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Exploring Visual Management and Continuous Improvement in a Manufacturing Context: A Structured Bibliometric Analysis

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Abstract

Many manufacturing organisations rely on continuous improvement (CI) activities to maintain their competitive position. Here, effective communication is seen as critical in facilitating the alignment of corporate strategy and CI efforts. As many firms increasingly struggle to ensure effective internal communication due to time pressures and the need to continuously adapt strategic information, visual management (VM) can provide a means to support effective information transfer. Therefore, this paper explores the impact of VM on CI within a manufacturing context by first systematically reviewing and summarising the extant literature. A bibliometric analysis reveals that while VM offers great potential to support CI efforts, the field lacks systematic and holistic scholarly examination in a number of areas. For example, the association of CI as a dynamic capability and the impact of digitalisation in connecting VM and CI.

Keywords: Visual Management; Continuous Improvement; Manufacturing; Literature Review

1. Introduction

Dynamic environments require businesses to develop corporate cultures that epitomise flexibility and continuous improvement (CI). However, CI initiatives are complex, and many attempts fail to achieve their expected results (McLean et al., 2017).

While definitions of CI vary, there is an underlying agreement that CI concerns "the planned ongoing and systematic process of ongoing, incremental and company-wide change of existing practices aimed at improving company performance" (Boer et al. 2000, p.xxiii). The rich literature on CI also highlights some key barriers and facilitators, one of which is effective communication (Hoem and Lodgaard, 2016; McLean et al., 2017).

Visual management (VM) offers a means to facilitate effective, efficient and flexible information transfer relevant for organisations in their effort of aligning their CI efforts with the changing business environment (Holtskog, 2013). Nevertheless, scholarly examination of VM's impact on CI is limited.

This exploratory study examines the impact of VM on CI within a manufacturing context by systematically reviewing and summarising the extant literature. Through a bibliometric analysis key themes are identified and critically examined to both identify future research opportunities and inform how practitioners might deploy VM more effectively.

2. Research methodology

The aim of this initial study is to investigate how VM impacts CI within a manufacturing environment - using the systematic literature review (SLR) approach. Limiting SLR to VM, CI and manufacturing, this research process (see Figure 1) follows a transparent and successive procedure with reproducible results to identify research gaps with implications for further primary studies (Denyer and Tranfield, 2009).

As per Tranfield et al. (2003), the literature was reviewed in three phases: (i) planning, (ii) executing and (iii) reporting. In the planning phase, criteria concerning excluding and including papers as well as scope are determined. The executing phase involves the definition and application of keywords and search strings in order to conduct an unbiased review. The final phase presents a description of the review results which point at common research themes and research gaps. In order to identify all relevant extant studies, the two major databases, viz. Scopus and Web of Science, were selected due to their extensive portfolios (Mongeon and Paul-Hus, 2016). Cross-checking with Google Scholar, Emerald and EBSCO was also employed to ensure completeness of the data set. The keywords used to identify publications followed the logic of the research scope (Table 1). In total, 1515 potential publications were found in Scopus, whereas Web of Science accounted for 208 papers. Following the search strings application, further refinement was carried out by limiting the subject areas in order to ensure pertinence. Merging the results of both databases and eliminating duplicates, 689 publications remained.

Table 1. Search string application process.

Research fields	Keywords	Search string
Visual management	Visual*; Visible management; Communication; Control; Workplace; Factory; Tool	Visual* OR Visible AND (Management OR Communication OR Control OR Workplace OR Factory OR Tool)
Continuous improvement	Continuous; Continual improvement; Kaizen	(Continuous OR Continual) AND Improvement OR Kaizen
Manufacturing	Manufacturing; Production; Operations	Manufacturing OR Production OR Operations

For the next phase, the title and abstract of each paper were assessed individually by applying inclusion and exclusion criteria. 89 publications were considered relevant for further analysis based on supplementary quality criteria such as transparent research aim, thorough methodology and clear linkage of VM and CI. As per Figure 1, additional relevant papers that might have been missed during the research process were also identified. After this final stage, the data set involved 43 papers, with meta-data transferred to R and VOSviewer for analysis.

