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INTERNATIONAL WORKSHOP
ADVANCES IN CLEANER PRODUCTION



"CLEANER PRODUCTION INITIATIVES AND CHALLENGES FOR A SUSTAINABLE WORLD"

Bibliometric Analysis of Literature on Product Life Cycle Management, Product Development Process and Sustainability and their Interfaces

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Agenda



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- ❑ *Background*
- ❑ *Research Methodology*
- ❑ *Bibliometric Analysis - Results*
- ❑ *Synthesis of Social Networks - Results*
- ❑ *Summary*

Background



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- ❑ *The competition in the global market has increased the concern of the companies about how to introduce environmental and sustainable issues into NPD (new product development)*
- ❑ *The possibilities of reduction in the use of necessary energy resources for production do exist in industry. In addition, there are initiatives in manufacturing for a cleaner production*
- ❑ *In this context, it is important to carry out studies on the concepts of PLM, NPD and Sustainability as well as its interfaces*
- ❑ *The work presents a bibliometric analysis of the literature on PLM, NPD and Sustainability (past five years)*



- ❑ *It is a theoretical-conceptual work based on search and review of literature on the concepts of PLM, NPD and Sustainability*
- ❑ *ISI Web of Knowledge database is accessed as well as a Brazilian portal which is linked to various databases (CAPES)*
- ❑ *The analysis is supported by software:*
 - ✓ *Sitkis (Schildt, 2002)*
 - ✓ *Ucinet (Borgatti et al., 2002)*
- ❑ *The networks were analyzed in two ways:*
 - ✓ *Structural characteristics*
 - ✓ *Actors' point of view Morphological or Positional*



Table 1 – Publications and Citations of the research issues

Concepts	Publications	Citations
PLM	749	1.675
NPD	6.803	16.296
Sustainability	13.931	57.252
PLM and PDP	142	215
PDP and Sustainability	115	277
PLM and Sustainability	51	142
PLM, PDP and Sustainability	9	6

Bibliometric Analysis – Results (2/15)

PDP and PLM



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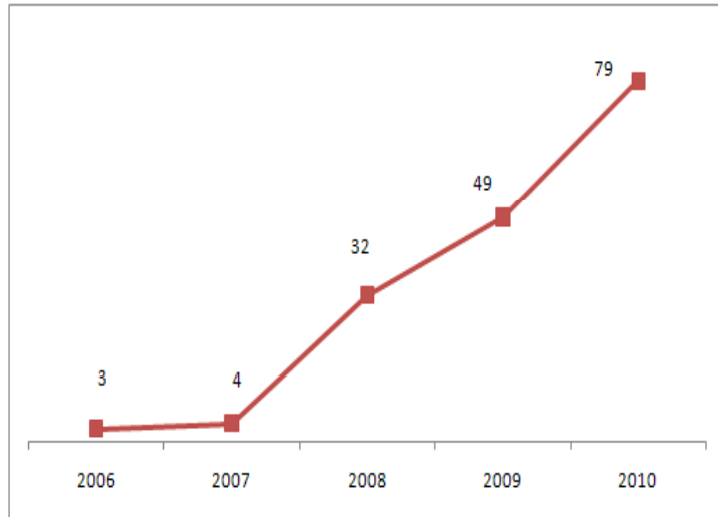


Fig. 1 – Number of Citations of papers cited at least 4 times per year on NPD and PLM

