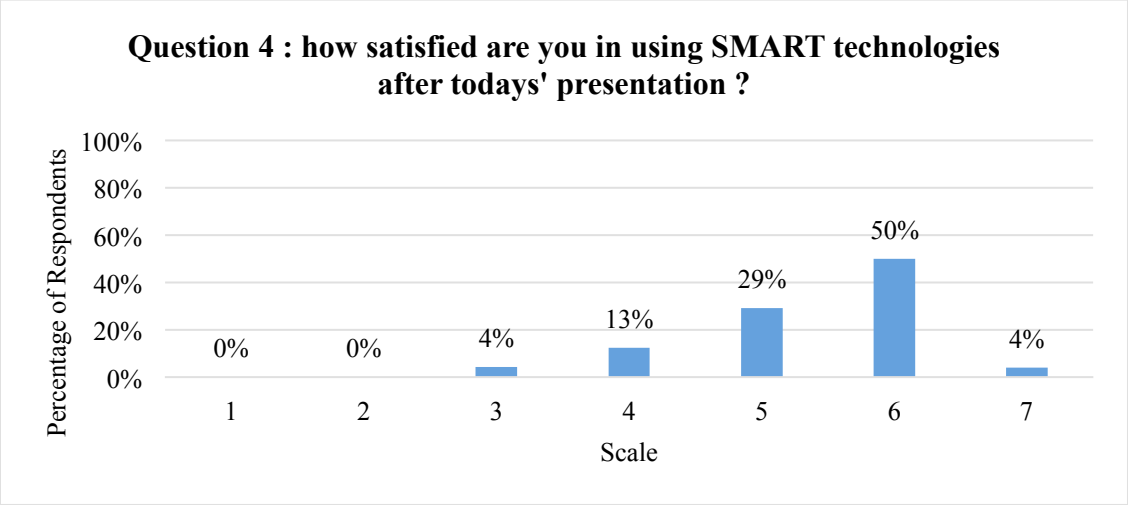

Figure 7. Reactions on IWB Presentation

Again, the peak of 50% believe SMART boards could positively impact company performance while 29% believe SMART would improve collaboration but remain hesitant to use daily. One of the reasons for such behavior may be the point that the content of daily meetings is simple enough and does not require sophisticated computer tools to make the meeting effective, relatable, and understandable. A similar peak was observed answering the question about improving company dynamics using SMART boards (Figure 8). Some fifty-two (52%) of participants indicated that the meeting performance would improve using IWB technologies.

