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CONNECTING GLOBAL PRODUCT DEVELOPMENT WITH CORPORATE STRATEGY

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1. Introduction

Economic and technological changes like the development of the Internet and the fall of the Soviet Union has enabled companies to globalise a wide range of activities. Functions and tasks, from manufacturing to research and development (R&D), is increasingly globally distributed [Gottfredson et al. 2005]. This creates many new challenges for multinationals as these activities have to be coordinated and integrated.

Changes in market, technology and market preference have led to companies seeking to reduce development costs, improve development quality, and shorten development time. Other reasons for engaging in global product development include, (1) to get design resources closer to the needs of local markets, and (2) to get design resources closer to distributed manufacturing resources. This is increasingly happening by globalising product development through offshoring and outsourcing. The first refers to a situation where the company owns the foreign organisational unit doing the work whereas with outsourcing it is owned by another company. Literature focusing on global product development has mainly focused on the design of products, excluding R&D and manufacturing. This paper therefore present literature with this focus on global product development.

Global product development started with the offshoring wave in the 1990s and has since grown [Eppinger 2006]. The key difference between conventional and global product development is the increased reliance on virtual collaboration across time zones and cultures as the team is now globally distributed [Eppinger 2006].

Many companies move from offshoring simple tasks to gradually offshoring more complex tasks like derivate products and new global products (see Figure 1). According to [Eppinger 2006] this development is a clear strategic move taken by the executives of the companies.

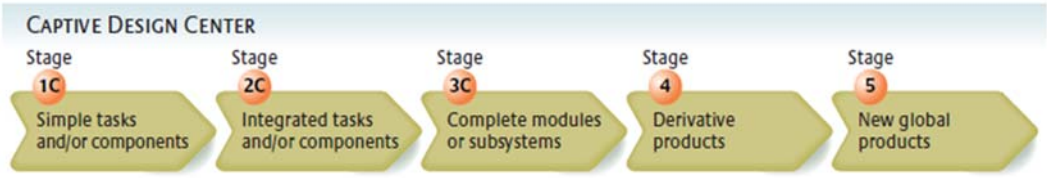

Figure 1. Global product development offshoring process [Eppinger 2006]

[Eppinger 2006] lists 10 success factors for global product development. These are (1) Management prioritises offshoring, (2) Process modularity, (3) Product modularity so interfaces can be clearly defined, (4) Core competences are identified, (5) Intellectual property is identified, (6) Data quality so

one system or database is a 'source of truth' for all the globally disbursed teams, (7) The infrastructure is created in such a way that power, network connections and other technical equipment is up to date and of the highest standard, (8) Governance and project management is needed to coordinate and manage the projects, (9) The need for a collaborative culture and (10) Organisational change management is needed to plan, train and educate staff who interact in the now global product development function.

Other research has focused on distributed teamwork, and cross-cultural collaboration. Research into international collaboration has shown how to best support teamwork changes from culture to culture which add a new dimension of complexity to management of distributed teams (e.g. [Zhang 2007]). Designers have also been shown to make design choices which have origins in their own culture, creating challenges for cross-cultural development teams.

Previous case studies have indicated that companies encounter problems in relation to (1) communication, (2) cultural differences, (3) unforeseen costs, (4) large travel costs and (5) internal opposition to outsourcing. Other problematic areas are likely to be collaboration, IP rights, learning and knowledge management, engineering productivity, innovation and quality, managing organisational change, and management control (e.g. [Ledernes Hovedorganisation 2004].

This review shows a need for further research into the reasons for complications with global product development and how these can be avoided as well as a lack of focus on the role of corporate strategy in relation to these issues, which forms the focus of this paper.

2. Aims

This paper aims to illustrate the impact corporate strategy has on the success of global product development. There is a lack of available literature showing how strategy connects with the operational level of carrying out global design tasks. The specific aims of this paper are to:

1. Understand the impact corporate strategy has on the success of global product development.
2. Investigate how challenges and solutions to these were handled in the case companies.
3. Illustrate possible improvements for organisations which globalise product development.

The data is based upon case studies of six companies involving 35 interviews.