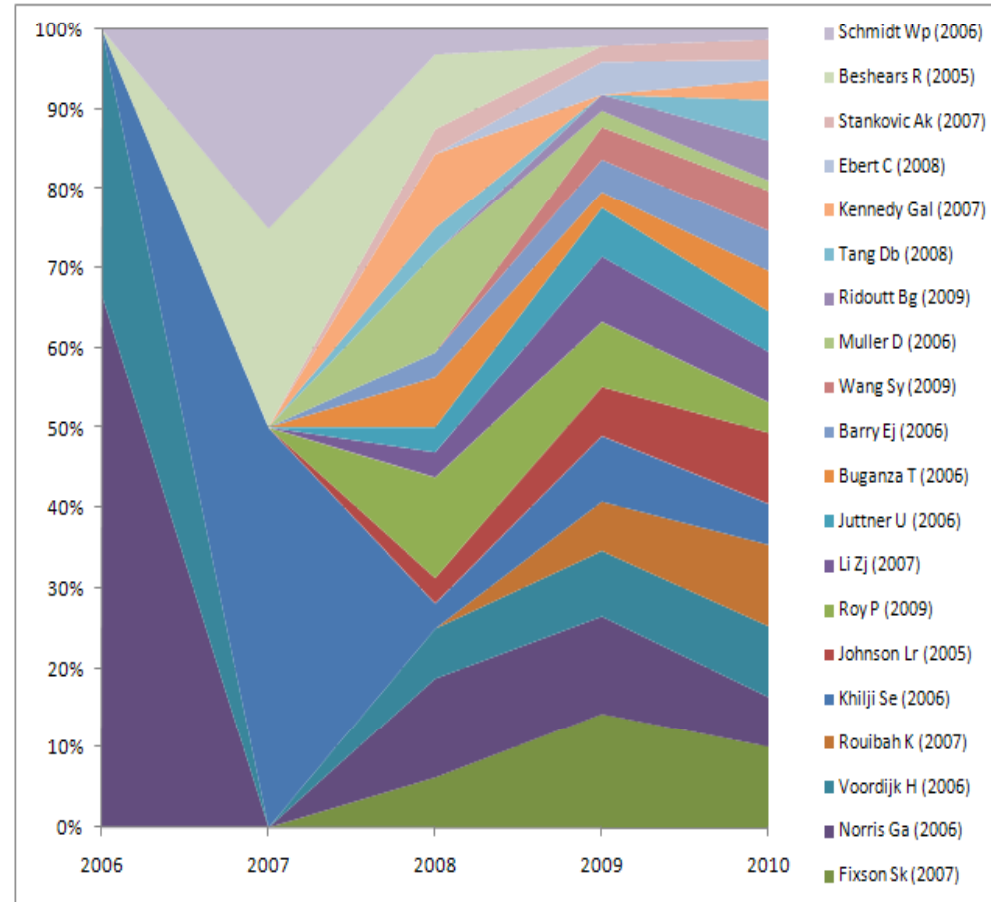


Fig. 2 – Citation percentage of the papers cited at least 4 time per year on NPD and PLM

Bibliometric Analysis – Results (3/15)

PDP and PLM



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- *Research on NPD and PLM involve:*
 - ✓ *Modularity in supply chain*
 - ✓ *Social impacts in the life cycle of products*
 - ✓ *Process management in turbulent environments*
 - ✓ *Using tools for decision making*
 - ✓ *Product Life Cycle Management*
 - ✓ *Integration (of what?)*

Bibliometric Analysis – Results (4/15)

PDP and PLM



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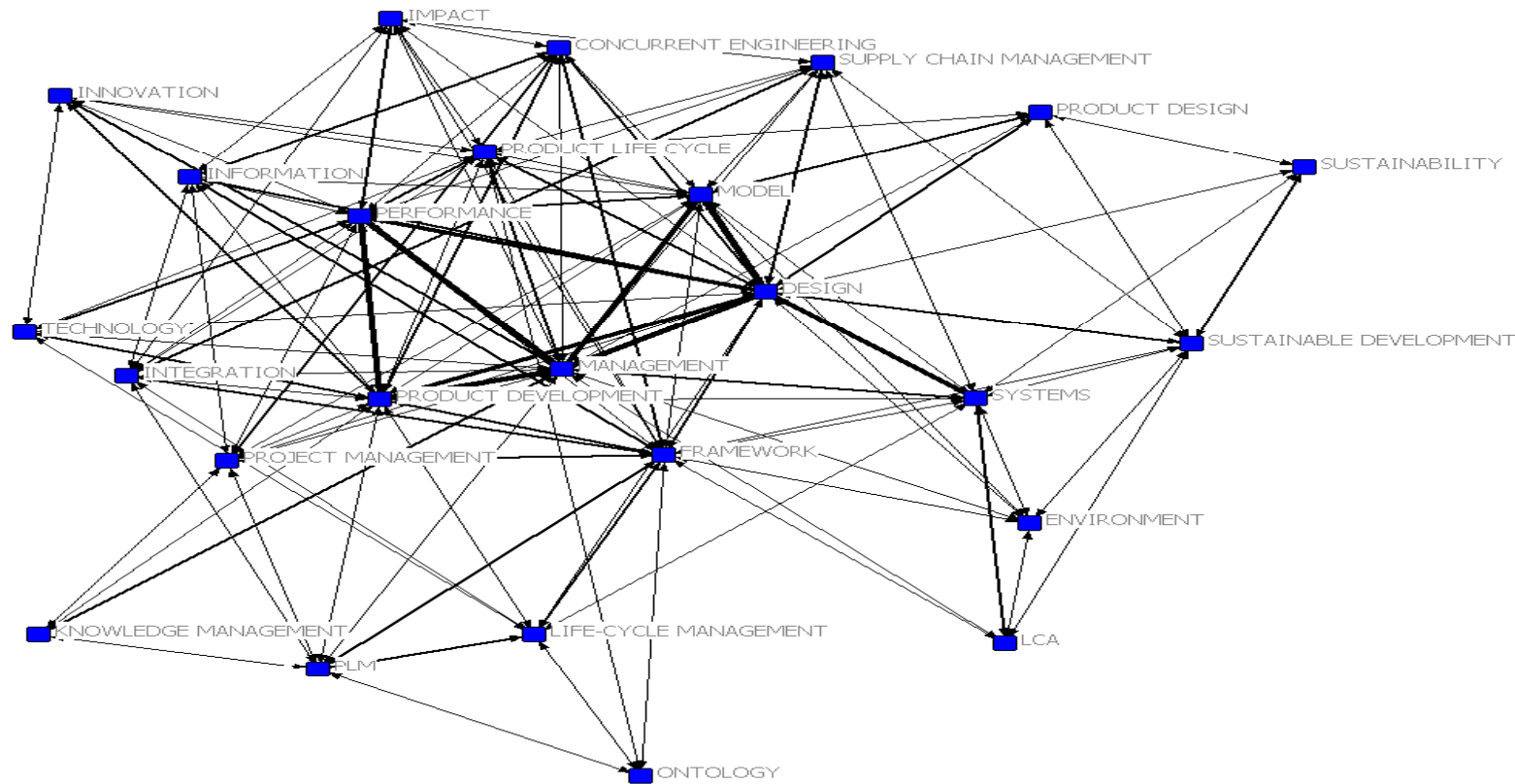


