

Research Paper

Yassir M. Samra*, Gary S. Lynn**, Richard R. Reilly***

Improvising in a crisis: an empirical study of NPD teams in the field of chemistry and chemical engineering

Organizational crises can ruin a firm's reputation and threaten its survival. The field of chemistry and chemical engineering has experienced this from the classic example of the Tylenol scare to Deepwater Horizon. In most cases, the firm is focused on communicating outwardly with external stakeholders but what about the rest of the firm? New product development (NPD) has delivered firms successfully from such financial peril and therefore can be instrumental in being a solution to a crisis. In this study, new product development teams are investigated to see their role in delivering a firm from an organizational crisis. Using an improvisational NPD approach towards dealing with a crisis, this study looks at teams at 55 firms that are associated with the field of chemistry and chemical engineering to determine whether a perceived crisis by the NPD team can be a motivating factor on the successful outcome of the new product being developed. The results indicate that a perceived crisis by the NPD team is positively correlated with project outcomes of speed and success, brings about improvisation, but does not moderate the relationship between improvisation and NPD project outcomes.

1 Introduction

Organizational crises happen infrequently but when they do, they threaten the survival of the firm. The history of organizational crises is primarily focused on firms associated with the fields of chemistry and chemical engineering. Notable crises where product tampering was suspect include Johnson & Johnson's Tylenol Scare (Pearson and Mitroff, 1993), Odwalla's E. coli outbreak (Choudhary, 2012), Coca-Cola's recall in Europe (Johnson and Pappas, 2003), and lead contamination of Nestle's Maggi noodles in India (Srivastava, 2019). In such cases, each firm suffered initially as they inspected and improved their products in question. Other firms such as Union Carbide's Bhopal gas leak (Weick,

1988), Exxon-Mobil's (then Exxon) Alaskan (Pearson and Mitroff, 1993) and BP's Gulf of Mexico oil spills (Halkos and Zisiado, 2020) brought about crisis management teams to quell the situation. In such cases, the firms kept operating, nonetheless. New product development teams within these firms were still working.

While crises may be debilitating, NPD can play a vital role to deliver the firm from a crisis. NPD team members perceiving a crisis, have the unique opportunity of taking on marginal risk since there's little left to chance since the crisis has done significant damage to the health of the firm. Along with

* Yassir M. Samra, Associate Professor of Management, O'Malley School of Business, Manhattan College, 4513 Manhattan College Parkway, Riverdale, NY 10471, USA, yassir.samra@manhattan.edu

** Gary S. Lynn, Professor of Business, School of Business, Stevens Institute of Technology, 1 Castle Point on Terrace, Hoboken, NJ 07030, USA

*** Richard R. Reilly, Emeritus Professor of Business, School of Business, Stevens Institute of Technology, 1 Castle Point on Terrace, Hoboken, NJ 07030, USA

proper management of the NPD process, a new product can be successfully launched, which becomes a solution to the situation (Akgün et al., 2006). For example, prior to Nintendo's Wii console, the firm had yielded considerable market share to Sony and Microsoft, putting the firm's survival in peril. In 2006, falling sales and a shrinking market share called for a drastic change. Nintendo developed and launched the first gaming console that involved the gamer using his/her body as a control for the avatar. This radical innovation revitalized Nintendo and made it a major player in its industry (Binns et al., 2014). While this example is not chemistry related, the example of Johnson & Johnson's NPD team bringing about a new way of coating and packaging Tylenol certainly is. Following this logic, this research suggests that NPD can be a solution and therefore a key outcome of a crisis.

The innovation literature relating to NPD provides insights into many best practices of successful NPD teams. The commonly adopted idea-to-launch process implies certain predictability or a somewhat measurable future. However, the environment is not always stable, which has been highlighted in past studies (e.g., Maltz and Kohli, 1996; Moorman and Miner, 1998). In a crisis, old rules generally do not apply (Starbuck et al., 1978). This study argues that because a crisis is an unplanned surprise event, an improvisational approach to NPD is more appropriate than a traditional one.

This research contributes to the field of crisis in different ways. Despite its importance, extant crisis management literature focuses on how firms deal with external

stakeholders or how the management reassures employees. The focus is primarily on public relations and reestablishing trust or the firm's reputation. This research attempts to add that NPD teams can assist in delivering a firm from a crisis. Furthermore, since organizational crises are generally associated with firms where strict quality control measures are enacted (i.e., the use of chemicals), this study shows that a perceived crisis by an NPD team can help deliver a firm from the threatening level in such an environment. In addition, the NPD literature focuses on improvisation to improve project outcomes, but little exists on its use in a crisis.

2 Conceptual Framework

Crisis and crisis management

The dictionary defines a crisis as an unstable or crucial time in which a change is impending (www.merriam-webster.com). A classic definition of an organizational crisis is an unanticipated, threatening situation, that requires an immediate response to quell (Herman, 1963). Although the crisis is an actual event, it can be a measure of perception that the value of the organization is seriously threatened (Billings et al., 1980). Table 1 shows how different authors define the term crisis in organizational settings. Almost all agree that a crisis is a threatening situation to a firm's existence that necessitates a sense of urgency based on either a surprise event and/or an uncertain environment. This uncertainty

Table 1 Organizational crisis definitions.

Author	Urgency	Surprise	Threat/Danger to Existence	Uncertainty
Barnett & Pratt (2000)			X	
Billings et al (1980)	X	X	X	X
Heath (1995)	X		X	
Hermann (1963)	X	X	X	
Kim (1998)			X	
Pearson & Mitroff (1993)	X		X	X
Shrivastava et al (1988)			X	
Smart & Vertinsky (1984)	X			X
Starbuck et al (1978)	X	X	X	
Weick (1993)	X		X	
Weick (1988)			X	X

creates a void of information available and thus confidence in decision-making is reduced (Plous, 1993).

