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PRODUCT DEVELOPMENT IN CHINA: COMPARISON BETWEEN DANISH AND CHINESE COMPANIES

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Keywords: product development process, decision making, user involvement, product strategy

1. Introduction

It is commonly accepted that product development (PD), which is defined by Ulrich and Eppinger [2008] as *'a set of activities which begins with a market opportunity perception and ends in the production, sale and delivery of a product'*, is an indicator of a company's competency in particular for manufacturing companies.

Increasing PD activities of a company are globally distributed owing to the changes in markets and geo-political conditions etc. [Hansen and Ahmed-Kristensen 2010]. As a result, increasing outsourcing and offshoring is taking place, especially to emerging lands, among which China plays a significant role due to its huge capacity and dynamic. Therefore, the integration of product development process (PDP) between these concerns requires knowledge about PDP in China and other emerging lands, and hence motivates this research paper.

Many research studies have investigated how to improve the efficiency of PD in terms of time, cost and quality [Flynn et al. 1994], and balance it with innovation [Naveh 2005]. Theoretical models with respect to PDP have been proposed based on these studies. This paper concerns three established PDP models: Stage Gate System (SGS), Product and Life Cycle Excellence (PACE) and Integrated Product Development (IPD) due to their worldwide acceptance and application, and deep insights into general situations as being a comprehensive guidance. The three models share a common foundation i.e. well-structured processes contribute to the development, and that mixed-function teams perform better than single-function teams. However the models have different emphases and use different terms. For instance, IPD emphasizes the structural organizational configuration [Adler 1995], [Eisenhardt and Tabrizi 1995] while SGS puts more effort on guiding companies step by step as an operational map [Cooper 2008].

Despite the close attention to PD under a western context, to the authors' knowledge there is very little literature about PDPs in China (or other emerging lands). From the literature review conducted the following gaps were revealed in existing research. Firstly, most academic studies have been conducted and most theories have been developed and tested in a western context, hence the suitability of these PD models in China is uncertain. Secondly, current research focuses primarily upon the applicability of one specific model. There is a lack of comparative research on different models and integrative studies from several insights. Thirdly, very little literature talked about implementing models in China especially within the global product development context and the majority of the few studies on this topic have been written in Chinese (e.g. [Jiang and Qin 2007]). Hence, it appears important to understand PD in China from an academic perspective, in particular with the trend to globalise the earlier stages of PD to move closer to a new market and for creating joint innovation [Hansen and Ahmed-Kristensen 2010].

Hence, this paper aims to investigate the patterns and challenges of PD in China through comparison across China and Denmark. The specific aims of this paper are to:

1. Understand the PDPs used in China with a secondary investigation on the product development organization (PDO).
2. Investigate the patterns of PDPs in Chinese companies by comparing with Danish companies in terms of three insights: decision making, user involvement, and product strategy.
3. Highlight the challenges of PD in China for international companies and propose possible improvements.

2. Research Methods

2.1 Data collection

A case study approach was selected due to the explorative nature of seeking unknown factors and elements of this study [Yin 1994]. In total, 11 interviews were conducted to understand the PD practice in six companies including two Danish companies and four Chinese companies. These were four manufacturing companies and two consultancies that serve the manufacturing industry (summarised in Table 1).

Table 1. Company Overview

Company synonym	Country	Type of companies	Founded in	Total employees	Development team in China
D1	Denmark	Global pump manufacturer	Founded in 1945; R&D in China was started in 2005	18000	109
D2		Local consultancy	1995	10	9 (in Denmark)
C1	China	Global Surveillance solution provider	2001	6000	About 2600
C2		Illumination manufacturer with local development and global business	2007	1000	About 100
C3		Local mould manufacture	2001	380	24
C4		Global design consultancy	2004	200	About 200

All the interviews were semi-structured and interview guides were prepared related to PDPs. As showed in Table 2, employees in relevant PD positions (e.g. project manager and technical manager) were selected as interviewees since they have a more comprehensive understanding of PD. 10 of the 11 interviews were conducted face-to-face and the final one was conducted online through instant messaging software. Nine of the face-to-face interviews were audio recorded with permission, while one was not recorded as permission was not granted. The interview language was selected based upon the interviewee's preference. All the recorded interviews were transcribed and the Chinese ones were later translated into English.

