Constructing a processual model of communication in new product development from a multiple case study of biotechnology SMEs

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Abstract

For most companies in the biotechnology industry, the core business is new product development (NPD). Indeed, there are still very few companies that have products that have reached the market. Research into NPD in biotechnology companies has largely focussed on success factors rather than the processes of NPD. One area receiving limited attention is the role of organisational communication in NPD. The authors of this study address this oversight in undertaking a multiple case study analysis of internal and external communication in NPD processes in biotechnology. The resultant framework for communication in NPD in biotechnology companies combines both structural and processual elements of communication. The authors found that the process of communication in NPD is essentially an information seeking and uncertainty reduction activity that occurs through both the internal and external environments of the firm. The framework is a hybrid of cross-functional, decision stage and network models.

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INTRODUCTION

Few industries are more dependent on new product development (NPD) than biotechnology.[1] For most companies in biotechnology, NPD is their core business with few having products already on market. One area which has had limited attention is the role of organisational communication in NPD.[2] Although the importance of information and communication have been recognised in the commercialisation of biopharmaceutical products,[3] this recognition is yet to spread to the 'mainstream' literature.

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Before proceeding, it is appropriate to provide a brief definition of organisational communication. A well-accepted definition of organisational communication is 'the process of creating and exchanging messages within a network of interdependent relationships to cope with environmental uncertainties'.[4] Some of the key concepts to be considered then in organisational communication are the exchange process, relationships and the internal and external environments.[5]

Although these key concepts can be seen as central in the NPD process, they have largely been considered in isolation rather than as a whole. In an early review of NPD research,[6] it was concluded that much of the literature that relates to people remains theoretical. This presents a need for an empirical contribution to the area that investigates the dynamics of functional integration. Issues needing investigation include *who* should be integrated, and *when* and *how* this can be best achieved. Key success factors in new product launch have recently been identified and it was concluded that information typically becomes more valid and reliable as the project moves through the process toward commercialisation.[7]

ORGANISATIONAL COMMUNICATION AND NPD

There have been two distinct foci in the NPD literature. Much of the NPD literature has concentrated on success factors and stages in NPD. Another more limited body of literature has explored the overall product development process and how it integrates with organisational strategy. Neither has incorporated the communication process extensively in their ruminations. Each approach has explored communication issues through the considerations of teams, particularly cross-functional teams, and external and internal exchanges and relationships (both vertical and horizontal).[8]

The result of a concentration on success factors and a limited process orientation is that the focus of communication in NPD has remained largely on facilitating NPD teams in their various forms. This has differed little from the work by Abernathy and Baloff[9] on inter-functional planning for new product introduction, or by Cooper and Kleinschmidt[10] and Takeuchi and Nonaka[11] who promoted the rugby team approach to NPD, or by Lester[12] who urged the establishment, support and guidance of venture teams for NPD.

There is, however, more to the communication process than liaison between and within teams. DiBenedetto[7] reflects on the process of information communication in stressing that information typically becomes more valid and reliable as the project moves toward commercialisation. The focus for DiBenedetto was clearly on market information-gathering activities, as such market research activities. NPD can be viewed in a more holistic light, particularly from the organisational learning perspective,[13] in which market information is gathered and employed to inform management decisions in the NPD process. Nevertheless, these approaches still only dealt with market information, leaving the gamut of communication issues largely untouched.

Atuahene-Gima and Haiyang[2] take the analysis further in their study on influence tactics in NPD, distinguishing between 'Soft Tactics': Information exchange, recommendations, request and coalition formation; and Hard Tactics: Legalistic plea, upward appeal and persistent pressure. Their list stresses the political nature of NPD in the marketing context observing that:

> In terms of usage frequency…hard tactics predominate in a political arena. The logic that where decision making is characterised by different thought worlds, factionalism and inter-functional conflict, communication becomes unidirectional characterised by negativity and hostility.

This political pressure effectively blocks the NPD process, particularly where this involves the symbiotic functions of Marketing and R&D, and indicates that tactics are contingent upon the NPD stage.