3. Empirical method

The nature of the research questions suggested a case study approach due to the explorative nature of an area wherein unknown factors and elements are sought [Yin 1994]. For consistency, all companies were large international corporations with headquarters and ownership in Denmark. The cases were all engineering, business to business (B2B) companies which produced different products. Table 1 shows the case companies, their type of company, the position of the interviewees, and the number of interviews. Please note that the companies are anonymous by request from the participants. X1, X3 and X4 produced smaller components in large batches, while X2, X5 and X6 delivered large scale engineering projects according to each customer's specifications.

Table 1. Description of cases

Company synonym	Type of company	Interviewees' positions	Nr. of interviews
X1	B2B telecommunication manufacturer	Vice presidents, daily managers	3 interviewees
X2	B2B construction manufacturer	Top level managers, daily manager	3 interviewees
X3	B2B electronics and mechanical manufacturer	CEO, vice president, daily managers	4 interviewees
X4	B2B electronics and mechanical manufacturer	CEO, vice president, daily managers	4 interviewees
X5	B2B construction manufacturer	CEO, vice presidents, daily managers	9 interviewees
X6	B2B construction manufacturer	Top level managers, daily managers	12 interviewees

By interviewing top managers in a CEO, vice president or key managerial position from different departments (e.g. procurement, manufacturing, engineering, sales and marketing), a multifaceted perspective is gained. As the CEO and vice presidents are often the main (or sole) deciding force with regards to offshoring, the perspective of the daily managers - who were responsible for implementation and the daily management - provided a more operational perspective on global production and development.

4. Data collection

Data was collected through 35 semi-structured interviews were conducted and the interviewer was open for new information. There was little or no documentation available of the globalization process, which meant the interviews were the primary data source. The questions were related to preparation, decision making, impact, and factors seen as leading to success for global product development. Not all interviewees were asked all the questions, as some questions were only relevant for certain groups. All the interviews lasted ca. 1 hour, and were audio recorded, transcribed, and coded. The coding scheme was based on an intense literature study whenever possible. There were 23 codes with categories within background information, motivation, difficulties with moving out, knowledge transfer, implications, lessons learned and future strategy for globalization. Many of the codes had sub-codes as indicated in Table 2. As there has been little investigation into this area of global product development, many of the codes were derived from the data. Table 2 shows an example of the codes used where the first code shown is from literature and the last 2 emerged from the dataset.

Table 2. Example from the coding scheme

Category	Code (subcode)	Definition
Knowledge transfer	Type (codified, personalization)	Codified knowledge can be written down while personalization is knowledge which is transferred through human factors
Unforeseen difficulties	Type (Misunderstandings, delays)	The difficulties the companies encountered which were seen as leading to an impact on the product
Product implications	Type (quality, functionality)	The effect on the product

5. Results

The outsourcing and offshoring process for each of the case companies were mapped against their product development process and the way they had started to globalise as well as the motivation for doing so was detailed. Despite the different industries represented some general patterns were observed in terms of how they had started to globalise their product development process, their motivation and the implementation process. Most of the case companies first globalised manufacturing and then the other phases followed. X1, X4 and X5 offshored/outsourced the entire function for the whole company (e.g. all of production) while X1,X2, X3, X6 only did so for certain projects/product lines or specific parts of a product.

Figure 2 compares the companies' offshoring and outsourcing activities to the generic product development model [Ulrich and Eppinger 2008]. X1 first offshored all of production, parts of production ramp-up, testing and refinement, detailed design, then outsourced all embedded IT, offshored parts of the system level design and finally outsourced all of production. X2 created an engineering office in China to serve the market there. Later detailed design for foreign projects drew on engineering resources from this location. X3 offshored parts of production, production ramp-up, and then parts of testing and refinement. X4 was a small company which outsourced all of production and production ramp-up. After being brought by a large multinational cooperation, X4 offshored production instead. X5 outsourced all production. In the 1990s X5 had brought a company which had a subsidiary in India. Over the years this office grew to offer engineering services to both local and global assignments. The Indian office now does most of the system level design and all subsequent

phases up to production for all standardized products. In 2010 the office also started to receive R&D assignments. X6 followed the same path as X2 though for a subsidiary in China.

