A co-word analysis
on Human Resource Management literature:
The role of technological innovation from 2007-2017

Dennis Trotta
Department of Management-Engineering, University of Padova (Italy)
Email dennis.trotta@phd.unipd.it

Patrizia Garengo
Department of Industrial-Engineering, University of Padova (Italy)
Email patrizia.garengo@unipd.it

Abstract

Purpose. In the last few years, the huge changes of the global competitive environment, have heavily affected managerial practices and scholarly literature. A relevant role is recognized to the change in the Human Resource Management studies, as the management of human resource dimension is strictly related to most of the management research streams. This research aims to identify the main themes related to the Human Resource Management (HRM) literature in manufacturing environment.

Methodology. A quantitative literature review is carried out using the co-word analysis technique (Cobo et al., 2015) as this methodology is recognized as a useful and objective approach in mapping research fields. The period covered by the analysis is from January 2007 to April 2017.

Findings. The literature review support the design of an overall map of the HRM literature related to manufacturing environment. The ten main themes are identified and the related topics are briefly described. The most significant are: Total Quality Management (Perdomo-Ortiz, Gonzalez-Benito and Galende, 2009), service and business strategies, customer satisfaction (Chuang and Liao, 2010), work organization, employee wellbeing.

Practical implications. The research identifies HR-practices such as employee selection, re-skilling of the workforce and re-definition of the employee career path, that in the last years are assuming great importance for the manufacturing companies.

Originality/value. In addition to the above findings, the research introduced co-word analysis in a HRM literature review and it supplies a whole map of the HRM research published in the last few years. This literature could be useful for leading future research on the investigated subject.

Keywords

Human Resource Management; Co-word analysis; Technological innovation; Bibliometric analysis

20th Excellence in Services
International Conference
Conference Proceedings ISBN 9788890432774

797

University of Verona
Verona (Italy)
September 7 and 8, 2017

1. Introduction

Human Resource Management (HRM) and Manufacture, are both influenced by the so-called Megatrends. Rump (2009) identifies six main megatrends (i.e. Demographic Change; Technological Innovations; Globalization; Knowledge Society; Women's Power; Value Changes) that impact on the HR function definition. Similarly, Ulrich and Dulebohn (2015) recognize six dimensions (i.e. Social trends; Technological trends; Economic trends; Political trends; Environmental trends; Demographic trends) that affect "how organizations work but also the nature of HR" (Ulrich and Dulebohn, 2005). In the last years, the technological innovation seems to be a crucial aspect for the future of both the HRM and the Manufacture. This importance is supported by the introduction in the workplace of new technologies (such as 3D printing, Autonomous Robots, Augmented Reality) that have the potential to change the way items are not only produced, but even projected and prototyped. Beside the singular application of the before mentioned technologies, academics along with consultants and practitioners see a much more important phenomenon at the horizon: the fourth industrial revolution. This revolution has also different names that differ relatively from countries to countries. The most famous synonyms are "Industry 4.0" (Hermann, Pentek and Otto, 2016), "Industrial Internet of things" (Arnold, Kiel and Voigt, 2016) and "Smart manufacturing" (Kang et al., 2016). While the words are different the meaning is approximately the same: the interconnection of a pool of technologies will transform the workplace into Cyber Physical System (Meißner, 2015) in which the employees will work together with machines, in a role of supervision. The average mansions of the blue collars will be completely different, re-defined, and some scholars speculate about the extinction of this kind of workforce in favor of a new one, a decline started since the third industrial revolution. Thus, it is of a high importance for HRM to be ready for the challenges that will have to face, in order to give to the practitioners, the right information to deal with the upcoming situation.

The first step in defining what HRM could do, is understanding what is already doing for companies in the manufacturing context, also because in the last years many new manufacturing models have emerged and pushed for an HR alignment in order to secure the good implementation of this new manufacturing models. To this extent, a literature review of the last ten years of research (2007 – 2017) between HRM and manufacture related topic is conducted, by using a co-word analysis (Cobo et al., 2011). One theme resulted pretty longitudinal in its importance: HR practices and their positive effect in implementing different kind of the before mentioned managerial model: Lean Management, Supply Chain, Total Quality and Environmental Management. While the link between HR and those models is really developed, the role of technological innovation is often a marginal aspect that can be found related to new product development, while its role as revolution forces seems not debated.

2. Methodology

The Human Resource Management literature is among all the managerial disciplines, the one having the greatest number of publications, since it attracts contributions of authors from different disciplines such as Sociology, Management, Economics, Psychology, etc. Choose the proper keywords for the query is an important task, since it keeps irrelevant results out of the analysis. In order to identify the right keywords, a preliminary review was conducted. The keywords included in the query are showed in Table 1.

Table 1. Keywords searched

HRM area	Context
"Human Resource Management"	"Supply chain"; "Production"; "Factory"; "Manufacturing".

To carry out the analysis some limitations is placed: first of all, for answering the purpose of the research, the authors decided to conduct the analysis by only choosing articles published in last years (i.e. January 2007 and April 2017), and to limit the analysis to companies in the manufacturing context. The authors also searched the keywords in the title, abstract and keywords section. The articles also had to be in English language and peer-reviewed.

The analysis is conducted with the use of the software Scimat, which performs different task and type of analysis, capable of producing descriptive statistics and bibliometric technique calculations with different unit of analysis (words, citation, authorship). Table 2 contains all the information, and parameters used to conduct the analysis.