A pre-occupation with the product is understandable in NPD. In a review of the literature on product development decisions,[14] however, the major product development decisions identified were: concept

development, supply chain design, product design, performance testing and evaluation, and product ramp-up and launch. Nowhere in the 108 selected references surveyed on 'product development decisions within a project' is any reference made to communication. Teams are considered by 15 of the 77 selected references surveyed on 'decisions in setting up a development project'. These authors confirm that the consideration of communication is made in relation to teams and functions where cross-functional communication (eg between marketing and engineering) is widely viewed as positive. Although insights about the nature of coupling among development tasks offer the promise of fostering communication where it is most valuable.[15,16]

INTERNAL AND EXTERNAL COMMUNICATION IN NPD

Internal communication is communication that remains within the boundaries of the organisation and among organisation members.[17] It then follows that external communication is communication that occurs across boundaries of organisations, between organisation members and representatives of the organisations' environment.

Communication and NPD were recently investigated in relation to high performance manufacturing.[5] The research presented a 'framework for analysing the communication system of a manufacturing firm' of which one part was specifically focussed on communication and information flows in the product development process. Information flow was viewed as pertaining to external and internal functions of the firm. The internal was divided into vertical (between management layers) and horizontal (across functions) information flows justifying the focus due to the importance of improving the development process because of the direct impact it has on design quality and time to market.

Early research into communication in NPD described how NPD teams are dependent on communication, both within the team and external to the teams.[18] This concurs with an earlier network model that depicted NPD as involving external inputs to a process of continual accumulation of knowledge throughout the functional departments of a firm.[19] This is in contrast to other research that contends that communication encompasses an essential requirement of the NPD process with information exchange across all functional departmental and hierarchical boundaries, that is paper, electronic, verbal, informal/formal, internal, external, inter-functional, interdepartmental, vertical, horizontal, procedures, and working practices.[20] More recently, organisational communication has been described as an information processing and uncertainty reduction activity.[21]

The movement of communication across boundaries has attracted significant attention in the work of Thompson,[22] Rogers and Agarwala-Rogers,[23] and more recently, Anacona and Caldwell.[24] The boundary spanner and its extension, the 'Boundary-Spanning Cosmopolite', create the nexus between the organisation and its external environment. Rogers and Agarwala-Rogers[23] explain 'in most systems, cosmopolites are concentrated at the very top and bottom'. The significance of cosmopolites is that they are usually the ones who engage in travel and are able to remain open to the outside environment.

Applying these ideas directly to NPD, Anacona and Caldwell[24] extended Tushman's[25] work to find that for successful NPD to occur the firm requires 'boundary spanners'. In order to exchange information externally and internally for better NPD, a firm requires employees to be spanning the boundaries of the firm to exchange information with other organisations.

BIOTECHNOLOGY, R&D AND NPD

Biotechnology has been given many definitions, but one of the clearest and simplest is that provided by the OECD in 1982 as; 'the application of scientific and engineering principles to the processing of materials by biological agents to provide goods and services'.[26]

The global biotechnology industry currently consists of more than 4,300

companies, 613 of these are publicly traded companies, which achieved a net loss of more than US$12bn in 2002.[27] These public biotechnology companies employed a total of 193,753 employees and achieved combined revenues of US$41bn in 2002. R&D investment was comparatively high with US$22bn invested. The biotechnology industry is analogous to the information technology industry – populated by a large number of entrepreneurial high-technology firms.[28] As a consequence, the industry is characterized by continually changing technologies and intense competition.

