PERFORMANCE MEASUREMENT IN GLOBAL PRODUCT DEVELOPMENT

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ABSTRACT

An organisation looking to form collaborations across borders is a consequence of an increasingly competitive world market. Recent studies highlighted key challenges and success factors organisation's face when globalising stages of product development. To optimize performance along these factors there is a requirement for the process to be monitored and measured relative to the business strategy of an organisation. It was found that performance measurement is a process that helps achieve sustainable business success, encouraging a learning culture within organisations. To this day, much of the research into how performance is measured has focussed on the process of product development. However, exploration of performance measurement related to global product development is relatively unexplored and a need for further research is evident.

This paper contributes towards understanding how performance is measured in global product development. More specifically, results from a survey and interviews highlight a need for further development in current performance measurement frameworks used in product development to facilitate the key factors and metrics in global product development.

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1 INTRODUCTION

The potential of reducing costs by offshoring and outsourcing parts of product development (PD) has led to global product development (GPD) becoming increasingly popular among engineering companies, especially within Europe. Advancements in communication technology have lowered the barriers of entry for organisations wishing to collaborate across borders. However, with the relocation of stages of the development process such as production and research and development, the level of uncertainty increases in the process and organisations face challenges related to culture, communication and organisational change management. For an organisation to achieve sustainable business success in the demanding and competitive world marketplace, a company must integrate relevant performance measures [Neely *et al.*, 2000]. There is therefore a need to closely monitor the process, providing indications of how well an organisation is performing towards the goals outlined at the outset. This paper aims to contribute to the further understanding of performance measurement in GPD. The motivations and challenges related to the relocation of stages of the PD process and the performance measures used to assess the success of a GPD project are explored in the paper. Recommendations towards a performance measurement system for GPD are presented.

2 LITERATURE REVIEW

2.1 Global Product Development

GPD is the globalisation of tasks and activities throughout the PD process, from the start of the process of the fuzzy front-end and R&D to manufacturing and maintenance activities [Hansen and Ahmed-Kristensen, 2012]. The globalisation of tasks may involve outsourced engineering work along with captive offshore engineering facilities. The processes of outsourcing and offshoring are defined as follows: Outsourcing; a different company owns the foreign organisational unit where the relocated work is completed and Offshoring; the company in question owns the foreign organisational unit where the relocated work is completed. An increasing demand for organisations looking to reduce development costs, increase access to new competencies and improve development quality whilst shortening their time to market has led to organisations looking to outsource or offshore stages of their development process. According to a study by the Aberdeen Group [2005], 78% of 125 enterprises across multiple manufacturing industries pursue Global Design as a strategy for reducing the cost of design. Globalising PD has an impact not only on the product and process, but also on the organisation as a whole and introduces new challenges. A change in PD activities and processes ultimately leads to organisational change management. Managing change across globally dispersed teams is a challenging task [Aberdeen group, 2005]. Hansen and Ahmed-Kristensen [2012] identified nine key challenges related to GPD and argued that cultural differences within different organisations influence 'the way people do things', with communication and knowledge sharing acting as a barrier of entry for globally collaborating organisations. A further challenge which is common throughout the literature is the lack of a global strategy and creating a common vision amongst globally dispersed teams. Eppinger and Chitkara [2006] suggest ten key success factors for GPD including collaborative culture, organisation change management and management priority. The ten factors are interlinked and their significance contextually dependent. To tackle the challenges in GPD and monitor their success rate, the global decision making framework (GDM) is suggested by Hansen and Ahmed-Kristensen [2012] as a guideline for companies. For the framework to be successful, the requirement for constant feedback to the management on the performance of the process is needed. This highlights the need for a defined set of Key Performance Indicators (KPIs) during the evaluation stage of the GDM framework.