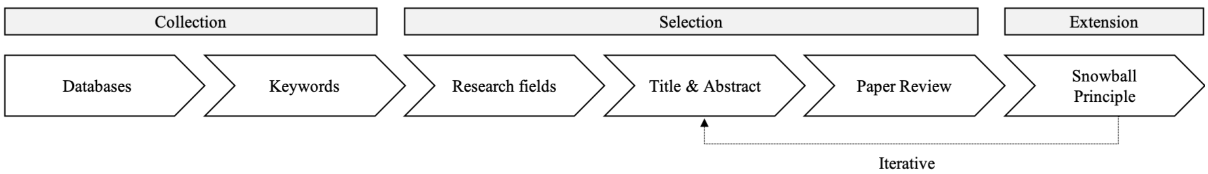

Figure 1. Research process.

3. SLR Results

The statistical software R (Ihaka and Gentleman, 1996) and VOSviewer (Van Eck and Waltman, 2010) were used to analyse and visualise the bibliometric network. Both tools abstract key information from the database such as name and location of authors, journal source, title, abstract and keywords. In addition, a thorough thematic content analysis was carried out to identify common research themes and methodologies, and to interpret the results meaningfully. For the purpose of this paper, and space constraints, only basic VOSviewer results are illustrated.

3.1. Scope analysis

Through network visualisation using VOSviewer, themes can be determined by analysing the co-occurrence of keywords (Figure 2). To simplify, only keywords are displayed that occur in at least two publications (i.e. in title and abstract). Circle size indicates the quantity of keyword occurrence, i.e., the higher frequency of keyword, the larger the circle. Moreover, relationships in terms of co-occurrence are visualised by distance. Items located in the centre of the visualisation represent the most prominent themes. Clusters of terms can also be created, which are visualised by colour coding schemes. Thus, themes and research gaps can be identified.

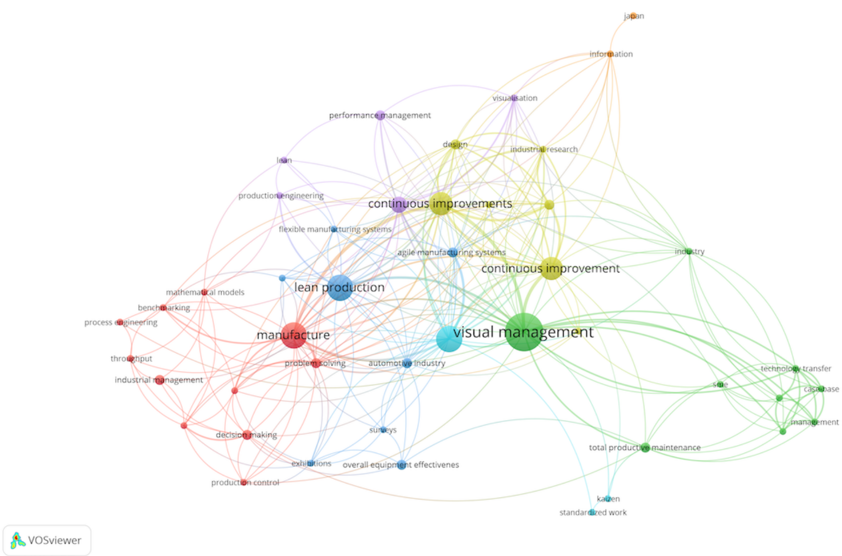

Figure 2. Visualisation of keyword co-occurrence.

The high number of clusters relative to sum of publications (i.e. seven categories for 43 publications) and low density of keywords imply a fragmented research field. Seven extant research themes were identified as: (1) manufacturing engineering, (2) technology transfer, (3) lean production, (4) continuous improvement, (5) visualisation, (6) lean manufacturing and (7) information. Within clusters, a high number of links are found, implying a strong co-occurrence of keywords. However, very few are linked to keywords of different clusters, which evidences the current focus of isolated research topics rather than holistic discussions. In summary, clusters and keywords indicate a strong focus on technical aspects with, for example, research on human aspects clearly lacking within this field. It is also possible to identify the most current themes by adding a time metric, which shows that VM is emerging. To fully understand the extant knowledge of VM in the context of CI, a thematic analysis is required.

3.2. Content analysis

The content of the publications was analysed in terms of the VM-CI relationship within a manufacturing context. Preliminary results indicate that VM impacts CI in four major ways: (i) by enabling information transparency through visual applications, tools and techniques, (ii) by supporting performance management (iii) by coordinating leadership and group dynamics, and (iv) by facilitating knowledge transfer.

