Rajagiri Management Journal
Volume 12, Issue 1, June 2018

A review of organizational control and innovation

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Abstract

The purpose of this paper is to review the effect of organizational control on innovation. Specifically, the effect of three types of organizational control – input control, behavior control and output control on the different types of innovation are studied. We find that behavior control has been studied extensively, followed by input control. However output control has not received much attention in research on organizational control and innovation. Of the various structural variables studied under these control types, four variables- professionalization, specialization, centralization and formalization, have been objects of considerable research. Based on the review, we present multiple propositions on the relationship between organizational control and innovation.

Keywords: Innovation, input control, behavior control, output control, organizational control

1. Introduction

The purpose of this paper is to study the effect of organizational control on innovation by reviewing papers in the area. Control is defined as "any process by which managers direct attention, motivate, and encourage organizational members to act in desired ways to meet the firm's objectives" (Cardinal, 2001 p.22). From our review, we have identified three types of organizational control

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that have been studied in relation to innovation. The three types are: input control, behavior control and output control. Input controlis related to the governance of the causal conditions of performance (e.g., professionalization, specialization); behavior control is related to the implementation of procedures and rules, regulating behaviors and activities (e.g., centralization, formalization); output control is related to the regulation of results and outcomes instead of the means by which outputs are achieved (e.g., emphasis on output, goal specificity) (Cardinal, 2001). Of the three types of control, behavior control has been studied extensively followed by input control. Only few papers have studied the effect of output control on organizational innovation, a point that Cardinal (2001) also emphasizes: "output controls have not been studied in either the literature on the management of technological innovation or the literature on innovation adoption" (p.25).

Under each control type, different control forms or sub-type have been identified in literature. Under the input control we have identified five forms - professionalization, specialization, socialization, depth of knowledge and organizational slack that have been studied in relation to organizational innovation. Of these, professionalization and specialization have been the objects of considerable research, while the other forms have only been sparsely studied. Under the behavior control, we have identified nine forms- centralization, formalization, internal communication, functional differentiation, performance evaluation, administrative intensity, routinization, vertical differentiation and stratification. Of these, centralization and formalization have been studied extensively in literature, while only few studies have been done on other forms. Under the output control, we have identified four forms of control - emphasis on output, goal specificity, rewards and recognition and emphasis on professional output. Table 1 lists the categorization of articles based on the forms of control examined.

Table 1: Categorization of articles based on theforms of control examined

Control Type	Control Sub-type	Articles
Input	Professionalization	Bao et al. (2012); Cardinal (2001); Chen and Huang (2009); Daft (1978); Damanpour (1987); Damanpour (1991); Dewar and Dutton (1986); Gambardella (1992); Hage and Dewar (1973); Kimberly and Evanisko (1981); Lauren and Foss (2003); Li et al. (2006); Pierce and Delbecq (1977)
	Specialization	Dewar and Dutton (1986); Bantel and Jackson (1989); Cardinal (2001); Damanpour (1987); Kimberly and Evanisko (1981); Damanpour (1991); Ettlie et al. (1984); Hage and Dewar (1973)

	Socialization	Persaud (2005); Rijsdijk and Ende (2011); Jansen et al. (2005); Li et al. (2010)
	Depth of Knowledge	Dewar and Dutton (1986); Ettlie et al. (1984); Damanpour (1991)
	Organizational Slack	Damanpour (1987); Nohria and Gulati (1996)
Behavior	Centralization	Dewar and Dutton (1986); Bailyn (1985); Cardinal (2001); Ettlie et al. (1984); Hage and Dewar (1973); Jansen et al. (2005); Jansen et al. (2006); Kimberly and Evanisko (1981); Lauren and Foss (2003); Damanpour (1991); Li et al. (2011); Persaud (2005); Pierce and Delbecq (1977)
	Formalization	Bonner (2005); Rijsdijk and Ende (2011); Brion et al. (2010); Cardinal (2001); Hage and Dewar (1973); Jansen et al. (2005); Ettlie et al. (1984); Jansen et al. (2006); Li et al. (2010); Damanpour (1991); Persaud (2005); Pierce and Delbecq (1977)
	Internal Communication	Damanpour (1991); Dougherty (1992); Jansen et al. (2005); Jansen et al. (2006); Lauren and Foss (2003); Persaud (2005)
	Functional differentiation	Damanpour (1987, 1991); Kimberly and Evanisko (1981); Pierce and Delbecq (1977)
	Performance evaluation	Cardinal (2001); Li et al. (2011); Shalley (1995)
	Administrative Intensity	Damanpour (1987, 1991)
	Routinization	Jansen et al. (2005); Ohly et al. (2006)
	Vertical differentiation	Damanpour (1991)
	Stratification	Pierce and Delbecq (1977)
Output	Emphasis on output	Cardinal (2001); Bonner (2005); Li et al. (2006); Li et al. (2010); Rijsdijk and Ende (2011); Walker et al. (2010)
	Goal Specificity	Cardinal (2001); Rijsdijk and Ende (2011); Shalley (1995); Zanzi (1987)
	Rewards and Recognition	Bonner (2005); Brion et al. (2010); Cardinal (2001); Lauren and Foss (2003); Li et al. (2006)
	Emphasis on professional output	Cardinal (2001)

The remainder of this paper is divided into two sections. In the first section, we briefly explain the different types of innovation as most of the papers reviewed have studied the effects of organizational control on a specific innovation type.