2.2 Performance measurement

Performance measurement can be defined as a search for optimizing the relationship between the input and output of a system, with the purpose of achieving a fixed objective and is measurable with the quantification of the effectiveness and/or the efficiency of an action or activity [Poulet *et al.,* 2010]. The approach to performance measurement during the creation of the "Tableau de Bord" performance measurement framework [Epstein and Manzoni, 1998] relies heavily on the mission and vision of a project for an accurate performance measurement to be made (see Figure 1). Before establishing the KPIs, a clear mission and vision must be transformed into a set of objectives. These objectives differ depending on the context of implementation, i.e. the unit or sector of the organisation in which they are to be implemented or the goal or outcome required of a particular project. The unit then translates

these objectives into Key Success Factors (KSFs), which are transformed into a series of KPIs to allow for performance measurement relative to the mission and vision at the outset.
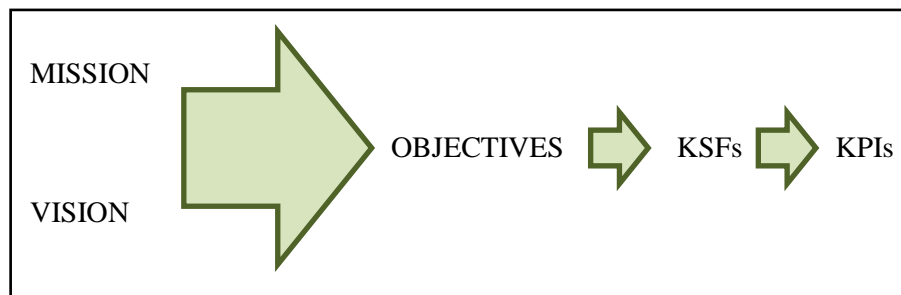

Figure 1 Epstein and Manzoni's [1998] approach to performance measurement.

Over the past few decades, research in performance measurement has predominantly been confined to PD rather than GPD. Currently, many organisations base their decision on how well a PD project performed solely on financial indicators [Kitinaka *et al.,* 2012]. When considering GPD, measuring performance from only financial indicators does not provide the means for accurate feedback. If a GPD project is deemed a failure financially in the short term, the long-term rewards of diving into new globally dispersed markets could act as a positive with regard to future collaborations, globalisation of knowledge and expertise and business dealings. When globalising PD, tackling performance measurement at an operational level can be extremely multifaceted and subjective, often depending on the type of organisation, project or individual involved [Masri *et al.,* 2010]. There is a lack of research focusing on what KPIs are required in order to successfully measure performance during GPD. A study conducted by Griffin and Page [1996] looked at the KPIs companies use for measuring performance in PD. 46 different indicators were identified from a total of 77 different articles and a company survey with 50 responses produced 34 different indicators that companies currently use [Griffin and Page 1996]. Some of the most popular indicators included customer satisfaction, profit goals, market position and development cost. A further study uncovered 66 variable KPIs along 20 different performance related dimensions [Cooper, 1998]. However, many of the KPIs found in Cooper's study were similar in nature, and grouping along different performance dimensions such as customer-based success, financial success and technical performance success was possible.

2.3 Framing the performance measures

The categorisation of KPIs across broader performance dimensions is a consistent practise among researchers when creating a framework for performance measurement. The creators of the Balanced Scorecard [Kaplan and Norton, 1996] suggest two basic types of KPI in any organisation; leading and lagging. Leading indicators are considered to be performance drivers (Revenue growth and mix, Customer satisfaction, Quality assurance, etc. displayed in Table 1) and lagging to be outcome measures (Financial, Customer, Internal and Learning and growth displayed in Table 1). The leading indicators tend to be more variable in nature, whereas the lagging or outcome indicators are more fixed. The lagging indicators or performance dimensions act as the foundation for the selection of the more focussed KPIs or leading indicators. The dimensions selected rely heavily on the business strategy and culture within the organisation. The development of such a framework allows for a generalisation and categorisation of performance measures for a specific project.