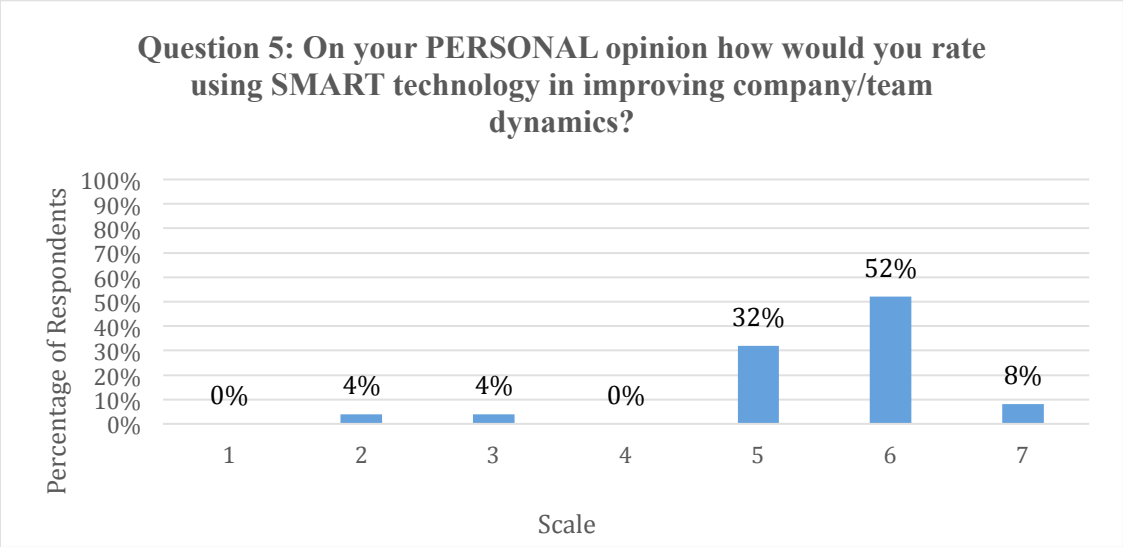

Figure 8. IWB impact on company / team dynamics

The most interesting data is represented in Figure 9 identifying the factors that impact a manager's decision to purchase and employ IWB technologies for daily business activities. This Figure represents three factors including financial, motivational, and internal readiness.

Financial - Am I ready to pay money for the SMART equipment? *(From scale of 1-7; mark that applicable)*

1	2	3	4	5	6	7
It is a waste of money	My company does not need it because we will never use it	Possibly – we do not need it, but I might change my mind	Neutral	Maybe - yes	Yes, we might seriously think about employing this tool in our company	Yes, my company needs it now

Motivational - do I see the importance of this tool/technology? Is it necessary for the organization? *(From scale of 1-7; mark that applicable)*

1	2	3	4	5	6	7
I see no value in this tool			Neutral			Yes, it is a very important tool

Readiness- Am I internally ready to force myself to learn about this tool and to employ it in my daily life? *(From scale of 1-7; mark that applicable)*

1	2	3	4	5	6	7
I do not want to deal with it at all	I do not want to do that	I am not ready, but might change my mind	Neutral	I will use it ONLY if I have to, someone else has to show me how	I will use it in a majority of cases	Yes, I am ready and I will use it daily

Figure 9 shows that the financial factor is not the most important aspect impact on manager decision-making. The neutral stage is represented by scale 4. The peak 42% of respondents showed "neutral" motivation (scale 4). Basically, they are not against using IWB tools, but do not have enough inspiration to work with it on an everyday or ongoing basis. In this case, people choosing a neutral scale 4 also have concern about financial expenses. In general, participants who chose scales 1-2-3 (arrow A) are more skeptical about IWB as compared to participants with more positive responses, scales 5-6-7 (arrow B). In the area of arrow **A** the financial aspect is the least important, and motivation and internal readiness are the primary factors that impact decision-making. For example 17% of respondents (scale 2) reported their non-readiness to work with an IWB, as "I do not want to do that." In scale 3, 26% of participants still show a low motivation for readiness as in, "I am not ready, but might change my mind."

In the arrow B area (scales 5-6-7) the financial factor is more influential. Participants are ready to invest in the purchasing of SMART boards once they have seen the importance of this tool for their company and thus have high internal readiness to learn about SMART.

Other interesting factors come from scales 6 and 7. If managers are personally interested to learn about IWB and the potential use in daily / business life, they are ready to pay for the tool; it is not important for them if the IWB impacts the company performance or not, rather managers are ready to spend the money only because they are personally interested in the tool. The conclusion is that personal internal readiness of upper level management is the first influential factor for the company to use or not to use IWB technologies.

Below indicates the results when we ran the logistic regression[1] with Q4 as the outcome (dependent) variable and Q6_1 (Financial), Q6_2 (Motivational) and Q6_3 (Readiness) as the predictor (independent) variables. The summary of the results are shown in the table below: Using SPSS software for prediction: B is the coefficient on the independent variable; the Wald test is used to test the true value of the parameter based on the sample estimate; S.E. is the standard deviation of the sampling distribution of the static; Exp(B) is the odds ratio predicted by the model; df refers to the degrees of freedom, the number of values in the final calculation. The statistical significance in our testing, the ***p*-value** is the probability of obtaining a test statistic as extreme as the one that was actually observed, where the null hypothesis is true. A researcher will often "reject the null hypothesis" when the *p*-value turns out to be less than a certain significance level, often 0.05 or 0.01.