Table 2. Parameters' summary of the analysis

Period	Starting date: January 2007 Collection date: April 2017
Database	Scopus
Unit of analysis	Keywords
Data reduction threshold	7
Network reduction threshold	1
Matrix	Co-occurrence
Normalization	Equivalence index
Cluster algorithm	Simple center algorithm Min 3 – Max 15
Document Mapper	Union Mapper
Quality index	H-index, Sum of citations
Analysis	Strategic diagram

As for conducting this literature review the authors lies upon the methodology of Callon, Courtial and Laville (1991) and Cobo et al. (2012), eight main steps compose this methodology, Figure 1 show these steps.

Figure 1.Workflow of the analysis (Cobo, 2012)

Data Retrieval → Preprocessing → Network Extraction → Normalization → Mapping → Analysis → Visualization → Interpretation

Among all, the step named "Preprocessing" is crucial: since data may contain several issues (such as: misspelling, duplication) secure the goodness of the data it is of great importance.

The analysis results in a map of cluster, which constitutes themes of research, placed in a strategic diagram (Callon, 1991), which use two factors: Centrality and Density. Centrality (Callon, 1991) refers to the number of links a cluster have with other clusters.

Figure 2. Strategic diagram by Callon (1991)
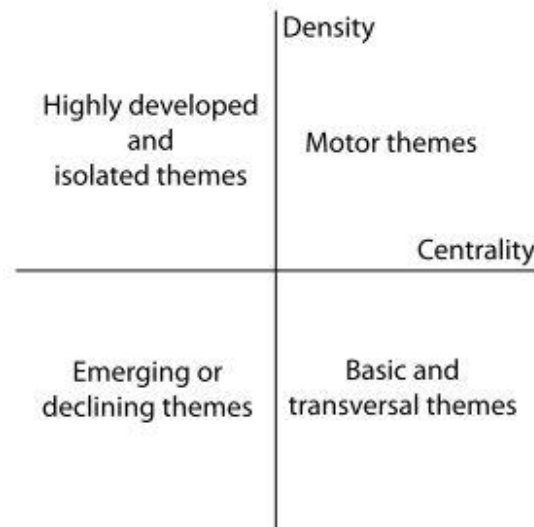
When many links link to cluster, that cluster represent a crucial theme investigated by the academics. On the other hand, Density (Callon, 1991) assesses the strength of the links between the keywords that compose the cluster, and it gives an idea of how will develop that field in the future. In other words, a field of research is composed by themes mapped by these two factors. Themes can be of four type:

1) *Motor themes*: strong centrality, strong density. Themes in this quadrant are well developed and central to the other clusters.
2) *Highly developed and isolated themes*: themes well developed inside, but with low external connection.
3) *Emerging or declining themes*: themes in this quadrant are not developed and they also have poor internal connection.
4) *Basic and transversal themes*: they are important to the research field but they do not possess a good degree of development.

The analysis is completed adding a third dimension: the H-index. The H-index "depends on both the number of a scientist's publications and the impact of the papers on the scientist's peers" (Hirsch, 2005). In this way, clusters are displayed as balls, where the bigger the ball is the more important is the cluster.

3. Analysis and results

The literature review of HRM in the manufacturing context follows the steps (Fig. 1) suggested by Cobo (2011). The descriptive statistics (Fig. 3) elaborated with the software Scimat, shows that since 2007, the number of publication for the researched keywords grows exponentially. Despite a little drop in publication in the year 2012, the overall trend result strongly positive (Fig. 3.1). On the other hand, these descriptive statistics does not allow to

know more about the way HRM impact on those companies, or which HRM topics are the most discussed in the literature by academics and practitioners, along with the why. Neither is possible to establish a causal nexus between HRM and Supply Chain, Manufacturing, Factory and Production.

In terms of countries, the intersection between HRM and manufacturing is more studied in United States, along with the United Kingdom, Australia, Spain and Italy with Germany behind following. Among the principal countries before mentioned, there are also many ones from Asia that are heavily contributing to development of this area of research: China, Malaysia, India and Taiwan. This comes with no surprise since many companies have production plants in Asian countries while they keep the corporate head in Europe or USA.

Figure 3. Descriptive Statistics

| Fig. 3.1 Articles by year | Fig. 3.2 Articles by country |
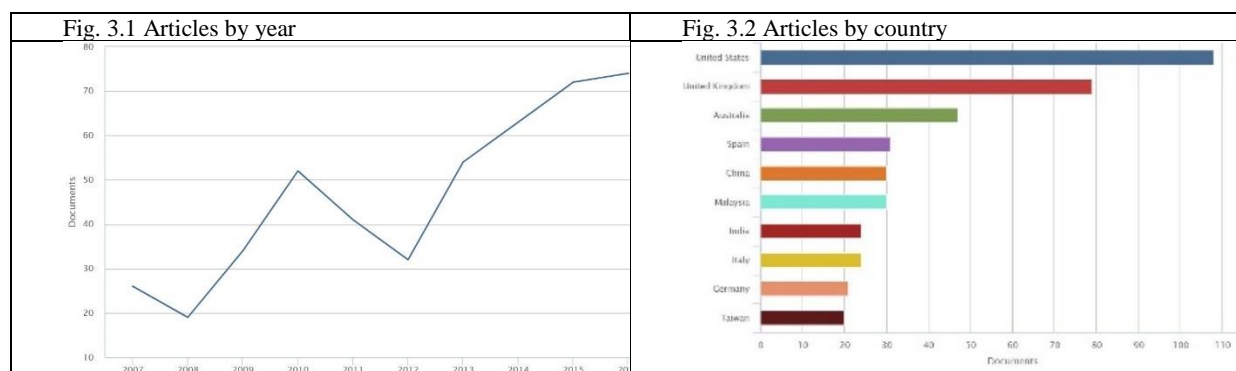
Another useful insight comes from the number of articles published in the journal (Table 3). Of the top seven journal with the highest number of articles, only two are clearly related to the HRM, while the others come from the production and the operations research field. This atypical composition may represent, even if in a shallow way, that the journals interested in production are becoming more and more interested in HRM.

