Research Paper

On the Implications of NPD Process Management on DRR Solutions Management

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ABSTRACT

The ability to compress time and enhance process quality are key determinants of effective New Product Development (NPD) and equally Disaster Risk Reduction (DRR) management. This paper explores the qualitative relevence of an Analytical Hierarchy Process (AHP) derived unified conceptual model of correlation coefficients between NPD sub-factors of success and performance measures drawn from dominant classical NPD models. The paper shows the application of the conceptual model to compare base isolation with damper technologies that are amongst the most advanced earthquake risk reduction strategies. The study finds that there are significant benefits for successful knowledge transfer between NPD and civil engineering and earthquake resilience engineering sectors, and there are many potential academic and professional benefits from doing so.

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1. Introduction

Creating a resilient infrastrucutre, dampens and reduces the negative impacts on citizens and commercial organisations. The crucial role of such resilience engineering reduces casualties, physical damage, and interruptions to economic activities as a result of natural hazards, catastrophic events as well as their complex interactions/dependencies on the physical and social worlds of communities. Disaster Risk Reduction (DRR) models draw on scientific research that provides an evidence-base for solutions management in this context. However, scientific innovations do not always consider the processual and organisational aspects associated with the achievement of highly effective process solutions that yield the resilience of structures to cope with the effects of natural and man-made disasters.

Since the advent of Total Quality Management (TQM) and its fundamental principle that organsiational process management is more effective and efficient than the classical functional specialisation approach where specialist departments are created to manage a limited set of responsibilities (the organisational silo approach) for a process (e.g. logistics, operations, engineering, purchasing, and quality departments are departments in a manufacturing process). Within the silo approach, knowledge is guarded by specialists and involvement in a process - such as making a new product - is a singular activity undertaken by that department, which then hands off to another (e.g. the engineering department will design a facility and hand off to the operations department to manage the actual production of goods and then hand off to logistics to distribute them). The TQM approach ignores the delineation of departments and follows "the process" focus whereby a team structure is adopted and delays/mistakes are reduced by colocation. Such a process/processual approach is widely used in all manner of project and operational activities with benefits for pooled knowledge, seamless handovers, and combining technical skills to determine the most effective solutions for stakeholders and consumers (ahead of a potential disaster) or to deploy processes on detection of an imminent disaster (agile and reactive approach). The need for a multidisciplined and process approach was first identified in the 1960s when researchers first studied man-made and natrual disasters. These studies culminated in 'normal accident theory' (NAT) and a belief that all modern complex organisations, structures and systems would, over time, become unmanageable and fail catastrophically (Perrow, 1960). This fatalist view was later replaced with approaches to high reliability and resilience engineering to create a robust, reliable, resilient and predictive approach to solutions design.

The 'resilience' challenges affect modern civil engineering and construction, in the context of seismological disturbances and risks, implies linking and transferring interdisciplinary research approaches (in the form of technological innovations) to solve known problems is a major gap and area of significant promise for advancing professional DRR practice and incorporating resilience engineering. To further the academic understanding the Framework for Disaster Risk Reduction (endorsed by the United Nations in 2015) provides an interpretive mechanism which, as a comprehensive framework, demands conformance to four priorities for action and seven achievable targets for disaster risk reduction (DRR) worldwide. Conformance is, it is argued, ensure effective and efficient processes and solutions to disaster scenarios. Two of the four priorities are: 1) understanding disaster risk; and 2) investing in DRR for resilience.

Natural disaster categories include global classifications of floods and storms (most frequent natural hazard related disasters accounting for 44% and 28% of the total events between 2000 and 2019 respectively), geophysical hazards, such as earthquakes and volcanic activity, made up a total of 9% of all events (the majority of which are earthquakes inclusive of tsunamis). Despite their relatively low frequency, earthquakes and tsunamis are the deadliest forms of disaster and account for 58% of the total fatalities, severe economic losses and substantial infgrastructure damage (Freddi et al. 2021).

Earthquakes therefore contribute to large-scale human and economical loss each year and typically have a devastating impact on comparatively poorer nations that lack preparation, investment funding, and preventative solution preparedness. Solutions are available though. They include different technologies developed to help reduce losses yet their effectiveness as countermeasures are severely limited if process management of resources is inefficient and ineffective.