In the second section, we discuss the effect of three types of organizational control on innovation and present the propositions.

Process of literature review

The selection of papers for the review started with the article Cardinal (2001) as the base. Cardinal (2001) is one of the seminal and highly cited[1] paper that studied the relationship between organizational control and innovation and has played a prominent role in shaping the field over the past decade. We did a keyword search on all the articles that cited Cardinal (2001).

Google Scholar was used for the keyword search. Following keywords were used: *organization control and innovation, organizational structure and innovation, organizational factors and innovation, HRM practices and innovation.* To identify articles published before Cardinal (2001), we followed a snowball sampling process, in which we identified relevant articles from the references of the already selected articles. Through this process, a total of 56 articles were collected. Then we read the abstract of these papers and checked their relevance with the topic of our study. In this process, we have to omit few papers as they were not directly related to our topic. For instance, Adler and Chen (2011) discusses about the relationship between management control and creativity. We didn't include this paper in our review as we were interested in studying the relationship between management control and innovation and not creativity. Finally we selected 30 articles to be included in our review. A summary of these 30 articles is given in Appendix 1.

Types of Innovation

Most of the studies reviewed have studied the effects of organizational control on a specific type of innovation. So in this section, we briefly explain the different types of innovation identified in the literature. Three types of innovation have received the most attention in the literature, eachrepresenting a pair of innovationtypes: technical and administrative, process and product, andincremental and radical (Damanpour, 1991). In addition to these three types, few recent papers (Brion et al., 2010; Jansen et al., 2006) talk about organizational ambidexterity (exploratory and exploitative innovation). Few other papers (e.g., Jansen et al., 2005) take a knowledge based view on innovation and talk about absorptive capacity. These different types are explained briefly below.

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[1] As per Google Scholar database, Cardinal (2001) has received 782 citations as on Jan 5, 2018.

Administrative and technical innovation

Technical innovations are concerned with basic activities of work and can be related to services, products or technological processes. Administrative innovations pertain to administrative processes and structure of the organization. They are more related to management than the basic work activities of an organization (Damanpour, 1987, 1991; Kimberly and Evanisko, 1981).

In addition to administrative and technical innovation, Damanpour(1987) has studied the effect of organization control on another type of innovation called "ancillary innovations". Ancillary innovations are those that happen at the intersection of the organization and its environment and are not fully controlled by the organization's management. Examples include community service programs of a library, after-school supplementary education programs and consumer involvement programs for generation of ideas.

Product and process innovation

Innovations such as introducing new services or products by an organization to meet user or market needs are called product innovations. Innovations such as introducing new elements in the service of the organization or the production process such as material inputs, equipments, tasks and work flow mechanisms are called process innovations (Damanpour, 1991).

Radical and incremental innovation

Radical and incremental innovations are classified based on the amount of change caused by an innovation. Radical innovations create vital changes in the organizational activities that are clearly different from existing routines and practices. Incremental innovations create only minor changes in the organizational practices (Dewar and Dutton, 1986; Ettlieet al., 1984).

Exploratory and exploitative

Innovations that are radical and are created to meet the requirements of new markets or users are called exploratory innovations (Jansen et al., 2006; Brionet al., 2010). They offer new distribution channels, designs or create new markets. Exploratory innovations depart from existing knowledge or require new knowledge.

Innovations that are incremental and are created to meet the requirements of

existing markets or users (Jansen et al., 2006; Brionet al., 2010) are called exploitative innovations. They expand existing services or products instead of innovating new ones, strengthen existing skills, and increase competence of existing distribution channels (Jansen et al., 2006). Exploitative innovations reinforce available structures, practices and skills and build on existing knowledge.

Absorptive capacity

Absorptive capacity is defined as a "set of organizational routines and processes by which firms acquire, assimilate, transform, and exploit knowledge to produce a dynamic organizational capability" (Zahra and George, 2002, p.186). These four capabilities represent four dimensions of absorptive capacity. The dimensions *knowledge acquisition* and *assimilation* are called "potential absorptive capacity" and they represent efforts spent to identify, acquire and assimilate new knowledge from sources external to the organization. The dimensions *knowledge transformation* and *exploitation* are called "realized absorptive capacity" and they represent efforts spent in gaining new insights by combining existing knowledge and newly acquired knowledge and incorporating them into actions.

Organizational Control and Innovation

In this section, we review the effect of three types of control (input, behavior and output) on innovation. As noted earlier, while input and behavior controls have been studied extensively, output control has been studied only by few papers. Of the 30 papers reviewed, 20 papers have studied one or more forms of input control, 21 papers have studied behavior control and only 10 papers have studied the output control.