Table 1 Kaplan and Norton's [1996] performance measurement framework for the Balanced Scorecard

Financial *(How do we look to our shareholders?)*	**Customer** *(How do customers see us?)*	**Internal** *(What must we excel at?)*	**Learning and Growth** *(Can we continue to improve and create value?)*
- Revenue growth and mix	- Customer satisfaction	- Quality assurance	- Sharing of knowledge and expertise
- Cost reduction	- Market share	- Development time	- Individual and organisational allignment
- …	- …	- …	- …

Many of the KPIs uncovered during the studies by Griffin and Page [1996] and Cooper [1998] can be placed within the framework suggested by Kaplan and Norton [1996]. However, the KPIs uncovered during the two studies were PD specific rather than GPD specific. The motivations and challenges related to GPD add further complexity to the KPIs to be used in performance measurement.

3. METHODOLOGY

Before undertaking empirical research the motivations and challenge factors described in literature for GPD contrasted with the current performance measurement framework presented by Kaplan and Norton [1996]. Highlighted by Epstein and Mazoni [1998], incorporating business strategy into a performance measurement system is paramount to its successful employment and the requirement to understand the relationship between the motivations and challenge factors for GPD and current measurement systems is evident. Hence the challenges and success factors were categorised amongst the performance dimensions suggested by Kaplan and Norton [1996].The categorisation process (Table 2 and Table 3) was a preliminary analysis of the relationship between the success and challenge factors for GPD [Hansen and Ahmed-Kristensen, 2012 and Eppinger and Chitkara, 2006] with the performance dimensions outlined by Kaplan and Norton [1996]. The aim of this exercise was to investigate whether there was a need for further developments in the performance measurement framework presented to incorporate the success and challenge factors outlined for GPD. Given the high subjectivity associated with performance measurement and the success and challenge factors, concrete conclusions were not made based solely on this exercise and any grouping or relationships were also based on the authors' knowledge and experience with the subject. Table 2 presents the factors that could potentially fit within the performance measurement framework. Table 3 presents those which do not fit and could create new performance dimensions. The factors marked with (*) hold a link to multiple performance dimensions. Communication for example could potentially fit under all of the dimensions and therefore has been put in a group in Table 3. It is interesting to see a minimal amount of factors under the financial and customer dimensions. The majority of the success factors can be linked to different performance dimensions, in contrast to the challenge factors. This is largely due to the nature of the challenge factors. The success factors are more goal orientated, similar to the performance dimensions, however the challenges are more risk related. Also, the framework proposed is not specifically designed for GPD.

Table 2 Categorisation of success and challenge factors for GPD under performance measurement framework.

Performance dimensions for PD					Key:	
Customer	Financial	Internal processes	Learning and growth		Key:	
Product Modularity		Organisation change management	Collaborative culture*		* - Factor fits under multiple headings	
		Infrastructure	(Knowledge sharing)		(Challenge factors)	
		Data Quality			Success factors	
		Process Modularity*				
		Core Competence (Organisational structures)				

Table 3 Success and challenge factors for GPD unable to fit within performance measurement framework.

Performance dimensions for GPD		
Unknown entity	Unknown entity	Unknown entity
(Communication*)	(Synchronising distributed designs) (Standardizing tools and processes*)	Governance and Project Management
(Cultural differences)		Management priority

(Documentation*) (IP rights and IP security)	(Lack of a common vision)

According to Manzoni and Epstein [1998], understanding the relationship between the goals and the performance measures is key in the design of a performance measurement system. The exercise highlighted a gap between the motivations and challenges for GPD and the current performance measurement systems for PD. The challenge and success factors require transforming into KPIs to allow for distribution within the framework. Furthermore, the grouping of the factors in Table 3 suggests there is a need for further performance dimensions or lagging indicators if the framework is to accommodate the factors for GPD. Drawing on these conclusions, there was a need to take a closer look at the challenge and success factors and the performance measurement methods related to GPD rather than PD. The relationship between the KPIs for GPD and the performance measurement system outlined by Kaplan and Norton [1996] could then be addressed.

