AN EXAMINATION OF HOW KNOWLEDGE MANAGEMENT CAN BE INTEGRATED INTO THE NEW PRODUCT DEVELOPMENT PROCESS

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ABSTRACT

Most of the research studies in New Product development (NPD) are descriptive, outlining the Critical Success Factors (CSFs) for launching new products. This paper will go beyond the surface of these CSFs to investigate how a knowledge resource can be generated from these factors through a more rigorous approach to the process of knowledge management (KM). It has been evidenced that ineffective management of the NPD process is strongly linked to the high failure rate of new products. The study has revealed that the NPD Process is not only a sequential list of activities as indicated elsewhere, but it is also a complex and dynamic process closely linked to KM. Without effectively managing the New Product Development process and without formally capturing knowledge in the NPD Process, the performance of new products launched in the ceramic tile industry is shown to suffer in the marketplace. The main objectives of this research can be split into two components. The first component examined the impact of the management of the NPD process on the market success rate of new ceramic tiles launched. The result from this case study concurs with the findings from the literature: the high failure rate of new tiles launched during the trade fairs is closely associated with the low proficiency of the NPD Process. The second component of the study examined how KM can be integrated in the NPD Process to enhance the market success of new products.

1. INTRODUCTION

The low cost advantage of the production of ceramic and porcelain tiles from China and other emerging countries adds further pressure for the Spanish ceramic tile industry to leverage competitive variables, other than cost, to differentiate the products in the global market. The high proliferation of new products launched during the major trade fairs in Spain and Italy further emphasises the movement of the European ceramic tile industry towards a differentiation strategy where firms are expected to launch new design of tiles that are either supplied by the glaze/enamel manufacturers or developed in house. The strong fashion element in the development of new design of tiles further reduces the product life cycle and thus, increases the pressure for sales to be generated from the new products at an early stage.

The NPD Process in the ceramic tile industry is still conducted in an intuitive and random way and the lack of a structured methodology is clear cut. There is a heavy reliance on the glaze/enamel manufacturers to set the trend of the design for the next period and most ceramic tile manufacturers will replicate the proposed design with little or no changes. The new product development process is still viewed essentially by many firms as a selection of new design of tiles proposed by the glaze manufacturers. On the other hand, firms which have adopted a strong design differentiation strategy invest in the development of the design in-house and may also co-operate with the glaze suppliers to develop new prototypes.

However, even for firms with strong in-house design capabilities, there is little emphasis on the management of the new product development as a process model, as posited in the New Product Development literature. Studies have shown that following the steps in a logical order will improve success rates in the marketplace. However, despite this concerted effort, the failure of new products remains stubbornly high with current estimates ranging between 40 and 90% as it will also be illustrated in this case study.

In part, this could be a failure on the part of academics to communicate their research in a way that is interesting and relevant to practitioners. While we agree this may be part of the problem, we also suggest that the problem also lies in the failure to connect knowledge management into the process. This paper examines this connection and investigates whether knowledge management (KM) can support the NPD process for higher success rate in the marketplace. To this effect, an in depth case study was carried out in a ceramic tile manufacturer in Castellon.

The first objective (P1) of this paper is to test the relationship between the proficiency of the NPD Process and the performance of new products. It has long been considered that a high-quality new product development process should lead to new product success. We examined the impact of 13 stages of the new product development process on actual sales performance of the recent new products launched.

The second objective (P2) of this paper is to examine the extent to which the KM Process can support the relationship between the NPD Process and performance of new products. To this end, the 3 Phases of the KM Process (Acquisition, Storing, Sharing[1]) are used as a methodological tool to understand how a knowledge resource can be constructed from the Critical Success Factors (CSFs) of NPD. The two propositions of the research question are illustrated below in Figure 1:

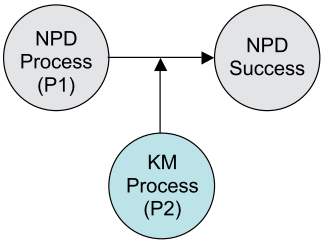

Figure 1. Conceptual Model

2. THEORETICAL FRAMEWORK. REVIEW OF NEW PRODUCT DEVELOPMENT PROCESS

The next section will provide a summary of the seven Critical Success Factors (CSFs) of New Product Development, relevant to the ceramic tile industry.

