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Søndergaard, Erik Stefan; Ahmed-Kristensen, Saeema

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Decision making in Global Product Development: Case studies from Danish industry

Erik Søndergaard (esso@dtu.dk)
DTU Management Engineering, Technical University of Denmark

Saeema Ahmed-Kristensen
DTU Management Engineering, Technical University of Denmark

Abstract
Globalisation leads engineering firms to replace traditional co-located development with global distributed development activities. They make decisions regarding global product development; often with limited experience and information available. Previous research points towards a need for better understanding and support of decisions made in global product development. Through case studies, this paper explores what information is needed for specific decision types. Findings show that decision making is often not a well-structured process, but also give an understanding of which assessments are needed for different decisions. The empirical data serves as input for further development of managerial decision support tools.

Keywords: Strategic planning, Decision-making, Global Product Development

Introduction
Today engineering companies rely more and more on Global Product Development (GPD) in order to stay competitive in the global market (Hätönen & Eriksson 2009), and as a consequence product development activities are increasingly being distributed around the globe. Launching research and development (R&D) activities in new locations leads to various different opportunities as well as challenges for the engineering firms (Eppinger & Chitkara 2006) (Hansen & Ahmed-Kristensen 2012). On one hand GPD provides unique new opportunities, i.e. the opportunities for expanding the business into new markets (Zhang & Gregory 2011), getting access to better resources and talent, and to keep the development costs low (Lewin et al. 2009). On the other hand, GPD also leads to several new management challenges, i.e. maintaining and improving efficiency of the global engineering organisation (Tripathy & Eppinger 2013), managing the decentralised processes and virtual innovation teams (Zedtwitz et al. 2004) and managing cultural and organisational differences (Hansen & Simplay 2013). It is commonly agreed that GPD requires strong coordination efforts (Tripathy & Eppinger 2013) and strategic planning, implementation and control of the global activities (Hansen & Ahmed-Kristensen 2012). These are some of the aspects that the engineering companies must be aware of when making decisions about outsourcing and offshoring of product development tasks. Often, however, they are not aware of these aspects and this frequently leads to negative effects of the decisions made, such as higher costs than initially expected, decreased product quality due to higher complexity

in the development process as well as cultural and communication issues (Hansen & Ahmed-Kristensen 2012).

Research shows that decisions are often made on an ad-hoc, or "learning-by-doing" basis, and consequently the decisions often not lead to the desired results (Hansen & Ahmed-Kristensen 2012). Dealing with incomplete or inaccurate information for decision making imposes challenges for the methods and processes used (Shishank & Dekkers 2013). This points towards a need for a better understanding of how decisions for GPD are made, which methods can support the decision making process, and which information is needed for the decision makers to make good decisions (Dekkers, 2011). The explorative study in this paper presents a multiple case study of decisions related to outsourcing and offshoring of product development activities and projects from the perspective of strategic management. Furthermore possibilities for more detailed research on the topic are identified. The paper proceeds as follows: First, a short background on the globalisation of product development is outlined, followed by the research questions and conceptual model for the study. This is followed by a summary of the research methodology, the data collection and data analysis. The key findings are hereafter presented, followed by a concluding section.

Background

The globalisation of product development

While outsourcing and offshoring of manufacturing activities is a fairly well researched field and the practice has been widespread among engineering companies over the last three decades, the outsourcing and offshoring of R&D is a more nascent research field with relatively limited academic literature on the topic (Bardhan 2006). A characteristic of outsourcing and offshoring R&D is that the study of it lies in the junction of many fields, including business studies, engineering design studies and operational management studies (Bardhan 2006). In recent years offshoring and outsourcing has moved up through the value chain, from being mainly focused on production, to include all steps of the engineering value chain (Hansen & Ahmed-Kristensen 2012). Since the 1990s, R&D centres have gradually moved to emerging markets in Southeast Asia, India, and China (Zedtwitz et al. 2004). While outsourcing and offshoring was earlier focused mainly on manufacturing tasks (the outsourcing wave of production to low cost countries in Asia), it nowadays also includes R&D and overall innovation activities (Bardhan 2006). More complex and higher value adding activities are increasingly being offshored, requiring access to expertise and highly skilled workers in the offshoring locations (Lewin et al. 2009). The intensification in outsourcing and offshoring of development activities means that firms face new, complex issues of organisational structure and control (Bardhan 2006) and establishing new global R&D centres will most likely affect all parts of the organisation (Khurana 2006). Zedtwitz et al (2004) found that the first generation of international R&D organisations are characterised by R&D duplication, meaning that the home R&D set-up is duplicated in the new location, while more advanced R&D organisations assign different competencies to each R&D unit (Zedtwitz et al. 2004).