Research also suggests that people may not make a distinction between crises that pose latent threats and those immediate (Barnett and Pratt, 2000). Whether a crisis exists may not be as critical, but if it exists in the minds of many people then its consequences will be real (Galtung, 1984). This is particularly crucial to organizations because they respond to the environment based on how they perceive it can be managed (White et al., 2003). Extant literature of crisis management has been done across various fields, such as consumer packaged goods (Johnson and Peppas, 2003), tourism (Hajibaba et al., 2016), pharmaceuticals (Priporas and Vangelinos, 2008), and automobiles (Fan et al., 2013). Crises can be initiated by various events, including product recall (www.cpsc.gov), economic recession (Fan et al., 2017), political and social change (Martins, 2015; Szántó, 1994), natural disaster (Quarentelli, 1988), and so forth.

Furthermore, Penrose (2000) asserts that firms perceive a crisis not only as a threat but as an opportunity. Successfully resolved crises involve the firm restoring its reputation and bringing back customers. Siomkos and Shrivastava (1993) find that firms need to face the crisis and not avoid it to survive. While they may have a financial burden, successful firms must be capable of dealing with the emotional fallout caused by a crisis. Mitroff et al. (1989) suggest that while most firms are not prepared for a crisis, those who are, often have key personnel that serve to help the firm navigate the crisis to emerge successfully. Effective crisis management involves detecting potential problems and mitigating the risk of what can and cannot be managed. Potential problems that can be fixed will result in no crisis occurrence; however, situations that cannot be planned for and threaten the firm can result in an actual crisis (Mitroff et al., 1987).

Once a crisis has emerged, it is up to the firm on how to manage it. Affected firms can have teams that interact with each other in an effort to bring about a positive change and become more sustainable. Since a crisis is something new, remaining silent during a crisis is not an appropriate strategy (Xu and Li, 2013). Considering that a crisis is often perceived as being threatening, any attempt to manage the situation is better than doing nothing. In fact, an attempt to manage the crisis likely results in a positive outcome as the current environment may have already had a negative impact on the firm.

Crisis and improvisation

From Table 1, some authors define an organizational crisis is a never-before-seen, surprising situation that can cripple a firm and as such, a normal reaction cannot be the answer to minimizing the damage (Starbuck et al., 1978). Therefore, a crisis requires a creative response to abate. The limited amount of time a crisis affords the affected firm, warrants an improvisational approach to the situation. To define improvisation, Barrett (1998) describes improvisation as coming up with novel responses without a set plan and Bastien and Hostager (1988) define improvisation as inventing and executing new ideas. This stream states that improvisation is a deviation from normal routines or behavior. This is synonymous with the definition of creativity (Amabile, 1996). An example of this is when an organization designs a creative marketing strategy (Moorman and Miner, 1998). The idea may be new and innovative, but it is not necessarily improvisational; improvisation is synonymous with creativity only under a time constraint or pressured situation. To better define improvisation, Crossan and Sorrenti (1991) define it as intuition guiding action in a spontaneous way. Cunha et al. (2001) define improvisation as the conception of action as it unfolds. Perry (1991) defines improvisation as formulating and implementing strategies in real time which is echoed by Weick (1993) as improvisation has no distinction in time between composition and performance. Moorman and Miners' (1998) definition of improvisation states that improvisation is when the planning and execution converge in time so that they occur simultaneously.

Therefore, the ability to accept real-time information as true and act upon it with little (or no) planning constitutes the act of improvising. This is sometimes referred to as managerial fire-fighting (Smart and Vertinsky, 1984) as an organization seeks to find alternative solutions to remedy the crisis. However, high-pressure environments are generally considered to be infertile grounds for improvisation (Cunha and Cunha, 2001) as they do not provide sufficient time to think creatively (Amabile, 1996). Weick (1993) asserts that when people are put under pressure, they respond in their most habituated ways which doesn't necessarily lead to positive outcomes. On the other hand, since a crisis is generally a new situation, requiring a new response, improvisation is the answer to dealing with the threatening situation.

Crisis and new product development

Despite its threatening nature, a crisis can motivate firms to achieve superior performance. Chemically related firms are more prone to an organizational crisis as they attempt to ensure strict quality control measures. However, when a failure strikes, it can be devastating and threaten the firm's existence like in Union Carbide's case where, toxic gas was released into the atmosphere on the people of Bhopal, India. Over 3,000 people died soon afterwards and over 100,000 people have since been affected from breathing the gas. The firm paid millions in damages to the Indian government but the CEO at the time hadn't answered to criminal charges. On the other hand, Johnson & Johnson, after hearing that 5 people died from consuming their product, immediately initiated a nation-wide recall. This prompted the firm to ultimately create new packing for Tylenol and a few years later, after another death, the firm initiated another nation-wide recall before introducing new coatings to make their product even more tamper resistant. The two preceding examples, each dealing with the field of chemistry, show how firms can manage and mismanage a crisis (Samra, 2005).