2.1. CRITICAL SUCCESS FACTOR 1: NEW PRODUCT DEVELOPMENT PROCESS LEVEL

In most of the studies, the first driver for top performance is the level of proficiency of the NPD Process based on the 13-Activities model. As defined in the literature (Cooper and Kleinschmidt, 1995), the NPD Process is comprised of the following thirteen activities as illustrated in Figure 2.

	Activities	Description
Front Up Activities	Initial Screening	Generation of ideas
	Preliminary Market assessemnet	A first market assessment of the ideas generated
	Preliminary technical Assesememt	Preliminary appraisal of the technical implication of the ideas generated
	Detailed market study	Marketing research through a representative data collection of the market needs
	Predevelopment Business Analysis	Financial Analysis leading to go/no go decision prior to product development
	Product development	Design and development of the product e.g Prototype or sample product
Back end Activities	In house prototype test	Testing the prototype or sample in the lab under controlled conditions
	Customer test of products	Testing the prototype or sample under real life conditions with the customers
	Test Market/Test Trial	
	Trial Production	Trial production to test the production facilities
	Pre commercialisation analysis	Business analysis
	Production start up	Full sacale of production
	Market launch	Marketing activities to promote the product

Figure 2. Thirteen Activities of New Product Development Process

The proficiency of these 13 activities of the NPD Process (Cooper and Kleinschmidt, 1986, 1987,1988) can be evaluated according to two criteria: the number of activities carried out and the tangible resource (financial and labour days) invested in each activity.

2.2. CRITICAL SUCCESS FACTOR 2: ORGANISATIONAL LEVEL

In contrast, though the CSFs to NPD, pertaining to the structure and culture of the organisation, are secondary to the proficiency of the NPD process, they were identified as present in the top performers. Senior Management Commitment to New Products, entrepreneurial climate for product innovation are classified as facilitators to the NPD Process (Cooper and Kleinschmidt, 1995). Besides, cross-functional team (technical and production, Purchasing, Sales and Marketing) has been identified as a key critical success factor in many studies (Joyce 1986, Katz et al 1985, Griffin 1997, Pinto and Pinto 1990,1991,1993, Rothwell 1974, Rubestein et al 1976, Parry and Song 1994). This specific CSF is an enabler to a concurrent new product development approach where each of the each activity of the NPD process is performed is a concurrent rather than sequential way. This allows any conflict across departments to be voiced in the upstream phase of the development process and reduces thus, the cost of late modifications.

2.3. CRITICAL SUCCESS FACTOR 3: HIGH KNOWLEDGE OF THE MARKET (DEMAND AND SUPPLY SIDE)

There is a strong consensus in the literature that the winning products are characterized by high understanding of the customers' need by product developers in the front activities of the NPD Process (Preliminary Market Assessment, Detailed Market Study) and also at the back end of the NPD Process (Test market, Trial sell). In the case of the ceramic tile industry, the knowledge for innovative ideas from the supply side of the market can be gathered from the regular visits of the NPD team to all major trade fairs in Spain, Italy, USA and China, providing a high exposure to the NPD team to innovative ideas. As for the knowledge from the demand side, it can be acquired through regular visits of the NPD team to the main target customer and also through the integration of targeted customers at an early stage in the New Product Development process.

2.4. CRITICAL SUCCESS FACTOR 4: EARLY INVOLVEMENT OF SUPPLIERS IN NPD PROCESS.

The vertical integration of suppliers in the NPD Process allows the firm to extend the available resources by maximising the use of the creative potential of suppliers (Burt and Soukup 1985). Maidique and Zirger (1985) found that early supplier involvement enables early detection of potential problems. Research conducted shows that supplier involvement is positively related to accelerated development time (Gupta and Wilemon 1990, Millson et al 1992, Imai and Takeuchi 1985, Ancona and Caldwell 1992). By tying up product/process development, the new product outcome is characterised by improved quality, reduction of product and process development costs and shortening of time to market. In the ceramic tile industry, early co-operation between the New Product Development team and the enamel suppliers is a key element to ensure the

technical feasibility of the prototypes at an early stage. The enamel suppliers provide not only new design of tiles for each new season but they may also cooperate with the Technical Tile Developer of the firm for selection of the most appropriate colour pigments for the development of new prototypes, in the event that new design is developed in -house.