Survey results from an Outsourcing Research Network (ORN) study from 2004-2006 concluded that new product development (NPD -including product design, engineering services, and R&D) was the second most frequently offshored business function after IT (Manning et al. 2008). Although most global companies still conduct R&D in their

home country, trends go toward having smaller R&D facilities in strategic locations rather than all in one place (Khurana 2006). Although this trend has been predominant some time, the research concerning offshoring of higher skilled development processes is still in its early adopter phase (Manning et al. 2008).

Decision support

Decision support tools for GPD are still a nascent research area, and there is a lack of practical support tools for GPD decisions (Eppinger & Chitkara 2006). Earlier research has aimed at developing decision frameworks for different scenarios. Barragan et al. (2003) proposed a 4-step decision framework for sourcing product development services (Barragan et al. 2003). More recently, Shishank and Dekkers (2013) argue that no existing decision-support approaches recognise engineering and design phases as iterative, and that such support tools are needed because information is incomplete and inaccurate, as specifications only become available progressively (Shishank & Dekkers 2013) (Søndergaard & Ahmed-Kristensen 2014). It is this missing link in decision making information that this research aims at covering.

Definitions

Global Product Development (GPD) is defined as product development where the development activities include distributed teams in multiple global locations. ***Outsourcing*** is defined as sourcing from a 3rd party supplier, delivering a certain task, product component or part of the PD process, while ***offshoring*** is defined as the situation where the company expands development activities in new locations, while maintaining ownership and control of the subsidiary (Hansen & Ahmed-Kristensen 2012).

Research aim & research questions

The aim of this research is to map decision processes in industrial cases with focus on identifying the methods used for making decisions and the information the decisions are based upon, and sub sequentially to identify what information is needed for developing managerial support tools for facilitating decision making in GPD. To understand which assessments and decision processes managers need to consider when making the decisions, the following questions are addressed:

1) *How and why were decisions regarding outsourcing or offshoring of development tasks made, and what were the consequences of these decisions?*
2) *Which information is needed for supporting managerial decisions?*

Methodology

The work presented in this paper, consists mainly of results from a descriptive study focusing on observation and analysis of decisions in an industrial case setting.

Case studies

This study applies an exploratory multiple case study approach, since case studies are particularly suitable for answering *how* and *why* questions (Yin 2009). The cases consist of qualitative data collected through in-depth interviews with decision makers at different management levels in three Danish engineering companies. Due to the explorative nature of the study, this research applies a multiple case-study approach, which allows us to achieve an in-depth understanding of the research topic (the decisions) (Yin 2009). A multiple-case design (Yin 2009) was chosen for the ability to

compare across the cases, and look for literal and/or theoretical replications of the studied phenomenon (decisions, information and outcome of decisions). The three case companies were selected based on four main similarity criteria: 1) Danish engineering company with at least 20 years of experience, 2) A company size of at least 500 employees, 3) Product development and engineering departments, 4) Development activities in several global development locations.