2.2 Data analysis

To analyse the data, a predesigned code scheme was applied to all the interview transcripts. The transcripts were divided into segments, defined by the intent of the interviewee [Goldschmidt 1991]. Each section was coded with predefined codes, where the code categories consisted of the following six groups:

1. Background information: the company name, type, interviewee's position.
2. Product development organization: the functional composition of project team.

3. Product development process: the type of PDP model used, the development activities, the referred insights, objectives, and evaluation of PD, challenges, and future improvements.
4. Globalisation: the motivation and challenges of global PD, e.g. time difference.
5. Chinese market: the characteristics of Chinese market.
6. Comments: comments for the section.

Table 2. Interview Overview

Company	Interview	Place	Role	Recorded	Language
D1	Individual	Suzhou, China	Director	Y	English
	Group		Technical Manager	Y	Chinese
			Senior Product Designer		
	Individual		Program Manager	Y	Chinese
	Individual		Program Manager (User insights)	Y	Chinese
D2	Group	Hillerød, Denmark	Program Manager	Y	English
C1	Group	Hangzhou, China	Technical Director	Y	Chinese
			Quality Manager		
C2	Individual	Shenzhen, China	Deputy Director (Co-founder)	N	Chinese
	Individual		Quality Manager	Y	Chinese
	Individual		Development Manager	Y	Chinese
C3	Online	-	Director	N	Chinese
C4	Individual	Shenzhen, China	Senior Designer	Y	Chinese

3. Results

3.1 Product development process

Academically, different PDPs were modelled for various contexts. A generic PDP can fit in most contexts especially a market-pull situation [Ulrich and Eppinger 2008]. Figure 1 illustrates the process in order to understand and compare the PDPs in case companies.

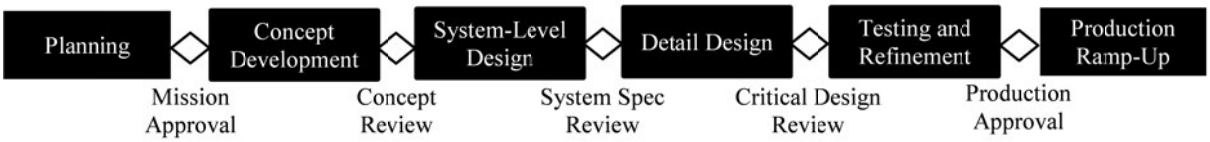

Figure 1. Generic Product Development Process

It was found that all six companies had standard PDPs described in documents that varied from one to another. As showed in Table 3, both Danish companies fully implemented Stage Gate model in their PDPs. Only one out of the four Chinese companies (C2) applied the Integrated Product Development (IPD) model with the primary motivation to become a listed company. Consultancy team were hired to support the implementation of a standardized process, while its own employees had very limited knowledge about the model. The processes in the remaining Chinese companies were mostly developed based on internal and external experience and formal models were not employed.

Table 3. Product development process model application

	D1	D2	C1	C2	C3	C4
PD Model applied	Stage Gate	Stage Gate	None	IPD	None	None

The PDPs evolved according to the context. In D1, a similar stage gate process has been used for decades with small modifications, whereas the Chinese companies' processes have undertaken substantial changes during the last few years. C1's technical director emphasised the constant

improvements: "*[the process] is modified every year. Sometimes are small adjustments and sometimes are big evolutions*". The current PDPs in each company are illustrated in Figure 2.