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	Q6_1	.083	.420	.039	1	**.843**	1.087
	Q6_2	.768	.522	2.167	1	**.141**	2.156
	Q6_3	-.924	.433	4.562	1	**.033**	.397
	Constant	2.099	2.447	.736	1	**.391**	8.156

a. Variable(s) entered on step 1: Q6_1, Q6_2, Q6_3.

[1] Logistic regression, in statistics, is a type of probalistic classification model used to predict or refer specifically to the problem in which the dependent variable is binary.

Using binary logistic regression, as provided, where the outcome is coded as "0" or "1" and leads to the most straightforward interpretation e.g. Are managers apt to invest in SMART after a presentation of the features. The significance column has been highlighted and it contains the p-values for the 3-predictor variables. Q6_3 has a p-value less than 0.05 and so it significantly affects the outcome variable; which correlates to the internal "readiness" of managers to use SMART technology after a presentation. Also, Q6_2 is close to the 0.05 cut-off threshold, but is not significant. Whereas, Q6_1 has a high p-value and so, it is least indicative of the outcome variable, among the 3-predictor variables, supporting our findings that financial factors are not significant. Nor is gender a significant variable in our study.

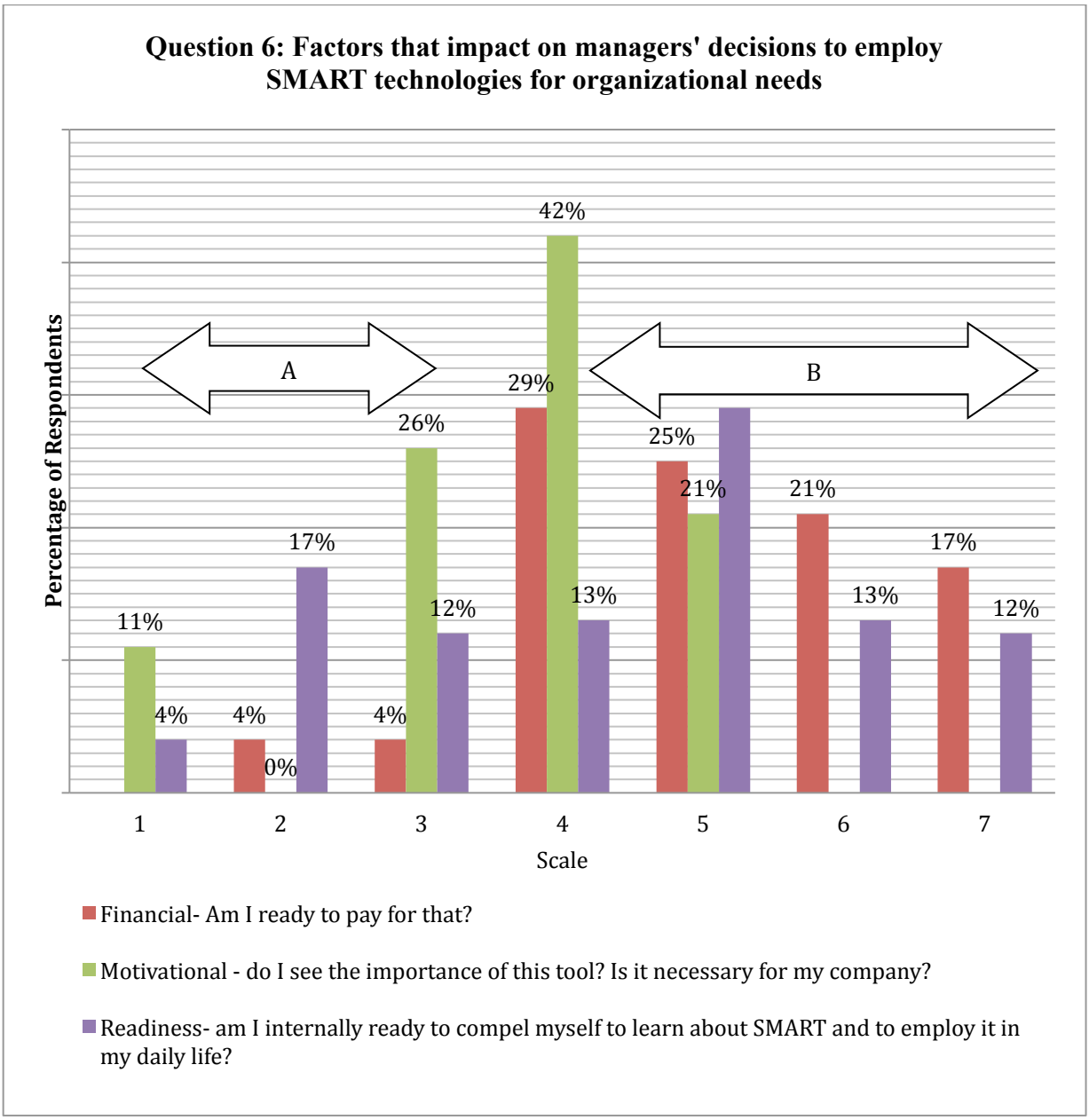

Figure 9. Factors that impact manager' decisions to employ IWB technologies

Conclusion

Although the results of the study spawn more questions than provide answers, it is a stepping-stone into conducting a longitudinal study regarding IWB, technology, pracademics, collaboration, and innovation. This initial study was relatively small, yet it was important to show the perceptions of using SMART boards within organizations before studying further.

The overall study is designed to answer the question of whether or not embracing the use of technology such as IWB leads to greater innovation within an organization, ultimately giving them a competitive advantage. In order to answer this question and focus on implementing best practices on collaboration and improving innovation, the perception of factors that influence users utilization of this technology must be understood. Therefore, three specific factors were evaluated in relationship to a manager's perceptions on their willingness to use technology such as IWBs. The three factors are financial, motivational, and readiness. The results indicated the financial factor was not significant in the manager's decision-making process of whether or not to use the IWB technology. This was surprising as the initial cost to invest in the technology starts around $10,000 and can go well above $100,000. In order to implement the full collaboration functionality of the IWB, more than one unit would need to be purchased. In addition, resources would need to be spent on demonstrating the capabilities and advantages of the foresaid technology.