Table 1: Case companies

	Case A	Case B	Case C
Industry	Medical devices	Industrial pumps and valves	Analytical equipment for food industry
Global employees	1.700	18.000	1.150
Global footprint	4 global R&D centres	5 global R&D sites	R&D in 4 countries
Interviewees	Vice presidents, project managers, development engineers	Global project manager, development engineers	VP, Product innovation
Drivers for GPD	• Development closer to production • Cost reductions in total R&D	• Scalable global development • Organisational structure changes	• Development cost reductions • Access to new markets
Key decisions made	• Start-up development projects in Asia • Move specific tasks abroad	• Change of global organisation and governance structure	• Start-up development projects in Asia • Outsourcing of software development
Offshoring or outsourcing?	Both	Mainly offshoring	Both

Interviews

A total of 18 interviews were conducted. The interviews were semi-structured interviews with duration of 60-90 minutes, following a pre-defined interview protocol with specific themes based on literature. The overall interview themes were: Decision making (who decided, what was decided and how was it decided), decision implementation (how was the decision implemented), decision understanding, decision outcomes (what were the results and effects of making that specific decision) and lessons learned as well as suggestions for improving future decision making. The structure of the interviews was adapted to the individual interviewee, depending on their level and involvement in decision making. All interviews were transcribed in the *Atlas.ti* software for data coding and analysis.

Data collection & analysis

Data collection

The collected data consists primarily of interview transcriptions, with a few supporting documents collected. A semi-structured interview protocol was developed, based on an interview flowchart, and a total of 18 interviews were conducted in three companies in the period March 2014 - August 2014. All interviews were audio recorded, transcribed and coded for analysis and comparison. A total of 51 specific decisions were identified in the interview data and mapped into a decision making scheme.

Case companies

The selected case companies were three Danish engineering companies, all headquartered in Denmark, and all having widespread global development activities. In common for all three cases is that they have both production and development facilities in China, and all of them have to some degree outsourced non-core competencies, especially in case A and case C (while in case B, the company aimed at keeping and developing new core competencies within the company rather than outsourcing them). An overview of the key data for the case companies in this study is shown in Table 1.

Data analysis

All transcribed interviews were coded and analysed according to a pre-defined coding scheme. The coding scheme was developed based on a literature review, which identified overall themes, including decision motivation, decision type, decision input, decision methods and decision results. Based on these themes, a set of sub-codes was developed, with several codes for each theme. The coding scheme was developed in two steps: Firstly a theory driven, top-down approach, where the categories and codes were derived from literature, and secondly through a data driven, bottom-up approach, where additional codes were added when coding the interview transcriptions and new codes or categories emerged from the data. This two-step approach was applied in order to avoid data confinement. An overview of the general coding themes is shown in Table 2.

Table 2: Coding scheme categories

Category	Definition	Codes (examples)
Type of GPD	Outsourcing, offshoring or a combination of these	• Outsourcing • Offshoring • Both
Decision motivation	The main motivation for making the specific decision	• Cost reductions • Closer to production • Access to new markets
Input	Inputs or trigger that lead to making the specific decision	• Market information • Business case • Requirements • Customer feedback
Assessment	Formal assessments that were made before making the specific decision (if any)	• Resource assessment • Cost considerations • Business case • Resource assessment • No formal assessment
Method	Method used for making the decision (if any)	• Ad-hoc decision making • Vendor selection process • Design review • Resource planning
Decision type	Strategic or operational decisions	• Strategic decision • Operational decision
Decision classification	Specification of the decision category	• Offshoring decision • Outsourcing decision • Location decision • Product design decision • Process design decision • Market/commercial decision

Implementation	How the specific decision was implemented	• Create distributed team • Employee training • Process redesign
Results	The main results of the decisions	• Successful decision • Some challenges • Decision failed

Decision mapping

Following the iterative development of the coding scheme, all interviews were coded in detail; all identified decisions were listed in a table, and for each single decision category data was identified and listed. A total of 51 decisions were identified and mapped, each single decision represents 1 unit of analysis. These 51 decisions were sub sequentially mapped for all projects and interviews. The recorded information for each single decision included: 1) The type of GPD involved, 2) The driver for the specific decision, 3) The input used for making the decision, 4) The method (if any) used for making the decision, 5) The decision itself, 6) The type of decision, 7) How the decision was implemented, and 8) The result of the specific decision. An example of a specific decision mapped into these categories is shown in Figure 1.