3.1 Research Aim
The aim of the research was to investigate the methods of measuring performance of a project when parts of PD are outsourced or offshored. This was twofold: firstly the literature review mapped the success and challenge factors related to GPD against established performance measurement frameworks. Secondly the empirical studies in the following section set out to identify the KPIs used in practice as a method of measuring performance in GPD.

3.2 Research approach
The objective for the empirical research was to gain an insight into the organisation's current method of measuring performance and how this compared with the framework for performance measurement set out in literature. Two empirical studies were conducted: a survey and interviews. The survey focused primarily on understanding the motivations and current performance measurement systems in GPD and was the primary data source. The interviews were semi structured and contributed towards a broader understanding of the challenges involved with performance measurement in GPD and how these are overcome in practice. The results from the interviews were used as a secondary data source. A coding scheme for the data analysis for each of the studies was developed. This was an iterative process and new categories were developed in the coding scheme as more data was acquired in order to avoid the confinement of data. The knowledge gained for each of the studies influenced the direction of the study that followed and also the data coding scheme. The approach allowed for a process of on-going data reflection with developments to the data collection framework made where necessary. This approach was employed due to the high subjectivity of performance measurement.

3.3 Participants
The participants were divided into two groups, the participants for the survey and the participants for the interviews. The total number of surveys dispatched was one hundred, which was based on other similar studies regarding performance measurement in the literature [Cooper, 1998 and Griffin and Page, 1996]. Thirty-eight of the surveys were distributed to organisations that had previously attended a workshop held at Denmark's Technical University regarding GPD and currently outsourced or offshored stages of their PD. The remaining sixty-two were passed to a sourcing community for further distribution. From one hundred surveys, there were a total of twenty-eight usable responses (see Table 4 for overview of participants). Twenty-seven of the respondents had their headquarters based in Denmark and one respondent in the United Kingdom. When responding to the survey, a number of participants indicated that they would be interested in a follow-up interview. Six of these participants were selected for an interview with each from an organisation with the headquarters in Denmark. Table 5 shows the breakdown of the participants for the interviews and exercises.

Table 4 Twenty-eight survey respondents

	Criteria	Number of organisations
Company size:	Small (<50)	7
	Medium (50-250)	2
	Large (>250)	19
Industry sector:	Manufacturing	17
	Information Technology	9
	Energy	1
	Other	1
Job Title:	Engineer	4
	Senior Consultant	4
	Sourcing Manager/ Director	6
	Project Manager	3
	Founder	1
	Managing Director	2
	Senior Manager	5
	Scientist	1
Number of years at organisation:	<1	2
	1 to 2	4
	2 to 4	3
	4 to 5	2
	>5	14

Table 5 Six interviewees

Industry type	Years at organisation (Years)	Job title
Consultancy	12	Founder
Manufacturing	8	Project Manager
Manufacturing	5	Senior Consultant
Consultant	4	Senior Consultant
Manufacturing	>30	Engineer
Consultancy	1.5	Managing Director

3.4 Data collection

A quantitative approach to data collection was adopted for the survey results. The survey was kept short (between six and ten minutes to complete) to maximise the response potential. SurveyMonkey™ was used as a platform for developing the online survey. Multiple choice questions were designed where possible to help with the gathering and analysis of the data. After the open ended questions, a number of leading questions, when considering the KPIs that are used for GPD, were developed to ensure the respondent considered answering along the four performance dimensions outlined in the