Fig. 3 – Network of key words of most cited papers on NPD and PLM.

Bibliometric Analysis – Results (5/15)

PDP and PLM



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- *It highlights the relationship between the subjects:*
 - ✓ *Performance*
 - ✓ *Product development*
 - ✓ *Management*
 - ✓ *Model*
 - ✓ *Systems*
 - ✓ *Design*

- *It was not possible to identify a network of cross-citations among the selected papers on NPD and PLM*

- *Co-citations among the following papers: Fixson (2007), Voordijk et al. (2006), Buganza Verganti (2006) and Barry et al. (2006)*

Bibliometric Analysis – Results (6/15)

PDP and Sustainability



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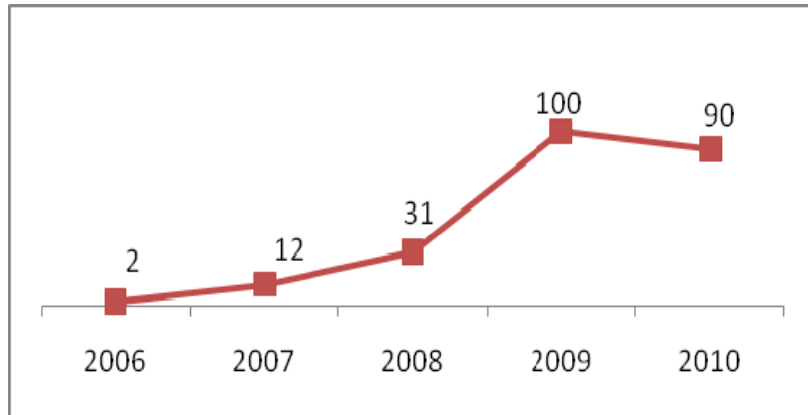


Fig. 4 – Number of citations of papers cited more than 4 times per year on NPD and Sustainability