Visual applications, tools and techniques – VM exploits the realisation of process transparency by providing tools and techniques for visually exposing opportunities for improvement. Most research has been concerned with developing suitable tools that allow better decision-making in regards to continuous improvement activities through visual transparency. For example, Vilarinho et al. (2018) developed dashboards to improve the performance of equipment and processes, and to engage workers in CI activities by providing information on quality, action plans and suggestion schemes. While results indicate improved information flow and communication in this single-case study, it did not measure the isolated effectiveness of their proposed CI contents. Similarly, visual operations tools such as value stream mapping (e.g., Rohac and Januska, 2015) serve the purpose of increasing transparency in regards to improvement potentials (e.g., Anand (1996). Finally, Bilalis et al. (2002) argue that visual factories can be a valuable tool for change management (and CI) due to its facilitation of exchanging, revising and updating information. However, extant studies in this realm often focus on the development, use or adaption of single tools intended for a very specific application (e.g. eliminating waste) while neglecting the holistic concept of CI.

Performance management – Communicating performance measures objectively (e.g., Murata and Katayama, 2016) through visually transparent means may assist teams in focusing on target achievement and to reinforce discipline (Parry and Turner, 2006). Bititci et al. (2016) investigate how visual performance management impacts performance measurement, in linking business strategy to improvement efforts and the development of a CI culture. While Kurpjuweit et al. (2018) emphasise that VM should be implemented as distinct lean practice rather than as a supporting feature, van Assen and de Mast (2019) propose a positive relation between visual performance management and performance improvement, with lean as a mediating factor. In addition, visual performance management appears to moderate the effects of lean, hence, it is argued that visual performance management should be regarded an infrastructural fitness factor.

Supporting leadership – VM is sometimes referred to as a leadership tool because it communicates strategic information and goals related to CI, and assists in coordinating teams (Poksinska et al., 2013). According to Bateman et al. (2016), visual boards engage people in CI activities and problem-solving, which is supported by Jaca et al. (2014) who found that the more people are involved in improvement activities, the more VM practices were used – and vice versa.

Knowledge transfer – While Harrington et al. (2019) provide practitioners with a visual representation of the current state of knowledge sharing within networks, this aspect of VM within manufacturing is nascent with only three publications found which make use of visualisation (e.g., Murata et al., 2014). Furthermore, the role and function of VM in the learning process of CI behaviour is not explored.

4. Conclusion

This synthesis demonstrates that the majority of research has been conducted with a practical orientation, primarily in terms of visual tool development. Also, extant research findings are mainly derived from individual cases focusing on SMEs. Notwithstanding, a first attempt to theoretically explain the effectiveness of visual devices is made by Beynon-Davies and Lederman (2017), using affordance theory, to go beyond mere information transfer. The extant literature has also pointed at the lack of research of VM despite its relevance for modern and future manufacturing organisations (Tezel et al., 2016). The results of this preliminary study are summarised as follows:

- While the concept of VM is well examined in other domains, it is only just emerging in the context of CI and manufacturing – and mainly linked to the lean manufacturing approach.

- Current research of the impact of VM on CI is limited to enabling information transparency through visual applications and techniques; in supporting performance management; in coordinating leadership and teams, and finally, facilitating knowledge transfer.
- Most studies are based on practice-oriented single cases, with limited research on longer-term effects, resulting in a fragmented research field with no distinct definition of VM.
- The majority of research examines the application of single visual tools with CI as only one outcome, indicating a lack of research on isolated effects of VM on CI behaviour.
- One major deficit is the understudied field of knowledge transfer and learning, which highlights the process-orientation of CI rather than developing a holistic CI culture.

From these findings, some implications for further research can be proposed. First, there is a lack of research that investigates the impact of VM on CI from a dynamic capability perspective. Within the CI literature, developing CI as a dynamic capability rather than a mere process or outcome has been highlighted (Anand et al., 2009; Bessant et al., 2001). Second, CI has mainly been linked to lean philosophies, hence, considering different CI approaches might aid a better understanding of the functionality and benefits of VM. Third, VM should be analysed more from a behaviourism perspective, particularly focusing on the causes of CI actions triggered by visual cues. Finally, only five of the analysed publications imply some form of digitalisation, hence, future research will investigate the link between VM and CI within digitised environments.

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