Furthermore, the motivational factor did not show as being significant to the manager's decision to use IWBs. Although after the short informative presentation concerning the capabilities of IWBs, the majority of respondents had a positive attitude/perception/satisfaction regarding IWB concepts and capabilities.

The final factor, internal readiness, is the most important factor impacting a company's decision to employ IWBs. The decision-making becomes easier upon understanding the importance of innovative tools especially if an impact on company performance is at stake. And yet, upper-management is the primary influential factor as to whether a new technology, a SMART IWB in this study case, is purchased and subsequently introduced. However, the stakeholders of an entire entity, in order to implement and use productively, must overcome the complexity of using new technology tools. This is the technological challenge to innovation, full participation and company-wide adoption.

In summation, according to the obtained demographics of this study, the majority of current industry top-managers are in the age category of under 40-years of age. This category is classified as a "young generation" and some are even recent college graduates (who graduated less than ten years ago). Thus, an important question should be raised in future studies about the college preparation of engineering leaders and top-managers. Often innovation involves risk, of which psychological discomfort in adapting new tools or working environs is an example (as demonstrated with IWB-like products). The study confirms that if the leader internally is ready for new challenges and has the desire to learn something new, even a financial factor will not prevent the company from adapting technologies for better ways of communicating. It is critically important to provide engineering students with the abilities to work under fast-changing environments and to educate them to be psychologically ready for the new challenges in

academia and in industry. Notably, decision-making in an ill-defined setting can be different from the decision-making in familiar classroom settings. Specifically, this is the crux for future engineers and why pracademic approaches matter: an engineer's professional life will require working in ill-defined settings with constraints; this is where Engineering Education helps.