The management of organisational processes to control risks is often associated with business continuity assessments within a broader process of development. The most typical process of significant value to DRR is the new product development (NPD) process knowledge. The crossover of knowledge bases provides a process to manage DRR activities so that resilience against disasters (earthquakes etc.) are inbuilt into any plans for physical asset and building management and containment. Rarely has such a transfer of core knoweldge been reviewed in the established academic literature and enabling features of classical models of NPD have yet to be employed in DRR frameworks. Testing the utility of crossover knowledge to the DRR context is highly value (see Soetens et al., 2005). The research gap offers potential new directions and meaningful progress in the process of DRR and the pre-empting, designing out of failures and management of active disaster responses. To facilitate this crossover of knowledge, new product enabling factors were ranked and applied to improvements in earthquake risk reduction.

Knowledge management and crossover knowledge are forms of innovation and an essential element of any organisation's capabilities and resultant long-term viability, prosperity, and external performance. Contemporary innovation management in NPD processes remains a critical business activity (Harris & Trainor, 2009) as it has a direct impact on the economic sustainability of manufacturing industries especially within competitive markets. However, the success of the NPD process cannot be guaranteed, and disturbances include the poor identification of customer needs and poor internal coordination of the NPD process in a quality and timely manner (Gonzalez-Zapatero et al., 2016).

Effective NPD requires project managers to address two critical questions in order to select the most promising new products in terms of the potential for success (or failure) of the new product, and what organisational factors contribute to (or inhibit) successful launch of the product. Pragmatically, such decisions concern the development and implementation of screening evaluation methods for new product project selection, and the effective development management practices that govern the process (Cooper & Kleinschmidt, 1987a).

Organisational investments in resources (financial, human capital, and other resources) can be substantial but without understanding the key drivers of the NPD process (factors of success), project failure may still be resulted. Such failure is not necessarily the result of poor management or employee commitment but may include ignorance of the key drivers that catalyse the processes, assets and capabilities needed to realise a great product (Pisano, 2012).

The research underpinning a conceptual model known as "Conceptual Model I" (Moghadam et al., 2020) showed that the focus of NPD processes had moved from an advertising and efficiency bias (Ciarapica et al., 2016) to other identified success factors (such as a firm's resources, product fit, and a commercial entity factor). Enveloping all these factors was a further concept that of "Information Acquired", which was the most important factor that united all activities and resulted in greater levels of NPD success (Moghadam et al., 2020). In this paper, the key factors of the Conceptual Model I are applied to the New Seismic Products (NSPs) that are alternative technology solutions to improved building resilience under earthquake conditions.

In the following sections of this paper, a short review is undertaken to identify the key factors of NPD in the Conceptual Model I followed by the qualitative application of the Conceptual Model I key factors to the DRR process.

2. Key Factors for Prioritizing Seismic NPDs

The modern approach to NPD was conceptualised by Cooper's 1979 study (Project New Prod I), which established a conceptual model of key factors (needed to present and managed) to generate successful outcomes and responsiveness. The purpose of this paper is to dissect the conceptual model of Moghadam et al. (2020), which drew from Cooper's seminal works but also other researchers, and to rank the different technologies proposed to reduce the risk of earthquakes. Analytical Hierarchy Process (AHP) analyses, correlation coefficients between NPD sub-factors and success performance measures such as return on investment (RoI) were employed and conducted, which resulted in the unified Conceptual Model of NPD or Conceptual Model I (illustrated in Table 1).

Cooper's (1994b) definition of the NPD process was adopted because it focuses on the NPD process (as opposed to the techniques of New Product Introduction (NPI), which concerns the outcome of the NPD process and the launch stage of a project or product and market offering (Sharma et al., 2018). A historical time-series methodology was used to systematically explore and refine the literature. The review examined and deconstructed the conceptual models of leading authors and seminal publications developed from 1972 to 2008 when NPD studies began to focus on single factors rather than a holistic process management approach. This time period also resulted in the greatest number of combinations of success factors, sub-factors and relationships, and greatest of academic debates at the organisational level rather than recent models, which idnetify single factors to improve the performance of stages of a process.