From the review, we also observe that earlier papers before 1990s, have focused mainly on the antecedent conditions of innovation. They predominantly studied the effect of structural variables such as specialization, centralization and formalization on innovation (e.g., Hage and Dewar, 1973; Kimberly and Evanisko, 1981; Damanpour, 1987). Also most of the studies were based on a sample from USA. But over the last decade or so, we see many studies were done using samples from European and Asian countries such as China (e.g., Bao et al., 2012; Li et al., 2006) and Taiwan (e.g., Chen and Huang, 2009). Topics such as ambidexterity (e.g., Jansen et al., 2006; Brion et al., 2010), innovation in SMEs (Li et al., 2011), HRM practices and innovation (Lauren and Foss, 2003; Li et al., 2006) have received more attention in the recent literature. Also recent studies are

taking a knowledge based view, and studying constructs such as absorptive capacity and knowledge management in relation to innovation (e.g., Jansen et al., 2005; Li et al., 2010).

Input Control and Innovation

As noted earlier, five forms of input control have been studied in literate in relation to organizational innovation. They are professionalization, specialization, socialization, depth of knowledge and organizational slack.

Table 2: Effect of input controls on innovation

Innovation type studied	Author and Year	Findings and Viewpoints
	Effect of professionalization on innovation	
Technical and Administrative	Daft (1978); Damanpour (1987); Li et al. (2006)	Daft (1978) proposes the technical and administrative innovations as adual-core model of innovation in organizations. Professionalization has a stronger effect on technical innovation than administrative innovation.
	Kimberly and Evanisko (1981)	Professionalization is not a significant predictor of both technical innovation and administrative innovation.
	Chen and Huang (2009)	Strategic human resource practices such as professionalization have a positive effect on knowledge management capacity which, in turn, affects innovation performance positively.
Increment and Radical	Dewar and Dutton (1986)	Professionalization is not significantly related to both incremental and radical innovation
	Cardinal (2001)	Professionalization positively related to the incremental and radical innovation
	Bao et al. (2012)	Professionalization enhances radical innovation
Product/Service	Hage and Dewar (1973); Gambardella (1992); Lauren and Foss (2003)	Professionalization is significant in predicting product innovation
NA	Damanpour (1991)	Type of innovation does not moderate the professionalization-innovation relation. But in general professionalization is positively related to innovation.
Stage of innovation - Initiation, adoption, implementation	Pierce and Delbecq (1977)	Professionalism is positively related with all three stages of organizational innovation
	Damanpour (1991)	Stage of adoption does not moderate the professionalization-innovation relation.

	Effect of specialization on innovation	
Technical and Administrative	Kimberly and Evanisko (1981); Damanpour (1987, 1991); Bantel and Jackson (1989)	Specialization had a stronger effect on technical than administrative innovation
Increment and Radical	Ettlie et al. (1984);Cardinal (2001)	Specialization has a positive effect on both radical and incremental innovation
	Dewar and Dutton (1986)	There is no significant relationship between specialization and radical or incremental innovation
Product/Service	Hage and Dewar (1973)	Specialization is significant in predicting product innovation
Stage of innovation	Damanpour (1991)	Specialization is stronger in implementation stage than initiation stage
	Effect of socialization on innovation	
NA	Persaud (2005); Rijsdijk and Ende (2011)	Socialization positively impacts innovation
	Jansen et al. (2005)	Socialization positively affects realized absorptive capacity but not associated with potential absorptive capacity
	Li et al. (2010)	Socialization significantly moderates the relationship between knowledge exploitation and knowledge codification, but does not significantly moderate the endogenous innovation and knowledge exploitation.
	Effect of depth of knowledge on innovation	
NA	Dewar and Dutton (1986); Ettlie et al. (1984); Damanpour (1991)	Depth of knowledge positively affects radical and incremental innovation. But the effect is stronger on radical innovation compared to the effect onincremental innovation.
	Effect of organizational slack on innovation	
NA	Damanpour (1987)	The effect of organizational slack is stronger on technical innovation than ancillary or administrative innovation
	Nohria and Gulati (1996)	Organizational slack has aninverted U-shaped relationship with innovation.Both too less and too high slack will negatively affect innovation.

Professionalization

This reflects an organization's professional knowledge gained by its members through experience and education. It is measured in terms of the percentage or number of employees with particular educational backgrounds or by the degree of professional training received by employees (Damanpour, 1991). Introduction of diverse kinds of professionals or "technical generalists" who maintain contact

with their field through reading, attendance at meetings, etc., should positively relate to diversity of ideas and then to innovation (Hage and Dewar, 1973).

Except for two studies (Kimberly and Evanisko, 1981; Dewar and Dutton, 1986), all other studies have identified a positive effect of professionalization on innovation. Also the strength of the effect seems to vary based on the type of innovation - technical or administrative. Three studies (Daft, 1978; Damanpour, 1987; Li et al., 2006) have found that professionalization has a stronger effect on technical innovation than administrative innovation, which is contrary to Damanpour (1991) who found that type of innovation does not moderate the professionalization-innovation relation. Regarding the relation between professionalization and stage of innovation, two studies (Pierce and Delbecq, 1977; Damanpour, 1991) have found that professionalism is positively related with all three stages (initiation, adoption and implementation) of organizational innovation.