Table 3. Journal with most number of papers related to HRM

Journal Name	Number of articles per journal
International Journal of Human Resource Management	55
International Journal of Production Research	21
Journal of Cleaner Production	21
International Journal of Operations and Production Management	13
International Journal of Manpower	12
International Journal of Production Economics	11
TQM Journal	10

The literature review conduct to the identification of ten clusters, or research themes. These themes are identified inside a strategic diagram, who also display the H-index of the themes with a number. The strategic diagram (Fig. 4) shows that there are four main clusters in the "motor themes" area (i.e. Human resource management, Process Management, Organizational Innovation, Performance), which represents themes high researched and connected. Four other clusters are in the lower left quadrant (i.e. Business Strategies, Employee, Organizational Performance, Managerial implications); these research themes could be emerging or declining. Only one cluster populates the upper left quadrant: Green

Human Resource Management, this area usually represents poor connected theme, even if it has a good development. The cluster named "Logistics", however, by only looking at this Strategic Diagram is not possible to say whether this theme is increasing in importance or if it is declining.

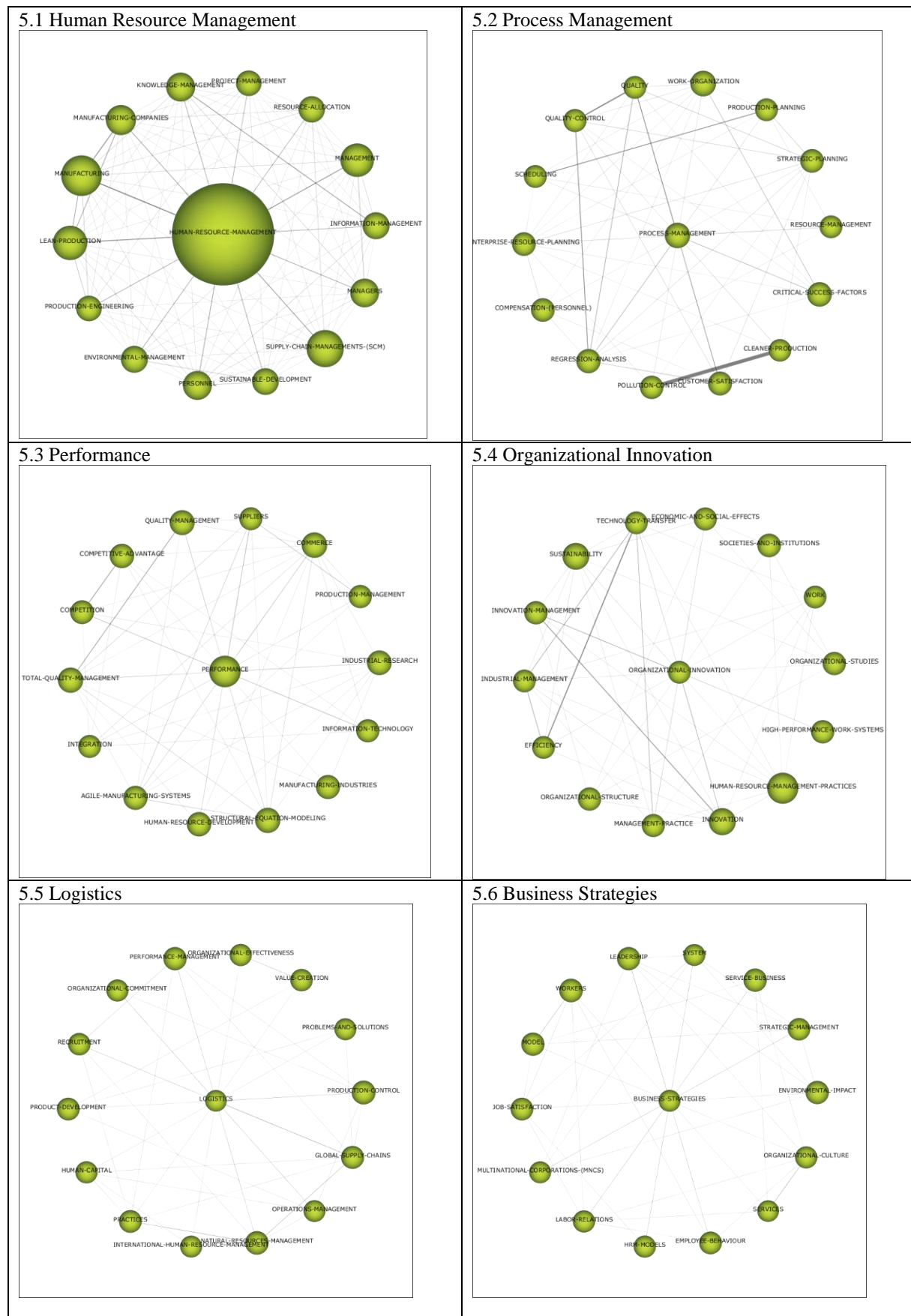*Figure 4. Strategic Diagram of the analysis*
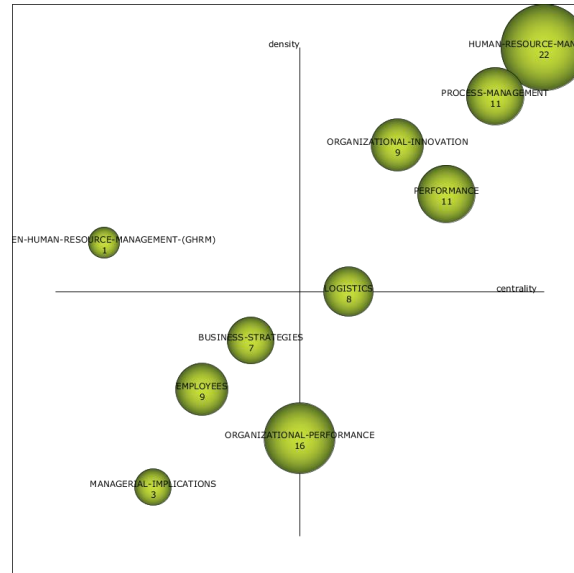
The size of the green balls in Fig. 4, are proportional to the H-index (Hirsch, 2005) of each theme. In light of this, it is possible to say that the cluster with the highest H-index is the one named "Human Resource Management" and it is in the upper right quadrant of the motor themes cluster. The second cluster is the one named "Organizational Performance" and it is situated in the lower left quadrants, so this theme may be a new one or a declining one, but it seems to have good development and citations inside the field. All the other clusters have an h-index between 11 and 9, only two clusters have small H-index: Green Human Resource Management (H-index=1) and Managerial Implications (H-index=3). The Cluster "Human Resource Management" is the one with both the greatest number of citations and number of articles (Table 4) while "Organizational Performance" is the second one. "Green Human Resource Management" and "Managerial implications" are the only two clusters with few publications and low level of citations. This could be caused by the newness of the themes, or because they still have not attracted the attention of the researchers.