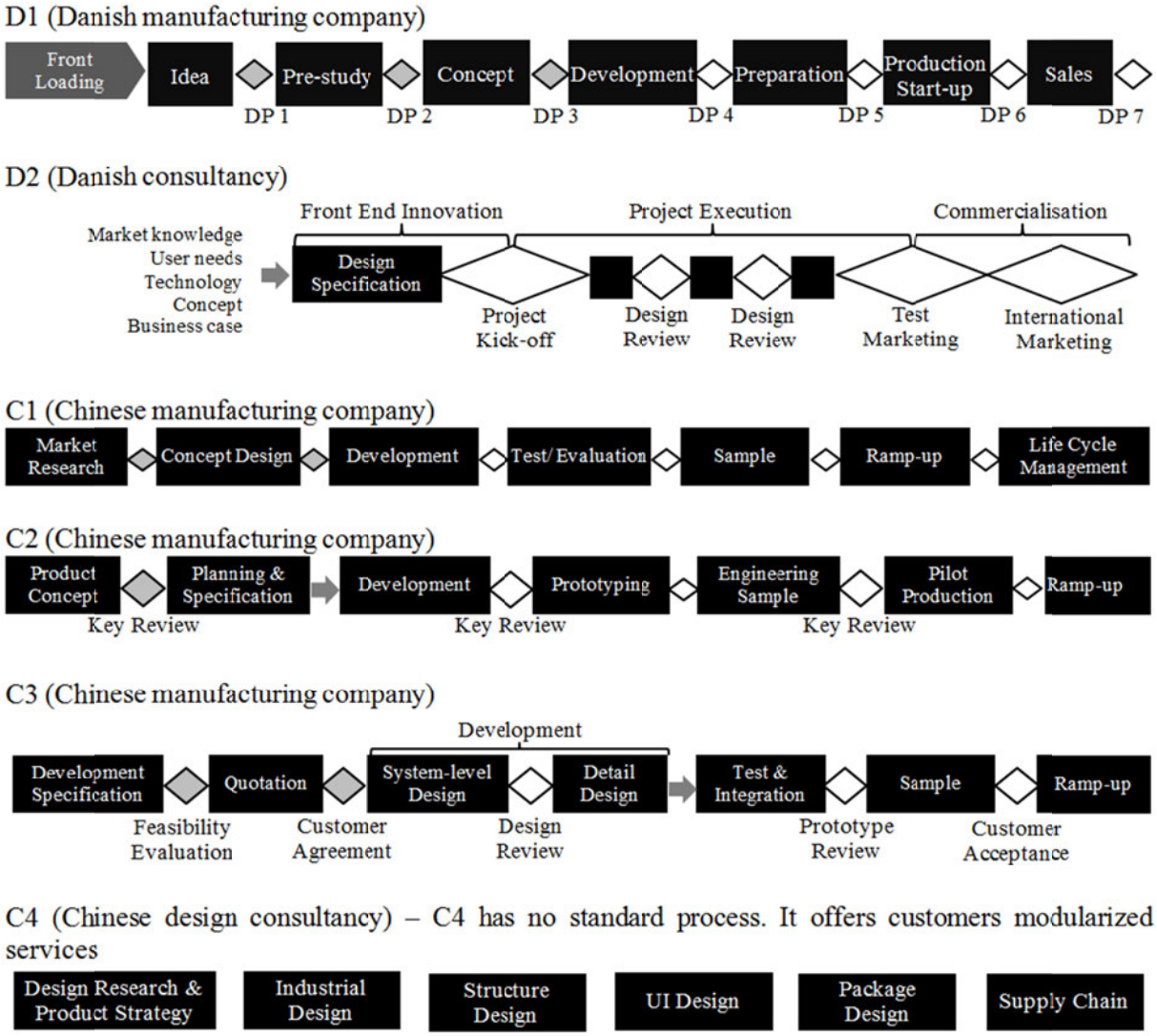

Figure 2. Case Product Development Process Overview

3.2 Product development organizations

PDOs in the case companies were also investigated to better understand how individuals were linked in the processes. All of the six companies stated that their organizational structures were kept updated. Their current PDOs are described in Table 4.

Table 4. Product Development Organizations in Cases

Company	Project team (PT)	Project manager (PM)
D1	Multifunctional team	Professional PM with management knowledge
D2	Flexible PT consist of mainly engineers	Professional PM with management knowledge
C1	Engineer-based team	Professional PM with responsibility to function performance
C2	Engineer-based team	Technical managers are also play as PM
C3	Engineer-based team	PM is taken by a senior engineer in the PT
C4	Flexible PT built up upon customers' requirement	Anyone in the PT can apply to be the PM

D1 had a multi-functional project team where people from different functions were represented and were coordinated by a project manager. In contrast the Chinese manufacturing companies had mainly engineers based project teams while other functions were involved indirectly, i.e. were closer to a functional organisation. For instance, in C2 one support team served all the project teams at the same time and market and sales people were involved through monthly meeting. The Chinese companies preferred to appoint project managers with technical background (rather than professional management skills) and the managers were also responsible for the products' functional performance.

3.3 Insights

This section reports three insights gained from the study in order to gain an in-depth understanding on PDP in China: Decision Making, User Involvement and Product Strategy. Figure 3 displays how the three insights are connected with the two core subjects: PDO and PDP.