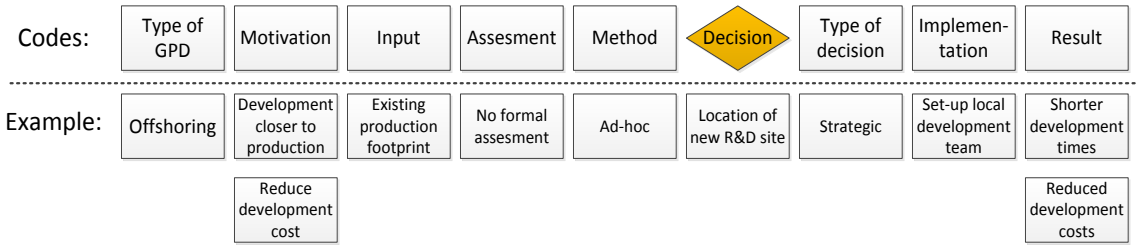

Figure 1: Example of a single decision analysis

The mapping of each decision and the corresponding process allowed for an analysis of the entire decision process, and this can be used for further analysis across each decision to better understand the process, inputs, assessments and methods used for each individual decision.

Results & key findings

Throughout all three cases, it was found that even though it was possible to map the decisions, it was not always straightforward to identify in detail how the decisions were made and which assessments and information had been the base for each decision. One of the key findings was that, in contrast to what literature suggests, decisions were not made in a very structured manner, and the cases showed that decision making in practice is not nearly as structured as research suggests. However, mapping of the decision processes reveals common tendencies across the cases and provides an understanding of the decision process. Mapping the individual decision paths also makes it possible to identify which information is needed at which point to make the decisions. Some of the key findings are presented in this section, with the analysis focusing on the input information that was used for each decision, compared to the motivations, decision types and decision methods used.

Decision motivations and corresponding decision information

A cross comparison of the motivations for the mapped decisions against the input information used for making the specific decisions reveals some patterns across the

cases. When the motivation is to gain access new markets, the information needed for the decision is market information, business cases and assessment of the existing activities in the market(s). Market information is also a key input when deciding whether to develop a new product or not. If the driver for the decision is to move the development activities closer to the production, the required information concerns the existing production organisation. However, other important considerations include information about the existing competencies (in all locations), the organisational structure and the previous experience in all locations. The results of the comparison are shown in Table 3.

Table 3: Decision input related to decision motivation

		Decision motivation											
		Risk reduction	Market access/proximity	Access to new/better resources	Dev. closer to production	Gain new competencies	Improved development quality	Develop new product	Cost reductions (all types)	Reduce time to market	Scalable/flexible resources	N/A	Total
Decision input	Business case		1								1		**2**
	Competencies assessment			1	1	4			1	1			**8**
	Control over activities			1								1	**2**
	Cost savings								2				**2**
	Customer feedback						2			1			**3**
	Existing footprint		2		3								**5**
	High lead times									1			**1**
	Market information		2					5					**7**
	Org. structure changes				1		2				4		**7**
	Previous experience				1							1	**2**
	Process design issues						2					1	**3**
	Project prioritization								1				**1**
	Requirements (product)			1		2			1		1		**5**
	Resource assessment								1	1			**2**
	Risk assessment	1											**1**
	Total	1	5	3	6	6	6	5	6	4	6	3	**51**

Decision information input and method used

The information or assessments that were used as input for making the decisions were compared with the motivation for each decision. Analysis of the data revealed that more than half of all decisions (53%) were made in an unstructured way (ad-hoc decision making) where it was not possible to point out a specific method used for making the decision. Apart from these unstructured decision methods, resource planning is identified as one of the more common methods used for making decisions and the table shows that resource planning is related to information regarding the market, business cases, organisational changes and resource assessments. The analysis also shows that design review as a decision method (i.e. making decisions regarding product changes)

requires customer feedback as input information. Vendor selection as a decision method requires information in the form of competencies assessments and requirements (both product and process requirements). The results of the comparison are shown in Table 4.