Proposition 1a: Professionalization positively affects organizational innovation

Proposition 1b: The type of innovation, administrative or technical, moderates the effect of professionalization onorganizational innovation

Proposition 1c: Professionalization positively affects all three stages, initiation, adoption and implementation of organizational innovation

Specialization

Specialization represents different specialties in an organization. Other names such as "complexity" is also used to represent this variable (Hageand Aiken, 1967). It is measured by the number of occupational types or job titles present in an organization (Damanpour, 1991).More the diversity of specialists, the greater is the organizational knowledge base and hence specialization is generally hypothesized to be positively related with innovation (Damanpour, 1987).

From our review, we could find that, specialization positively affects innovation. Except for one study (Dewar and Dutton, 1986), all other studies support the positive effect. Also like professionalization, specialization has a stronger effect on technical innovation than administrative innovation (Kimberly and Evanisko, 1981; Damanpour, 1987, 1991; Bantel and Jackson, 1989). Regarding the stage of innovation, specialization is stronger in implementation stage than initiation stage (Damanpour, 1991).

Proposition 2a: Specialization positively affects organizational innovation

Proposition 2b: The type of innovation, administrative or technical, moderates the effect of specialization on organizational innovation

Proposition 2c:The positive effect of specialization is stronger in implementation stage than initiation stage

Other forms of input control

The other three less studied forms of input control are socialization, depth of knowledge and organizational slack.

Socialization: This represents the mechanisms employed by an organization to in still organizational norms, shared values, and beliefs into the employees (Li et al., 2010). The mechanisms include activities such as trainings, team activities, meetings and other indoctrination programs. Socialization creates a shared understanding among the employees and minimizes the misunderstandings over the meanings and interpretations of an organization's knowledge (Li et al., 2010). From our review, we can infer that, socialization positively affects innovation and is related to knowledge constructs such as absorptive capacity and knowledge codification and exploitation.

Depth of Knowledge: This represents the technical potential and resources of an organization. It is measured by the presence of a technical personnel (Dewar and Dutton, 1986) or technical group (Ettlie et al., 1984). From our review, we find that depth of knowledge is positively related to both incremental and radical innovation. But it the effect is stronger on radical innovation than on incremental innovation (Dewar and Dutton, 1986)

Organizational Slack: It represents the difference between the current resource pool of an organization and minimum resource level required to sustain operations. Examples of slack resources are excess employees, capacity and inputs (Nohria and Gulati, 1996). The presence of slack in an organization implies that the organization can absorb failure, buy expensive innovations, and can explore new ideas and hence slack can positively affect innovation (Damanpour, 1987).For instance, it was found that organizational slack strongly affects technical innovation (Damanpour, 1987). However Nohria and Gulati (1996) have found that slack has an inverted U-shaped relationship with innovation. Hence we need more studies to conclusively propose the relationship between innovation and organizational slack.

Proposition 3:Socialization positively affects organizational innovation

Proposition 4a: Depth of knowledge positively affects organizational innovation

Proposition 4b: The effect of depth of knowledge is stronger on radical innovation than on incremental innovation

Behavior Control and Innovation

Of the three types of control, behavior control has been the object of considerable research (Cardinal, 2001). In our review, we have identified nine forms of behavior control that have been studied in relation to organizational innovation. They are centralization, formalization, internal communication, functional differentiation, performance evaluation, administrative intensity, routinization, vertical differentiation and stratification. Of these, centralization and formalization have been studied extensively in literature, while the other forms have been only sparsely studied.

Table 3: Effect of behavior controls on innovation

Innovation type studied	Author and Year	Findings and Viewpoints
Effect of centralization on innovation		
Technical and Administrative	Kimberly and Evanisko (1981)	Centralization is negatively related to technological innovation and not significantly related to administrative innovation
Increment and Radical	Dewar and Dutton (1986)	Centralization is not significantly related to both incremental and radical innovation
	Cardinal (2001)	Centralization is positively related to both incremental and radical innovation
	Ettlie et al. (1984)	Centralization is negatively related to both incremental and radical innovation
Product/Service	Hage and Dewar (1973);Lauren and Foss (2003);Persaud (2005)	Centralization is negatively related to the firm's ability to innovate
Exploratory, Exploitative	Jansen et al. (2006)	Centralization has a negative relationshipwith exploratory innovation; but not significantly affects exploitative innovation
NA	Damanpour (1991)	Centralization is negatively related to innovation; Type of innovation does not moderate the centralization-innovation relation.