The items identified in Table 1 could each impact on DRR planning and execution in different ways (e.g. providing a foundation for a decision-making tool used to select the most appropriate resilience method to combat the impact of natural disasters on buildings/structures).

3. Application of Methodology to Earthquake Engineering

NPD project management is an inherently fragile and risky business activity (Bhuiyan, 2011). It is estimated that for every seven new product ideas only four will progress to commercial

Table 1. Suggested NPD factors for earthquake risk reduction products (Moghadam et al., 2024).

Factors	Definition	Example of Sub-Factors
Market Environment	This category consists of sub-factors that represents information about the market that the NPD project was intended for.	• Degree of customer needs changing in the market. • Customer need of the specific product.
Information Acquired	This category consists of sub-factors relating to the information acquired during market research and technical assessment phases of the NPD process.	• Knowledge of consumer needs, wants and technical aspects needed for the new product. • Knowledge about the competition product, strategy, and pricing. • Understanding new products technology.
Commercial Entity	This category entails sub-factors that represents the characteristics of the new product after its development and launch within its target market.	• New product that offered unique benefits not found in the competition. • Quality of the product. • Introduction of a superior product.
Firm's Strategy	This category consists of sub-factors relating to the strategy that the firm employs regarding the NPD project.	• Degree of risk taking in respect to decision-making. • Level of aggressiveness toward competitors. • Firm's behaviour in respect to action.
Project Definition	This category represents sub-factors relating to the project planning phase of the NPD process.	• Participation of all project team members in planning. • Project concept. • Project requirements and specifications.
Nature of the Venture	This category consists of sub-factors relating to the characteristics of the NPD project in terms of newness.	• Newness of the product to the firm. • Innovativeness of the product to the market.
A Firm's Resources and Product-Organisational Fit	This category consists of different firm's resources, product-organisational fit and product-market fit sub-factors derived from the NPD process.	• Cross-functional integration. • Personnel and skills of the market research division. • Managerial skill of management.
Proficiencies of Processes	This category consists of sub-factors relating to the NPD process itself, from idea generation till launch of the new product.	• Prototyping and testing in-house. • Market research. • Full production start-up.

Source: The Authors.

realisation. Of these, two projects will move to the product launch phase and only one will successfully reach the target market audience. Regardless of whether an organisation seeks low-cost or differentiation advantages from its solutions, NPD factor awareness remains a critical form of assurance of process success.

In the construction industry, many NPDs relate to seismic loss reduction (BHRC 2022). Two significant categories of these NPDs impact on the design methodology and seismic resilience (design codes) for buildings and include the NPDs of seismic base isolation and seismic dampers. Base isolators and dampers are the main solutions available to urban planners and seismic engineers to mitigate the earthquake damages and at the same time provide the flexibility that they need in their designs. Due to the obvious need for these tools, start-up companies in earthquake-prone countries (such as Iran) have devoted efforts and resources to the development of these tools and protocols but again these lack a significant attention to the type of processes that make these solutions and innovation/solution exploitation effective.

The base isolation solution involves putting flexible bearings or pads of layered rubber and lead substrates between the building's foundations and the structure above. Thus, no force is transferred to the building from ground movement (the building does not experience the earthquake). Base isolation technology introduces flexibility in the structure so as not to expose inflexible joints in the building construction. Such flexible pads offer resistance against lateral movements and, if chosen properly, the forces induced by ground shaking can be a few times smaller than those of buildings erected directly on terra firma (Lipte et al., 2022). These changes in the structural response using base isolators is shown in Figure (1).

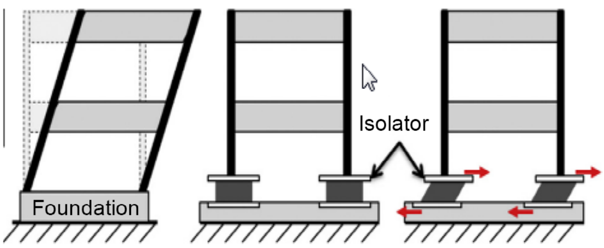

Figure 1. Base isolation system (Thenozhi & Yu, 2013).