Table 4: Decision information vs. method used

		Decision method									
		Ad-hoc decision making	Business case	Design review	Feasibility study	Resource planning	Risk assessment	Scenarios	Vendor selection	N/A	Total
Decision input	Business case	1				1					2
	Competencies	4			1				3		8
	Control over activities	1						1			2
	Cost savings	1	1								2
	Customer feedback			3							3
	Existing footprint	5									5
	High lead times	1									1
	Market information	5	1			1					7
	New organisational structure	3				1				1	5
	Organisational growth					1				1	2
	Previous experience	2									2
	Process design issues	1			1					1	3
	Project prioritisation									1	1
	Requirements	2	1						1	1	5
	Resource assessment					1	1				2
	Risk reduction	1									1
	Total	**27**	**3**	**3**	**2**	**5**	**1**	**1**	**4**	**5**	**51**

Decision information input and decision types

The analysis of which input information related to certain types of decisions illustrates that when outsourcing decisions are made, the decision is often based on competencies (existing competencies and required competencies) is a key information input, together with clear requirements for the outsourced task or product component. This indicates that outsourcing decisions are often based on the search for competencies that do not exist internally within the company. The comparison also indicates that offshoring decisions are likely to be based on the existing footprint (the company is likely to offshore new development activities to locations where they are already having i.e. sales or production activities). The results of the comparison are shown in Table 5.

Table 5: Decision information vs. decision type

Decision input	Decision type: Discontinue project	Distributed development	Location decision	Market / commercial decision	Offshoring decision	Organisational design	Outsourcing decision	Process design decision	Product design decision	Production design decision	Total
Business case					1					1	2
Competencies					1	1	5		1		8
Control over activities							1	1			2
Cost savings							1	1			2
Customer feedback				2					1		3
Existing footprint			2		3						5
High lead times		1									1
Market information	1	3		2	1						7
New organisational structure					1	2		2			5
Organisational growth						2					2
Previous experience					1	1					2
Process design issues						1		2			3
Project prioritization								1			1
Requirements	1						3			1	5
Resource assessment		1					1				2
Risk reduction			1								1
Total	**2**	**5**	**3**	**4**	**8**	**7**	**11**	**7**	**2**	**2**	**51**

Which information is needed for which decisions?

Based on the analysed decisions from the cases describes, it was possible to identify which information has been used for certain types of motivations, certain types of decisions and certain types of decision methods. From the analysis it was found that when making decisions, the decision maker should get a clear picture of what the actual motivation is for the decision, and based on the motivation, relevant inputs can be identified. The case study data points towards some general information input which are common, but it also showed the complexity of the decisions, and that the information, methods and decision types are context specific and are likely to differ from case to case. The cross comparisons showed that decision information is widespread across motivations, methods and decisions types, but some general patterns were observed. i.e. that existing footprint and activities should be considered for offshoring decisions and core competencies and product/process requirements should be considered for outsourcing decisions. On the other hand, decisions about changes in the organisational design showed to be based on a range of different information inputs, which underlines the complexity and contextual dependency for this type of decisions.

Conclusion & contribution

The empirical evidence from the decision making case studies provided a deeper insight into the existing decision making process, and what information the different decisions were based on. Analysis showed that the majority of decisions were made in an ad-hoc manner, with no structured decision process or method applied for making the decisions. The analysis also revealed, that while there are some general patterns, decisions are also quite unique and context dependent.

Implications for managerial decision making

The analysis shows which decision information is needed different GPD decisions. The findings can be used for developing support tools for facilitating decision making for both experienced and unexperienced managers. Such support tools should guide them in which assessments to undertake, depending on the motivation, decision type and methods they intend to apply. In order to create an even better indication of information needed for decision support, additional cases could be added to the same analytical framework presented here, in order to make the data more rich, extensive and consistent.

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