2.5. CRITICAL SUCCESS FACTOR 5: EARLY CUSTOMER INTEGRATION IN NPD PROCESS.

The theoretical foundation of customer integration in NPD Process originates from the resource dependence theory (Pfeffer and Salancik 1978). The objective of customer integration is for the firm to coordinate beyond its boundary with the resource owner. In the context of NPD in the ceramic industry, the missing resource of the firm when developing new products is related to information on the main target customers' preferences in terms of design characteristics of the tile (colour, texture, size, matching borders with plain tiles). In order to bridge this gap, by involving customers in the New Product Development Process, the product developers reduce the risk of product failure by attenuating the level of uncertainty to some extent as the voice of the customer is being built in the NPD Process.

2.6. CRITICAL SUCCESS FACTOR 6: CO-OPERATION WITH INSTITUTIONS IN THE INDUSTRIAL DISTRICTS.

In the Spanish ceramic tile industry, 75 percent of the supply chain stakeholders are located in the province of Castellon, which accounts for 90 % of the Spanish tile production. It is not only ceramic manufacturers who are located in the Province of Castellon but also their suppliers or other related companies such as manufacturers of machinery, frits, enamels and ceramic colouring agents, design studios, mould manufacturers and those manufacturers making special decorative pieces to match the plain tiles. This high geographical concentration of these parties in one province typifies the structure of an Industrial District which is characterised by a flow of experiences, information, and knowledge within the district with little or no constraints. Firms thus can access easily new knowledge that resides in the network of relationship and this is altogether facilitated by organisation as ITC, ALICER, ASCER, which play a fundamental role as a conductor for the dissemination of innovative ideas, technologies or design trend.

2.7. CRITICAL SUCCESS FACTOR 7: USAGE OF INFORMATION FROM PAST AND CURRENT PRODUCT DEVELOPMENT PROJECTS.

The effective recording of past product development provides a learning platform for current or new team members: thus, the new product development process does not take place in historical vacuum. Studies have shown that the recording of information from past projects and efficient retrieval of that information combined with cross-functional integration impact on better prototype development and higher financial performance of new products in firms (Sherman et al 2005, .Kyrialopolos 2004) The storing and rapid retrieval and dissemination of information from past projects influence product development performance positively (Lynn et al 1997).

3. REVIEW OF KNOWLEDGE MANAGEMENT PROCESS.

The common denominator across these seven Critical Success Factors to New Product Development is the information processing component. In this light, it is important to understand how a knowledge resource can be generated from the information underpinning these CSFs. To this effect, the 3 phases of the KM Process will be used a methodological tool to evaluate how a knowledge resource can be built from these CSFs.

The 3 Phases of the KM Process (Acquisition, Storing/ retrieving, Sharing/ interpretation (Pentland 1995, Alavi and Leidner 2001) is illustrated in Figure 3.

