Innovating in IS: a Pharmaceutical Case Study into Modelling Creative Climate.

Completed Research

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Abstract

This case study was a qualitative exploration on the influencing characteristics of creative climate, within IS innovation teams at a top tier “Big Pharma” company. Using Template Analysis, a 14-dimension theoretical model was tested against qualitative data from 35 IS innovation stakeholders. A good fit was found in the qualitative codes derived from the field data. Further, the theoretical model was expanded to produce a rich set of sub-classifications. This study contributes to literature as Conceptual Research and adds to the extant literature by providing additional perspectives and extending the model within a new context; IS teams supporting drug development. The method and output of this research can be used by innovation and knowledge management practitioners in IS environments as a template model as they try to gain deeper understandings, mitigate barriers, and support enabling opportunities to create new knowledge, solve problems, and improve innovative output.

Keywords

organizational creative culture, innovation, creativity, creative climates, creative press, organizational change

Introduction

The sharp patent decline currently being experienced in the pharmaceutical industry has resulted in a seismic shift in thinking and approaches. VanEck (2016) estimates that the period from 2015 to 2020 will see a global loss of sales of $215bn (US) due to patent expirations, and this has produced a rethink on several frontiers: supply chains, mergers, employment, technology, etc. According to Horrobin (2000), at the forefront of the industry’s rebirth is the need for drug product innovation. However, Segerstrom (1998) suggests that the maturity of the Pharmaceutical industry indicates that all of the quick wins may have been already accomplished.

According to NIHCM (2002), between 1989 and 2000, of the 1035 new drugs that were approved by the FDA, only 15% were approved as New Molecule Entities (NMEs). Examples of these true innovations are Fosamax, and Actos. 46% of new drugs approved during that time were spin offs of already available active ingredients. More recent, an analysis by Paul et al. (2010) suggests that NME’s approved globally between 2005 and 2010 were down 50% compared to 1999 to 2004. Pammolli et al. (2011) suggest that due to a lack of innovation, ‘Big Pharma’ has found itself in its current patent crisis position.

According to West and Altink (1996), the role of innovation in today’s knowledge economy is a well discussed strategy to increase competitiveness and as stated by Tidd and Bessant (2009), “Innovation furthers business growth, enables companies to capture larger market share, and is a means to increase overall profitability.” In the pharmaceutical industry, technology plays a foundational role in generating new ideas for drug product innovation and development. Examples of this include using Natural Language
Processing (NLP) to analyze and provide insights on millions of data points in “real-world evidence” patient cases. Another example includes using IT to map gene targets to diseases and chemical entities, producing rich ontologies which open up opportunities for product innovation. A third example may include using Artificial Intelligence (AI) to analyze millions of medical research papers to produce knowledge maps or graph databases of the domain, similarly identifying innovative opportunities for technical scientists. Paul et al. (2010) details drug R&D research avenues for improved innovation in which technology supports. Olszak et al. (2018) categories the use of IS that support an organization’s ability to produce innovative output into six broad areas: (1) Problem finding and innovation opportunities (2) Acquiring information resources (3) Information analysis, knowledge discovery, providing suggestions concerning new ideas (4) Evaluating and selecting discovered knowledge (5) Communicating newly discovered knowledge in an organization, and (6) Evolving creative knowledge in an organization, organizational learning.

The application of innovative IS is a partnership between relevant technical subject matter experts and IS technical teams. Key activities encompass understanding the innovation opportunity, and subsequently either adapting commercial software, and / or developing open source applications or in-house development. According to Bennetts et al. (2000) the role of IS Subject Matter Experts is one of facilitation, and that technology adaptability is a social process. Innovation and its main precursor creativity are facilitated at a human level (Amabile 1997). Single ideas may originate from an individual, but the ecosystem of idea development and its implementation is usually a team effort (West 2002).

The aim of this paper is to explore the creative press of teams that produce innovative IS. At the start, we examine the relevant literature covering creativity, innovation, and creative climates. Next, an inductive research approach is described with the aim of exploring in more detail creative climates within a case study environment for innovative IS. Then key learnings are presented and discussed. Finally, the contribution to both the literature and industry are presented.