literature review. The possible answers to the multiple choice questions were structured related to the performance measurement framework suggested by Kaplan and Norton [1996] and the most common KPIs for PD by Griffin and Page [1996]. An 'Other' checkbox provided the respondents with the opportunity to include KPIs more specific to GPD. For the open-ended questions in the survey, categories were developed to summarise the answers to these questions and allow for the variable results to be grouped under multiple headings. The categories were developed after the two studies were complete and all data was gathered to ensure the data was not confined. A mixture of quantitative and qualitative methods to data collection was adopted for the interviews. The interviews were semi structured and face-to-face with each lasting between 60-100 minutes. During the interview process, the development of a predetermined coding scheme was necessary. The six interviews that were recorded were transcribed. Following this, the transcriptions were applied to the previously developed coding scheme and amendments and further categories were added to the scheme where necessary. To allow for the quantification of data from the interviews, it was indicated each time a particular word or phrase was mentioned that was related to the categories. A number of the sub-categories contained dropdown lists in the coding scheme to help with the grouping of data during analysis. When a KPI was suggested by two or more of the interviewees, which fell under the 'Other' category, a new KPI for analysis was created.

4. FINDINGS

4.1 Key challenges and success factors for GPD

A coding scheme was used to collect the data concerning the key challenges and success factors during the interviews. The interviewees were unaware of the challenges and success factors found in literature prior to the interview, encouraging them to think independently regarding their motivations for GPD. Communication was the most mentioned key challenge and was addressed by all of the interviewees. The factor was mentioned 36 times in total, which is 25 times more than the next factor, cultural differences. The remaining factors from literature were not discussed so much during the interviews. The results for the key success factors were similar in that there was one which was mentioned far more than the others. Collaborative culture was mentioned on 23 separate occasions during the interviews. It was addressed by all of the interviewees; in contrast to the other success factors. Similar to communication, collaborative culture was by far the most mentioned factor. Collaborating across borders is a necessity for GPD. One of the main consistencies throughout the interviews was the agreement of the need for a collaborative culture during a project. Second to collaborative culture was core competence, which was mentioned by five of the interviewees, totaling to 12. A key area for discussion relating to this factor was the importance of aligning individual expertise to the particular task outlined within a project. This was identified as a crucial criterion for success in GPD.

4.2 Key Performance Indicators for GPD

The results from the survey and interviews form the analysis for the KPIs. The results of the KPIs used by the participating organisations for measuring the performance of GPD from the survey are illustrated in Figure 2. A total of 17 KPIs (including 'Other') are used. The top three most common KPIs are development cost, customer satisfaction and project vs. time plan. Development cost was used by 10 different organisations. When considering the number of useable responses to this question; 83.3% of the respondents indicated they use or have used this KPI in the past. Furthermore, customer satisfaction has a 75% indication rate and project vs. time plan 66.6%. A number of the 'Other' KPIs included flexibility, cost per hour and cost of external development cost against internal development cost. The results from the interviews for the KPIs used in GPD are displayed in Figure 3. The interviewees mentioned a total of eight KPIs from those found during Griffin and Page's study [1996]. The 'Other' category generated a total of 15 different KPIs. The individual KPI mentioned the most, outside of the 'Other' category, was sharing of knowledge and expertise, being mentioned a total of 10 times by three different interviewees. The most notable result from Figure 3 is the inclusion of the new KPI 'Communication capability'. Whilst collecting the data from the interview, Communication capability was mentioned seven times by four different interviewees as an indicator for measuring performance, which resulted in a new category being generated. Based on the statements made by the four different interviewees, Communication capability in the context of measuring performance in GPD is defined by the author as *"An external collaborator's ability to communicate (or not have the*