Table 4. Clusters' analytics

Name of the cluster	Number of articles	Articles' H-index	Sum of Citations
Human-Resource-Management	209	22	1,698
Process-Management	39	11	325
Performance	44	11	594
Organizational-innovation	28	9	433
Logistics	20	8	215
Business-strategies	22	7	265
Organizational-performance	55	16	638
Employees	32	9	188
Managerial-implications	6	3	16
Green-human-resource-management-(ghrm)	4	1	4

All the topics related to the cluster are important element investigated in the field of Operations Management. Figure 5 shows the composition of ten clusters described below.

Figure 5 - Clusters obtained from the analysis

5.1 Human Resource Management	5.2 Process Management
KNOWLEDGE-MANAGEMENT, PROJECT-MANAGEMENT, RESOURCE-ALLOCATION, MANUFACTURING-COMPANIES, MANAGEMENT, MANUFACTURING, INFORMATION-MANAGEMENT, HUMAN-RESOURCE-MANAGEMENT, LEAN-PRODUCTION, MANAGERS, PRODUCTION-ENGINEERING, SUPPLY-CHAIN-MANAGEMENTS-(SCM), ENVIRONMENTAL-MANAGEMENT, PERSONNEL, SUSTAINABLE-DEVELOPMENT	QUALITY, WORK-ORGANIZATION, PRODUCTION-PLANNING, QUALITY-CONTROL, STRATEGIC-PLANNING, SCHEDULING, PROCESS-MANAGEMENT, RESOURCE-MANAGEMENT, ENTERPRISE-RESOURCE-PLANNING, CRITICAL-SUCCESS-FACTORS, COMPENSATION-(PERSONNEL), REGRESSION-ANALYSIS, CLEANER-PRODUCTION, POLLUTION-CONTROL, CUSTOMER-SATISFACTION

5.3 Performance	5.4 Organizational Innovation
QUALITY-MANAGEMENT, SUPPLIERS, COMMERCE, COMPETITIVE-ADVANTAGE, PRODUCTION-MANAGEMENT, COMPETITION, PERFORMANCE, INDUSTRIAL-RESEARCH, TOTAL-QUALITY-MANAGEMENT, INFORMATION-TECHNOLOGY, INTEGRATION, MANUFACTURING-INDUSTRIES, AGILE-MANUFACTURING-SYSTEMS, HUMAN-RESOURCE-DEVELOPMENT, STRUCTURAL-EQUATION-MODELING	TECHNOLOGY-TRANSFER, ECONOMIC-AND-SOCIAL-EFFECTS, SOCIETIES-AND-INSTITUTIONS, SUSTAINABILITY, WORK, INNOVATION-MANAGEMENT, ORGANIZATIONAL-STUDIES, INDUSTRIAL-MANAGEMENT, ORGANIZATIONAL-INNOVATION, EFFICIENCY, HIGH-PERFORMANCE-WORK-SYSTEMS, ORGANIZATIONAL-STRUCTURE, HUMAN-RESOURCE-MANAGEMENT-PRACTICES, MANAGEMENT-PRACTICE, INNOVATION