Biotechnology as an industry is unique in a number of ways. R&D underpins the biotechnology industry; it is one of the most research-intensive industries in the world. There are extensive lead times in the research and product development process; 10–20 times that of IT. There are significant limiting factors such as patent procedures, funding cycles, standard clinical trial procedures, and approval processes for FDA and EUDC, and cycle times are largely out of the hands of the individual biotechnology company. According to the Biotechnology Industry Organization, expenditure on R&D by US biotechnology firms increased from US$5.7bn in 1993 to US$20.5bn on R&D in 2003, with the five biggest firms spending on average over $100,000 per employee on R&D.[29]

It is estimated that there are over 650 Australian biotechnology companies of which 214 are regarded as core biotechnology companies.[30] It is estimated that 51 per cent of Australian biotechnology products in the product pipeline are in the development phase, while 21 per cent are undergoing clinical trials or field tests.[30] The remaining 28 per cent of products are on the market at various stages of their product lifecycles. The product pipeline is dominated by three large companies (CSL Ltd, ResMed Inc, Cochlear Ltd), which account for 60 per cent of the products. Very few biotechnology companies will manage to develop their products to the market and this is the accepted nature of the biotechnology industry.

Most biotechnology firms are therefore highly research intensive and are under pressure to innovate to produce commercial products, processes or services from R&D within the time-frame of the funding horizon. Managing the innovation process, including obtaining timely, appropriate funding for all stages of the discovery pipeline and generating commercial outcomes, is crucial to ensuring firm survival. Managing the innovation process therefore requires not only excellent R&D, but also the development and release of final products, processes or services.

Publicly funded discovery and applied research is still an important aspect of the funding regime for new biotechnology firms in most countries. Frequently the expertise and focus of the new biotechnology firm is on the research side, rather than with the development and commercial skills. Having an excellent basis in R&D is, however, a definite advantage to the new firm – particularly if the founder and team are recognised internationally for their research excellence. Firms must be able to remain clearly focused on producing a product, process or service. This single focus becomes more important once investment capital is secured and commercial milestones agreed. One of the key challenges in research and development management for the 'Bio Entrepreneur' is therefore to encourage the dual focus of (blue sky) research while simultaneously achieving commercial outcomes by the research team.[31]

Biotechnology companies, and institutions involved in biotechnology, are seeking to develop sophisticated products and strategies to ensure that such products establish and maintain a market trajectory.[32] The challenge of achieving an efficient NPD process is of major concern to all biotechnology-based organisations that are seeking to commercialise their products. Many biotechnology companies are still involved in the early stages of the value chain, in early stage and applied research.[33] For all biotechnology companies the development of new products is their central focus. The only variant is the stage of the value chain the company is at. Investors are also very concerned with NPD or, more particularly, the burn rate associated with this product development.[34]

The biotechnology industry is shifting inexorably from an emerging industry to a

more mature industry. Major companies worldwide are looking at consolidation and contraction, through merger or restructuring. There has been a reduction in the number of publicly listed companies worldwide despite the 15 per cent increase in revenue between 2001 and 2002. It is also interesting to note that net losses increased by 116 per cent from US$5.8bn in 2001 to US$12.5bn in 2002.[29]

There is also evidence of a shift along the biotechnology value chain from an emphasis on discovery research to development, manufacture and marketing. Mark Levin, CEO of Millennium Pharmaceuticals,[35] observed that 'value has started to migrate downstream, towards the more mechanical tasks of identifying, testing, and manufacturing molecules that will affect the proteins produced by genes, and which become the pills and serums we sell'. This shift in value creation along the value chain will become more important as more biotechnology companies strive to move through their trial phases and approval processes towards the market. This commercialisation push is in marked contrast to the pharmaceutical industry, where new drug approvals have been dropping in recent years.[36] This change underscores the need to reinforce the NPD process in biotechnology companies. A better understanding of NPD will improve the efficiency of product commercialisation.