NPD teams, while may not be directly fighting the crisis, can certainly respond to and help the firm emerge from it. In NPD, teams require not only a strategy for risk taking but also one for risk management to select the projects that have the most potential. The ability to manage risk throughout NPD is vital. It is suggested that NPD teams that can successfully do so are associated with positive project outcomes (Mu et al., 2009). However, research in the field of crisis tends to focus on how to prevent or recover from one (Lin et al., 2006). Effective teams in crisis settings contain members who know their role and engage in more concise behavior and interaction (Stachowski et al., 2009). In NPD, a crisis can be in the form of a sudden change in the environment such as a change in customer tastes after a new product has been launched, a new regulation imposed on firms in a particular industry, or a product recall. Information is often limited as the firm decides which direction it wishes to pursue. As such, NPD team members can experience stress and anxiety due to the threatening nature associated with a crisis and the lack of information as it unfolds. This can lead to inflexibility and poor decision-making by NPD teams as their level of anxiety increases during a crisis (Akgün et al., 2006). On the other hand, NPD team members who are familiar with their

roles as well as those of their team members should exhibit more interaction and coordination in the NPD process, which can lead to a more favorable outcome.

While crises are generally addressed by senior management, lower-level organizational members – in this study, NPD team members – should also respond to such a threatening situation to assist in determining their firm's survival. An example of this is the case where a "crisis" was fabricated by the government of South Korea through imposition of new regulations designed to spark the Korean vehicle industry. While many executives did not see these new regulations as a significant crisis, employee perception of crisis was high. Because of it, Hyundai was able to design and develop a new Korean car, thereby moving from assembling foreign cars to a more integrated design and manufacturing firm (Kim, 1998). This case well reflects the role of NPD and engaged team members in crisis and how their perceived crisis can serve as a trigger for innovation.

Few studies have empirically explored the effects of crises on NPD. Akgün et al. (2006) examine the perception of crises by NPD team members and find that it is positively linked to creating new knowledge and processes but do not explore the direct effect of a crisis on project outcomes. In another study, Akgün et al. (2007) find that top management support positively moderates the relationship between perceived crisis and new product success. In both studies, the crisis was a measure of perception. Likewise, the term perceived crisis is adopted in this research to describe the extent to which people acknowledge a crisis and respond to it in the NPD process.

In summary, for a crisis to be managed, the NPD team and its members should be considered as an appropriate response vehicle as their decisions are not directly affected. In such a situation, the NPD team can manage the crisis by developing a successful new product.

Improvisation and new product development

Common formal processes in NPD tend to be associated with stable environments and with incrementally innovative products. In such times, NPD is predictable, and the technology associated with the new product is known. Therefore, this structured approach is very applicable,

and the empirical results indicate its association with successful project outcomes (Cooper and Kleinschmidt, 1986, Shepherd and Ahmed, 2000). But NPD isn't always this easy. Changes in the environment and technology are ever present and a new approach to NPD is warranted. Cooper (1994) proposed fundamental changes to the structured approach to include one that is more flexible. Cooper and Kleinschmidt (1995) defined a flexible NPD process as one where stages and decision points could be skipped or combined. They empirically support that flexibility at the firm level is significantly associated with positive new product performance.

But proficiency throughout a specific NPD process is not a universal answer. Brown and Eisenhardt (1995) have found other factors that may contribute to the likelihood of new product success such as having senior management involvement and support, a clear vision, and team stability. Scholars have also suggested that sequential models may also be too general to fit the demands of some products and services. For instance, structured models may be inappropriate for products requiring extraordinary speed, secrecy, address specific problems, or entail short production runs (Gwynne, 1997, Donada et al., 2021). They have also been shown to be rigid, and as a consequence, may reduce flexibility (Rosenthal, 1992). Indeed, scholars have suggested that they may be too structured for quickly changing competitive environments (Cooper 1994; Hoopes and Postrel 1999). As a response to some of the drawbacks of earlier sequential approaches - namely: rigidity and speed, a new approach to NPD emerged. This new improvisational approach focused on giving teams the ability to think and execute faster to get products out to the market (Moorman and Miner, 1998).

Few industries remain stable yet those that are in constant change require a far more flexible approach to NPD. This new model elevates flexibility from adapting to a situation to improvisation which refers to the deliberate and substantive fusion of the design and execution of a novel production (Miner et al., 2001). The use of improvisation is ideal for new situations and is far more applicable to the field of crisis than any sequential approach.

In a widely cited study on new product development activities at two midsize firms, Moorman and Miner (1998) found that improvisation can be an effective tool when an

organization faces environmental turbulence that requires action. One of the important findings of their research was that improvisation occurs with substantial regularity in the product development process. Also, it is important to mention that while improvisation may be attributed to start-up firms and small business environments, the two organizations in the authors' studies were two well-established organizations with formal structures, roles, and procedures.

Hypotheses: Crisis & Improvisation

In threatening situations, it is all too easy to rely on what one knows or what one has been trained to do (Barthol and Ku, 1959). This is seen in the airline industry where a captain does not rely on individual action but rather on the contingency plans that have been developed for the specific circumstance. Evaluation of pilot error accidents have found that the situation was (in some cases) worsened by relying on individual action (Anonymous, 2002). Heath (1995) proposes that the more an organization experiences disasters, the more routine will be their response. The situation of an airline's engine failure indeed threatens the lives of those on board, but prior planning for this circumstance (and others) can limit the damage (Quarantelli, 1988). Yet it is impossible to have a structured response for every contingency since the number of possible crises is virtually infinite (Weick, 1988). In this dangerously unfamiliar situation, some degree of trial and error is present and as Bateson asserts: "An explorer can never know what he is exploring until it has been explored" (Weick, 1988). Therefore, normal reactions to a crisis do not necessarily work because of the entirely new situation the organization is facing. In fact, Starbuck et al. (1978) claim that a situation cannot be deemed a crisis if normal behaviors produce improvements. Therefore, in returning to the airline example of engine failure, it is realized that this situation should not be a crisis for the airline crew but perhaps is perceived as a crisis to its passengers.