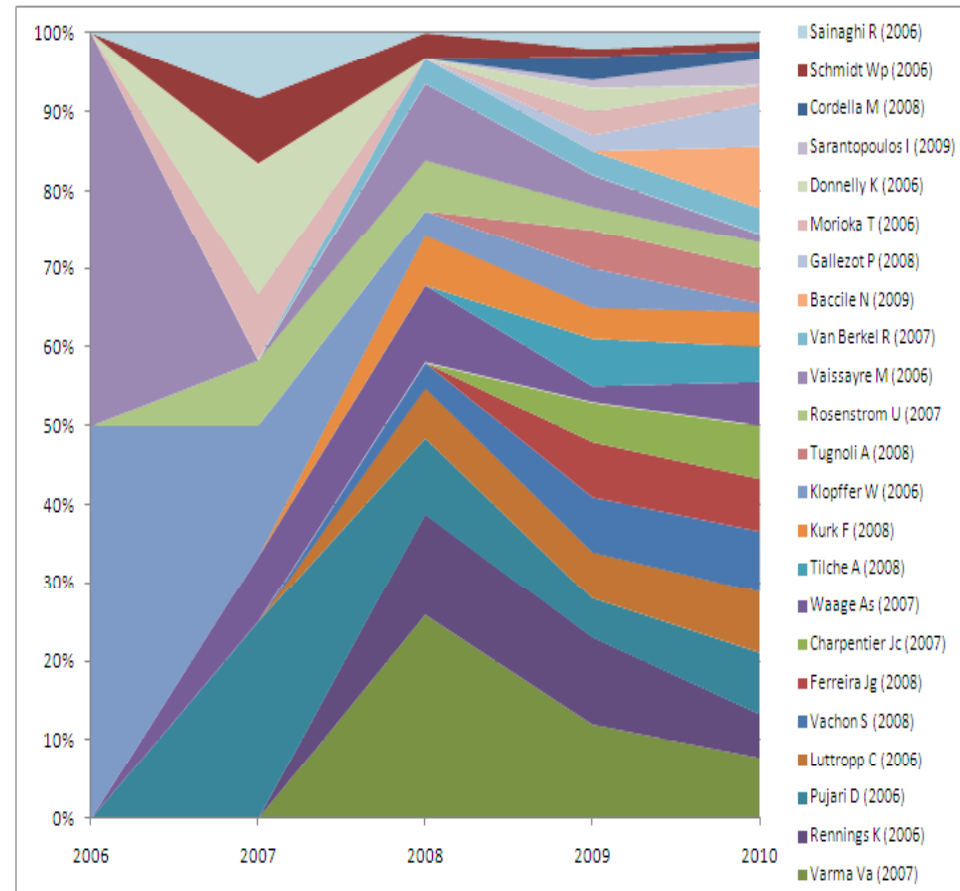


Fig. 5 – Percentage of citations of papers cited more than 4 times per year on NPD and Sustainability

Bibliometric Analysis – Results (7/15)

PDP and Sustainability



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- *Studies on NPD and Sustainability are facing:*
 - ✓ *Integrate environmental issues in NPD*
 - ✓ *Integrate the whole supply chain*
 - ✓ *Reducing the emission of carbon into the environment*
 - ✓ *Biomass*
 - ✓ *Eco-design*
 - ✓ *Tools to manage the life cycle of products*
 - ✓ *Change the strategy considering the sustainable development*

Bibliometric Analysis – Results (8/15)

PDP and Sustainability



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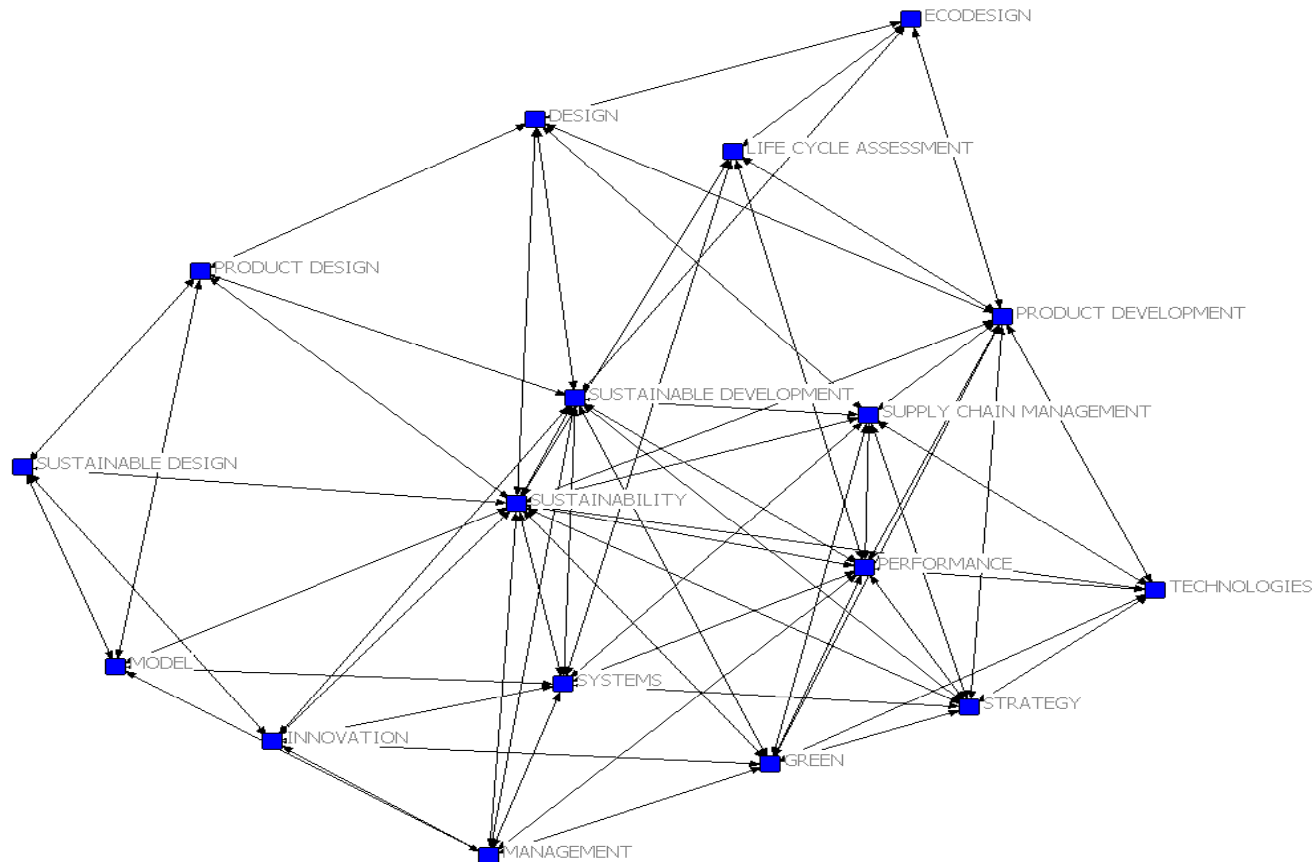