Despite an abundance of academic and scientific expertise, biotechnology firms suffer from a lack of management skill and knowledge. This lack of skills and knowledge impacts on the firm's ability to manage NPD as well as to secure the funding required for sustained performance.[30,37] Many biotechnology ventures arise from organisations that place a significant emphasis on heroic/basic/blue-sky research. Example organisations include universities, medical research institutes and other public sector research agencies. In the private sector, businesses that conduct research (eg pharmaceutical companies) also devote significant resources to applied and developmental work. Biotechnology ventures need to blend and manage both basic research and development appropriately, with a strategic view to commercialisation, either independently or more likely as part of an innovation collaboration, such as a network or cluster.[38]

Resultant of the preceding literature analysis, the research question for this study: 'How do the processes of internal and external communication occur in NPD in Biotechnology companies?' is derived. NPD is clearly critical to the success of individual biotechnology companies and to the growth of the industry as a whole. It is important then to explore the role of organisational communication in NPD for biotechnology companies so as to enhance the understanding of the processes underpinning NPD with a view to improving practice in biotechnology companies. The literature has not provided sufficient empirical evidence to state a hypothesis, particularly for the biotechnology industry, given its established uniqueness. In order to build the theory available in the area of communication in NPD in the biotechnology context, an exploratory approach to the empirical research was required.

STUDY DESIGN AND METHOD

To ensure that results could be generalised to theory (rather than a population), a multiple-case design was selected rather then a single case study approach. The value of multiple cases study is that they offer a 'full variety of evidence'.[39] Six sources of evidence can be chosen including documents, archival records, interviews, direct observation, participant observation and physical artefacts. As each of the interviews conducted were at the business locations, in many cases documentation was forthcoming. Direct observation could be made at the site; in a number of cases a tour of the location was conducted, in which sometimes confidential documentation about the business was provided for viewing.

Although NPD can focus on the product as the unit of analysis, our interest is in the NPD process at the firm level. As a result the unit of analysis for this study is the firm. The selection of these cases from a single industry sector, in this case biotechnology, minimises the explanatory variables that need to be considered in a cross-sectoral study such as industry concentration, varying life cycles,

Table 1: Interviews – exploratory, check for agreement/disagreement through to confirmatory verification of initial findings

Firm	Position	Position	Position
Alpha	R&D Director	Process Mentors (2)	R&D Manager
Beta	Marketing Manager	R&D Manager	Regulator Affairs Manager
Gamma	Managing Director	R&D Director	Clinical Trials Manager and Marketing Manager
Delta	CEO	Operation Manager	Marketing Manager
Epsilon	General Manager	Senior Scientist	Senior Scientist
Zeta	Executive Director	Project Manager	R&D Manager
Eta	Bus. Dev. Man	Executive Director	Project Manager

R&D cycles, regulatory environments and other external factors.

The multiple case study procedure used an adaptation of a convergent interviewing procedure[40] to gain convergence within and between cases. Convergent interviewing is an iterative process, involving refinement of questions until the point of data saturation. The interview protocol evolves from guide and probe questions to include more structure as agreements and disagreements are tested in a funnelling process toward saturation. In total, 28 interviews in seven case study biotechnology companies were conducted with senior management who represented a cross-section of management (Table 1). Initially, 20 subjects were interviewed. Verification of the initial findings was achieved via a second set of eight interviews.

Analysis occurred through the iterative nature of convergent interviewing and thematic content analysis. After each interview an Excel spreadsheet was used to record the main priorities and convergent interview findings of each subject. This matrix displayed common themes and patterns (eg communication mode, e-mail usage) along side cameo descriptors (eg 'it's better to over copy than under copy'). Then the transcripts were analysed through a series of systematic sweeps.[41]

RESULTS

Communication flow in the NPD process

The analysis of results combines both the communication process and the organisational framework in which it operates in order to understand how the process occurs in NPD. The process begins with a generic communication flow, and then explores the role of both internal and external communication in NPD.

An analysis of the data shows a communication flow occurs within the NPD process that is identifiable in all six cases (Figure 1). In the three smallest firms (Delta, Epsilon and Gamma), the process was not as structured and delineated. Within the organisation there is a hierarchical ordering of the communication flow:

- *Senior management* – board directors, senior management team including CEO, R&D director, Marketing Manager.
- *New Product Committee* – a group of senior and middle managers who have exposure to external stakeholders (ie sales executives), and experience in the industry who are responsible for evaluating NPD concepts.
- *NPD Project Team* – a group consisting of heads or managers of functional groups or delegates of functional groups.
- *Functional Groups* – engineering department, marketing, biochemists.
- *External Stakeholders* – venture capitalists, funding institutions, external research collaborators and institutions, suppliers and other organisations.