Dampers control floor vibrations and building displacement, cater for occupancy comfort and mitigate against major seismic events. Dampers are equipment that absorb seismic input energy and convert it to heat, hence reducing both displacement and acceleration demands on the structure. Damping devices are usually classified under two categories: (a) displacement dependent devices and (b) velocity-dependent devices. Metallic and friction dampers belong to the first category, while the second category includes visco-elastic and viscous fluid dampers. Figure (2) provides a general scheme for installing dampers in a building with a frame structure (Abarkane et al., 2017; Freddi et al., 2021).

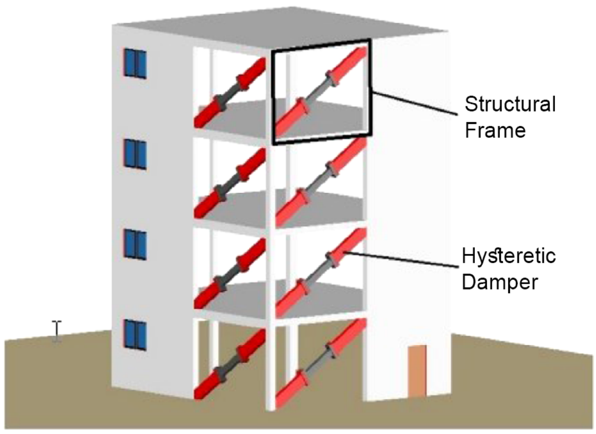

Figure 2. Basic configuration of a building structure with damper (Abarkane et al., 2017).

Having reviewed the main technological solutions and countermeasures of seismic activity, the next section will present the applicability of NPD factors as a means of enhancing the solution process.

3.1. Qualitative Comparison of Conceptual Model I key factors for Base Isolation and Dampers

In this section, the eight categories of Conceptual Model I key factors (Table 1) are introduce and qualitatively compared for base isolation and damper technologies.

3.1.1. Market Environment

The term "market environment" was first introduced by Cooper (1979) under his "environmental category", but it was not until Calantone and Cooper (1981), that the term "Market Environment" was defined as the market characteristics of new products in terms of size, geography, and competitive intensity. Cooper's (1979) "Environmental category" comprised of three factors "Market Environment", "Firm's Resources" and "Nature of the Project".

A comparison between base isolation and damper technologies from market environment shows that the customers need to dampers are larger. The base isolation is mainly suitable for governmental and public buildings; however, dampers can apply to more common and private buildings. As such, it is anticipated that market growth rate is larger for dampers technologies the level of customer satisfaction is larger for base isolation. Because base isolation is protecting both the building and its contends and reduces acceleration of the floors during earthquake.

Base isolation also better considers the fluctuation in customer need, as many customers move from ordinary houses to more luxury buildings. Base isolation also faces less competition from similar Firm's in the market. Dampers have a better perspective of foreign markets compared to base isolation technology. There are also more information are available regarding application of dampers for the customers to do a timely and in-depth decision making. Regarding a number of technological alternatives, base isolation does have much less competitors. From market environment perspective base isolation is a preferable format (camper base isolation).

3.1.2. Information Acquired

Effective information exploitation and uncertainty are inversely related. Organisations tend to prefer positions of certainty that their strategies and actions will result in commercial success (Cooper, 1979). Calantone and Cooper (1981) defined "Information Acquired" as the pool of knowledge derived and organised from the NPD process, such as marketing, competitive and technical (technological) information gathering. Engelen et al. (2012) later supported this view that the "Information Acquired" factor determined NPD success or failure as a result of holistic information sharing by all NPD staff.