**Literature research**

*Creativity and Innovation*

Creativity and innovation are two related constructs that are sometimes used interchangeably. The most widely used definition of creativity according to Mumford (2003) is the definition of Stein (1974), “novelty that is useful.” Innovation is defined by Ekvall (1997) as “a creative idea that has been brought to application,” or “something useful that works.” Creativity can be thought of as the first steps of innovation (George 2007), and Mumford et al. (2003) additionally suggests that innovation can be thought of as “late-stage creativity.” According to Tidd et al. (2009), “innovation is consistently found to be the most important characteristic associated with (organizational) success”, and Muller and Ulrich (2013) extends this picture by writing, “whether or not companies succeed in their innovation efforts largely depends on their creativity.

*4-Ps Creativity Model for IS*

According to Muller et al. (2013), modern IS creativity research is rooted in the field of psychology. Muller et al. (2013), writes, “IS literature has adopted key concepts from the psychology and management literature in which there is a firm belief that individual and group creativity are motivated and enhanced through organizational incentives such as work climate, and reward systems.” Building on the work of Rhodes (1961), Couger (1996) developed an IS-specific framework of four highly interactive components for creativity: person, process, product, and press. This is regarded in the IS domain as the “4-P model”.

According to Muller et al. (2013), the component of person is concerned with the disposition of individuals. The process component is concerned with motivation, perception, learning, thinking, and communication. The product component is concerned with the artifacts of thoughts that can be tested, evaluated, and analyzed in terms of creativity. Finally, the press is concerned with the work climate and its support for creativity in the organization. The literature used the word “climate” and “press” synonymously, but for consistency the remainder of this paper will use the term “climate” unless referring directly to the 4-P model.

According to Couger et al. (1993), “the creative output of IS organizations is influenced by organizational values and norms that promote and chart a course for creative activities.” Organizational climate is defined
by Isaksen et al. (2001) as, “recurring patterns of behavior, attitudes, and feelings that characterize life in an organization.” Climate leverages enablers at the individual, the team, and the organizational levels (Amabile 1997; Amabile et al. 1986; Hunter et al. 2007; Mumford and Hunter 2005; Oldham 2002) and according to Hunter et al. (2005) “creates a force for action.” Meaning and interpretation of one’s environment are the essences of climate (James et al. 1988) and granular studies are likely to yield greater understandings of behavior in organizations because people’s behavior is based on their interpretations they attach to situations (Gioia and Poole 1984).

Seidel et al. (2010) analyzed the key IS journals and determined that the 4-P model to be the most frequently used creativity framework, however, according to Khedhaouria et al. (2014), IS studies using the 4-P model has mainly focused on processes. Muller et al. (2013) in a detail analysis of IS literature, indicated that studies performed concerning the component of creativity has focused on technologies that support creativity, such as virtual environments. A pertinent study by Fagan (2004) qualitatively measured a Work Environment Inventory (WEI) model within a software development environment, and concluded that “that creative climate stimulants were significant determinants of work creativity.” There seems to be a paucity of studies of the press component in the 4-P model with working IS environments that explores creative climates in the development of innovative IS jointly with business subject matter experts to solve problems related to innovative output. This research addresses an exploratory approach to fill the knowledge gap in exploring creative climate characteristics for innovative IS that aids the development and supply of drugs.

Theoretical Model for Creative Climate

Examining the literature, there is a wealth (40 plus) of suggested taxonomies for creative climates. According to Hunter et al. (2005), the quantity of literature suggested creative climate taxonomies leaves innovation managers and researchers with a “fuzzy view” of its understanding and dimensions. For example, Ekvall (1997) produced a 9 level creative climate taxonomy, consisting of (1) Challenge (2) Freedom (3) Trust (4) Idea Support (5) Playfulness (6) Conflicts (7) Idea Time (8) Debate, and (9) Risk Taking. However, Nystrom et al. (2002) proposed 6 dimensions: (1) Support for new ideas (2) Encourage freedom (3) Challenge (4) Risk (5) Assumption (6) Debate. Responding to the need for a comprehensive, creative climate taxonomy with explicit definitions, Hunter et al. (2005), proposes a taxonomy shown in Figure 1, which according to the authors maps to 95% of the dimensions of over 40 creative climate taxonomies found in the literature.