The flow of communication highlights the influence of the network model of NPD.[19] Initially, the network model emphasises the external linkages coupled with the internal activities that have been shown to contribute to successful NPD. The fact that each of the arrows represent different roles of communication complies with the contention that the NPD process has differing needs at different stages.[42]

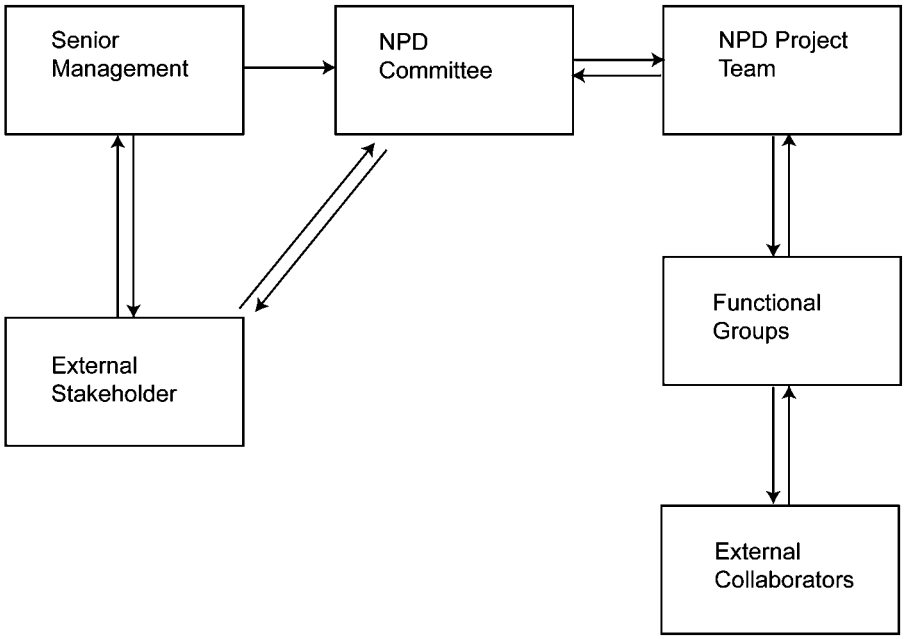

Figure 1: Generic Communication Process adapted for biotechnology firms. Adapted from: Forza and Salvador (2001)

All of the subjects explained that communication roles differ depending on the stage of NPD and can be summarised in the following list: envisioning, information disseminating, information seeking, information providing, engendering ownership, creating discipline, facilitating cross-functional planning and image managing. Each of these roles is illustrated in Figure 2. Each of these communication roles can now be discussed first in terms of internal communication and then in context of external communication.

Internal role of communication

Within the firm, the communication flow provides vision to the organisation, reduces uncertainty and coordinates the projects. The study identified communication processes associated with the interaction between the major groups involved in the NPD process. Traditionally, internal communication is responsible for task development, coordination and accomplishment.[17]

Senior Management to NPD Committee – envisioning – The communication that occurs in this stage can be explained using 'engagement' capability.[43] Engagement capability encompasses commitment formation, motivating, enthusing and path finding. It is this capability that the CEOs and GMs interviewed talk about in order for the NPD process to occur successfully. This was distinctly different from the role that communication plays in the next stage, where the NPD committee communicates with the NPD project team.