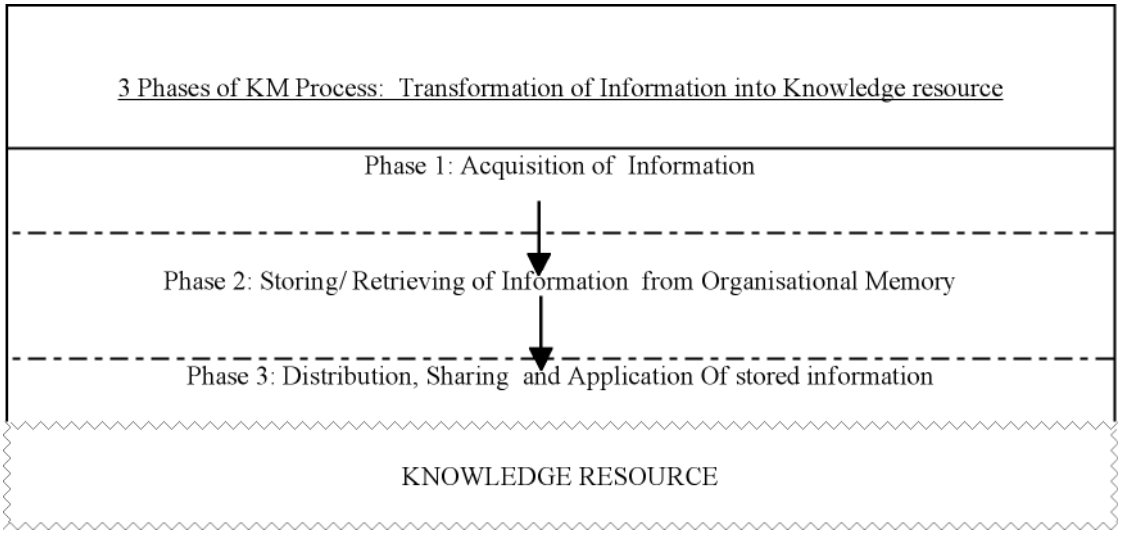

Figure 3: Three Phases of Knowledge Management Process

3.1. PHASE 1 OF KNOWLEDGE MANAGEMENT PROCESS: ACQUISITION

Phase one of the KM Process starts with the learning process at the individual level (Nonaka &Takeuchi,1995) and at this stage, members of the NPD team will access new information from the external or internal environment or previously stored information. Although knowledge is created in the mind of each member of the NPD team, the interaction among individual, group and inter-firm memories plays a critical for the development of new knowledge for each member. This is what Nonaka and Takeuchi (1994) refers to the amplification and development of new knowledge through 'communities of interaction'. The pivotal point is the mechanisms that enable the transfer of knowledge from the individual, group (internal and external) to enlarge the stock of knowledge of the Organisational Memory.

3.2. PHASE 2 OF KNOWLEDGE MANAGEMENT PROCESS: STORAGE AND RETRIEVAL

Knowledge Management aims to maximise the growth of new knowledge across team. However once this knowledge is generated, the storage and future retrieval of this knowledge from the Organisational Memory is critical for the transformation of

information into a resource. When knowledge is not stored or cannot be remembered, there is a deficiency in the performance of the Organisational Memory (Argote et al 1990, Darr et 1995). This deficiency is furthermore accentuated by labour mobility which typifies Industrial District as the Spanish Ceramic Industry: the performance of Organisation Memory depreciates when people holding valuable knowledge in their individual memory leave and this knowledge cannot captured at any other levels. In this view, an effective Knowledge Management system will find ways to preserve this critical knowledge beyond the level of an individual memory.

3.3. PHASE 3 OF KNOWLEDGE MANAGEMENT PROCESS: SHARING, DISTRIBUTION AND APPLICATION

Once the acquired information is stored for future retrieval, a knowledge resource can be generated if information is shared and distributed across members of the NPD team. The transfer mechanism of information or knowledge from the Organisational Memory depends on the type of knowledge being transferred and the transfer channels can be formal or informal. The consolidation of dispersed information from different units, stored in an IT enhanced memory extends the boundary of the transfer and facilitates sharing of information within the firm.

4. METHODOLOGY

An in depth case study was carried in a medium sized tile manufacturer located in Castellon: the number of employees is about 300. Sales from the Spanish market represent 24 % of sales. It is to be noted that there is a high geographic dispersion of the customers and the company exports to 91 countries.

4.1. DATA COLLECTION PHASE.

Data was collected from interviews with the Marketing Manager, Product Manager, Technical Tile Developer (NPD members), Sales Managers, Purchasing Manager, Production Manager, Quality Control Manager, Graphic Designer, and IT Analyst. The interviews were done by means of face-to-face semi structured interviews based on a set of predefined questions. Face-to-face interviews have allowed greater flexibility to elaborate on emerging variables, which have not been previously identified.

4.2. DATA ANALYSIS: VALIDITY & RELIABILITY.

The reliability of the data collection has been checked after the interviews. The answer to the questions where the respondents have to mention examples of product failure and success was corroborated with the sales results reports. Construct validity was achieved by having a chain of evidences for each measure. For example, for each variable being measured, a chain of evidence has been established and maintained by asking multiple questions for the same measure.

5. RESULTS

5.1. PROFICIENCY OF NEW PRODUCT DEVELOPMENT PROCESS.

The proficiency of the NPD Process has been assessed in terms of the number of activities performed and the number of days allocated to each activity as defined in the previous section. Figure 4 shows an activity-by-activity breakdown of the 13 steps of the NPD Process.