5.5 Logistics	5.6 Business Strategies
PERFORMANCE-MANAGEMENT, ORGANIZATIONAL-EFFECTIVENESS, VALUE-CREATION, ORGANIZATIONAL-COMMITMENT, PROBLEMS-AND-SOLUTIONS, RECRUITMENT, LOGISTICS, PRODUCTION-CONTROL, PRODUCT-DEVELOPMENT, GLOBAL-SUPPLY-CHAINS, HUMAN-CAPITAL, OPERATIONS-MANAGEMENT, PRACTICES, INTERNATIONAL-HUMAN-RESOURCE-MANAGEMENT, NATURAL-RESOURCES-MANAGEMENT	LEADERSHIP, SYSTEM, SERVICE-BUSINESS, WORKERS, STRATEGIC-MANAGEMENT, MODEL, BUSINESS-STRATEGIES, ENVIRONMENTAL-IMPACT, JOB-SATISFACTION, ORGANIZATIONAL-CULTURE, MULTINATIONAL-CORPORATIONS-(MNCS), SERVICES, LABOR-RELATIONS, HRM-MODELS, EMPLOYEE-BEHAVIOUR

5.7 Organizational Performance	5.8 Employees
5.9 Managerial Implications	5.10 Green Human Resource Management

As shown in Figure 5.1, "Human Resource Management" is the most important theme and it is directly related to Lean Management (LM), Supply Chain Management (SCM) and Environmental Management (EM). It also has the highest Centrality, Density and H-Index. "Process Management" (Fig. 5.2) shows the importance of Quality Management and its related topics such as improving services performance or customer satisfaction. "Performance" (Fig. 5.3) prevalently associate the HRM to the firm's performance linked to the TQM, Environmental Management, Lean Management and Supply Chain. "Organizational Innovation" (Fig 5.4) has its core in the process and product innovation and which HRM practices as a positive association. "Logistics" (Fig. 5.5) shows the centrality Logistics and Supply Chain Management have in the use of social capital, or the need of HRM practices that can facilitate the implementation on certain kind of SCM approach. "Business strategies" (Fig 5.6) deal with strategies for better manufacturing, and claim the importance of the strategic planning in order to obtain better supply chain performances. "Organizational performance" (Fig. 5.7) relates the topic of the performance with Strategic HRM, Organizational Learning and Work Practices, along with the importance of Teamwork and Employee Involvement. The theme "Employees" (Fig 5.8) strongly focus on employee

wellbeing and job satisfaction. "Managerial Implications" (Fig. 5.9) represents the topic of the implications coming from different thematic: employee relations, empirical analysis. "Green Human Resource Management" it is about the importance of having HRM practices aligned with the green component in order to facilitate the integration.

4. Discussion and conclusions

This paper seeks to shed light on the topics investigated in the HRM field when linked to manufacturing companies. The literature review identifies ten themes of research that are also relevant to the Operations Management field. HRM is strongly associated with Supply Chain Management (SCM), Lean Management (LM) and Environmental Management (EM). What seems to be crucial is the role of the HR function in enforcing the implementation of these approaches, all the three need HR support, at both the strategy and the practices level. SCM, LM and EM are present in the HRM literature, since many articles address the question of how integrate successfully these approaches while other focus on the HR practices needed, the HR-system adopted, the importance of team and the importance of leadership. From a quantitative point of view, this also find supports by both the descriptive statistics and the various results of the co-word analysis and by the placement inside the strategic diagram (Callon, 1991) in the quadrant named "Motor themes".

Regarding the HRM-SCM relation, articles connecting the two topics were lacking and there is an increasing trend in publications only in recent years. The HRM-SCM relation discuss mainly the importance of HRM in securing the SCM implementation. Some authors focus on the HR practices (Jabbour and De, 2016; Menon, 2012) others on the HR system (Smith-Doerflein, Tracey and Tan, 2011). Aligning the HR department with IT and SC leads to competitive advantage (Dao, Langella and Carbo, 2011), while aligning all the soft variables in the organization results in good SCM implementation (Shub and Stonebraker, 2009). HR practices' flexible job description, teamwork and training impact positively on the SCM implementation (Menon, 2012). Also, the role of Organizational Culture is crucial for HRM, that is "the most important human factor that must be addressed by the HR department" (Jabbour and De, 2016).

Human Resource Management discussion around Lean Management focuses on the implementation of LM, made possible by the HR practices. These practices are important in securing the successful integration of LM, companies should have certain HR practices (Liker, 2011) and, actually, they often adopt common HR best practices (Jurgens and Krzywdzinski, 2013). Recruiting, performance evaluation, benefit, training and rewards are linked to LM (Jabbour et al., 2013), with the last two considered success factors for the LM implementation. When HR practices focus on security, there are less accidents on the job so that "lean it's not mean" (Longoni et al., 2013).

HRM is thus considered an important factor for the implementation of Supply Chain, Lean Management, and Environmental Management. While the literature discusses about HR practices, what is missing is the role of the technological innovation in manufacturing sector. The lack of this topic from the literature of manufacturing comes with big surprise since many authors and researchers believe huge changes will occur due to increasing in technology innovation that will push traditional production to smart factory or cyber-physical system.

HR practices are also the most discussed topic inside the theme "Process Management". In particular HR practices facilitate the adoption of Quality Management. Leadership, strategic planning and human resource development are associated to Quality models (Arumugam et al., 2009). Those practices were also found to have negative impact on role conflict (Lenka, Suar and Mohapatra, 2010; Teh et al., 2009). Lenka (2009) highlights also the importance of

job satisfaction in influencing the customer satisfaction. Starting from the same premise, Feng (2014) describes the importance of service training and employee empowerment in order to have a better employee satisfaction related to customer satisfaction.