NPD Committee and NPD Project Team – information disseminating, and offering ideas – In line with the body of literature on project teams in NPD outlined earlier, the communication that occurs between the NPD committee and the NPD project team is an uncertainty reduction activity. In project teams, uncertainty may be perceived about: user needs, technologies, competition and the required resources to accomplish an innovation project.[21] This means that it is essential that the NPD committee provide as much information as possible to the NPD project team in order for them to function effectively. The more communication that occurred in terms of providing information, in response to information sought, the more smoothly the NPD process went. In return, members of the NPD project team would offer ideas to the NPD committee in terms of improving concepts or alternatively

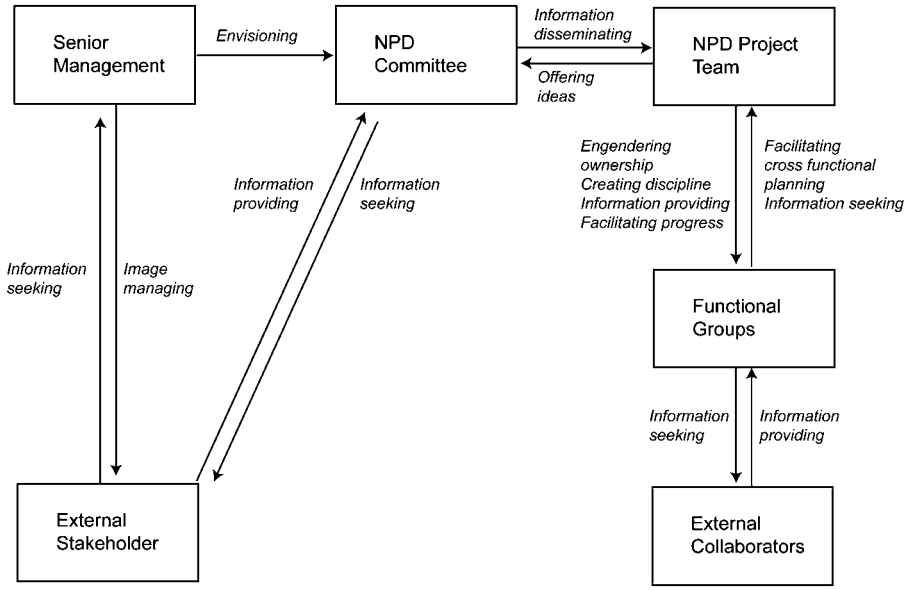

Figure 2: The role of communication in NPD in biotechnology firms

completely new concepts to consider. Once the NPD project team has been provided information by the NPD committee about the new products they will be developing, the members of the project team then disband and disseminate this information to their functional groups.

NPD Project Team and Functional Group – information disseminating, engendering ownership, creating discipline, information seeking, facilitating cross-functional planning – This communication is a combination of the uncertainty reduction activities as well as the engagement capabilities. An additional competence attributed to the engagement capabilities is enaction and integration,[43] and this is evidenced by the subjects' reports of the communication between functional groups and the project team creating discipline and 'getting things done'. As one respondent reported, 'If you can get the ownership right, people automatically start to do things'. This becomes quite important in terms of creating momentum for the project. When the members of the functional groups have a sense of ownership, they are proactive in seeking information they require, and providing information that will be necessary in advanced stages. This process is a highly iterative one, with members of the functional groups communicating to the NPD project team about further information required to keep the NPD process going and facilitate cross-functional planning.

The role of communication within the firm in the NPD process can then be considered as part of the firm's engagement capability and an uncertainty reduction capability. Both capabilities are necessary to keep the NPD moving efficiently in the right direction and achieve the intended outcomes. This is supported by the definition of internal communication being the human interaction that occurs within organisations and among organisational members.[17]

External role of communication

The value of external communication is that it enables members of an organisation to coordinate its activities with those in the relevant environment.[17] This includes influencing external stakeholders, providing direction for future strategies and gathering relevant information. The external role of communication can be summarised as: image managing, information seeking and information providing.

Senior Management and External Stakeholders – image managing, information seeking – Among boundary spanning behaviours were impression management and political engagement that sought to secure funds and resources.[24] As NPD in biotechnology is a

many year project, it is essential that the role of the fundraiser is performed to ensure a steady flow of investment funds. Subjects indicated that the external communication to the funds analysts and venture capitalists could be considered 'Investor Relations' or 'Public Relations'. In return, these stakeholders require information about the firm's milestones, progress and future research to continue funding. This has clear implications for developing communication capabilities to support NPD and these implications will be addressed in full about the 'fundraiser' role. The communication flows do not simply occur between senior management and external stakeholders. Rather the NPD Committee needs to communicate its successes and its requirements on specific projects to the external stakeholders.