Another example of a crisis event was the infamous Mann Gulch fire (Weick, 1993) where many of the firefighters perished. At first, the team of firefighters attempted to pass the gulch and move towards a river that would lead them to safety. As the flames quickly approached, the team leader, Dodge, decided to change direction and attempt to lead his crew up a steep hill to avoid the approaching flames but was unsuccessful. After relying on logical solutions, the

final act (of desperation) of Dodge (and to the amazement of his crew) was that he ordered his crew to abandon their firefighting tools and lit a fire in front of them and ordered them to lie in this ring of fire with him. No one heeded their superior's call and while they tried to outrun the fire, only two other members had survived unburned (a third survived but due to his burns, died the next day). It took 450 men and five days to get the 4,500-acre Mann Gulch fire under control, a fire that was originally classified as being between 10 to 99 acres. The Forestry Service held an inquiry and determined that had the crew obeyed Dodge's order to lie in the escape fire, they would have been saved.

The reason for a detailed description of this event is to illustrate that high-pressure environments are generally considered to be infertile grounds for improvisation (Cunha and Cunha, 2001) as they do not provide sufficient time to think creatively (Amabile, 1996). Weick (1993) asserts that when people are put under pressure, they respond in their most habituated ways. He continues by saying, "What we do not expect under life-threatening pressure is creativity" (Weick, 1993). Therefore, we can conclude that under times of crisis, the one thing we don't expect is improvisation, however if it is done, it can be very rewarding.

Few studies in the NPD literature have attempted to empirically establish an association between crisis and improvisation (Akgün et al., 2007, Samra et al., 2019). While several factors associated with new product success have been observed in turbulent environments, they have not been tested in crisis situations. It is important to understand the distinction between turbulence and crisis. The dictionary defines turbulence as a state of unrest or disturbance, while crisis is defined as an unstable or crucial time or state of affairs in which a decisive change is impending (www.merriam-webster.com), thereby implying that a crisis has a much higher degree of threat. Industries that are constantly turbulent and the successful firms in these industries have acclimated themselves to change (Brown and Eisenhardt, 1997) and therefore turbulence becomes part of their doing business. Crisis on the other hand can develop from a steady state. When a crisis does occur, the rules essentially get thrown out the window (Weick, 1993) and the NPD team must arrive at novel solutions quickly. Thus, as the literature accepts that improvisation can be a useful tool throughout NPD and a crisis, the following hypothesis is presented:

Hypothesis 1: For a firm in crisis, higher threat levels as perceived by the NPD team will be positively associated with higher levels of improvisation by the NPD team.

Hypotheses: Crisis & Outcomes

Since a crisis is a threat to survival, urgent (re)action is necessary to abate the situation. An organization typically has neither the luxury nor the time to analyze several responses nor to develop a manner with which to execute them in hopes of delivering itself from the crisis; rather the crisis will worsen the situation if action is not swiftly taken.

In sports (particularly American football), there are countless moments when a team sits on the brink of elimination with little time left to score and manages to overcome enumerable odds to become victorious in the most unorthodox fashion (Katz, 2001). One may argue that in sports, the perception of a crisis is not as threatening as it might be in an organizational setting (lives aren't being lost and there's always next season). But the lesson is still the same; in a crisis, time is limited before the situation exacerbates and all is lost. A perceived crisis can be successfully resolved by immediately addressing the threatening nature in hopes of a successful resolution. A company can prepare only so much for a crisis, but it can never eliminate the possibility of one occurring. Therefore, if a crisis does exist, then a rapid response is required to quell the situation. If left unattended, the crisis can have further detrimental effects on the organization.

In NPD, crisis can be a good thing as it presents the NPD team with an opportunity to shine and deliver the organization from its (financial) peril. To do so, the NPD team must react immediately to the crisis and develop (and launch) this new product quickly. Formally stated:

Hypothesis 2a: For a firm in crisis, higher threat levels as perceived by the NPD team will be positively associated with speed to market.

In addition, many NPD studies have shown a strong correlation between speed and success (Lynn et al., 1999; Cooper and Kleinschmidt, 1995; Samra, 2005). Therefore, if indeed a crisis is a good thing, then it will be positively correlated with both speed and success. Thus, the following is hypothesized:

Hypothesis 2b: For a firm in crisis, higher threat levels as perceived by the NPD team will be positively associated with higher levels of success in new product development and launch.

Hypotheses: Improvisation & Outcomes

With regard to the NPD literature, it has been empirically tested that proficiently using a structured approach will yield positive outcomes (Cooper and Kleinschmidt, 1986, Cooper and Kleinschmidt, 1987; Lynn et al., 1999; Millson and Wilemon, 2002; Shepherd and Ahmed, 2000). However, based on the preceding arguments, if this is the standard traditional approach to NPD, then it should not have any positive significance on the outcome of a new product in a crisis. On the other hand, there is support for the use of improvisation throughout new product development in uncertain and turbulent environments (Brown and Eisenhardt, 1997; Eisenhardt and Tabrizi, 1995). But a crisis is far more threatening in nature than a turbulent or uncertain environment because it contains not only an uncertainty factor but also the perception that the entire organization's survival is in question from this perilous situation. In fact, turbulent environments can be a part of the NPD team's industry (Eisenhardt and Tabrizi, 1995) as the more exposed the NPD team is to change, the more likely they will be able to adapt to rapid changes associated with turbulent environments.