need to communicate with a partner) before, during and after the process of GPD". Communication capability was the third most mentioned KPI behind sharing of knowledge and expertise with 10 and customer satisfaction, 8. A further noticeable pattern is the amount of times a different KPI was mentioned that fell under 'Other'. However, this was expected by the author as the structure for coding the KPIs was based on data gathered for measuring performance in PD rather than GPD. This generated 'Other' KPIs such as Follow up interest from customer, Company popularity, Collaborators' ability to think independently and Established lines of communication, to name a few. The total amount of 'Other' KPIs mentioned for measuring performance in GPD across the surveys and interviews was 22.
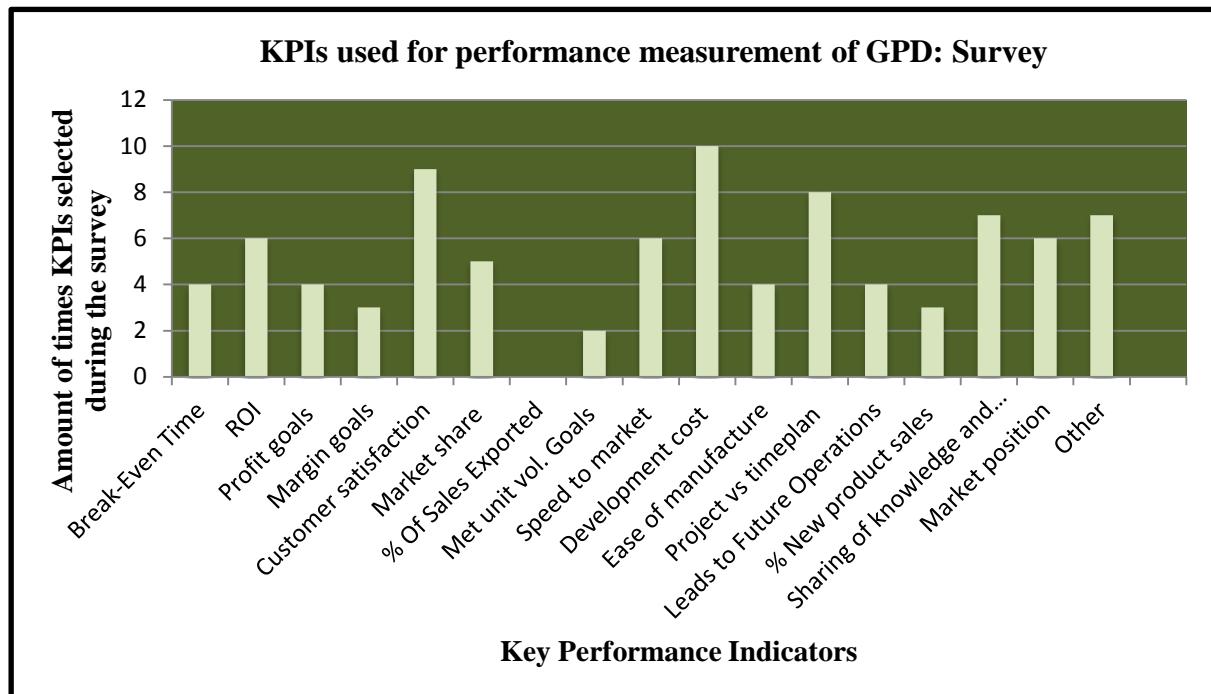