Fig. 6 – Network of key words of most cited papers on NPD and Sustainability

Bibliometric Analysis – Results (9/15)

PDP and Sustainability



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- ❑ *Identification of relationship among the following subjects:*
 - ✓ *Product development*
 - ✓ *Eco-design*
 - ✓ *Supply chain management*
 - ✓ *Sustainability*
 - ✓ *Performance*
 - ✓ *Sustainable development*

- ❑ *There was no cross-citation network*

- ❑ *Co-citation among the work of Luttrupp and Lagerstedt (2006), Waage (2007) and Van Berkel (2007)*

Bibliometric Analysis – Results (10/15)

PLM and Sustainability



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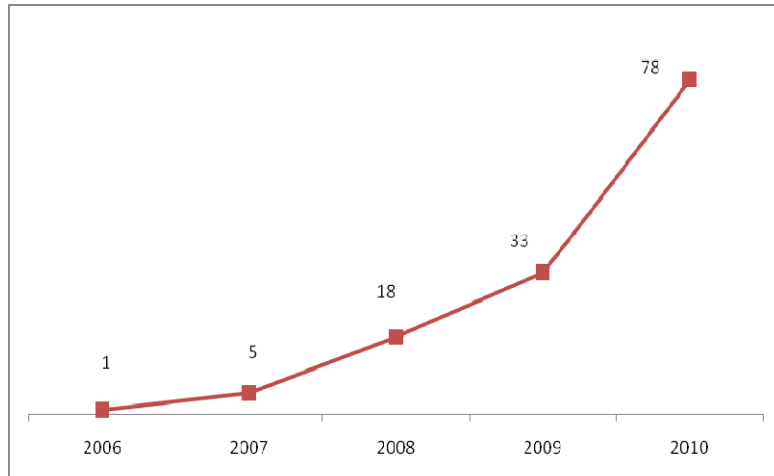


Fig. 7 – Number of citations of papers cited more than 3 times per year on PLM and Sustainability