NA	Damanpour (1991)	Centralization is negatively related to innovation; Type of innovation does not moderate the centralization-innovation relation.
NA	Bailyn (1985)	At the start of the career of R&D professionals, strategic autonomy should be lower than operational autonomy; operational autonomy should rapidly increase initiallyand it should be followed by increase in strategic autonomy
Stage of innovation	Pierce and Delbecq (1977)	Centralization will be negatively related with initiation and implementation, stronger with initiation than implementation and may be positively related to adoption.
	Damanpour (1991)	No difference in relationship based on stage of innovation
Knowledge Management	Jansen et al. (2005)	Decentralization positively affects acquisition but not assimilation dimension of potential absorptive capacity; not significantly associated with both dimensions of realized absorptive capacity
	Li et al. (2011)	Decentralization positively moderates the relationship between endogenous innovation and knowledge exploitation
Effect of formalization on innovation		
Increment and Radical	Cardinal (2001)	Formalization positively affects radical innovation and negatively affects incremental innovation
	Ettlie et al. (1984)	Formalization negativelyaffects radical innovation and positivelyaffects incremental innovation
Product/Service	Hage and Dewar (1973); Bonner (2005); Rijsdijk and Ende(2011) Persaud (2005)	Formalization is not significantly related to innovation Innovative capabilities are negatively affected by formalization
Exploratory and Exploitative	Jansen et al. (2006)	Formalization positively affects exploitative innovation; not significantly affects exploratory innovation
	Brion et al. (2010)	Ambidexterity has a positive relationship with innovation
NA	Damanpour (1991)	There is no significant relationship between innovation and formalization

Stage of innovation	Pierce and Delbecq (1977)	There is a negative relationship between formalization and initiation, but adoption and implementation have alow positive relationship with formalization
Knowledge Management	Jansen et al. (2005)	Formalization is not significantly associated with potential absorptive capacity; but significantly associated with realized absorptive capacity
	Li et al. (2010)	Formalization positively moderates the relationship between endogenous innovation and knowledge exploitation
Effect of internal communication on innovation		
NA	Damanpour (1991); Dougherty (1992); Lauren and Foss (2003); Persaud (2005)	Internal communication is positively related to the firm's ability to innovate
	Jansen et al. (2006)	Positively affects both exploitative and exploratory innovation
	Jansen et al. (2005)	Cross-functional interface positively affects both acquisition and assimilation dimensions of potential absorptive capacity; but positively affects only the transformation dimension of realized absorptive capacity
Effect of functional differentiation on innovation		
NA	Kimberly and Evanisko (1981)	Functional differentiation is positively related to technological innovation but not related to administrative innovation.
	Damanpour (1991)	Functional differentiation is positively related to innovation.
	Pierce and Delbecq (1977)	Functional differentiation will be positively and strongly related with the initiation stage than for adoption and implementation.
	Damanpour (1987)	Functional differentiation did not show any differential effect between the three innovations - Technical, Administrative and Ancillary
Effect of performance evaluation on innovation		
NA	Shalley (1995)	Expectation of evaluation has no effect on creativity.
	Cardinal (2001)	Frequency of performance appraisals has a positive relationship with radical

		innovation, but no significant relationship with incremental innovation
	Li et al. (2011)	Performance evaluation based on long term measures positively moderates the relationship between innovation and knowledge exploitation
Effect of administrative intensity on innovation		
NA	Damanpour (1987)	Administrative intensity was a stronger predictor of administrative innovation
	Damanpour (1991)	Administrative intensity is positively related to innovation
Effect of routinization on innovation		
NA	Jansen et al. (2005)	Routinization is negatively associated with potential absorptive capacity; but not associated with realized absorptive capacity
	Ohly et al. (2006)	Routinization is positively related to creativity & innovation
Effect of vertical differentiation on innovation		
NA	Damanpour (1991)	Vertical differentiation not significantly related with innovation
Effect of stratification on innovation		
NA	Pierce and Delbecq (1977)	Stratification will be negatively related with initiations.

Centralization

Centralization represents the degree of concentration of decision-making in an organization (Damanpour, 1991). It is measured by its inverse, decentralization, the degree of employeeparticipation in decision-making (Damanpour, 1991).Centralization is normally thought to hinder innovation as concentration of decision making power leads to attempts to preserve status quo and prevents imaginative solutions to problems and input from diverse sources (Hage and Dewar, 1973).

Almost all the studies in our review have found a negative relationship between centralizationandinnovation. Regarding the stage of innovation, Pierce and Delbecq (1977) proposed that centralization will be negatively related with initiation and implementation stage and positively related to adoption stage. But Damanpour (1991) in his empirical analysis did not find significant difference in relationship based on stage of innovation. Bailyn (1985) talks about two types of autonomy – operational autonomy and strategic autonomy. He argues

that, at the start of the career of R&D professionals, strategic autonomy should be lower than operational autonomy; initially there should be large increase in operational autonomy which should be followed by rise in strategic autonomy.Taking a knowledge based view, Jansen et al. (2005) find that centralization is negatively associated only with the acquisition dimension of absorptive capacity and not significantly related with other three dimensions and Li et al. (2011) find that decentralization positively moderates the relationship between innovation and knowledge exploitation.

Proposition 5:Centralization negatively affects organizational innovation

Formalization

Formalization represents the importance given to following procedures and rules in an organization. It is measured by the degree of freedom available to employees to pursue their activities in contrast to the availability of manuals and job descriptions that accurately define the activities (Damanpour, 1991).It is generally argued that rigidruleobservationinhibitsdiffusionand communicationofideas,suppressescreativity,and consequently is negatively associated within novation (Hage and Dewar, 1973).