The impact of HR practices in implementing Total Quality Management (TQM) is underlined by Kuei, Madu and Lin (2011) and Konecny and Thun (2011). The former focuses on the value added by skills, training, diversity management and leadership in the implementation of TQM, while the latter suggests that HR practices have "potential to improve plant performance", also Bayo-Moriones et al. (2011) claim that HR practices affect the development of quality management inside companies.

Since its birth, Human Resource Management is strictly linked to performance. Many authors investigate this relationship, which is also defined as the "holy grail" of the field. In the theme "Performance", the performance are often related to the HR practices, but not all the authors agree to the impact and positive effect of those. For Menezes (2008) the integrations of HR practices "result in superior firm performance". An important role is played by the leadership (Wickramasinghe and Garusinghe, 2010; Laohavichien, Fredendall and Cantrell, 2011). For Jacobs, Yu and Chavez, (2016) the performance must "establish effective internal communication processes and stimulate employee satisfaction". Of a different opinion, the results from Bevilacqua, Ciarapica and De Sanctis (2017) where the lean practices do not find any associations with growth in performance, while product mix variety and time effectiveness do it. Zhang, Li and Chen (2016) do not find any associations between green practices (which include HR green practices) and financial performance, but the authors find associations between green practices and operational performance due to the reduction in pollution and waste, which are mainly caused by inefficiencies.

HRM is important also for the development of "Organizational Innovation", which is also the last cluster of the motor themes. The organizational innovation seems to be affected by several factors. Ling (2010) affirms that there is a connection between the HR practices, however only training has a major association with product innovation, process innovation and administrative innovation. Also, Santangelo and Pini (2011) describe a positive association between HR practices and technological innovation. Jurgens (2015) claims the importance of training and reward system to boost knowledge sharing and thus fostering technological, while Bourke (2015) find that firm adopting certain HR practices perform better – in terms of technological innovation – than other companies who do not have them. On the importance of training debate also Kok and Ligthart (2014) who assert that training boost work flexibility, which enhance new product innovation, that is also found to be affected by hard corporate identity (Staub, Kaynak and Gok, 2016). Other factors that seems related to technological innovation are the "combination of diverse perspective", cultural differences, decision to outsource function to "promote technological innovation" (Mazzanti, Sandro and Paolo, 2009), adoption of Top Management Team (Prasad, 2015). The lack of innovation stands out as one of the factor related to poor competitiveness of companies (Antonioli, Mancinelli and Mazzanti, 2013).

In the cluster named "Logistics" is discussed the human resource dimensions of successful global supply-chain management; the growing importance of HRM in the management of supply chains is presented as a combination of resource-based (e.g. internal), market-based (e.g. external) and dynamic capabilities perspectives. In addition, selection, training and assessing the new 'breed' of global supply-chain managers is explored.

The first cluster in the "peripheral and underdeveloped area" is the one named "Business Strategies". Several research show the importance of those strategies, in particular Calabrese, (2012) states that, the field of operations' management and human resources' management is related, and he underlines the chance of contextually considering human resources and operation management.

In the last years, there is an increased interest in the wellbeing of the employees and in the job satisfaction, what HRM should do to reach higher level of both is what research tries to find. The cluster named "Employee" have a strong focus on employee wellbeing and job satisfaction. In particular, Menon (2012) find some HR practices (i.e. Teamwork, training, flexible work description, reward system) that could impact of the satisfaction level of the employees. The different needs of new generation of employees was the focus of Zhu et al., (2015), the authors find that the involvement of the workforce in the processes of decision making, supervision and management, impact on their satisfaction.

Another important factor influencing the job satisfaction is Lean Six Sigma, its dimensions (Define, Measure, Analyze, Improve, and Control/Define, Measure, Analyze, Design, and Validate, 5S and Kanban) "positively influences employees' performance, described by employee satisfaction, absenteeism, salaries and benefits, employees' commitment and employee turnover rate" (Brkic and Tomic, 2016).

Of marginal importance is the need for the HR function of having "appropriate governance principles" (Farndale, Paauwe and Boselie, 2010), the fact that the International Framework agreements could lead to high commitment (Sydow and Frenkel, 2013) and the role of employees' skills regarding supplier integration (Huo et al., 2015).

The cluster named "managerial implications" shows the importance of the HR practices in "predicting labour disputes" with managerial style "turned out to be a useful predictor". The literature of this cluster highlights, implication regarding the adoption of Six Sigma as a whole, which is influenced by the organization's structure.

The theme "Green Human Resource Management" is made of "practices aligned with environmental sustainability goals and which aim at developing employees' abilities, motivation and commitment, and involvement in support of those goals at the firm level". Green HRM has positive impact on environmental performance. Rajiani, Musa and Hardjono, (2016) points out the difficult of measure the HRM output since there is a "polarization between "Best fit" and "best practice".

5. Limitations

The literature review conduct in this study identifies ten clusters, which constitutes the themes discussed in the HRM field related to manufacturing. Despite all the precautions and attentions, this study is not free of limitations. The first limitation, the most obvious, is the study of the manufacturing area only through the lens of HRM. HRM is a relative recent model if compared to the long history of manufacture production. Adding the other models (i.e. "Personnel Management", "Industrial Relations", "Human Capital") would have resulted in an increased number of articles with different, when not contrasting, ideas and theories. The focus is only on the HRM and its spinoff (such as Strategic HRM or Green HRM), rather than study the most important theme for all the models.