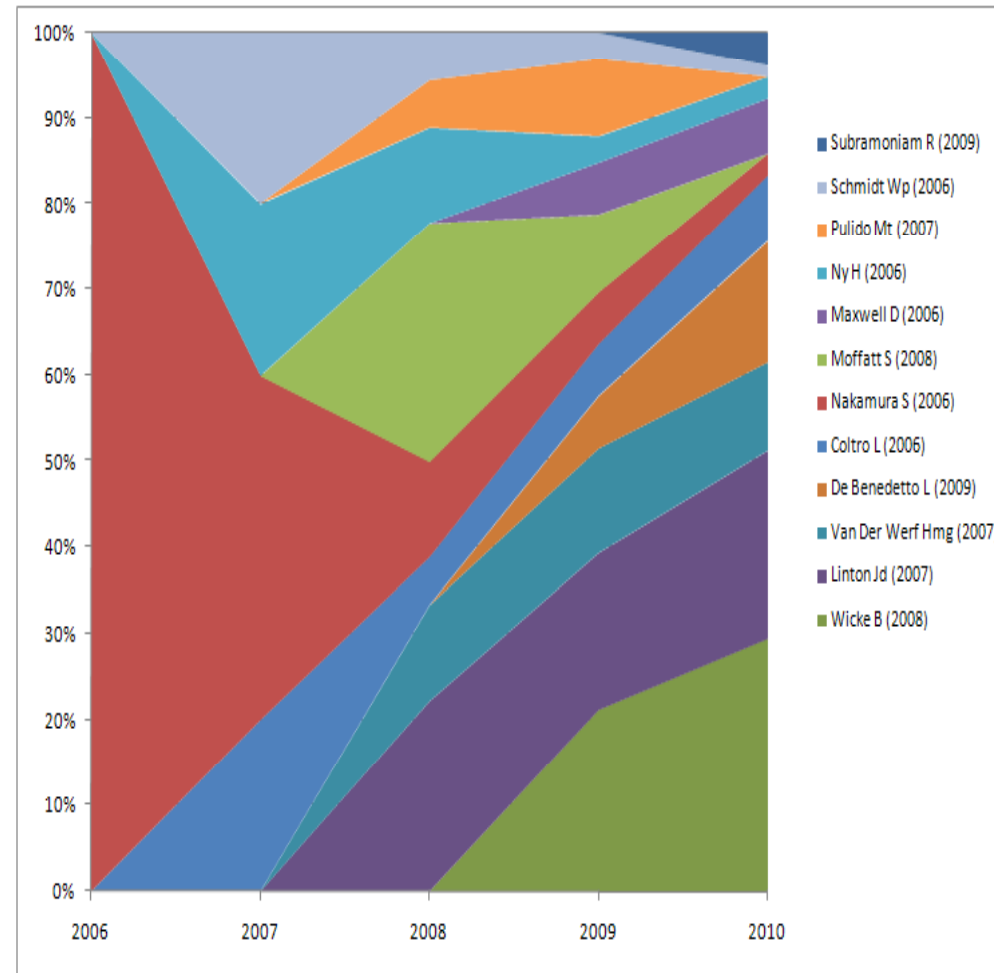


Fig. 8 – Percentage of citations of papers cited more than 3 times per year on PLM and Sustainability

Bibliometric Analysis – Results (11/15)

PLM and Sustainability



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- *Research on PLM and Sustainability involve:*
 - ✓ *Sustainability issues in supply chain*
 - ✓ *Analysis of environmental impacts*
 - ✓ *Managing the life cycle of products through the use of tools*
 - ✓ *Incorporation of environmental performance in strategy*
 - ✓ *Inclusion of concepts of recycling and end of life products*

Bibliometric Analysis – Results (12/15)

PLM and Sustainability



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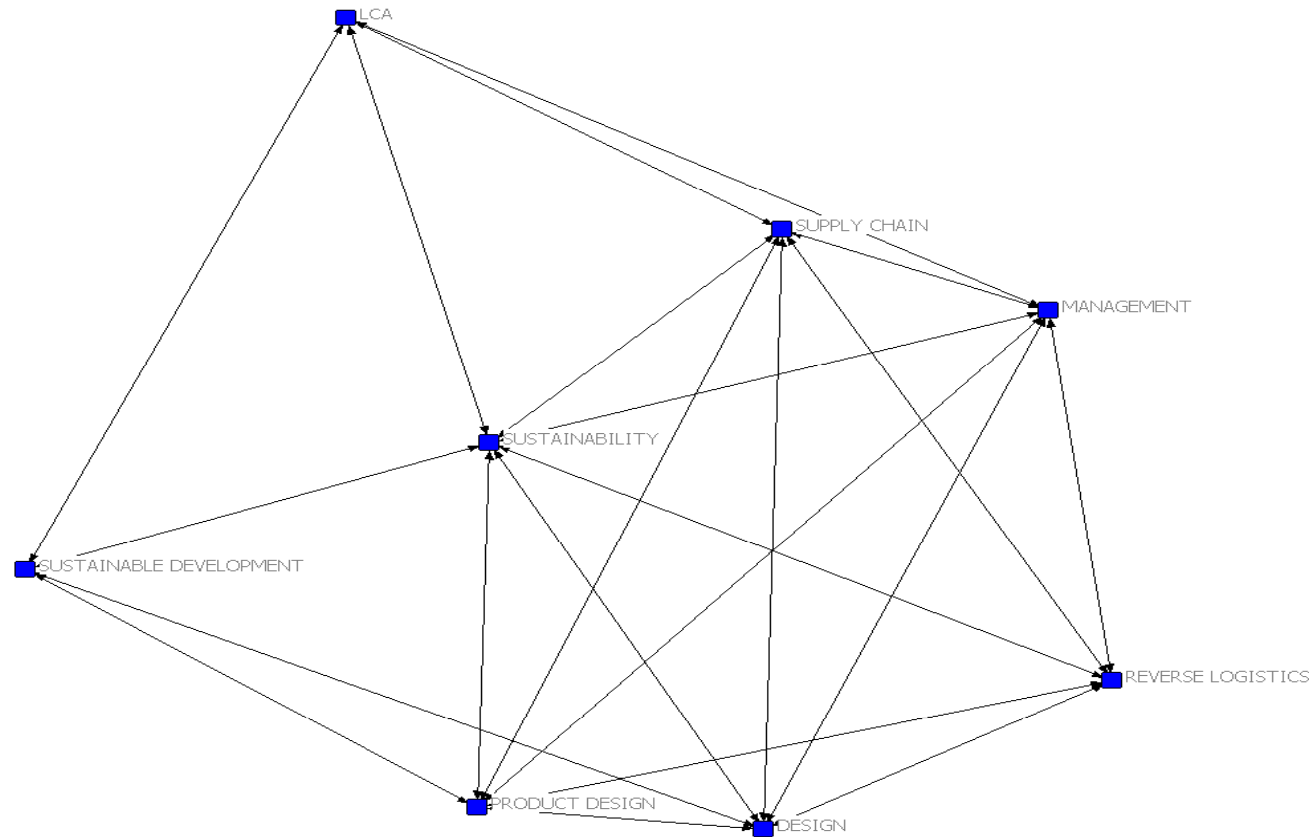