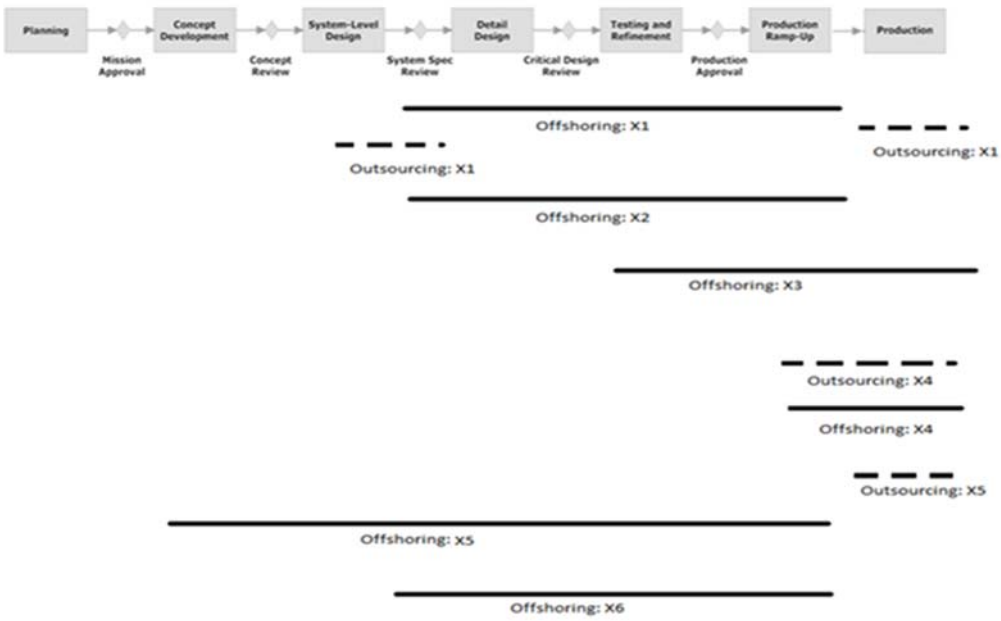

Figure 2. Company details for offshoring (full line) and outsourcing (dotted line) from the product development process

5.1 The role of strategy in global product development

The process of globalising product development observed in the case companies can be presented as consisting of four phases:

1. Motivation and strategy.
2. Preparation phase.
3. Implementation phase.
   a) Complications.
   b) Operational solutions to complications.
4. Managing the process.
   a) Complications.
   b) Operational solutions to complications.

Stage a) and b) are iterative as new problems are found and need to be addressed. Therefore, for each activity moved abroad this process seemed to come into play. All these stages are influenced by the company's characteristics and the external context the company operates in (see Figure 3).

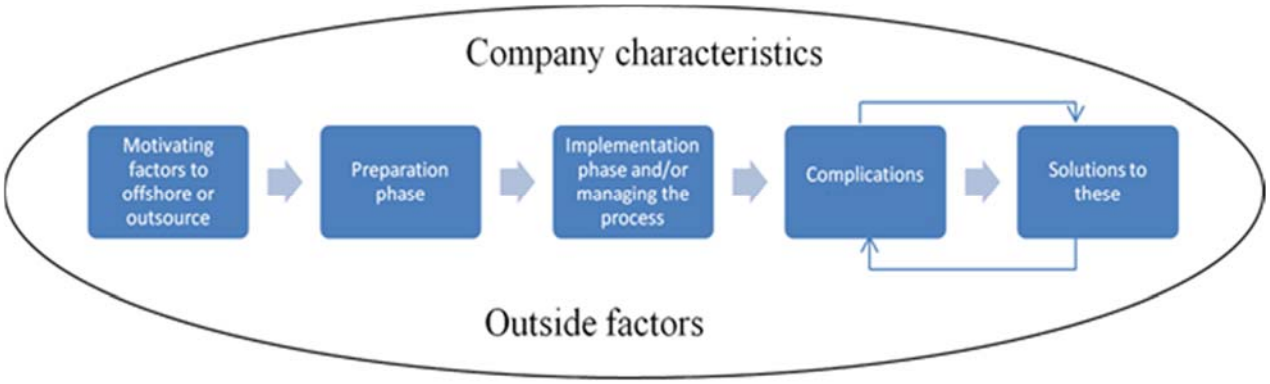

Figure 3. The phases in the offshoring/outsourcing process of product development process activities

The company characteristics which were the most influential on this process were:

1. Organisational factors
   a) Experience with offshoring and outsourcing.
   b) Organisational culture.
   c) Organisational structure, including processes and leadership.
2. Engineering project factors
   a) Product modularity.
   b) Process modularity.
   c) Knowledge properties of the product.