More research is required to connect the rigorous correlation between technology and innovation in the near future.

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Appendix: Survey

SMART Technology Learning Tools: Analysis of Industry Leader Perceptions and Satisfactions

SECTION 1

1. **When your company conducts business meetings or educational events, what technologies are used** *(Mark X if used):*
   - Computer
   - Projector
   - Smart Boards
   - Skype
   - SharePoint
   - WebEx
   - Citrix GoTo Meeting
   - IPods
   - Other _____

Using a 7-point scale, please respond to the following questions (from #1 to # 4):

1. Very unsatisfied (Do not use)
2. Usually dissatisfied but have to make it work (Learn it because forced - minimal use)
3. Dissatisfied but manageable (Force myself to learn but try to remain positive)
4. Neutral (Use it only when required)
5. Satisfied but hesitant (Do not use as often as possible)
6. Satisfied in most cases (Believe that it is effective for the organization)
7. Very satisfied (Always try to apply in different settings)

2. **How comfortable are you using the above-mentioned technologies for company projects?**
   1 2 3 4 5 6 7

3. **When your company decides to purchase and use a new tool/technology for daily routine activities (for example: supervisors' meetings, business conference calls, and etc.) how easy is it SPECIFICLY FOR YOU to adapt the new technology**?
   1 2 3 4 5 6 7

4. **How satisfied are you in using the SMART technology from today's presentations?**
   1 2 3 4 5 6 7

5. **On your PERSONAL opinion, how would you rate using SMART technology in**

improving company/team dynamics? *(Mark that applicable)*

1	2	3	4	5	6	7
It won't help at all.	I am skeptical about this tool	It might help, but most possibly it won't.	Neutral	It might help a little bit	It will help significantly	It will help dramatically. Meetings effectiveness will be highly increased. We need it!

6. **What factors might prevent you from using SMART tool technologies for?**

   a. **Financial** - Am I ready to pay money for that equipment? *(From scale of 1-7; mark that applicable)*

1	2	3	4	5	6	7
It is wasting of money	My company does not need it because we never use it	Possibly – we do not need it, but I might change my mind	Neutral	Maybe - yes	Yes, we might seriously think about employing this tool in our company	Yes, my company need it extremely

   b. **Motivational** - do I see the importance of this tool/technology? Is it necessary for the organization? *(From scale of 1-7; mark that applicable)*

1	2	3	4	5	6	7
I see no value of this tool			Neutral			Yes, it is very important technology.

c. **Readiness**- Am I internally ready to force myself to learn about this tool and to employ it in my daily life? *(From scale of 1-7; mark that applicable)*

1	2	3	4	5	6	7
I do not want to make a deal with that at all	I do not want do that	I am not ready, but might change my mind	Neutral	I will use it ONLY if I have to, someone else has to show me how.	I will use it in majority of cases	Yes, I am ready and I will use it

7. Was the Project Management presentation better or easier to follow today because of the technology tools used?

1 2 3 4 5 6 7

SECTION 2

Please answer the following demographic/general questions:

a. Field/ Industry:
   - Title _____
   - Occupation_____

b. Age (Select Range)
   25-34
   35-40
   41-50
   51-60
   61-70
   71 and older

c. Gender (M or F)
   - M
   - F
   - I wish not to disclose

d. How many people do you manage currently?
   1-20
   21-50
   50-100
   101-250
   251-5000
   Up 5000

e. Ethnicity
   - African
   - Caucasian
   - Spanish
   - Other

f. Education background (Specify)
   - Some college (not a degree)
   - Technical School or Associate Degree
   - BA / BS
   - MA / MS
   - Doctoral / Professional