Knowledge about customers' price sensitives is crucial for the development of the new product. In this regard, base isolation is usually much more expensive compared to the dampers. Among the classic dampers, frictional dampers are cheaper than yielding and viscose dampers. Understanding customer's behavior in respect to purchasing is essential for the development of the product. It is expected that the dampers can better address the customer's behavior uncertainty compared to the base isolation. Because there is a larger selection of the dampers available to satisfy behavior change customer's knowledge about customer's needs, wants and technical aspect needed for the new product is essential. The base isolation covers a wider range of customer's needs, wants and technical aspect. For example base isolation at the same time that protects the structural system also protects the nonstructural elements of the buildings. Another aspect of information acquired is knowledge about the competitor's product pricing strategies. There are not much flexibility in base isolation pricing among different competitor's, however as dampers cover a much wider selections, the competitor's pricing strategies become much important.Another aspect of information acquired is the market size information. Again, dampers have much larger market size, because traditionally, base isolation has been used only in special and essential buildings. Information and knowledge about the technical aspects needed for the development of the new product is essential. Development of some classes of dampers such as frictional or yielding dampers does not need much in-depth technical information. Regarding the knowledge about the competitor's product is essential for NPD success estimating the competitor's product features for base isolation is more difficult compared to dampers. Information regarding market demand forecast about dampers is somehow more accessible than base isolation.

3.1.3. Commercial Entity

The term "Commercial Entity" concerns the physical product offered to the market (Calantone & Cooper, 1981) and consists of the product itself (size, functionality, etc.), its price, marketing strategy and the services bundle around the product. Over time, the definition has remained constant albeit authors calling it "New Product Advantage"

(Cooper & Kleinschmidt, 1993) and "Competitive Advantage" (Song & Noh, 2006). According to Cooper (1979), "Commercial entity" (the sales revenue earning from NPD products) entails multiple synergistic goal-based tasks (e.g. idea creation, marketing research, production, and market launch). These positively influence NPD success and the quality of such interactions led to significant market share gains domestically and abroad (Cooper & Kleinschmidt, 1987b). The factors that influence this performance measure include product superiority technical features, quality, and consumer needs and benefits satisfaction.

Both base isolation and dampers satisfying the technical needs of engineers and customer effectiveness than traditional products. However, base isolation has more technical advantages and dampers have more pricing advantages regarding the quality of the new product as the underlying reason for their successes within the market in the earthquake prone regions, both base isolation and dampers have the necessary quality features. Base isolation and dampers both offer unique benefits and both solve customer's problems, but base isolation has more advantages in these regards.

If the initial cost is considered, both base isolation and damper are more expensive than traditional methods. However, based on life cycle costs calculations, application of these products are usually lead to much cheaper cost for the buildings. The life cycle cost reduction is more for base isolation compared to the dampers. The technology offered by base isolation and dampers is much more advanced compared to traditional building technologies. Base isolation provides more unique tasks than dampers.

3.1.4. Firm's Strategy Factor

A heavy emphasis is placed on "fit" and "alignment" for successful outcomes in the NPD literature, notably strategic fit. Droge et al. (2008) stress the importance of "Strategy" as a pivotal catalyst for NPD success under turbulent conditions. Gumusluoglu and Acur (2016) examined the impact of firm's strategy on NPD outcome, and concluded that it is a pre-condition for success in financial, market and technological opportunities (Gumusluoglu & Acur, 2016). That is an organisational NPD strategy must be considered as a separate factor itself and not simply implied. This finding suggests that there needs to be a formalized relationship and process of translating strategy into NPD process, content, structure, alignment with the customer-facing departments and all internal communication processes. Cooper and Song's in their diffrend research considers organisational strategy as manifested in the end-product (Commercial Entity). They acknowledge the need to manage strategy but focused as an enabler for NPD success. The extent of formalization and separation may reflect cultural differences in the companies they studied. It is apparent that authors had different views on the degree of formalization or implicitness of corporate strategy.

The level of competitive aggressiveness towards rivals is essential for the NPD projects. Both base isolation and damper producers try to have a firm stand toward traditional DRR technologies to convince the building owners to invest on a relatively more expensive DRR product. The Firm's behavior in respect to the actions planned and the degree of acceptable risk set for decision-making and execution of the NPD process is essential for its success. Comparing to the base isolation, damper producing firms are able to plan more accurately with less margin of safety and less risk. Long term technical and market opportunities in terms of outcomes are essential for the NPD process. It is expected that dampers have much longer technical and market opportunities compared to base isolation systems.