Activities	Y/N	No Of days	%
Initial Screening	Y	4	3,0%
Preliminary Market assessemnet	N		
Preliminary technical Assesememt	N		
Detailed market study	Y	8	7,0%
Predevelopment Business Analysis	N		
Product development	Y	30	26,0%
In house prototype test	Y	10	9,0%
Customer test of products	N		
Test Market/Test Trial	N		
Trial Production	Y	3	3,0%
Pre commercialisation analysis	N		
Production start up	Y	1	1,0%
Market launch	Y	60	51,0%
Total Number of Days		**116**	1,00

Y: Activity Done N: Activity Not Done

Figure 4: Results of Proficiency of New Product Development Process

The results indicate that the up-front market orientated activities are noticeable by their absence (stages 2, 3 & 5 not undertaken). Furthermore, what stands out from the result is the extent to which the NPD Process is loaded, in terms of resources, towards the middle and back end of the process. Indeed, only 10 percent of labour-days are expended in the front-end activities. This result provides evidence that the NPD Process is unbalanced.

5.2. PERFORMANCE OF NEW PRODUCTS.

The actual sales performance of new product has been benchmarked with the sales objective: a satisfactory return (set by the company) for the new products is a return of € 700 per panel on display in the showroom of the customer. The result in Figure 5 shows that the overall performance of the New Product Project for the four cycles is below the target for most of the new products launched.

Date	Jan. 05	June 05	sept-05	Jan. 06
Cycle	Cycle 1	Cycle 2	Cycle 3	Cycle 1
New Products				
% Above € 700	5%	25%	11%	13%
% On Target € 700	5%			13%
% Between € 700 - € 420	9%		11%	7%
% Below € 420	**81%**	**75%**	**78%**	**67%**

Figure 5. Sales of New Products launched compared to expected to target (%)

The evidence appears to support the link between the NPD Process and New Product Performance. The high rate of new product failure from the last four New Product Projects is correlated with the low proficiency of the NPD Process. To improve the performance of new products, the organisation should engage more fully in a balanced NPD Process.

5.3 MANAGEMENT OF KM PROCESS

We argue that KM can support the NPD process: on scratching the surface of these main CSFs of NPD, the information variable does appear. The objective was to understand how a knowledge resource, generated from the following CSFs of NPD which have been explained earlier, can support the activities of the NPD Process.

- Cross Functional team cooperation between production, purchasing, sale departments and NPD team.
- Usage of information from past and current product development projects.
- Early involvement of suppliers in NPD Process.
- Early customer integration in NPD Process.
- Co-operation with institutions in the Industrial Districts.
- High knowledge of the market (demand and supply side).

For the construction of a knowledge resource, information underlying the CSFs of NPD has to move along the three phases of the KM Process. In order to address the second research objective, these CSFs of NPD have been mapped onto the three phases of the KM Process (Acquisition, Storing, and Sharing). Figure 6 shows that information from three CSFs to NPD is successfully converted into knowledge.

KM PROCESS:
Phase 1: ACQUIRING ⟶ ***Phase 2: STORING*** ⟶ ***Phase 3: SHARING***

CSFs of NPD	Location Of Memories						
	Status of CSF	Individual	NPD Unit	Intra Firm	Inter Firm	Artefact	
Knowledge of the Market (Supply Side)	√	⌂⟷⌂		⟷	⌂		Yes
Supplier Integration	√	⌂⟷⌂		⟷	⌂		Yes
Cooperation with institutions in the Industrial District	√	⌂⟷⌂		⟷	⌂		Yes
Number of CSFs Acquired	**3**						
Storage of CSFs in Firm Memory	**Yes**						
Distribution, Sharing, Application of Information	**Yes**						
Creation Of Knowledge	√						

√ *Critical Success Factors Acquired .*
⌂ *Location of Information underlying the CSFs of NPD, which is acquired*

⌂ ⟷ ⌂ Sharing of Information from one memory to another

Figure 6. KM Process for CSFs of NPD converted into Knowledge

This information is stored at different levels of the memories of each of the following: individual members of the company, New Product Development team, intra firm level (Sales, Purchasing, Production, Marketing department) and inter firm level (enamel suppliers, organisations from the Industrial District). The trajectory of information, underlying these CSFs, from its source memory to its destination (NPD team) has been continuous and well synchronised, exercising thus a strong influence on the learning ability of the NPD team to generate 'higher state of knowledge'. This information has been transformed into a knowledge resource because the resource owner of this information (Internal Department or external partners to the firm) has intensively shared the relevant information with the New Product Development team at an early stage.