The motivation to move abroad as observed in these case companies were (in order of importance): cost, market access, and access to new competences. The importance of a motivation was inferred by the number of times this was mentioned during the interviews. The companies offshored or outsourced backwards in the product development process, starting with production. The exception from this was outsourcing for competences which was done independently from this. Large offshoring/outsourcing projects went through the process shown on Figure 3. Many functions and tasks were however moved as a result of these projects.

None of the companies had an overall strategy for globalising the product development process; it was a 'learning by doing' process. Strategic goals were either generic (growth in developing markets for X3 and X2), or very specific (offshore 15% of R&D in X6 and 10% of engineering tasks in X5), but did not directly address the future of the global product development process.

The preparation phase was brief and mainly involved top managers with a focus on desired outcomes. The implementation and daily management was handled by project leaders and other daily managers.

5.2 Encountered complications and implemented solutions

During implementation and the managing the relationship phase several problems emerged and solutions were implemented to counteract these. All of these problems and solutions were handled on the operational level by the daily managers. These problems can be separated into two categories; managerial and engineering project challenges (see Table 3Table).

Table 3. Encountered problems

Category	Problem	Seen in
Management	Culture	Communication style.
		Work approach.
		Leadership style.
		Technical methods and use of tools.
	Knowledge	Difficulties with sharing knowledge that is not codified.
		Hard to share knowledge virtually.
		Hard to develop new knowledge/innovation virtually and across cultures.
		Difference in how knowledge is communicated.
	Coordination	Different to ensure everyone have the same information at the same time.
		Different procedures.
		Delays due to time difference, misunderstandings, difference in access or control over data and databases.
	Communication	The English language is a foreign language for all.
		Culture can affect communication style.
		It is hard to communicate virtually.
		More misunderstandings can happen.
	Organisational structures	Difference in work culture with regard to written material, communication, leadership.

		Changes to work processes caused by globalising the product development process can be in contradiction to the structure and processes of the company.
Engineering project	Product features	Level of complexity in the product.
		Unexpected changes to the product and its development. Experience with the product and its features and development.
	Process features	Difference in the use of design methods and other technical methods, including difference in the process of developing and designing.
		Different approaches to what quality is.
		Difference in work approach and engineering practice.

Organisational challenges included collaboration, cultural differences, knowledge transfer, communication and organisational structures. The main challenge was that organisational structures, processes and culture often still supported the way of working which had been the norm before the task or function had been moved abroad. Examples include (1) contradiction of offshoring targets with turnover goals, (2) absence of new work structure to fit the new work environment, (3) absence of preparation of the workforce for the new work environment in the Danish headquarters, including expatriates and (4) absence of organisational structures to integrate the knowledge expatriates gain.

Engineering project challenges included many of the challenges mentioned in the global product development literature (e.g. [Eppinger 2006]) and added another dimension to those often illustrated in offshoring and outsourcing literature. These showed challenges related to the product and the product development process. These challenges resulted in rework, delays, misunderstanding and miscommunication (for more details on these impacts see [Hansen and Ahmed-Kristensen 2010], [Hansen and Ahmed-Kristensen 2011a].

In other words, globalising the product development process was not completely embedded in the organisation, its structures, routines, governance systems and reward systems. However, when addressing the challenges with globalising the product development process these aspects of the organisation was not addressed.

The complications were analysed on the operational level by the daily managers and therefore solutions were also on the operational level. Solutions employed by the daily managers were focused on employees, work processes or knowledge and communication. Examples were:

- Employees
  - Train engineers and workers in the foreign office by having them come to Denmark and 'learn by doing'.
  - Use of expatriates as leaders, to transfer knowledge and to supervise vendors.
- Knowledge and communication
  - Codification of knowledge.
  - Written and simplified communication.
  - One to one communication at the manager and top manager level only.
- Work processes
  - Increased control and quality checks.
  - Make a less complex product design.
  - Move more functions and tasks out to bridge the distance between functions.
  - Make the product development process more explicit.

The solutions thereby focused on operational changes. These solutions had positive and negative impacts as shown in Table 4. Some examples are that the solutions connected to work processes could, on the positive side, make these processes more efficient and could ensure current work workarounds could be discovered. However, on the negative side, more time and resources was spent on knowledge transformation and not all knowledge could be made explicit.