As for uncertain environments, they are the midpoint between a turbulent environment (where changes can be anticipated) and crisis (where the threat level is extremely high and imminent). Uncertain environments are uncharted for NPD teams and differ from turbulent environments as they are not simply changes that the team can adapt to, rather, they are environments where the NPD team must decide if they wish to enter based on unavailable information. In a crisis, the company in question is in peril and it is imperative to respond to the situation at hand. The NPD team can still

function in this newly created uncertain environment, but like the rest of the firm, it may feel threatened by the onset of the crisis. As successfully resolved crises require creative answers, the NPD team can improvise to be successful. As previously mentioned in the preceding hypothesis, both speed and success are highly correlated and since a crisis can occur at random to any organization and it is completely unpredictable and unrecognizable as a potential threat, the following hypotheses are presented:

Hypothesis 3a: A firm in high crisis will exhibit a stronger relationship between improvisation and speed in the NPD process than a firm in low/no crisis.

Hypothesis 3b: A firm in high crisis will exhibit a stronger relationship between improvisation and new product success than a firm in low/no crisis.

3 Research Design Methodology

Figure 1 illustrates the overall picture of the relationship of the 3 variables: the level of perception of a crisis, improvisation, and project outcomes speed & success. Hypotheses 1 & 2 suggest that as the perception level of a crisis increases, so does the frequency of improvisation as well as the likelihood of both a faster and more successful product launch. To test this, a bivariate correlation matrix will indicate any support for these hypotheses. Hypotheses 3a & 3b will require using a hierarchical regression model with three blocks. The first two will contain the variables improvisation and crisis, respectively, while the third will contain a new variable that consists of the cross-product between improvisation and crisis. If a significant result is found in the third block, then a new dichotomous variable will be created to differentiate between a firm in high crisis and one in low crisis. Since the construct of crisis is one based on the perception by NPD team members, it is subjective. Different team members can rate the level of crisis differently from others even as the situation remains the same. Some members have prior knowledge or experience with a similar situation and therefore will not rate or perceive a threat as high as someone who lacks knowledge or experience with a similar situation.

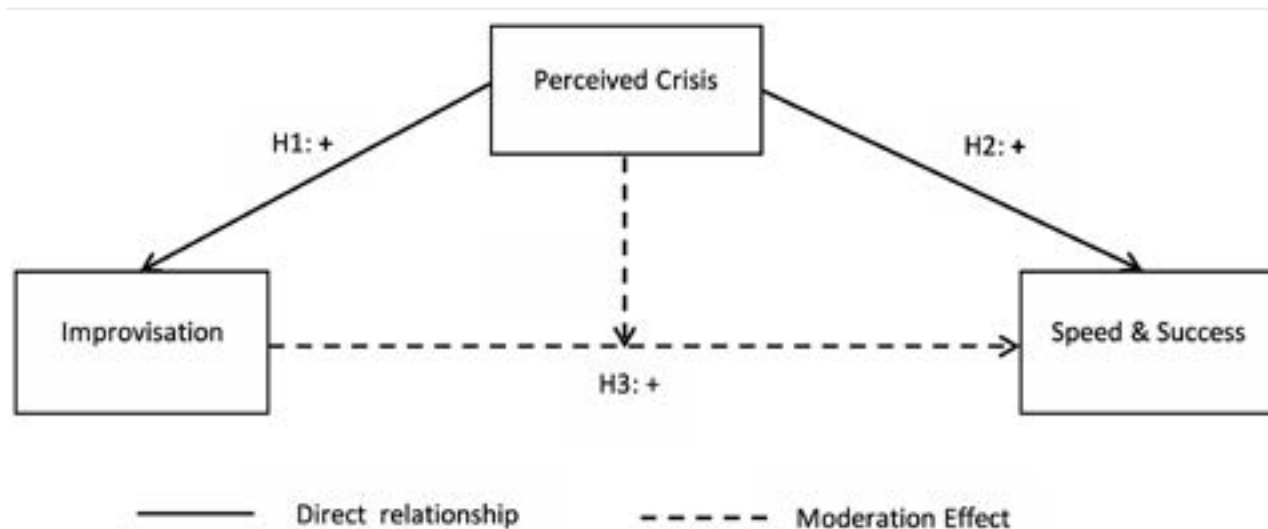


Figure 1 Conceptual Model.

For this study, a high crisis will be one where the NPD team member rates the situation higher than the median score of all respondents. Conversely, a low perception of crisis will be one where the NPD team member rates the situation as lower than the median score across all respondents. Finally, a new set of regressions should be able to empirically demonstrate that improvisation is more closely related to positive outcomes during a crisis than not.

Sample

To test our hypotheses, a questionnaire was developed based on previous research (Billings et al., 1980; Cooper 1994; Cooper, 2001; Kessler and Chakrabarti, 1999; Moorman and Miner, 1998; Schein, 1993). After designing and refining the questionnaire, a contact person in a variety of US based

chemically related companies was selected to participate in this study. These firms were selected with the intention of identifying industries that are related to pharmaceuticals, petrochemicals, and chemical manufacturing. In other words, industries that can experience an organizational crisis like Johnson & Johnson, Coca-Cola, and British Petroleum, were the target. This would in turn make for a more natural response from the respondent on the perception of a crisis within the firm. The contact person in each company was asked to select a project manager or senior team member (respondents are primarily product/project managers, senior team members or department managers and directors) who was with the project from pre-prototype through launch. The project manager was asked to provide the product and industry that the firm operated in. Lukas and Ferrell (2000) and Podsakoff and Organ (1986) found that managers rely on their own self-reports and provide

Table 2 Industry of new product being developed.