3.1.5. Project Definition Factor

The 'Project Definition' Factor entails the planning, protocols, requirements, and specifications of the NPD project. Cooper and Kleinschmidt (1987b) refer to an example of a well-defined project in terms of strategy and project definition, which was critical to the success, especially the financial success, of the new project. They explain that to increase the chances of financial success, organisations should define the phases and strategy, and set milestones for the project, before development, although most organisations in their study did not do that (Cooper & Kleinschmidt, 1987b). This illustrates the important link between the

"Project Definition" and "Firm's Strategy" factors. Cooper in his 1994 study noted that NPD projects that undertook rigorous product definitions resulted in higher market share, success rate, profitability and met organisation sales and profit objectives. Incorporating early product definition in their new product development process highlighted pre-development and preparatory activities. Further, product definition activities can be utilised as a communication method and a guide for members of project teams. Clear and visible goals and targets for the development teams are established, which lead to a more efficient and cost-effective development process (Cooper, 1994a).

Concept creation for the project is essential for the developmental of the new product. As there are much more diversity in dampers compared to the base isolation systems, it is easier to develop a novel concept for a new damper system. Also setting project specifications and requirement also creation of detailed project planning and control measures are essential for the development of the new product. It is usually more difficult to develop detailed project specifications, planning and control measures in producing type of base isolation.

3.1.6. Nature of the Venture

The nature of the commercial venture is a factor that Calantone and Cooper (1981) define as the attributes of the NPD project in terms of its newness to the company and marketplace. Cooper (1979), Cooper and Kleinschmidt (1987b), and Cooper and Kleinschmidt (1993), suggest that the "Nature of the Venture" has a relatively low impact on the outcome of the new product project. However, they argue that the dilemma faced by organisations during new product project development is in choosing the best level of product innovativeness relative to the market's elasticity of demand. This is embodied in his sub-factor "Newness of the Product" and contended that it is strongly related to the success of the project, but the "Degree of Product and Market Newness" to the organisation is highly related to its failure. This differentiation clearly shows a higher level of risk of failure when the company has less information and predictability concerning the product and its performance. However, this is not wholly surprising as these sub-factors are not related to eachother. Hence, organisations should be able to select and manufacture highly innovative products without obtaining new markets or the need to shift to a new product category. Base isolation systems are more innovative and are one of the kinds for the market compared to the dampers. On the other hand, it is easier to develop new categories of dampers. Also it is easier to produce new type of damper that is novel for the firm that has high level of mechanical and technical complexity.

3.1.7. Firm's Resources and Organisation-Product Fit Factor

The concept of "fit" with the environment and an internal "fit" is needed if optimisation is to occur for any business seeking to sell new products and make a return on NPD investments. In this research, the "Firm's Resources and Organisation-Product Fit", which are technical and marketing synergies, and the skills and resources of different departments. Also, managerial and operational styles are considered as elements of organisational resources. Cooper and Kleinschmidt (1987) and later Haverila (2012) propose that the synergy or organisational fit, which are the right skill sets and characteristics, is an important factor that influences the financial success of the NPD project. They argue that an internal fit is needed that matches the organisation's fit of resources, skills and knowledge, and when this fit, which could be thought as the organisation's culture is achieved it will result in higher chances of financial success (Cooper & Kleinschmidt, 1987) (Haverila, 2012). Synergy in areas such as: resources and skills, R&D and product development, marketing research, engineering, salesforce and distribution, consumer services, production and advertisement impact the financial success of NPD projects. Furthermore, this could be used as a screening method for the evaluation of a new product project (Cooper & Kleinschmidt, 1987).

The technical, marketing, and management skills of the managers are essential for the development of the NPD project. Usually, managers of both base isolation and damper producing firms have these three qualifications. The resources and skills of the concept developmental and R & D and engineering teams are also essential for the development of the NPD project. Often R & D and engineering teams in base isolation projects require higher level of expertise.

The skills and resources of manufacturing teams are essential for the development of the new product. Base isolation technology needs higher level of expertise in manufacturing. The quality of the available material and raw resources are important for the development of new product. The quality of the available material and raw resources are essential for the development of new damper products but are vital for the development of new base isolation products.