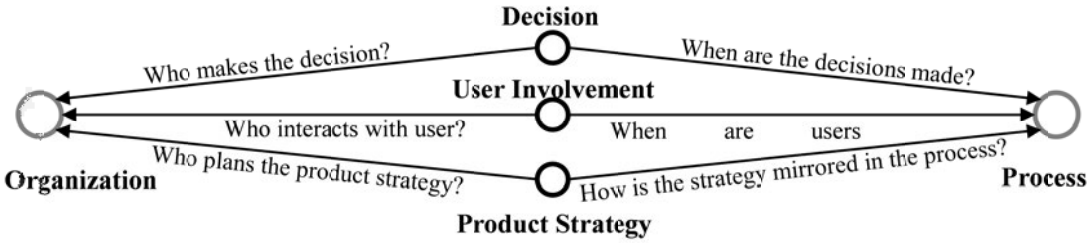

Figure 3. Connections between Insights and Process/Organization

3.3.1 Decision making

In PD, decisions are made at different levels. Often important ones are when the project goes through the decision points (gates). Once a process is designed, where to make decisions and how to make them are also in place. Viewing PDP as a risk management system [Ulrich and Eppinger 2008], one essential goal of setting decision checkpoints is to reduce the risks in the project. The gates allow the project to be reviewed in detail when moving to the next phase before the budget dramatically increases, so that the "wrong" projects can be cut off at early stage [Cooper 2008]. Normally, the more frequently the project is scrutinised, the fewer risks are undertaken. However too many decision points may be a waste of time and resources.

Table 5 presents the overview of decision points and decision makers in four manufacturing companies. Consultancies were not taken into consideration here since their decision making processes were highly customised according to different projects and hence not comparable.

Table 5. Decision Making Facts in Cases

Company	D1	C1	C2	C3
Number of decision points (DPs)	7 formal gates	6 reviews	3 key reviews 2 small decision points	5 reviews
Ratio of DPs before development to total number of DPs	3:7 = 0.43	2:6 = 0.33	1:5 = 0.2 1:3 = 0.33 (key reviews)	2:5 = 0.4
Decision makers for project approval	Top managers (below CEO)	CEO (Co-founder)	Evaluation committee (Essentially co-founders)	Not available
Decision maker for project review	Multifunctional decision board	Managers	Key reviews :Evaluation committee Small DPs: Project team	Managers

Note: in Figure 2, ◇ refers to DP before development

The project control system in D1 was more controlled than in the Chinese companies. D1 had 7 strict and formal decision points in the process, where the project was evaluated by the same decision board, which consisted of members from four functions: user, sales, supplier, and operations. Decisions were

made in the board meeting. This was in accordance with the concept of a multi-functional decision committee in most theories (e.g. [McGrath 1996]). Differently, Chinese companies had less decision points in general and showed more flexibilities. As a typical case, C2 stated that its PDP included two levels of decision points: three key reviews and two small decision points where different decision makers were involved. C2 was the only Chinese company which mentioned evaluation committee referring to IPD. However, in practice, the committee members did not contribute equally to the decisions since they were from different levels of the company hierarchy. When engineers, managers and directors sat together, normally the director's opinion had biggest influence on the final decisions. Both C1 and C2 involved project leaders/managers in the decision making process to a certain extent.
Additionally, compared with Chinese companies, D1 held more control during the early stages including concept development and specification. All Chinese companies had a lower ratio of numbers of decision points before the development phase to the total number of decision points than D1 (Table 5). C1 emphasised that it planned product evaluation from the beginning of the process. It evaluated the project based on the results of testing the prototypes, samples and production possibilities. In addition to the traditional internal tests e.g. reliability and maintainability, products were sent to external testing companies and users were invited to experience the products before launch.

3.3.2 User involvement

It is commonly accepted that user focus is essential to PD and several methods and approaches have been proposed by researchers in order to involve users effectively (e.g. [Kujala 2008]). Theoretically the main user involvement is in three phases during PDPs: specification phases, concept development and the prototyping [Kaulio 1998].
Figure 4 illustrates key user involving activities through PDPs in three manufacturer cases: D1, C1 and C2 (C3 was eliminated as limited data). In order to facilitate comparison, the activities were mapped to the generic process where the system-level design and detail design were combined as one development phase.