Industry	Number of Firms	% of Sample
Chemicals	8	14.5
Coatings	4	7.3
Consumable goods	10	18.2
Lubricant Manufacturing	4	7.3
Natural Gas	1	1.8
Petrochemical Manufacturing	12	21.8
Pharmaceutical Drug Manufacturing	12	21.8
Plastics	4	7.3
Total	55	100%

reliable and objective data. Also, Huber and Power (1985) note that simply averaging multi sources is less likely to be accurate than using a key informant. After the selection of the respondents, they were informed that their responses would remain anonymous and their responses will not be linked to a company or product name. This increased the motivation of informants to cooperate without fear of reprisals. To improve the accuracy of retrospective reports, recent projects were selected to eliminate the elapsed time between the events of interest and the collection of data. Of the 301 "contact people" asked to participate, 244 of them returned a questionnaire (an 81.1% response rate), of which 55 had sufficient data to be included in both the

correlation and regression analyses. Industries ranged from the manufacturing of pharmaceutical drugs and other consumable packaged goods to plastics and the manufacturing of petrochemical related products such as fuel additives, lubricants, and other chemicals (see Table 2).

Measures

For this study, questions were measured on a Likert-type scale from 0 = strongly disagree to 10 = strongly agree. Table 3 provides a summary of the measures.

Table 3 Summary of Measures.

Dependent Variable	
Success	To operationalize new product success, six questions were asked referring to how well the project met volume, sales, profit, ROI, and market share expectations. All items loaded onto one factor and the mean was used as the variable. References: Cooper, 1994; Cooper, 2001
Speed	To operationalize speed, four questions were asked. Since a multi-company and multi-industry sample was used, the speed-to-market differences in the nature of projects were controlled by using relative measures. This approach and item content were similar to that of Kessler and Chakrabarti (1999). Speed-to-market was assessed by comparing actual performance to pre-set schedules, company standards and similar competitive projects. Reference: Kessler and Chakrabarti, 1999
Independent Variables	
Improvisation	To operationalize improvisation, the following three questions were asked: (1) the team figured out the NPD process as it went along versus following a rigid well-defined plan, (2) the team improvised in developing the product versus strictly following the plan, and (3) the team improvised in commercializing this product versus strictly following the plan. Items were adapted from Moorman and Miner (1998). The mean of these items was used as the variable. Reference: Moorman and Miner, 1998
Moderating Factor	
Crisis	Three questions were asked to measure the perception level of crisis. Specifically, respondents were asked the level of crisis in within their organization, environment, and with their customers that their current project would help solve. References: Billings et al., 1980, Schein, 1993

Measure Validity & Reliability

Before testing the proposed model, the structure and reliability of the constructs were assessed. To measure each construct, a factor analysis was performed (on the items asked in the questionnaire) along with a varimax rotation method and Kaiser normalization to validate the number of constructs used as well as to confirm whether the items mentioned for each construct were indeed capturing their respective construct (Tabachnick and Fidell, 2001). After the extraction of components with an eigenvalue > 1.00, four variables remained explaining 63.8% of the variance. A loading factor value of 0.5 and above in each component in the varimax rotated component matrix validated the items as acceptable measurements of the constructs.

Each variable in the model consisted of the average of the items in each component. To ensure the practicality of the measures, an Alpha reliability test was performed. All Cronbach's alphas (see Table 4) were above the minimum acceptable level of 0.7 as recommended by Nunally (1978).

4 Empirical Findings

Crisis and Improvisation

To determine if a crisis can present an opportunity, positive bivariate correlations between crisis and each of the two outcomes must be found. The results presented in Table 5 illustrate that indeed there is a positive correlation between crisis and improvisation, thus supporting H1. The results also show that crisis significantly correlates with both speed and success, thus supporting both H2a & H2b. Also, it is worth

mentioning that speed was significantly related to success as they had a correlation coefficient that is consistent with past studies.

Hypotheses 3a & 3b sought to assess the degree to which predictor variable improvisation along with crisis explained the variance of project outcomes speed and success. To find support for the final two hypotheses, two regression models were used to assess the fit of the model and the impact of the predictor variable on both speed and success. In each case, the first variable in the model included the predictor variable improvisation. The next variable in the model was the moderating variable crisis. The final variable in the model included a cross-product between improvisation and crisis to determine any interaction effect between the two variables. If so, the results would indicate that improvisation may be better in times of crisis than in times of stability.

Speed to Market

The variable improvisation was found to have a non-significant impact on speed. The squared correlation ($R^2 = 0.000, p < 0.979$) was not significantly different from zero. This would mean that improvisation in NPD in these industries does not help speed the process of a new product launch. On the other hand, the variable crisis was found to have a significant impact on speed as the squared correlation ($R^2 = 0.157, p < 0.005$) was significantly different from zero. This result is like the previous analysis indicating that a perceived crisis is positively associated with improvisation (H1) and the speed (H2) with which a new product can be launched. The final block in the regression results indicates that there is no significant interaction between improvisation and crisis

Table 4 Measures and Reliability.

Predictor Variable	No. Items	Mean	Standard Deviation	Alpha
Predictor Variable <i>Improvisation</i>	3	5.56	2.21	0.76
Moderating Variable <i>Crisis</i>	3	4.58	2.32	0.74
Dependent Variables <i>New Product Success</i>	7	5.36	3.02	0.97
<i>Speed to Market</i>	4	5.44	2.64	0.85

Table 5 Bivariate Correlations (N = 55).