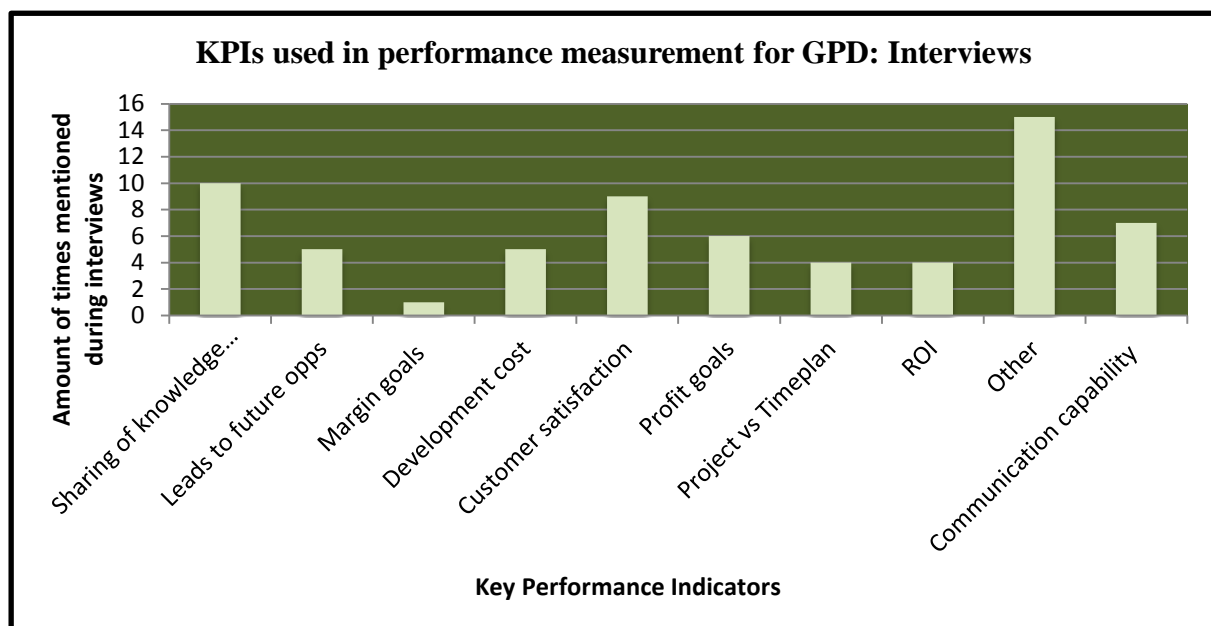*Figure 2 KPIs used in GPD: Survey*

Figure 3 KPIs used in GPD: interviews

The next step of analysis involved categorising the KPIs found for GPD under the performance dimensions suggested by Kaplan and Norton [1996]. Before this was analysed, the KPIs that fell under the 'Other' category for the survey and interviews were divided among the performance dimensions