![Figure 1: 14-dimension Creative Climate model](image-url)
The research questions in this research were:

1) Are the characteristics of Hunter’s (2005) theoretical model presented in Figure 1, representative of the creative climates within a Pharmaceutical IS context?

2) If Hunter’s (2005) theoretical model in Figure 1 is a good fit, what are the enriched dimensions that provide further sub classifications to the theoretical characteristics for this type of IS organizational environment?

**Research Approach**

**Research Design**

The main purpose of this study is to propose a comprehensive, conceptual framework, so that the characteristics of organizational creative climates can be explored in a rigorous manner. To address this objective a qualitative inductive methodology is used. This approach will test and build on the theoretical model for further exploration insights and meaning. The approach has 4 stages: (1) select relevant informants (2) design qualitative data gathering tools (3) conduct research (4) analyze results (5) present key learnings.

**Informants**

Within the case study’s IS project teams framework a four level hierarchal structure was identified. 42 stakeholders from various innovation driven projects were invited to be interviewed. The resources invited were functionally and managerially dispersed, and proportional to the hierarchal pyramid structure of the organization representing the range of IS project functions including business subject matter representation, project management, leadership, and IS design and development. 35 out of 42 stakeholders responded and the final mix of stakeholders represented a good distribution across the levels in the organization. This diversity of resources input presented a wide range of viewpoints which is key to Template Analysis (Symon 2012). The aim with the informant pool was to gather information to explore (a) What participants perceive to be creative enablers (b) What participants perceive to be creative inhibitors (c) What participants say are actual creative enablers, and (d) What participants say are actual creative inhibitors.

**Semi Structured Interviews**

According to Myers and Newman (2007), the qualitative interview process is the most common and one of the most important data gathering tools in qualitative research. In this research semi-structured interviews were utilized, which as described by Fontana (2000), are an exchange where there is an incomplete script and where some improvisation based on the perspectives of the interviewee is expected. The interviews were designed to solicit:

- What influences creativity and innovation in the work organization, and
- What is it about the persons and the work environment that makes a difference.

The semi-structured interview guide for this research was split into four exploratory phases:

- Understanding innovation as a concept and its relevance to Informatics;
- Examples of innovation within the IS organization;
- Subject matter exploration around creative and innovation climates;
- Closing questions / discussions.

Myers et al. (2007) highlight the many critiques surrounding qualitative interviews, including the artificiality of the interview, lack of trust, lack of time, elite bias, the Hawthorne effect and so on. To mitigate some of these risks, the Dramaturgical model they proposed was adopted. The interviews were recorded, transcribed, and NVivo was used for coding.
Template Analysis and Coding Analysis

Template Analysis (TA) as discussed by Brooks et al. (2015) emphasizes the use of hierarchical coding but balances a high degree of structure in the process of analyzing textual data with the flexibility to adapt it to the needs of a particular study. Central to TA is the development of a coding template, usually on a subset of the data, which is then applied to further data, revised and refined. TA allows the use of ‘a priori’ codes, both in the initial template and in its subsequent revisions. Using TA in this manner allows the theoretical model to be tested, as well as generate new knowledge. This diversity of informants presented a wide range of viewpoints which is key to Template Analysis (Symon 2012).

One possible critique to TA within this research context is the risk that the dataset is viewed and interpreted through the prism of the theoretical template. This validity concern was mitigated by using the case study terms and language to label codes. These local language codes were then mapped to the theoretical model if appropriate. The mapping from local language to the theoretical template was then verified with a subset (group of 5 out of 35) of the group participants.