Table 4. List of positive and negative impacts of the implemented solutions

Positive impacts	Negative impacts
The risks of knowledge loss related to employee turnover are reduced through greater reliance on explicit knowledge.	Unexpected product changes caused by operational changes and solutions to the challenges listed in Table 3.
Current workarounds can be discovered, thereby reducing unnecessary complexity in production and the product development process in general.	Unexpected changes to the product development process caused by operational changes and solutions to the challenges listed in Table 3.
Processes and procedures can be made more efficient.	Time and resources used on knowledge transformation.
The supply chain network can be redesigned for greater efficiency.	Time and resources used on security and quality check-ups.
Increase the product portfolio and functionality (when outsourcing to a strategic partner). Product functionality can better fit local market needs.	Cultural implications of reliance on written communication and codified knowledge.
Process descriptions and work documents can be kept up to date, making it easier to share and find mistakes.	The risk of more human error in production.
Encourages a traditional organisational setup with task division and top-down control which can make complexity easier to manage.	Lack of transparency between the headquarters and the subsidiaries.
	Not all knowledge can be codified, making it difficult to focus on explicit knowledge sharing.
	Not all products or tasks can be separated into subcomponents which make it difficult to focus on modularity.
	Encourages a traditional organisational setup with task division and top-down control which may not be suited for all tasks or situations.

The positive impacts were related to increased efficiency, while the negative impacts were related to increased time and money spent on the endeavour as well as unexpected changes to the product, product development process and organisation. There is therefore a need for a better way to evaluate challenges and select solutions which will lessen the negative impacts.

5.3 Connection to corporate strategy

A key reason for the challenges within global product development is the decoupling between the activity and the company's strategic development. This were evident in 3 areas; (1) a lack of a clear strategy concerning global product development, (2) global product development activities which were not connected on the strategic level and (3) solutions to challenges were not connected to the corporate strategy nor did they include changes on other aspect of the organisation.

The case companies had started to globalise the product development process over many years. The original decision had been taken by top managers which little involvement from other stakeholders. There was no reflective or iterative action afterwards which meant any challenges had to be handled on the operational level. Globalising product development was an emergent process where some activities had been moved out as a consequence of something else already being out. Therefore, there had not been developed a clear strategy for the long term goal with global product development. This also meant that the current global product development activities were carried out on a project basis; there was no overall plan for how to connect these projects. Challenges with global product development were therefore also addressed emergently by the daily managers and engineers working with the task. Changes were therefore limited to this scope which meant that other organisational features, including the organisational structure, processes and procedures, might not reflect this change.

There is therefore a need to connect global product development activities which the strategic layer of the organisation.

6. Connecting corporate strategy with global product development

The continuous circle of challenges with global product development can be explained due to a disconnection to the strategic layer of the organisation. In addition to Eppinger's points (2006), the following points can therefore be added as success steps within global product development. These are derived from both the case study material and relevant literature from operational research, organisational studies, global manufacturing and global supply chain management:

1. Develop a strategy for global product development.
2. Clarify possible positive and negative impacts of moving a given task.
3. Develop an operational plan which details how the global development task is to be carried out.
4. Develop key performance indicators (KPIs) to ensure the desired results from global product development are being archived.
5. Handle any challenges with consideration to the developed strategy and make any necessary changes to the operational plan.

The first step is to develop a strategy. Using best practice from change management and project management, as many of the involved stakeholders as possible should take part in this. The strategy should specify desired outcomes but not detail how to reach them. Examples can be that projects need to be fitted better to a given local market, more diverse products should be developed within a certain product category etc.

To be able to develop an operational plan an investigation regarding likely impacts moving a given task will have on the organisation, the product development process and the product itself should be carried out [Hansen and Ahmed-Kristensen 2011a]. This means clarifying interfaces, including how knowledge is shared, to whom and how. Hereafter, organisational structures, processes and procedures can be changed to facilitate the global task and thereby address possible negative impacts before moving out.

The operational plan should also be developed using as many involved stakeholders as possible. This plan should include where to do what activities, who is responsible for them, when communication should take place and how and so on. The plan should also detail a timeline for what should be done when. Furthermore, KPIs are developed to ensure the goals in the strategy are reached.