where possible. Also, given the amount of times mentioned and the current unfamiliarity of 'Communication capability', the KPI was considered as a performance dimension for the following analysis. This exercise resulted in six of the 'Other' KPIs being distributed within the five performance dimensions, which left a requirement for the 'Other' category to remain among the dimensions. The categorising of the 'Other' KPIs was conducted solely by the main author. The results for grouping the KPIs for GPD from the survey and interviews under the performance dimensions are displayed in Figure 4. The results from both studies follow a similar pattern. The survey scores slightly higher along each of the performance dimensions, apart from communication capability as this dimension was irrelevant for the survey results. This can be explained due to the number of participants being greater for the survey. The KPIs that fall under the internal dimension for the survey portray the largest difference in results between the two studies. When considering the results for the interviews, learning and growth was mentioned the most times with 18. The sharing of knowledge and expertise KPI influences this high result as it was mentioned 10 times among the interviewees. Furthermore, the consistency of the results for the 'fifth' performance dimension: Communication capability against the other four dimensions suggests that its inclusion to the framework is justified. The 'Other' category only scored 6 during the interviews and 7 during the surveys. However, it is interesting to take a different angle of analysis for the 'Other' category. Although the KPIs within this dimension were not mentioned as often as the other dimensions; the amount of individual KPIs that fit within the 'Other' category was 6 during the interviews and 7 during the survey. The other dimensions contained the following number of individual KPIs: Financial – 4, Customer – 2, Internal – 4, Learning and growth – 3 and Communication capability – 4. Therefore, although the 'Other' KPIs were not mentioned as frequently as the KPIs within the different dimensions, they hold the most amount of individual KPIs within the 'Other' category.
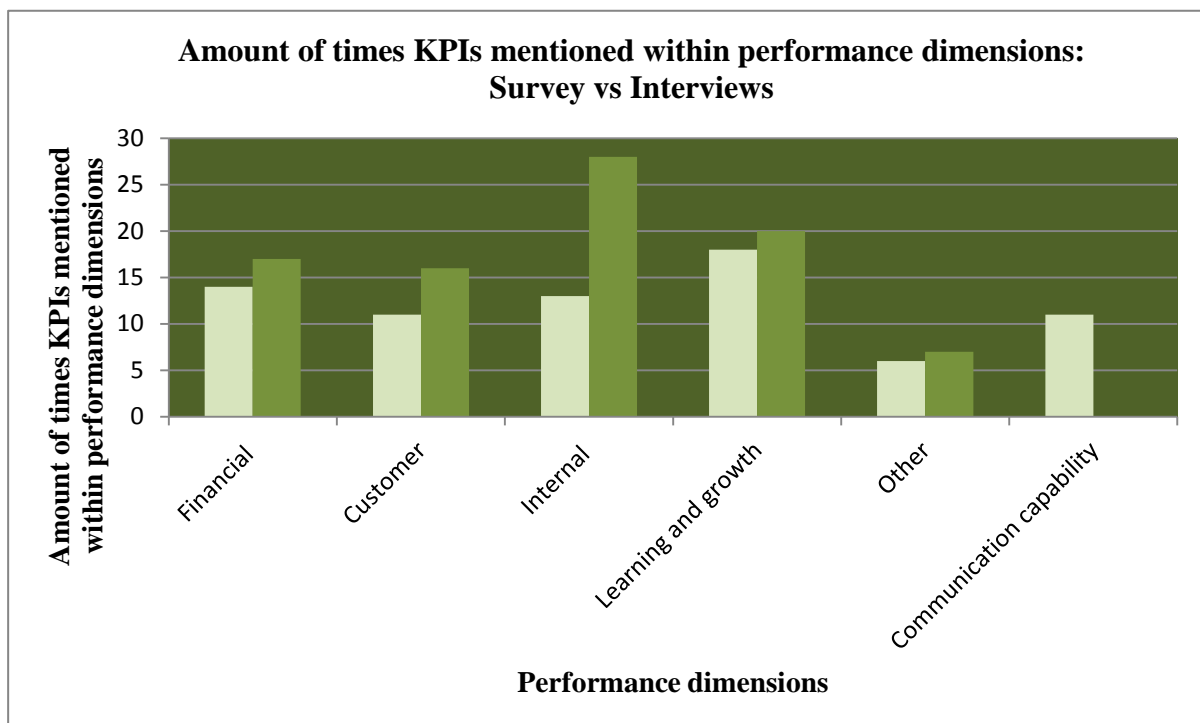

Figure 4 KPIs for GPD within performance dimensions

The number of KPIs that could not be categorised under the performance dimensions indicate that the performance measurement framework suggested by Kaplan and Norton [1998] is insufficient to facilitate the KPIs generated for GPD, and the need for further performance dimensions is evident.

3 CONCLUSION

The paper investigated key performance indicators for global product development. From the literature the main challenge and success factors for GPD established an understanding of an organisation's motivation for GPD. Kaplan and Norton's [1998] performance measurement framework was identified as a method for framing KPIs. This proposed framework's for performance measurement in PD was

used to categorise the challenge and success factors for GPD. This indicated a gap in the literature between the performance measurement frameworks for PD and the challenge and success factors for GPD and demonstrated a need for further studies. Hence a survey with 28 companies and 6 interviews were conducted to further investigate KPIs for GPD. The organisation's current method of performance measurement collected from these two empirical studies further highlighted the gap and recommendations for further performance dimensions within the framework. Hence, current frameworks for KPIs have yet to incorporate categories that are relevant for GPD. By building on previous work in the area and utilizing aspects of established methodologies from performance measurement in PD, this paper has highlighted the need for further dimensions in current performance measurement frameworks. Furthermore, KPIs for measuring performance in GPD have been presented.

ACKNOWLEDGMENTS

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