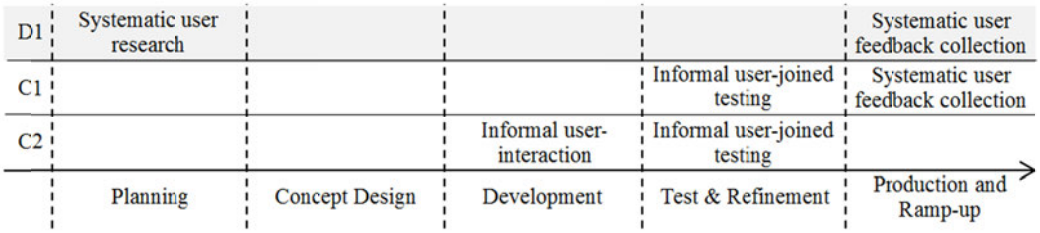

Figure 4. User Involvement in 3 cases

Comparing the user involvement of the Danish company to the Chinese Companies provided some key differences. D1 had the systematic user research in the planning phase. In this company, PD was divided into: front-loading project for concept generation and collection; and PD project. In the front loading part, professional teams (user insights teams) were formed for user research. After the products were launched user feedback was tracked and gathered by sales and a complete information processing system was in place. The user information was collected by the user insight teams and passed step to step through the PDP. No other group or individuals in the development team were encouraged to interact with users directly.
Comparatively, there was a lack of user involvement in early stages in the two Chinese companies compared with the Danish one. One quality manager from C2 described that its specifications and concepts were mainly based on investigations on competitive products in the markets. Chinese companies involved users late in the test & refinement phase. Both C1 and C2 invited users to try their products. Most user involvement activities in Chinese company were non-systematic and informal. Particularly, in C2, individual engineers were inspired to communicate with users, and rely upon their initiative rather than a formal process. A key difference observed was the systematic involvement of users in Danish companies focusing on understanding user requirements (involvement early in PDP), whereas the Chinese companies relied on the individual imitative of engineers and focused primarily in user testing (involvement late in PDP).

In both consultancies, Danish and Chinese, users were highly involved through the process and the consultancies assisted clients with user involvement when required. For instance, C4 supported clients to identify end user needs.

3.3.3 Product strategy/portfolio management

McGrath [1996] says that product strategy is decisive for planning PD. It is implemented through decision making on project selection and resource allocation [McGrath 1996]. Similar notion is described with the term portfolio management by Cooper et al. [1999]. Product strategy or portfolio management is tied to with decision making process [Cooper et al. 1999], [McGrath 1996].
From the analysis of the interviews, a key difference was observed in the companies' use of portfolio management, and road mapping of projects. D1's CEO had a clear vision of the company in 2025. Their portfolio planning department investigated the potential projects for five years periods assessing their suitability and in line with stage gate model [Cooper et al. 1999]. However, the notion of portfolio management was fuzzy in the Chinese companies, with their product strategy that was very market orientated. One project manager from C1 summarized its strategy as: "*Accumulate for a well-grounded start. Act statically based on the situation and need*". They prepared for upcoming opportunities and responded quickly to them, and hence agility in the market was a key priority.
In addition, Chinese companies address primarily the market and user needs when plan their portfolio while D1 also mentioned sustainability and social responsibility.