	New Product Success	Speed to Market	Crisis	Improvisation
New Product Success	1			
Speed to Market	0.568**	1		
Crisis	0.197*	0.360**	1	
Improvisation	0.011	0.041	0.294**	1

* $p < 0.05$; ** $p < 0.01$

($R^2 = 0.161$, $\Delta R^2 = 0.004$, $p < 0.625$), thus demonstrating no support for H3a. This result indicates that there is no significant difference in the relationship of improvisation and speed based on the perception level of crisis in the selected industries where an NPD team was working on a project. In other words, the perception of a crisis does not moderate the relationship between an improvisational approach and the speed with which a NPD can launch a new product.

This result is slightly different from H2b where it was shown that a perceived crisis has a significant association with a successfully developed new product. The squared correlation ($R^2 = 0.046$, $p < 0.063$) for crisis was partially significantly different from zero based on the p-value being under the standard of 0.1 for marginal significance. The final block in the regression results indicates that there is no significant interaction between improvisation and crisis ($R^2 = 0.05$, $\Delta R^2 = 0.004$, $p < 0.604$), thus demonstrating no support for H3b.

New Product Success

The variable improvisation was found to have a non-significant impact on success. In the selected industries, the amount of improvisation done by the NPD team does not significantly impact the outcome of the project. The squared correlation ($R^2 = 0.001$, $p < 0.833$) was not significantly different from zero. The variable crisis was found to have a marginally significant impact on success.

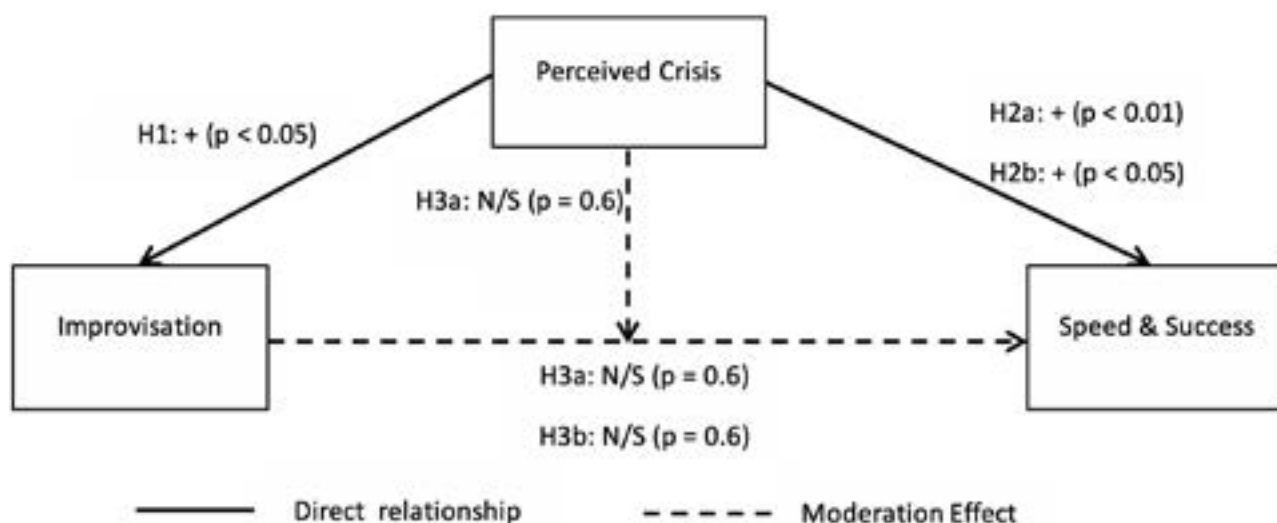


Figure 2 Results of Conceptual Model.

5 Contributions and Implications

Theoretical Implications

First, few studies have addressed crisis and its effects on NPD. As stakeholders are increasingly alert to product safety, crisis management is undoubtedly becoming crucial to firms. This research fills a gap by examining how the perception of a crisis impacts the firm's NPD process. This study, to some extent, is in line with the dynamic capabilities theory, which suggests that successful firms should be able to adapt to a changing environment by using a combination of their competencies. In this research, the crisis is viewed as an impactful aspect of the environment and suggest that NPD can be an effective solution for a crisis.

Second, information sharing is viewed as a key success factor for NPD (Troy et al., 2008) and informal communication is a vehicle of sharing (Samra et al., 2019). As NPD team members become less formal during a crisis, they will rely less on the use of formal communication methods as this will increase NPD time, embrace informal communication which can lead to the NPD team improvising more during a crisis, and should speed up the NPD process.

Third, we find the existence of improvisation and successful outcomes brought out by a crisis but not linking the three together. This sheds light on simultaneous theoretical development of the conceptual framework. The moderating variable of crisis does have an impact on improvisation and project outcomes but in this study, improvisation cannot be linked with positive project outcomes. This creates a managerial dilemma which will be discussed in the next section.

Managerial Implications

The mixed effects of crisis perception on improvisations lead to a key question for managers: what is to be done if improvisation won't help the NPD team succeed in a crisis?

First, improvisation is a default outcome of a crisis, suggesting that it cannot be completely avoided as a crisis requires something new and less formal. In the onset of a crisis, an NPD team will improvise and share information in an informal manner by communicating outside of formal channels. However, a balanced approach should exist.

While NPD teams implement an improvisational approach, a moderate level of it may be ideal so that they can avoid errors on the account of a lack of a structured approach while not spending too much effort on a formal approach to get the job done. Too much improvisation will hinder the positive effect of perceived crisis on the NPD team as time is spent inefficiently and incorrect decisions are being made and/or executed without a formal process for consideration.