Using key performance indicators it can quickly be seen whether the global product development task is performing to specifications or whether there is a problem. Having clear roles and responsibilities and a detailed process for using the data from the performance indicators can ensure the data is used for reflection and finding complications. In order to evaluate the success of global product development, the company needs to measure both hard and soft KPIs. Examples of hard KPIs are employee retainment, time-to-market, market share, resources employed. Whereas the soft KPIs can include, for example end-user statements, supplier feedback, employee satisfaction surveys, surveys to understand culture across the organisation and feedback from organisational units.

When a global product development task is carried out and challenges are encountered, for example with communication, the operational plan is revisited. It is here important the organisation is able to learn and adapt to new information and conditions to prevent the same challenges from reappeared. This means the organisation should be able to react to the causes for complications and address these. For example, communication difficulties could mean that communication should take place in a different way, at a different time, between other or maybe more people or any combination hereof. Involving as many relevant stakeholders as possible in this solution process will help ensure support for it. Any changes should still fit with the strategic goals and the operational plan should be rewritten accordingly.

In this way it can be ensured that the global product development task supports the organisational strategy and that organisational features like structure, processes and procedures support the workflow and work approach. This in turn can lessen challenges within global product development and can increase the chance of success. In this manner this article expands on the success criteria listed by [Eppinger 2006] to include a strategic focus throughout the process instead of only indications of top management support of a given global product development task.

These recommendations are the basis for a framework within global product development which includes the above steps as a way to connect corporate strategy with a global product development process [Hansen and Ahmed-Kristensen, 2011b].

7. Evaluation

Validation was conducted following Kirkpatrick's methods as extended by [Ahmed (2001)]: Reaction, validation, results, learning, behavior. Due to the nature of this study the focus was on:

1. Reaction: The reaction to the results from stakeholders
2. Learning: What stakeholders learnt from the results and how easy they were to understand
3. Validation: Improvements to the results

This validation approach is appropriate for a study if this nature due to the focus on industry applicability and because the result of the study was an approach, a tool, to the stakeholders.

Five workshops with industry participants were carried out in 2011 as well as through meetings with the interviewees and through 4 presentations of the results at Danish Industry events. During these events the participants confirmed the findings and when presented with the proposed approach to handle challenges within global product development by connecting this area with corporate strategy they felt this could be useful for them while being an approach which would be easy to learn. A key element of the workshops was to ask the companies to list current challenges, current solutions and best practice to ensure these were represented in the results. More than 40 Danish companies took part in the validation process, with several of the case companies being represented at the workshops as well. This ensured external and internal validity of the results. As a consequence of the usefulness of the research and as a result of direct requests for a "how to" guide by industry representatives at the workshops, a guide for Danish companies on how to globalize their product development process was created which included this connection to the strategic level of the organisation [Hansen and Ahmed-Kristensen 2011b].

8. Conclusions and further research

35 interviews conducted in six companies showed complications with global product development was related to managerial and technical aspects and that these were addressed on the operational level through a focus on work processes, employees and knowledge and communication. However, these solutions resulted in both negative and positive impacts. The reason for this is a disconnection between corporate strategy and global product development. This study showed this was evident in three areas; (1) a lack of a clear strategy concerning global product development, (2) global product development activities which were not connected on the strategic level and (3) solutions to complications were not connected to the strategy nor did they include changes to other aspects of the organisation.

To address these complications within global product development and increase the chance of a successful global product development process it was suggested that a company include a strategic aspect to their global product development activities. This meant adding five key areas to the success criteria mentioned by [Eppinger 2006]; (1) Develop a strategy for global product development, (2) Clarify possible positive and negative impacts of moving a given task, (3) Develop an operational plan which details how the global product design task is to be carried out, (4) Develop key performance indicators to ensure the desired results from global product development are being archived and (5) Handle any challenges with consideration with the developed strategy and make any necessary changes to the operational plan.

These results suggest that global product development need to become an integrated part of the organisation's corporate strategy so that the interfaces of the global task and the structure, processes and procedures in the company to handle these can complement the goal with global product development.

The implications for engineering education are a focus on the connection between technical tasks and their business implications. The study showed that further research is needed to detail how global product development can become embedded in the organisation. Further studies are also needed to investigate how a company can ensure global product development and the strategic development of the organisation not only compliments each other but also delivers most competitive advantage.

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