Fig. 9 – Network of key words of most cited papers on PLM and Sustainability

Bibliometric Analysis – Results (13/15)

PLM and Sustainability



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- *There is a relationship among the subjects:*
 - ✓ *Sustainability*
 - ✓ *Supply chain*
 - ✓ *Management*
 - ✓ *Reverse logistics*
 - ✓ *Product design*

- *Cross-citation between the work of Linton et al. (2007) and Dehghanian and Mansour (2008)*

- *Co-citation among the work of Linton et al. (2007), Ny et al. (2006), De Benedetto and Klem (2009) and Subramoniam et al. (2009)*

Bibliometric Analysis – Results (14/15)

PDP, PLM and Sustainability



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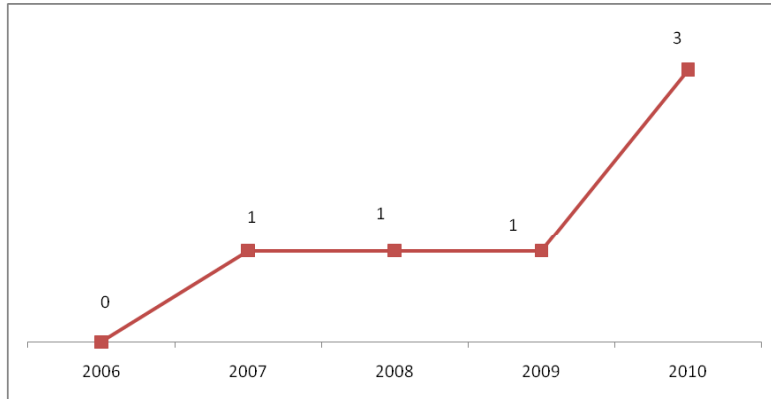