Another limitation is the time chosen (2007-2017). The periods of ten years it is not broaden enough to perform a longitudinal analysis of the evolution of the field.

References

Antonioli, D., Mancinelli, S., & Mazzanti, M. (2013). Is environmental innovation embedded within high-performance organisational changes? the role of human resource management and complementarity in green business strategies. *Research Policy, 42*(4), 975-988. doi:10.1016/j.respol.2012.12.005

Arnold, C., Kiel, D., & Voigt, K. (2016). How the industrial internet of things changes business models in different manufacturing industries. *International Journal of Innovation Management, 20*(08), 1640015.

Arumugam, V., Chang, H. W., Ooi, K. -., & Teh, P. -. (2009). Self-assessment of TQM practices: A case analysis. *TQM Journal, 21*(1), 46-58. doi:10.1108/17542730910924745

Bayo-Moriones, A., Merino-DÃaz-De-Cerio, J., Antonio Escamilla-De-LeÃ³n, S., & Mary Selvam, R. (2011). The impact of ISO 9000 and EFQM on the use of flexible work practices. *International Journal of Production Economics, 130*(1), 33-42. doi:10.1016/j.ijpe.2010.10.012

Bevilacqua, M., Ciarapica, F. E., & De Sanctis, I. (2017). Lean practices implementation and their relationships with operational responsiveness and company performance: An italian study. *International Journal of Production Research, 55*(3), 769-794. doi:10.1080/00207543.2016.1211346

Brkic, V. S., & Tomic, B. (2016). Employees factors importance in lean six sigma concept. *TQM Journal, 28*(5), 774-785. doi:10.1108/TQM-10-2015-0131

Calabrese, A. (2012). Service productivity and service quality: A necessary trade-off? *International Journal of Production Economics, 135*(2), 800-812. doi:10.1016/j.ijpe.2011.10.014

Callon, M., Courtial, J. P., & Laville, F. (1991). Co-word analysis as a tool for describing the network of interactions between basic and technological research: The case of polymer chemsitry. *Scientometrics, 22*(1), 155-205.

Chuang, C., & Liao, H. (2010). Strategic human resource management in service context: Taking care of business by taking care of employees and customers. *Personnel Psychology, 63*(1), 153-196.

Cobo, M. J., López-Herrera, A. G., Herrera-Viedma, E., & Herrera, F. (2012). SciMAT: A new science mapping analysis software tool. *Journal of the Association for Information Science and Technology, 63*(8), 1609-1630.

Cobo, M. J., López-Herrera, A. G., Herrera-Viedma, E., & Herrera, F. (2011). An approach for detecting, quantifying, and visualizing the evolution of a research field: A practical application to the fuzzy sets theory field. *Journal of Informetrics, 5*(1), 146-166.

Cobo, M. J., Martínez, M., Gutiérrez-Salcedo, M., Fujita, H., & Herrera-Viedma, E. (2015). 25years at knowledge-based systems: A bibliometric analysis. *Knowledge-Based Systems, 80*, 3-13.

Dao, V., Langella, I., & Carbo, J. (2011). From green to sustainability: Information technology and an integrated sustainability framework. *Journal of Strategic Information Systems, 20*(1), 63-79. doi:10.1016/j.jsis.2011.01.002

Farndale, E., Paauwe, J., & Boselie, P. (2010). An exploratory study of governance in the intra-firm human resources supply chain. *Human Resource Management, 49*(5), 849-868. doi:10.1002/hrm.20387

Hermann, M., Pentek, T., & Otto, B. (2016). Design principles for industrie 4.0 scenarios. *System Sciences (HICSS), 2016 49th Hawaii International Conference On,* 3928-3937.

Hirsch, J. E. (2005). An index to quantify an individual's scientific research output. *Proceedings of the National Academy of Sciences of the United States of America, 102*(46), 16569-16572. doi:0507655102 [pii]

Huo, B., Han, Z., Chen, H., & Zhao, X. (2015). The effect of high-involvement human resource management practices on supply chain integration. *International Journal of Physical Distribution and Logistics Management, 45*(8), 716-746. doi:10.1108/IJPDLM-05-2014-0112

Jurgens, U., & Krzywdzinski, M. (2013). Breaking off from local bounds: Human resource management practices of national players in the bric countries. *International Journal of*

Automotive Technology and Management, 13(2), 114-133. doi:10.1504/IJATM.2013.052996

Jabbour, C. J. C., & De, S. J. (2016). Green human resource management and green supply chain management: Linking two emerging agendas. *Journal of Cleaner Production, 112*, 1824-1833. doi:10.1016/j.jclepro.2015.01.052

Jabbour, C. J. C., De, S. J., Govindan, K., Teixeira, A. A., & De, S. F. (2013). Environmental management and operational performance in automotive companies in brazil: The role of human resource management and lean manufacturing. *Journal of Cleaner Production, 47*, 129-140. doi:10.1016/j.jclepro.2012.07.010

Jacobs, M. A., Yu, W., & Chavez, R. (2016). The effect of internal communication and employee satisfaction on supply chain integration. *International Journal of Production Economics, 171*, 60-70. doi:10.1016/j.ijpe.2015.10.015

Kang, H. S., Lee, J. Y., Choi, S., Kim, H., Park, J. H., Son, J. Y., . . . Do Noh, S. (2016). Smart manufacturing: Past research, present findings, and future directions. *International Journal of Precision Engineering and Manufacturing-Green Technology, 3*(1), 111-128.