Contrary to general opinion, we find that most of the studies in our review have found positive relation between formalization and innovation. According to Ohlyet al. (2006), "routinization" might explain why formalization might have positive relation with innovation. They argue that when formalization results in routinization of tasks and activities, it might free cognitive resources of employees to ponder about other aspects of work and hence formalization can be beneficial for innovation.Regarding the stage of innovation, Pierce and Delbecq (1977) propose that formalization will negatively affect initiations, but will positively affect adoption and implementation. Taking aknowledge based view, Jansen et al. (2005) find that formalization is significantly associated with realized absorptive capacity and Li et al. (2010) find thatformalization positively moderates the relationship between knowledge exploitation and innovation.

Proposition 6: Formalization positively affects organizational innovation

Other forms of behavior control

The other less studied forms of behavior control are internal communication, functional differentiation, performance evaluation, administrative intensity, routinization, vertical differentiation and stratification.

Internal Communication: Internal communication reflects the level of communication within an organization among its various units. It is measured in number of ways, such as the frequency of meetings, number of contacts among employees within and across levels, and the levelof participation by different units in decision-making (Damanpour, 1991). Terms such as cross-functional interface (Jansen et al., 2005), interdisciplinary work groups (Lauren and Foss, 2003), connectedness (Jansen et al., 2006) have been used to denote internal communication. Internal communication is generally hypothesized to have positive relation with innovation as it leads to exchange of ideas within an organization(Damanpour, 1991).This is consistent with our review finding, as all the studies reported a positive association between internal communication and innovation.

Functional Differentiation: This reflects the degree ofdifferentiation in an organization in terms of functional units (Damanpour, 1991). Functional differentiation is generally hypothesized to be positively associated with organizational innovation as it results in creation of a coalition of professionals within units who could introduce innovations (Damanpour 1987, 1991; Kimberly and Evanisko, 1981). From our review, we also infer positive relation between functional differentiation and innovation. While Kimberly and Evanisko (1981) found differential effect between technological and administrative innovation, Damanpour (1987) did not find any such differential effect between innovation types.

Performance Evaluation: While performance evaluation is an important behavior control, its impact on innovation has received less attention (Cardinal, 2001).Cardinal (2001) found that frequency of performance appraisals is not related to incremental innovation, but positively affects radical innovation. Similarly Shalley (1995) found that expectation of evaluation has no effect on creativity.Li et al. (2011) found that performance evaluation based on long term measures positively moderates the relationship between innovation and knowledge exploitation. So,from these limited studies we can infer that performance evaluation is positively related to innovation. But more studies are required to concretely establish the link.

Administrative Intensity: Administrative intensity represents administrative overhead. It is measured in terms of proportion of managers compared to all employees in an organization. Since adoption of innovations depends on leadership support and managerial coordination, a higher administrative intensity will positively affect innovation (Damanpour, 1987; 1991).In our review, both the studies (Damanpour, 1987, 1991) have found positive relation between administrative intensity and innovation.

Routinization: Routinization refers to automaticity in behavior (Ohlyet al., 2006). Organizations follow routinization to develop tasks that does not require much attention(Jansen et al., 2005). There are two different views on the relationship between innovation and routinization. On the one hand, routinization might positively affect innovation as it frees cognitive resources of employees, on the other hand routinization might be an antithesis to creativity(Ohlyet al., 2006).Ohly et al. (2006) found a positive association between innovation and routinization. But more studies are required to concretely establish the link between routinization and innovation.

Vertical differentiation: Vertical differentiation refers tothe level of hierarchy in an organization usually measured by the number of levels below top most level. More hierarchical levels in an organization might impede communication and flow of ideasacross levels and hence negatively affect innovation (Damanpour, 1991).There are not many studies looking at this relationship. More studies are required to strongly establish the link between vertical differentiation and innovation.

Stratification: Stratification is indicated by the degree of status congruence and ease of intra-organizational mobility (Pierce and Delbecq, 1977). Stratification is generally hypothesized to be negatively related to innovation as status-striving behavior is incompatible with creative thinking and leads to personal insecurity (Pierce and Delbecq, 1977). More studies are required to establish the link between stratification and innovation.

Proposition 7: Internal communication positively affects organizational innovation

Proposition 8: Functional differentiation positively affects organizational innovation

Proposition 9:Administrative intensitypositively affects organizational innovation

Output Controland Innovation

As noted earlier, very few papers have studied the effects of output control on innovation. From our review, we identified four forms of output control – emphasis on output, emphasis on professional output, goal specificity and rewards and recognition.