Second, if a team maintains a moderate level of improvisation, what else can a team do to facilitate a perceived crisis in the NPD process? One solution is that managers should consider incorporating a more structured process as the NPD team does not need to communicate to external shareholders when an organizational crisis occurs. They can focus on getting the project done successfully by ensuring that the quality of the new product meets required standards by the firm's industry.

Third, since external communication is typically done by public relations and/or senior management, it may help facilitate information sharing if top management is involved in the NPD process. A high degree of senior involvement and support can reduce the NPD team members' anxiety levels brought out by a crisis by reassuring the team of their role and providing resources for them to ensure that they are confident in their execution of the NPD process in a timelier manner. This could in turn, reduce the time needed for NPD and increase the likelihood of completing a project faster and more successfully.

6 Research Limitations & Future Research

This research is not without limitations.

First, while we studied multiple industries that deal with chemistry and chemical engineering, crises in different industries may play varying roles. In this regard, future research should examine the uniqueness of industry characteristics. NPD teams operating in industries that are used to product recalls due to sub-standard chemical composition in food quality or pharmaceuticals may have an advantage when it comes to a crisis as they are more ready to adapt to removing products from the retail space. On the other hand, firms in plastics and petrochemicals may have

a more difficult time adapting. If a plastics manufacturer or oil refiner makes sub-standard products that are unreliable and break easily, this may not necessarily cause illness to the public. In other words, a sudden threatening event in one industry may have firms that are less surprised than others that are more likely to be impacted in more stable environments where firms in an industry operate under the axiom of "business as usual". Such firms in said industries may suffer much more during a crisis, thereby putting their survival at risk.

Second, model testing was based on survey responses. As such, it is recommended that researchers collect actual financial measures (e.g. revenue before, during, and after a crisis) to examine the impact of the new product that was developed and launched. Doing so will better show firms that successfully managed the crisis and those that didn't so that different factors can be considered for future study.

Third, conceptualization of crisis in this study focuses on utilizing NPD as a solution to the perceived threat of a crisis. Yet, the cause of the crisis may be the failure of the new product. For example, a new pharmaceutical drug that has adverse effects on patients can make the new product both the cause of the crisis as well as the result of one. Future studies can study specifically the consumables industry of food and pharmaceuticals from a longitudinal perspective.

7 Conclusion

Through empirical examination of outcomes of NPD (speed & success), its proposed antecedent (improvisation), and moderator (crisis), this study demonstrates associations between these variables. Generally, the data support the propositions of this research. Significant relationships were confirmed between crisis and improvisation, as well as crisis and outcomes (both speed and success); however, improvisation was not associated with positive outcomes of NPD. These findings increasingly confirm the theory that a crisis is not only something to avoid but can serve as an opportunity to shine and prosper.

The results also illustrate that while a crisis may lead to improvisation, this does not necessarily mean that team improvisation will have more of a significant impact on new product success under crisis conditions than not. The investigated industries for this study were limited to firms that are heavily involved with chemicals. Therefore, it can only be inferred that a crisis may lead the NPD team to improvise, however, the team performed other tasks associated with NPD that would lead to successful outcomes during a crisis.

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APPENDIX 1: QUESTIONNAIRE

Respondents were initially asked:

What industry was this product in? Please briefly describe this product:

For each of the variables, respondents were asked to rate the following questions based on the instructions below:

To what extent does each of the following statements correctly describe the selected project? Please rate each of the following items to indicate the extent to which you agree or disagree where **0 = STRONGLY DISAGREE**, **10 = STRONGLY AGREE**, and the numbers between 0 and 10 indicate various degrees of agreement or disagreement.

APPENDIX 1A: Factor Analysis of Predictor Variable (loading factor)

Team Improvisation (0 = strongly disagree, 10 = strongly agree)

The team figured out the new product development process as it went along vs. following a rigid well-defined plan. (0.76)

The team improvised in developing this product vs. strictly following the plan. (0.84)

The team improvised in commercializing this product vs. strictly following the plan. (0.69)

Eigenvalue = 1.75

Percentage of variance explained = 7.00

APPENDIX 1B: Factor Analysis of Predictor & Moderating Variable (loading factor)

Crisis (0 = strongly disagree, 10 = strongly agree)

The team felt that there was a crisis in the company or division (lower sales, profits, etc.) to which this project would help solve. (0.704)

The team felt that there was a crisis in the environment (concerning competitors, suppliers or legal regulations) that this project would help alleviate. (0.866)

The team felt that there was a crisis with customers or potential customers that this project would help solve. (0.743)

Eigenvalue = 1.60

Percentage of variance explained = 6.39

APPENDIX 1C: Factor Analysis of Dependent Variable (loading factor)

Speed to Market (0 = strongly disagree, 10 = strongly agree)

This project was developed and launched faster than the major competitor for a similar product. (0.794)

This project was completed in less time than what was considered normal and customary for our industry. (0.844)

This project was launched on or ahead of the original schedule developed at initial project go-ahead. (0.853)

Top management was pleased with the time it took the NPD team from specs to full commercialization. (0.813)

Eigenvalue = 2.31

Percentage of variance explained = 9.22

New Product Success (0 = strongly disagree, 10 = strongly agree)

This project met or exceeded volume expectations. 0.872

This project met or exceeded the 1 st year number expected to be produced and commercialized. 0.769

This project overall, met or exceeded sales expectations. 0.925

This project met or exceeded profit expectations. 0.897

This project met or exceeded return on investment (ROI) expectations. 0.840

This project met or exceeded customer expectations. 0.825

This project met or exceeded market share expectations. 0.886

Eigenvalue = 7.98

Percentage of variance explained = 31.93