4. Discussion

Based on the presented facts, this section concludes and discusses the patterns of PD in China. Possible explanations for the differences between Chinese and Danish companies are also discussed. One can argue that the companies' age and size influence the results. The Danish company is well established and large with a reputation for clear product identities and high quality. However, other factors matter as well. The key patterns observed were:
Firstly, the study indicates that Danish companies have solid knowledge on theoretical models while Chinese companies learn from practical experience. Chinese companies have relatively less knowledge about PD theories, with a limited number of Chinese companies that have implemented PDPs, which are to a lesser extent than the Danish companies and are externally driven. One example is C2's engineer-based project teams do not match the concept of cross-functional teams in IPD. The interviews and the literature review indicate that the Chinese companies' PD practice is rather crude according to theories. They have started to realise the importance of models but the understanding and use of these models is still in the early phases.
In the Chinese companies, a number of drawbacks highlighted in literature as best to be avoided were found. Utilizing development time as the sole criterion or key criterion conflicts with IPD's multiplicity of objectives [Gerwin and Barrowman 2002]. Their pure market orientation opposes with PACE's comment that a conditioned response to the market will not stand in a favourable competitive position [McGrath 1996]. In addition, the same employers acting as both project leaders and decision makers in a project team, is described as errors or fail points by Cooper [2008].
However, Chinese companies were found to have better performance in some aspects in terms of flexibility. Compared with the seven fixed gates in the Danish model D1, the two decision making layers in C2 is a better expression of changing gatekeepers based on the risk associated with the decisions [Cooper and Edgett 2012]. From the cultural perspective, the long power distance in China [Hofstede et al. 2010] contributes to the power centralization and shapes the relationship between project manager and team players differently in Chinese companies, thus allows a small group to represent the team or company to make fast decisions. To some extent, the flexibility allows the project to have a simpler frame, in terms of the quick response to challenges and new opportunities, however this is risky as the decision points are informal (and not the gate). In 2012, C2 had 52 PD projects; none of these were killed through the decision points. Only one project was delayed to the next year. However, from the literatures, the company can suffer if some 'bad' project keep wasting resources and are never cut off. In addition, the flexibility is reflected by the frequency of changing the PDPs. Chinese companies continue with implementing new processes and organizational structures

and absorbing successful experiences from other companies, the flexibility is an attempt to full use the dynamic resources in the market, which is full of opportunities with numerous new knowledge and experience poured into. One technical manager from D1 said that the transferring of personnel was very common in China relative to the stable employ loyalty in Denmark. People moving from one job to another drives the knowledge and experience flow. Chinese companies, especially small and medium size companies are more prone to hire employees with experience in large size international companies, which could help them to quickly grasp new knowledge. When new employees come in the company, it is likely to change the process in order to integrate the new knowledge. Thus, the flexibility appears as a way for Chinese companies to rapidly learn and apply new knowledge.

Secondly, less effort has been put on the early stages in Chinese companies than in Danish companies, which can be seen both from the decision making setup and user involvement emphases. It seems a paradox that Chinese companies have such strong market/user orientation but put such little effort on studying user needs. One possible explanation can be found from the interviews, the Chinese companies have different approaches of user needs, instead of implicit user needs, they prefer proved user needs in the market. C1's technical director described that the company had never been the first one to invent complete new products to the market but it could quickly catch up what others were doing. It indicates a possibility of deeply involving users in the later stages in the processes in Chinese market possibly due to its huge capacity of low-end needs. Involving users in the test & evaluation phase can gather direct feedback for small and quick modification. It also reveals the gap of innovation abilities between Chinese companies and Danish companies which Chinese companies are trying to reduce. Here the consultancies' role should be noticed. They can bring the manufacturing companies professional knowledge and assist them in user investigation with practical tools. For example, the design research activities in the Chinese design consultancy C4 are highly similar with that in D1's front loading project. In fact, the main business for C4 in Shenzhen is with small and medium size companies which are transforming. The combination of consultancies and manufacturer may be a trend of reshaping the PD activities and innovation abilities in China.

Thirdly, the nature of being an international company affects PD. An investigation was conducted on interfaces between groups in different locations and from different department in D1. As a global company, those interfaces increase the complexities of task distribution. For example, Figure 5 shows the interfaces in one project driven by the Chinese site (only the most relevant departments are illustrated).

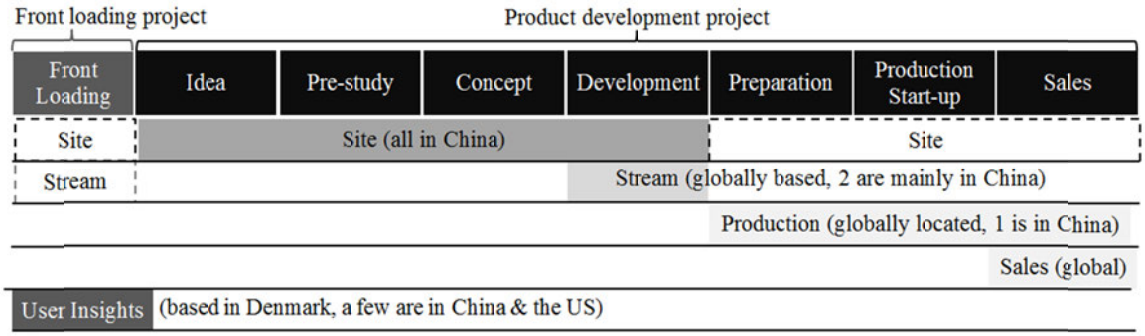

Figure 5. Interface Overview of One Project in D1

The PD project in D1 is globally based to a great extent, which may explain why D1 requires a strict decision making process to control the project quality carried out in several locations. Normally a single site is accountable for a project. Functions are located close to the most relevant sites in order to minimize the regional interfaces, e.g. the two streams (departments accountable for components design) that have the most cooperation with the Chinese site also have most members settled in China.