Fig. 10 – Number of citations of papers cited at least once a year

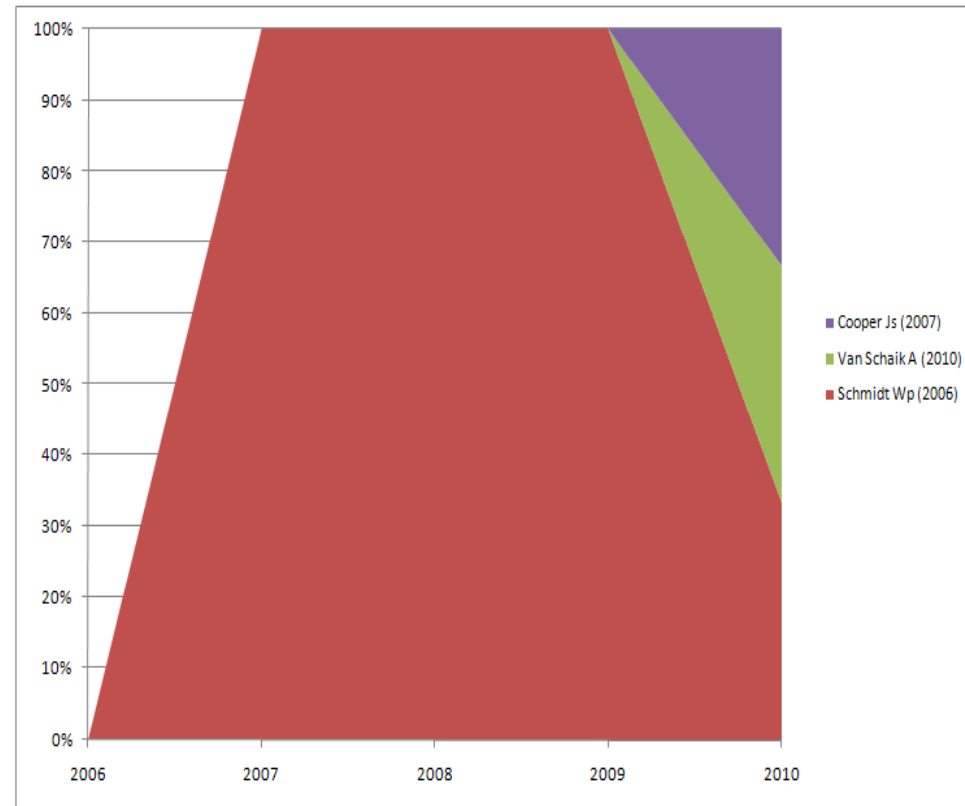


Fig. 11 – Percentage of citations of papers cited at least once a year

Bibliometric Analysis – Results (15/15)

PDP, PLM and Sustainability

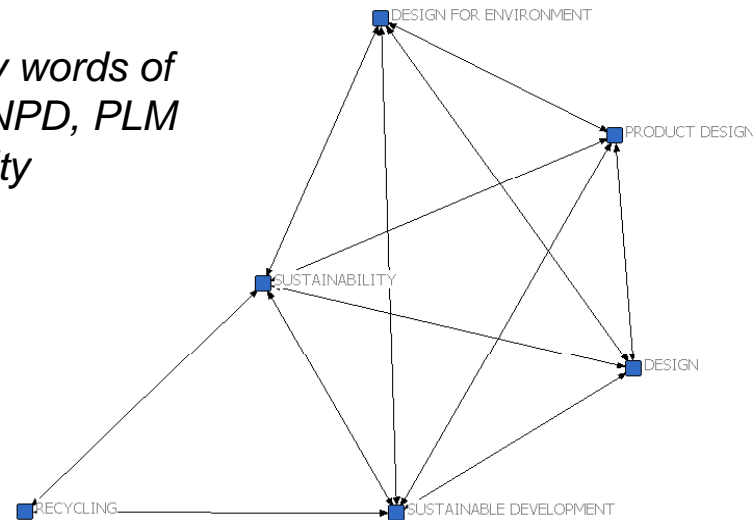


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Fig. 12 – Network of key words of the most cited work on NPD, PLM and Sustainability



- ❑ A network of citations and cross or co-citation were not found.
- ❑ Fleischmann et al. (2000) was the most cited reference (two citations)
- ❑ Because of the small number of references cited, it was not possible to draw up a network of relationships among most cited papers and references on NPD, PLM and Sustainability.

Synthesis of Social Networks - Results (1/3)



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- *The centrality indicators allow us to analyze the network as a whole and individually, facilitating the understanding of the importance of each actor and their relationships*

- *Based on the importance of indicators of the network, this analysis included the following indicators for the networks of key words:*
 - ✓ *Density of network*
 - ✓ *Degree of centrality*
 - ✓ *Betweenness degree*
 - ✓ *Closeness degree*

Synthesis of Social Networks - Results (2/3)



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Tab. 2 – Examples of software output Ucinet with imported data from the software Sitkis

Key words	Out Degree	In Degree	Nrm Out Deg (%)	Nrm In Deg (%)
SUSTAINABILITY	10.000	10.000	83.333	83.333
SUSTAINABLE DEVELOPMENT	7.000	7.000	58.333	58.333
DESIGN FOR ENVIRONMENT	6.000	6.000	50.000	50.000
DESIGN	5.000	5.000	41.667	41.667
RECYCLING	4.000	4.000	33.333	33.333
PRODUCT DESIGN	4.000	4.000	33.333	33.333

Synthesis of Social Networks - Results (3/3)



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Tab. 3 – Synthesis of the results of the pointers of the networks of words keys

Networks keywords	Density	Degree centrality	Betweenness centrality	Closeness centrality
NPD and PLM	36,95%	14,93%	14,89%	40,25%
NPD and Sustainability	42,86%	20,12%	24,65%	66,73%
PLM and Sustainability	51,43%	18,59%	20,97%	67,21%
NPD, PLM and Sustainability	80,00%	41,67%	17,77%	53,25%

Summary



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- ❑ *It is important to state that the studies on NPD, PLM and Sustainability are growing in the analyzed period. However, it was identified that there is little work being done on the three concepts all together*
- ❑ *The examined publications incorporate the concept of sustainability and PLM in the NPD. They are more extensively applied in industries, supply chain and software development*
- ❑ *This paper emphasises the improvement NPD, performance assessment, and the integration of information from different areas*
- ❑ *There is a trend increased towards environmental issues demanded from society and the need of organizations to employ strategies that consider product end of life (remanufacturing, recycling and reuse)*

Acknowledgments



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Thank You!

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