Results and Key Learnings

Results and Key Learning 1:

The subject matter of creativity and innovation within this case study context, produced deep conversational engagements, and a rich set of codes and concepts with all participants. On average each interview produced over 100 coding instances (which are expressions of concepts and or / relationships between concepts). This suggests robust dynamics in the subject matter of using innovative IS systems to improve business innovation value in pharmaceutical organizations.

Results and Key Learning 2:

The theoretical model proposed by Hunter et al. (2005) was a good fit for the qualitative data. 95% of the 172 coding classifications obtained from the interviews fitted as sub-classifications to the theoretical model. This suggests that the theoretical model is an acceptable construct to view the top line dimensions of what drives creative and innovative climates at group and organizational levels.

Results and Key Learning 3:

Deeper insights for each of the 14 dimensions were uncovered and identified as sub-classifications which provides rich learnings. 172 case study sub-classifications were coded and were divided into enabling and inhibiting aspects for each dimension. Inhibiting aspects to creative dimensions has limited research coverage in the literature and no research has been done within Pharmaceutical IS, as far as known by the authors. These enrichments therefore represent new knowledge. In addition to sub-classifications coded, many stakeholders identified relationships between concepts and these were also documented via rich pictures (Armsom 2011). For example, according to one participant, “because there is trust we can afford to take risks and present ideas.” Therefore, the ontological positive relationship between trust and risk taking was coded and documented. In this case study, 471 relationships between concepts were discovered.

The scope of this paper is to provide practitioners with a tested template model and a method to obtain creative climate practical insights within their own environment. Therefore, an in-depth presentation of the enrichment of all 14 dimensions covering all 172 sub-classifications is out of scope, but as a demonstration to the method, the key theoretical model concept of interpersonal exchange, mentioned in Figure 2, will be expanded in the following section.

Interpersonal exchange dimension enriched (one example out of the 14)

Interpersonal exchange is a construct that focuses on the manner in which team members interact with each other. Tett and Burnett (2003) propose 'trait activation theory' which suggests that positive situational contexts in work environments, expressed in its climate, can actually activate an individual’s creative features that are complementary to the contextual influence. Within the IS case study data, the various
subcategories coded were classified as either enablers and inhibitors. These field data enrichments are covered in Figure 2 and Figure 3. These are presented as sub-categories to the Theoretical Framework.

**Fig 2: Enablers for Positive Interpersonal Exchange in case study’s IS environment – “day to day factors”**

**Fig 3: Inhibitors for Positive Interpersonal Exchange in case study’s IS environment – “day to day factors”**

**Discussion**

In response to the first research question, “Are the characteristics of Hunter’s (2005) theoretical model presented in Figure 1, representative of the creative climates within a Pharmaceutical IS context?” the case study data suggests that the theoretical model presented by Hunter et al. (2005), is a good fit to this case
study environment. The limitation of the theoretical model is that it does not provide sufficient granular creative climate detail for organizational change. For example, for a particular environment, how is the meaning of Organizational Integration expressed or interpreted, and what are its enablers and inhibitors for organizational change for a particular organization? This observation is consistent with the literature, as George (2007) suggests that the granular dynamics of creativity may vary from industry to industry and from function to function. For example, the meaning and dynamics of autonomy will be different between a doctor and a marketing analyst. Providing clear meanings is an essential component of any improvement initiative, and according to Rentsch (1990), deconstructing creative climates into multiple and detailed facets is a valuable way to clarify some of the confusion over meaning and obtaining organizational alignment. A detailed taxonomical construct is therefore an important tool for innovation practitioners with the goal of improving innovative output.

With regard to the second research question, “If Hunter’s (2005) theoretical model in Figure 1 is a good fit, what are the enriched creative climate dimensions that provide further clarifications sub classifications to the theoretical concepts characteristics for this type of IS organizational environment?” a rich set of sub-classifications (172 in total) to the theoretical model were identified. These concept enrichments provide the organization with deeper insights and sense making into each of the higher-level theoretical constructs in which organizational change actions can then be planned and monitored.