In addition, the front loading project seems isolated from the PD project. Most of the user insights team work in Denmark while only a few are in China dealing with small and discrete tasks. This supports the designed user information flow but distances the user insights group from the end users. Moreover, it is difficult for the employees beyond Denmark to have a thorough understanding on the user information. It then will be risky if a project is mainly focused on a market outside of Denmark.

5. Challenges and suggestions

The challenges of global product development have been summarized by Hansen and Ahmed-Kristensen (2010) as culture, quality, and physical distance, a lack of codified knowledge of PDP, and a lack of consistency between practice and the already codified knowledge. Some of them are reflected in this study with several challenges appearing particular critical and can possibly be improved by learning from the Chinese companies:

- The fierce competition with local fast pursuers who are experts in developing at a high speed;
- Frequent renewal of personnel makes knowledge management and sharing more complicated;
- Balance between flexibility and standardization;
- To optimize the complicated interfaces within a global project;
- To improve the efficiency of project execution.

Accordingly, the following suggestions on PD in China are proposed to international companies:

1. Documentation of processes can be improved

The essence of explicit documentation of the process has always been emphasized in global product development [Hansen and Ahmed-Kristensen 2010]. It was found that documentation is already gaining increasing attention from international companies, especially large size companies, which still can be and should be continuously improved. More common-used and easy-understood terms can be applied in the documentation in order to help new employees to pick up the company's working language and be integrated as part of the team within the shortest time. In addition, trainings for foreign employees on professional knowledge and company culture are important.

2. Product development processes can be redesigned

The current effort on redesign of PDPs for emerging markets is far from enough. The processes can be redesigned for being easier to split the tasks. It can be achieved in two ways. First, process could be designed and applied flexibly according to the context. Naveh (2005) suggests implementing a low level IPD at early stage for better innovation performance, and high level in later stages to gain more control of efficiency. Moreover, it is worth considering localizing the process or part of the process for special projects. For instance, a large pump design specifically for a Chinese user can be processed faster since fewer inputs are needed from other locations compared with a global PD project. The second is to implement organizational transitions in order to support the process in a more efficient way by simplifying the interfaces between different functions and locations. The employees from the emerging lands can be encouraged to take short periods at the headquarters (such as Denmark) to gain a better understanding of the company culture and future strategies.

3. User involvement can be reshaped

One critical challenge for international companies when enter emerging markets is a lack of knowledge of local users. Western companies usually target the user segment with similar income and lifestyles to their traditional users [Universe Foundation 2011]. In fact, the largest potential user group in emerging markets should be defined differently, which asks for systematic and strategic user research. At this stage, it is necessary for international companies to stay close to users. The suggestion is to bring the user research team to the real context and let them talk to the real users.

6. Conclusion

The study has been carried out by conducting interviews in two Danish companies and four Chinese companies. The focus was upon investigating the practice of PD in China. The analyses to understand PDP also undertook a supporting investigation on PDO through the three insights: decision making, user involvement and product strategy. The small sample size and uneven company scale and age were accepted as limitations of this research, and were a result of prioritising a delayed interview in an exploratory study whereas future studies could focus upon a large dataset with a more focused research question. Despite this, the results from the comparison between the Danish and Chinese companies indicated an insight into the way that Chinese companies develop products. The findings showed that the Chinese companies were more flexible and a number of differences were observed including, that they involve users primarily in the test & evaluation phase for user testing, whereas the

Danish companies are much more user-centred, having user involvement early in their process to identify user needs.
The paper suggests possibilities for future research. Traditional theories developed under western context still apply in China. However, specific models need to be developed for emerging markets. Two possible directions for future research are: 1) investigating the user involvement and evaluation models in terms of strong market orientation, or: 2) a comparative study on different product theories/models, this could assist companies to fully implement the methods and integrate beneficial solutions from the different models.

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