5.4. POSITIVE EFFECT OF KM PROCESS ON NPD PROCESS

The results indicate that only three CSFs (knowledge of the supply side of the market, supplier integration, co-operation with Industrial District) are converted into a knowledge resource. The trajectory of information underlying these CSFs from its source location to its destination (NPD team) has been enabled by intensive sharing activities. Information underlying these three CSFs has been successfully converted into a knowledge-based resource as it has moved along the three phases of the KM Process. This resource is then, in turn, injected in several activities of the NPD Process. In the case study, the following activities of the NPD Process namely Detailed Market Study, Product development activities, In House testing and Trial Production are improved because of the injection of the knowledge resource from the supply side of the market as exemplified by the strong cooperation of the NPD team with the enamel suppliers from that the very beginning of the process up to production start up. The regular visits of the NPD team to international trade fair and the active co-operation with organisations from the Industrial Districts enhance their stock of knowledge about the supply side of the market.

In contrast, information underlying four CSFs to NPD is not converted into knowledge though these factors are present in two or more memories as shown in Figure 7.

KM PROCESS:
Phase 1: ACQUIRING ⟶ ***Phase 2: STORING*** ⟶ ***Phase 3: SHARING***

CSFs of NPD	Location Of Memories						
	Status of CSF	Individual	NPD Unit	Intra Firm	Inter Firm	Artefact	
Knowledge of the Market (Demand Side)	P	⌂		⌂▼	⌂▼		No
Cross- Functional Team:							
Technical and Production Synergy	P			⌂ ▼			No
Purchasing Department	P			⌂ ▼			No
Sales Team	P			⌂ ▼			No
Number of CSFs Partly Acquired	4						
Storage of CSFs in Firm Memory	Yes						
Distribution, Sharing, Application of Information	No						
Creation Of Knowledge	No						

P Critical Success Factor Partly Acquired
⌂ *Location of information Underlying Critical Success Factors (acquired) of New Product Development*
▼ *Non-Sharing Activity from source (other unit, Inter-firm, Artefacts) to destination NPD Team*

Figure 7. KM Process for CSFs of NPD not converted into Knowledge

The performance of the organisational memory is not at its optimum level because the information remains isolated at its source memories: memory of individual members of the company, internal departments of the company (Production, Purchasing and Sales departments) and external memories (customers' memories). This information remains locked in the memories of these owners of information and it is not shared with the NPD team. The missing activity to convert the stored information into knowledge is cross-team sharing.

5.5. NEGATIVE EFFECT OF THE MISMANAGEMENT OF KM PROCESS ON NPD PROCESS

If information is acquired by any member of the company but is not shared with the NPD team, the performance of the organisational memory is weakened and a knowledge resource is not created because the information remains isolated in the source memories. For example, the late involvement of the Technical/ Production, Purchasing and sales Departments in the NPD Process, prevents a knowledge resource from being generated. When members from these departments voice their requirements, it is either too late to be integrated in the product development or else, it adds to the development cost due to late modifications of the prototypes. The lack of synergy between these departments and the NPD team impacts negatively on the *In house prototypes test activities* and *Trial Production* activities. The random visits of the

NPD team to the ceramic distributors prevent members of the team to have a clear idea of the accurate requirements of the main target market, weakening thus the up front activities of the NPD Process namely *Initial Screening, Preliminary Market Assessment, Detailed Market Study, Pre Development Business Analysis.*

Finally, the information underlying the remaining three CSFs to NPD (Figure 8) is not even acquired in any way by the firm and this implies that it is not stored and cannot be retrieved from any memories by the New Product Development.

KM Process for CSFs of NPD not converted into Knowledge

KM PROCESS:
Phase 1: ACQUIRING ⟶ ***Phase 2: STORING*** ⟶ ***Phase 3: SHARING***

CSFs of NPD	Location Of Memories						
	Status of CSF	Individual	NPD Unit	Intra Firm	Inter Firm	Artefact	
External Communication: Customer Involvement	X				•		No
Information about Past and Current NPD Projects							
Archives of sample of tile developed and rejected	X					•	No
Database For NPD and MIS Tool for analysis of product failure and success	X					•	No
Number of CSFs Not Acquired	3						
Storage of CSFs in Firm Memory	No						
Distribution, Sharing, Application of Information	No						
Creation Of Knowledge	NO						