Hunter et al. (2007) performed a meta-analysis on the theoretical model of Hunter et al. (2005), and suggested that the three dimensions with the largest effect sizes to innovation output were interpersonal exchange, intellectual stimulation, and challenge. Tiwana and McLean (2005) also support the mediating role of integrating expertise within an IS team setting to improve creative output. The case study data suggests some alignment to these observations, since dimensions related to intellectual stimulation and interpersonal exchange were discussed most robustly and produced the most enrichments. Caution is advised in comparing qualitative to quantitative data and further quantitative study is recommended. From the case study data, challenge did not appear distinguished from the other dimensions, but an explanation can be that the IS environment was already a high-pressured and challenging environment, and therefore relatively speaking challenge did not stand out. In regard to intellectual stimulation, climate sub-classifications identified for this case study organization include combinatorial thinking, collaboration, group ideation, tacit knowledge exchange, diversity, job rotations, debate, etc. Like the granular dimensions linked to interpersonal exchange, these sub-classifications offer direction for further exploration to the intellectual stimulation concept. The concepts of intellectual stimulation and interpersonal exchange are recommended as entry points to any organizational change improvement initiative focused on improving innovation output, as they represent the ‘low-hanging fruits’.

**Contribution to Literature**

Using the qualitative research classification scheme by Golden-Biddle (2007), the literature is identified as being “incomplete.” This Conceptual Research contributes to the literature by developing a conceptual framework that allows researchers to address a paucity of studies in IS innovations regarding creative climate. It positions a theoretical model developed in the psychological domain within an IS innovation environment augmenting extant thought. This paper claims that the literature model does not sufficiently cover the perspectives in an operational environment of IS innovations and is supported by the results of this case study which details further model enrichment.

**Contribution to Industry**

This paper gives innovation practitioners interested in improving the use of IS for innovation. Although the case study is focused within a pharmaceutical IS implementation team, the methodology is generalizable to organizations that require technology for their own output innovation. The output of the Conceptual Research will offer an organization an enhanced view of their creative climate characteristics, providing scope and focus for organizational change. The key components of the Template Analysis methodology are:

- A theoretical model to be used as an initial ‘a priori’ template;
- A qualitative data gathering method in the form of semi-structured interviews using a Dramatourgical approach;
• A framework for semi-structured guidance questions;
• Using coding to categorize local organizational team language in order to map to the theoretical model and to identify any new characteristics;
• The use of ‘rich pictures’ to identify relationships between concepts explored.

Limitations of research

This research was based on a single case study within a particular industry sector. Although there are many commonalities between pharmaceutical companies, caution is advised on making any generalization assumptions. However according to Gioia et al. (2013), some generalization is encouraged if, as in this case, there are commonalities and relevance from one similar company to another. Another limitation of the research is due to the nature of qualitative research which taps into individual perceptions of the organization. As with any qualitative research, which uses semi-structured interviews, there were certain topics that were discussed and explored more than others. Finally, a third limitation of this research is the perception of reality Thamhain (2003). In this research, participants focused on the enablers and inhibitors on initiatives that they perceived were innovative. There was no measure if those initiatives were innovative, and the variability of innovation between projects were not considered. Further research may include choosing established (quantitative) creative and innovative projects and interviewing the involved participants. Further research may also include quantitative studies to determine strengths and weaknesses of an organization measured against the model.

Conclusion

The use of innovative IS in research-based pharmaceutical companies is foundational to its ability to produce innovative medicines and deliver those medicines in a profitable manner. This includes developing in-house IS systems, using open source IS applications, or configuring commercial software to fit a unique operating environment with specific business use case challenges. In this study a theoretical framework on creative climates, based on an aggregation of literature models, was tested and enriched using qualitative data from IS innovation projects at a case study organization. A good fit was found in that 95% of the field data codes with thick descriptions mapped successfully to the theoretical model. The study extended and enriched the theoretical model of 14 dimensions with 172 sub-classifications, which provide added meaning of the theoretical model for this case study environment. The expansion of the theoretical dimension of interpersonal exchange was presented to demonstrate the approach and the enriched outcome.

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