Table 4: Effect of output controls on innovation

Innovation type studied	Author and Year	Findings and Viewpoints
Effect of emphasis on output on innovation		
NA	Cardinal (2001); Bonner (2005); Rijsdijk and Ende (2011)	An emphasis on output is positively related to innovation
	Li et al. (2006)	Technological innovation has a negative relationship withemphasis on output
	Walker et al. (2010)	Emphasis on output mediates the relationship between Innovation and organizational performance
	Li et al. (2010)	Emphasis on output moderates the relationship between endogenous innovation and knowledge exploitation in an inverse U-shaped relationship
Effect of goal specificity on innovation		
NA	Cardinal (2001); Rijsdijk and Ende (2011)	Goal specificity is positively related to innovation
	Zanzi (1987)	Goals tend to be less defined in the organic organization and better defined in the mechanistic one
	Shalley (1995)	High levels of creativity occur when individuals have a creativity goal
Effect of rewards and recognition on innovation		
NA	Cardinal (2001); Lauren and Foss (2003); Bonner (2005); Brion et al. (2010)	Rewards and recognition are positively related to innovation
	Li et al. (2006)	Material incentive has a negative relationship and non-material incentive has a positive relationship to technological innovation
Effect of emphasis on professional output on innovation		
NA	Cardinal (2001)	Emphasis on professional output has a positive relationshipwith incremental innovation, but no significantrelationshipexists with radical innovation

Emphasis on output: Emphasis on output means organization sets standards of performance and assesses outputs against them. Achievable and clear goals provide required information and motivation to act towards preferred ends (Bonner 2005; Cardinal, 2001). Some examples of output measures are profits, customer satisfaction, revenue, market share and product or service quality. In our review, most of the studies have found positive association between emphasis on output and innovation.

Goal specificity: This refers to providing clear defnition of the product goals. A clear goal specificity might reduce errors as it decreases uncertainty (Rijsdijk and

Ende, 2011). In our review, a positive association is found between goal specificity and innovation.

Rewards and recognition: In our review, all the studies found a positive association between rewards and recognition and innovation (Cardinal, 2001; Lauren and Foss, 2003; Bonner, 2005; Brion et al., 2010). Li et al. (2006) found a differential effect between material and non-material incentive. They found that material incentive has a negative relationship and non-material incentive has a positive relationship to technological innovation

Emphasis on professional output: Only one study (Cardinal, 2001) in our review has studied this variable. Cardinal (2001) found that emphasis on professional output, which is presenting papers and publishing in journals, has a positive relationship with incremental innovation, but no significant relationship exists with radical innovation (Cardinal, 2001). More studies are required to concretely establish the relationship between emphasis on professional output and innovation.

Proposition 10: Emphasis on output positively affects organizational innovation

Proposition 11: Goal specificity positively affects organizational innovation

Proposition 12: Rewards and recognition positively affects organizational innovation

Conclusion

In this paper, we reviewed the effect of three types of organizational control on innovation. While the results were contradictory in few studies, we can broadly see that input controls professionalization, specialization, socialization and depth of knowledge positively affect innovation. The effect of professionalization and specialization is stronger on technical innovation. Behavior controls centralization negatively affects innovation while others such as formalization, internal communication, functional differentiation and administrative intensity has a positive relation with innovation. The output controls emphasis on output, goal specificity and rewards and recognition positively affect innovation. We cannot conclusively assess the relationship between innovation and other forms of control such as emphasis on professional output, stratification, vertical differentiation, routinization, performance evaluation and organizational slack. More studies are required to assess the relationship. Many studies (e.g., Bao et al., 2012; Jansen et al., 2006) have highlighted the importance of industry specific moderators such as environmental dynamism and environmental competitiveness that might influence the control-innovation relation. In our review, we observed that the sample used in the studies varied greatly from schools, library, and hospitals to high-tech companies, financial services, and MNCs. So future work can compare studies from a specific industry to yield more insights.

Appendix 1
Summary of reviewed articles

	Author	Year	Sample	Control Type	Control Subtype	Innovation Type	Relationship studied
1	Hage and Dewar	1973	Social welfare and health organizations	Input, Behavior	Specialization, Professionalization, Centralization, Formalization	Product	Studied the relationship between elitevaluesand controls such as professionalization,formalization and centralization
2	Pierce&Delbecq	1977	Theoretical paper	Input, Behavior	Professionalization, Centralization, Formalization, Functional differentiation, Stratification	Stages of innovation - Initiation, adoption, implementation	A review of initiation, adoption and implementation stages of innovation
3	Daft	1978	High schools	Input	Professionalization	Technical and Administrative	The role played by technical employees and administrators in innovation adoption
4	Kimberlyand Evanisko	1981	Hospitals	Input, Behavior	Specialization, Professionalization (external integration), Centralization, Functional differentiation	Administrative and Technical	Effect of contextual, organizational and individual variables on administrative and technical innovation
5	Ettlieet al.	1984	Food processing industry	Input, Behavior	Specialization, Depth of knowledge (Concentration of technical specialists), Centralization, Formalization	Increment and Radical	Relationship of strategy-structure causal sequence with incremental and radical innovation
6	Bailyn	1985	Theoretical paper	Behavior	Centralization	-	Analyzes the strategic autonomy and operational autonomy for R&D professionals
7	Dewar and Dutton	1986	Footwear industry	Input, Behavior	Specialization, Professionalization, Depth of knowledge (number of technical specialists), Centralization	Increment and Radical	Factors that predict the adoption of incremental and radical innovation