X *Critical Success Factor Not Acquired*

• *Possible Location of information Underlying Critical Success Factors (not acquired) of New Product Development*

Figure 8. KM Process for CSFs of NPD not converted into Knowledge

It is important to note here that information present in the external memory (inter firm level) of the organisation (customer knowledge) is not sufficient to be considered as part of the organisational memory unless the connection is made to an individual or group memories within the reach of the organisation. Hence, the disconnection between the memories of the resource owner with the organisation impacts negatively on the organisational memory. The New Product Development team cannot access and retrieve any information either from archives of samples of previous product failures or successes or from any database which would uncover the common characteristics of previous failures and successes. This level of information will facilitate the learning environment of the New Product Development while developing prototypes and to avoid repeating the same mistakes done in the past, due to failure to remember all characteristics of products failure or success. In Figure 8, we have named the location of information which is either stored in a library of all tiles developed in the past or in a database which enables in depth analysis of product failure and success, as *'Artefact'*.

Given that the case firm does not integrate customers at an early stage during the development of prototypes to collect feed back and it does not have any access to any stored information from past NPD projects, the information remains locked at its source and is not transformed into a knowledge resource. We find a negative impact on *Preliminary Market Assessment, Detailed Market Study, Product Development, and Customer Test of Products* activities of the NPD process. The decision making process of the NPD team is weakened due to incomplete information and the NPD team operates in a historical vacuum.

5.6 FUNNEL SHAPE OF THE KM PROCESS

Mapping the above results in the Conceptual Model, we can see that the 3 Phases of the KM Process can have a funnel shape, as illustrated from the dotted line in Figure 9, clearly showing the mismanagement of the KM Process.