New Product Development Committee and External Stakeholders – information seeking, information provision – All of the external stakeholders that the NPD Committee communicated with were market oriented, for example, suppliers, clients and clinicians. Five of the seven cases emphasised the importance of the market in NPD. The communication that occurred in this flow was primarily market research, and centred on spotting opportunities for the firm. This is contrary to the current realm of NPD research. Despite some authors' assertion that the market pull focus was dominant in the 1970s and that current NPD is integrated with technology push,[44,45] five of the seven cases studied in this research were led by marketing departments. This is all the more interesting in an industry that is regarded to be science led, indicating a technology push focus over a market pull approach. For these respondents, the decision to develop a product was made after market information gathering had occurred through the market research process.

Functional Groups and External Collaborators – information seeking and information providing – The communication flow that was apparent in the firms studied indicated that functional groups communicated with collaborators or commercial partners such as research centres and universities. Early research found that communication among team members and outsiders stimulates the performance of development teams.[46,47] This was, however, referring to the informal communication that occurs, not the fee-for-service communication transactions. Indeed, all of the respondents spoke of an awareness of the difficulties of communicating with the external collaborators.

DISCUSSION AND CONCLUSION

Managers need to understand that the role of communication is multi-varied and that at different stages of the NPD process different communication flows will occur. With this knowledge, managers can assess whether deficiencies reside in the firm's current processes. For firms engaged in NPD, this provides an opportunity to improve capabilities for innovation and continually improve competitive advantage.

The generic communication process of NPD observed is an example of the confluence of open systems theory, information theory and uncertainty reduction theory. This is because the generic process highlights the importance of interaction with the external world,[22] depends on the transmission of signals[48] and uses information to reduce the high uncertainty of NPD.[49] Alpha and Beta were larger organisations and thus had the staff to create a separate senior management level to the NPD committee and the NPD project team. The other cases were smaller and thus the senior management took on all of the functions of NPD committee and NPD project team. In these cases, the boundaries between the senior management, NPD committee and the NPD project team were blurred.

Regardless of firm size, however, NPD engagement was necessary for the firm and was considered an open system whose processes incorporated both external and internal communication. This enabled integrative efficiency-based and innovation-focused processes and created a process of sustainable competitive advantage.

The actual model of NPD that occurred is a hybrid of cross-functional, decision stage and network models.[19] It is not unusual that the process followed is not specific to the previously developed models, as previous

models developed were not intended to be accurate, generalised representations of the innovation process, but a basis for examining the features of innovation. The two-way flows of communication represented by the arrows in the model are indicative of multiple iteration.[50] The implication of these multiple iterations is that the analysis of the communication process must be conducted on multiple levels. In so doing, this research answers Saren's criticism that models of innovation process do not describe what exactly goes on in the firm during the process.[19] It also builds a comprehensive framework for building organisational meta-capabilities to support NPD.

In conducting this study the research established processes that assist firms in developing capabilities that will support NPD. This was achieved by integrating the strategic perspective,[43] enabling and engaging capabilities with an open systems perspective of communication.

Secondly, in answering the research question: 'How do the processes of internal and external communication occur in NPD in Biotechnology companies?', this study found that the process of communication in NPD is essentially an information seeking and uncertainty reduction activity that occurs through both the internal and external environments of the firm. There is a symbiotic relationship that occurs between the internal and external communication. Without the external communication of PR and image management investment, funds cannot be raised to support the activity that requires efficient internal communication. Similarly without the internal communication the NPD does not occur that is necessary to assure the external stakeholders of the value of the organisation.

The structured analysis and findings provided by this study has served to further our understanding of the critical controlling mechanisms of communication in the success of NPD in biotechnology firms. This improved structure will serve to enhance the management of communication in high-technology companies whose survival depends directly upon NPD, which these days includes the vast majority of firms.

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