8	Damanpour	1987	Public libraries	Input, Behavior	Specialization, Professionalism, Organizational slack, Administrative intensity, Functional differentiation	Technical, Administrative and Ancillary	Effect of organizational factors on three types of innovations -Technical, Administrative and Ancillary
9	Zanzi	1987	Public accounting firm	Output	Goal specificity	Organic and Mechanistic	Studies the variables that are associated with organic and mechanistic organizations
10	Bantel and Jackson	1989	Banks	Input	Team diversity (Specialization)	Technical and Administrative	Studies the relationship between top management teams andinnovation
11	Damanpour	1991	Meta-analysis	Input, Behavior	Specialization, Professionalization (external communication) and Depth of knowledge (technical knowledge resources), Centralization, formalization,Functional differentiation, Vertical differentiation, Internal communication, Administrative intensity	Increment and Radical,Product and process, Technical and administrative	A meta-analysisof thepotential determinants of organizationalinnovation
12	Dougherty	1992	Computer, communication and chemical industry	Behavior	Internal communication	Product	Studies how shared interpretive schemes and organizationalroutines inhibit product innovation
13	Gambardella	1992	Pharmaceutical firms	Input	Professionalization	Product	Relationship between firms' in-house research programs, the ability to exploit outside scientific information and product innovation
14	Shalley	1995	UG students (Experimental methodology)	Behavior, Output	Performance evaluation, Goal specificity	-	Examines the relationship of goal setting, evaluation and coactionwith individualproductivity and creativity
15	Nohria and Gulati	1996	264 functional departmentsof two MNCs	Input	Organizational slack	-	Relationship between slack and innovation in organizations

16	Cardinal	2001	Pharmaceutical firms	Input, Behavior, Output	Centralization, Specialization, Professionalization, Frequency of performance appraisals, Formalization, Rewards & recognition, An emphasis on professional output,An emphasis on output, Goal specificity	Increment and Radical	Studies the effect of input, behavior, and output controls on radical and incremental innovation in the context of R&D professionals.
17	Lauren and Foss	2003	1900 Danish business firms	Input, Behavior, Output	Professionalization (internal and external training), Centralization, Internal communication (interdisciplinary work groups),Rewards & Recognition (Performance related pay)	Product/Service	Relationship between HRM systems and innovation performance of companies
18	Bonner	2005	Projects from several industries	Behavior, Output	Formalization, Emphasis on output, Rewards & Recognition	-	Studies the relationship of output and process controls with customer interaction in new product development (NPD) projects
19	Jansen et al.	2005	Organizational units of financial services firm	Input, Behavior	Socialization, centralization, formalization, routinization, internal communication (cross-functional interface)	Realized and potential absorptive capacity	Examines the antecedentsof realized and potentialabsorptive capacity
20	Persaud	2005	79 R&D units of MNCs	Input, Behavior	Socialization, Centralization, Formalization,Internal communication	Synergistic Innovative Capability	Studies the relationship betweeninnovative capabilities and the coordination structures of MNCs
21	Jansen et al.	2006	Organizational units of a large European financial services firm	Behavior	Centralization, Formalization, Internal communication (connectedness)	Ambidexterity (Exploratory, Exploitative)	The effect of centralization, formalization and Internal communication (connectedness) on exploratory and exploitative innovation

22	Li et al.	2006	194 high-tech firms in China	Input, Output	Professionalization (Employee training), Rewards & Recognition (Material and Non-material), Emphasis on output	Technical	Studies the relationship between HRM and technological innovation in the context of Chinese high-tech firms
23	Ohlyet al.	2006	A German high tech firm	Behavior	Routinization	-	Relationship between routinization and creativity & innovation
24	Chen and Huang	2009	146 Taiwanese firms	Input	Strategic Human resource practices (professionalization and training)	Technical and Administrative	Takes a knowledge-based view in examining the relationship between HR practices and innovation
25	Brionet al.	2010	108 large manufacturing and service firms (> 250 employees) in France	Behavior, Output	Formalization, Rewards & Recognition (Performance oriented management)	Ambidexterity (Exploratory, Exploitative)	Relationship between organizational context and innovation ambidexterity
26	Li et al.	2010	607 Chinese firms	Input, Behavior, Output	Socialization, Formalization, Emphasis on output	Endogenous innovation	Studies how endogenous innovation is increased using organizational controls
27	Walker et al.	2010	English local governments or authorities	Output	Performance management (Emphasis on output)	Process innovation (Information technology and administrative)	Studies the relationship between performance management and innovation
28	Li et al.	2011	213 SMEs in China	Behavior	Strategic control (Performance evaluation based on long term measures, more autonomy)	Endogenous innovation	Studies the relationship between innovation, strategic control and knowledge management
29	Rijsdijk and Ende	2011	148 NPD projects of organizations in Netherlands	Input, Behavior, Output	Socialization, Formalization, Goal specificity, Emphasis on output		investigates the effects of input control, behavior control and outcome control on product concept effectiveness of new product development projects
30	Baoet al.	2012	High-tech firms in China	Input	Professionalization (external learning)	Radical	Studies the relationship between radical innovation and administrative and technical learning

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