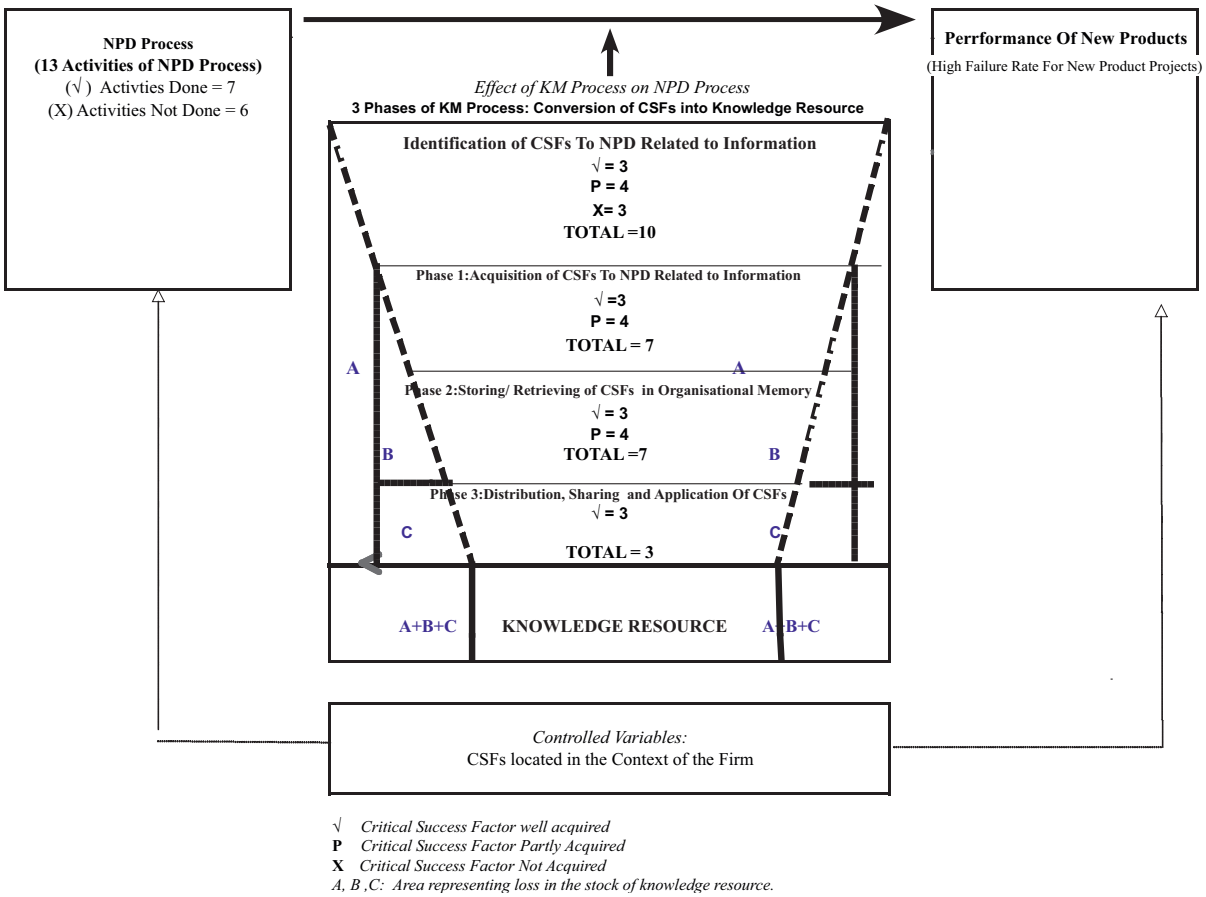

Figure 9. Mapping of KM, NPD Processes on the Conceptual Model

The study has revealed that the transformation of information, underlying these Critical Success Factors, into a knowledge resource is not an automatic process. Out of the ten Critical Success Factors of NPD, which can support the NPD process in the company, information from only 3 of the CSFs have been converted into a knowledge resource to support the NPD Process.

Thus, it can be concluded that a reduction in the knowledge base is a consequence of the depreciation of information, underlying the CSFs, along the 3 Phases of KM Process. The sedimentation of knowledge, which remains at the bottom of the funnel, is dependent on the degree of shrinkage along the Acquisition, Storage, and Sharing continuum and the loss is represented by area A and B as shown below. The low proficiency of the New Product Development Process (illustrated by the thirteen activities) is correlated with the high failure rate. The KM process cannot fully support the NPD process as it fails to generate a knowledge resource from all the Critical Success Factors of NPD.

6. CONCLUSION

This study makes a contribution to the literature by supporting the perspective that the proficiency of New Product Development Process is linked to performance of new tiles launched in the marketplace. This finding is important both for academics and for practitioners. This analysis has revealed the importance to go beyond the traditional assessment of the proficiency of the NPD Process in terms of number of activities performed and the labour days allocated to each activity of the NPD Process. It is the disruption of the information flow underlying the CSFs of NPD along the 3 phases of the KM Process, which prevents a knowledge resource from being generated, and it has been shown how several activities of the NPD Process are thus impaired. The study has revealed the need for new product developers in the Spanish tile industry to have a more rigorous approach to the New Product Development and to Knowledge Management processes: the uncertainty when launching new products can largely be reduced through a more structured approach and plan of action to manage the new product development activity as a process model.

7. RECOMMENDATIONS

1. Early Involvement of Purchasing and Production

Early involvement of Purchasing and Production departments in the NPD process will make any modifications as requested by these two departments explicit at an early stage, thus reducing the development time and cost of late modifications.

2. Integration of Customer

It is suggested that the customer should be involved in the selection of the prototypes to be launched. The objective is to collect tacit information about why the design (e.g. format, colour, texture) might be rejected at a later date. This will provide an opportunity for the Technical Tile Developer to modify the design of the products at an early stage.

3. Reducing the Knowledge Gap from the Demand side

Given the high dispersion of the customers in 90 countries, the challenge is to capture the information from the multiple locations of the external customer world in a synergistic way so that perturbations from the demand side can be captured in a continuous and real time basis. The close proximity of the sales managers and customer service staff with the customers make

them the ideal point of contact between the demand market and the NPD team. Existing CRM software can act as a platform for the Sales Managers, Customer Service staff to enter the feed back of customer about the collection and also to register any information, pertinent to NPD team (e.g. new ideas from competitors' product portfolio, special request from customers, reasons why products fail).

4. Reducing The Knowledge Gap From Past Experience

In recording the history of current and past NPD projects, the causes of failure and success of each new product project will be more visible to the NPD team. By maintaining a library of samples of all prototypes and by developing MIS tools that enable in depth analysis of common characteristics of product failure/success (example: size, colour, texture, style), will provide access to a new level of information. It is considered that this will help members of the NPD team to clearly see the causes of failure/success. Thus, they will be less prone to repeat the same mistakes as a consequence of the opportunity offered for a continuous learning process, enabled by a structured Knowledge Management System.

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