Kok, R. A. W., & Ligthart, P. E. M. (2014). Differentiating major and incremental new product development: The effects of functional and numerical workforce flexibility. *Journal of Product Innovation Management, 31*, 30-42. doi:10.1111/jpim.12190

Konecny, P. A., & Thun, J. -. (2011). Do it separately or simultaneously - an empirical analysis of a conjoint implementation of TQM and TPM on plant performance. *International Journal of Production Economics, 133*(2), 496-507. doi:10.1016/j.ijpe.2010.12.009

Kuei, C. -., Madu, C. N., & Lin, C. (2011). Developing global supply chain quality management systems. *International Journal of Production Research, 49*(15), 4457-4481. doi:10.1080/00207543.2010.501038

Laohavichien, T., Fredendall, L. D., & Cantrell, R. S. (2011). Leadership and quality management practices in thailand. *International Journal of Operations and Production Management, 31*(10), 1048-1070. doi:10.1108/01443571111172426

Lenka, U., Suar, D., & Mohapatra, P. K. J. (2010). Soft and hard aspects of quality management practices influencing service quality and customer satisfaction in manufacturing-oriented services. *Global Business Review, 11*(1), 79-101. doi:10.1177/097215090901100105

Longoni, A., Pagell, M., Johnston, D., & Veltri, A. (2013). When does lean hurt? - an exploration of lean practices and worker health and safety outcomes. *International Journal of Production Research, 51*(11), 3300-3320. doi:10.1080/00207543.2013.765072

Mazzanti, M., Sandro, M., & Paolo, P. (2009). What drives (or hampers) outsourcing? evidence for a local production system in emilia romagna. *Industry and Innovation, 16*(3), 331-365. doi:10.1080/13662710902923909

Meißner, S. (2015). What's the meaning of industry 4.0? [Industrie 4.0 - Was ist das eigentlich?] *Stahl Und Eisen, 135*(2), 53-58.

Menon, S. T. (2012). Human resource practices, supply chain performance, and wellbeing. *International Journal of Manpower, 33*(7), 769-785. doi:10.1108/01437721211268311

Perdomo-Ortiz, J., Gonzalez-Benito, J., & Galende, J. (2009). An analysis of the relationship between total quality management-based human resource management practices and innovation. *The International Journal of Human Resource Management, 20*(5), 1191-1218.

Rajiani, I., Musa, H., & Hardjono, B. (2016). Ability, motivation and opportunity as determinants of green human resources management innovation. *Research Journal of Business Management, 10*(1-3), 51-57. doi:10.3923/rjbm.2016.51.57

Rump, J. (2009). Arbeitswelt im umbruch. sechs megatrends. *Personalwirtschaft, Trends 09*, 8-11.

Santangelo, G. D., & Pini, P. (2011). New HRM practices and exploitative innovation: A shopfloor level analysis. *Industry and Innovation, 18*(6), 611-630. doi:10.1080/13662716.2011.591977

Shub, A. N., & Stonebraker, P. W. (2009). The human impact on supply chains: Evaluating the importance of "soft" areas on integration and performance. *Supply Chain Management, 14*(1), 31-40. doi:10.1108/13598540910927287

Smith-Doerflein, K., Tracey, M., & Tan, C. L. (2011). Human resource management and supply chain effectiveness: An exploratory study. *International Journal of Integrated Supply Management, 6*(3-4), 202-232. doi:10.1504/IJISM.2011.044885

Staub, S., Kaynak, R., & Gok, T. (2016). What affects sustainability and innovation - hard or soft corporate identity? *Technological Forecasting and Social Change, 102*, 72-79. doi:10.1016/j.techfore.2015.06.033

Sydow, J., & Frenkel, S. J. (2013). Labor, risk, and uncertainty in global supply networks - exploratory insights. *Journal of Business Logistics, 34*(3), 236-247. doi:10.1111/jbl.12022

Teh, P. -., Yong, C. -., Arumugam, V., & Ooi, K. -. (2009). Does total quality management reduce employees' role conflict? *Industrial Management and Data Systems, 109*(8), 1118-1136. doi:10.1108/02635570910991337

Ulrich, D., & Dulebohn, J. H. (2015). Are we there yet? what's next for HR? *Human Resource Management Review, 25*(2), 188-204.

Wickramasinghe, V., & Garusinghe, S. (2010). An exploratory study of human resource aspects of international technology transfers to sri lankan private sector manufacturing firms. *International Journal of Operations and Production Management, 30*(6), 584-611. doi:10.1108/01443571011046030

Zhang, Z., Li, P., & Chen, S. (2016). Preliminary study on the intelligent manufacturing innovation project of clothing manufacturing enterprises. *Wool Textile Journal, 44*(5), 62-65.

Zhu, Y., Xie, Y., Warner, M., & Guo, Y. (2015). Employee participation and the influence on job satisfaction of the new generation of chinese employees. *International Journal of Human Resource Management, 26*(19), 2395-2411. doi:10.1080/09585192.2014.990397

Biographical sketch

Dennis Trotta, Ph.D. student in Management-Engineering, Department of Management-Engineering, University of Padova, Italy, research interests: innovation in Human Resource Management.

Patrizia Garengo, Associate Professor of Business and Management, department of Industrial-Engineering, University of Padova, Italy, research interests: innovation in management and performance measurement and management.