3.1.8. Proficiencies of Processes Factor

Calantone and Cooper (1981) defined "Proficiencies of Processes" as the ability and quality of execution of all the NPD processes from idea creation to its launch within its target market. In some studies, such as Song and Parry (1997) and Song and Montoya-Weiss (2001), this factor was separated into "Market Proficiency" and "Technical Proficiency". However, in later studies, Thieme et al. (2003), Song and Noh (2006) and Swink and Song (2007) "Market Proficiency" and "Technical Proficiency" are combined into one single factor, which reduces the complexity of NPD factor linkages. "Proficiencies of Processes" is a factor used by Cooper throughout (Cooper, 1979; Cooper & Kleinschmidt, 1987b; Cooper & Kleinschmidt, 1993) and these studies indicate this to be the most important influence on the outcome of NPD projects. Both marketing and technical aspects were recognised as influences on success, an observation, which was also supported by the work of Slack et al. (2010). "Proficiencies of Processes" brings together other factors such as "Information Acquired", "Firm's Strategy", "Project Definition" and "Firm's Resources and Organisation-Product Fit", which all influence directly the quality of execution of the NPD process. It also influences indirectly the "Commercial Entity" factor that is the output of the NPD process and is thus linked to the outcome of the new product project.

The exploratory stage of the NPD process that is the pre-concept development or idea generation stage and the concept development stage are essential for the NPD projects success. These stages are usually more complex for base isolation compared to damper. The preliminary market assessment and market research stages of the NPD process are essential. Base isolation needs more in-depth preliminary market assessment and market research stages compared to dampers.

The financial analysis stage of the NPD project is also considered as essential. This stage is especially important for development of base isolation products. The five stages of the NPD process that are, preliminary technical assessment, product manufacturing, prototype development, prototype testing in-house, and full production start-up are considered essential. All these five stages are much more difficult in the case of base isolation products.

The technical service team for serving the end customer, quality control, and cost reduction control measures are essential aspects of the NPD process. These are more important in the case of base isolation products. In the subsections of part 3.1 of this paper, a qualitative comparison of conceptual Model I key factors for base isolation and dampers are performed. The results are summarised in Table (2) base isolation has more chance of success.

Table 2. Ranking of damper and base isolation based on NPD key factors.

No.	NPD Factors	New Seismic Products	
		Dampers	Base Isolation
1	Market Environment		✓
2	Information Acquired	✓	
3	Commercial Entity		✓
4	Firm's Strategy	✓	
5	Project Definition	✓	
6	Nature of the Venture		✓
7	A Firm's Resources and Product- Organisational Fit		✓
8	Proficiencies of Processes		✓

4. Results

The NPD factor summary (Table 1) presents all the main factors/sub-factors necessary for undertaking the NPD process within any given industry. The seminal works of the leading NPD authors were ranked by Thieme (2007) yet this analysis was flawed by its disregard for regional, country, sector and industrial differences. These weaknesses were corrected by the structured analysis of Moghadam et al. (2020) and an AHP inspired ranking matrix that was originally applied to NPD but has been amended to the contextual specificity of DRR planning and process management.

Initial work by Soetens et al. (2005) in their research proved that these ranked factors were pertinent and key elements in construction and the decision making of what process to implement to ensure high quality constructions. The validated utility of such knowledge cross-over between the NPD field of Operation Management (OM) and civil engineering therefore offers new insights and potentially new theoretical developments of use for earthquake engineering and seismology DRR systems and their effective proactive and reactive management.

This research investigated the feasibility of qualitative application of new product development processes methodology to rank disaster risk reduction technologies. Two classes of DRR technologies that is base isolation and damper are selected for this purpose.

According to Table (2), base isolation has more chance of success. However, a closer look at quantitative comparison of base isolation with damper as reported in sections 3.1.1 to 3.1.8, shows that to achieve a more reliable results there is a need for a qualitative comparison of these two technologies. The paper proves the utility of looking outside of a technological determinism of DRR solutions management and shows significant potential for professional practice development if such knowledge transfer flows from the process models of management studies to the precision of engineering for greater resilience especially as a means of managing the implications of seismic activity and earthquakes on the infrastructure of a region or a nation.

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