Understanding the Changing Nature of Cluster Drivers

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***Abstract*- Many cluster examples from around the world offer insights into cluster success, however there is relatively much less attention given to the factors which drive the development and existence of clusters. This paper examines cluster drivers reported as part of the cluster literature, as well as examining cluster drivers identified within the Australian Aerospace Cluster. The findings of this research outline that existing cluster literature offers a somewhat static view of cluster drivers that does not adequately capture the impact of complex inter-relationships which exist between cluster drivers. The paper identifies a number of inter-relationships between cluster drivers within the Australian Aerospace Cluster.**

Keywords-component; clusters, drivers, barriers, inter-relationships, aerospace industry

I. INTRODUCTION

Clusters have been researched over many years and one area of cluster literature which is identified as integral to the operations of clusters is that of cluster drivers. However, drivers are rarely the primary focus of cluster research and the applicability of reported drivers beyond specific cases is not well understood. This paper examines the literature on cluster drivers and reports on the cluster drivers uncovered while investigating the Australian Tooling Cluster. It was found that cluster drivers extend beyond those reported in the literature. There are also dynamic and often complex inter-relationships between these cluster drivers which are not reported in the cluster literature. The recognition of significant drivers and of the interrelationships between drivers may have critical impacts on the way in which clusters are theorized and managed.

II. FORCES DRIVING CLUSTER DEVELOPMENT AND CONTINUATION

Over the last two decades clustering has become attractive not only to cluster practitioners but also to policy makers. The academic literature is replete with examples of cluster successes, as well as a variety of cluster models designed to facilitate or represent such success. This section will consider what the literature reports actually drive the development of clusters, and once established what it is that drives the continuation of a cluster.

The literature presents two main areas in considering the drivers for cluster development and continuation. The first area of discussion offers a range of possible advantages and benefits that clustering may bring to both the cluster as a whole and individual firms within the cluster. Bagwell (2008) suggests that firms are drawn to participate in clusters due to perceived advantages, including increases in competitiveness and productivity, growth of individual firms, the establishment of new firms, as well as increased profitability and innovation. Other authors such as Navickas and Malakauskaite (2009) have compiled similar lists of benefits and advantages, including the ability to minimise costs, increase knowledge and learning amongst firms, and improved accessibility for cluster members to external resources.

The second area of discussion distinguishes cluster drivers, as opposed to advantages and benefits for cluster development and continuation. Lin and Sun (2010) created a list of drivers based on Porter's (1990) Diamond for competitive advantage, with the first five cluster drivers modified from Porter's model. Those drivers are factor conditions, local demand conditions, related and supporting in industries, firm structure, strategy and rivalry; and government support. In a similar manner Cortright (2006) identified seven cluster drivers, which he terms 'Micro-foundations of clusters'. Cortright based the first three of his cluster drivers or micro-foundations on the work of Alfred Marshall (1966), being labour market pooling, supplier specialization, and knowledge spillovers. The remaining micro foundations were based on Cortright's own review of the cluster literature.

There appears to be an element of cross over with authors describing the advantages and benefits associated with clustering, as well as describing cluster drivers. Indeed, an argument can be made to suggest that it is the cluster advantages or benefits which draw a firm to a cluster and the driver(s) which lead to the establishment and continuation of the cluster. This section examines the advantages, benefits and drivers for clustering as reported in the literature. Rather than distinguishing the different facets of this area of the literature, this section will consider all under the banner of

DOI: 10.5176/2010-4804_2.4.254

cluster drivers. The overlap of cluster drivers, benefits and advantages is an area which may make for a valuable contribution to the cluster discussion as future research. The following section is divided into a series of sub headings which capture the essence of cluster advantages, benefits and drivers. Not all cluster barriers have been summarised, rather those which reoccur throughout the literature.

A. Changing supply chain structures and increased global competittion

Supply chain considerations have become increasingly important within cluster research, with some authors mapping supply chains, inputs, outputs and the general flow of goods and services (Porter 1998a, 1998b, Klier 1999). The development of clusters has challenged the traditional supply chain structure by providing smaller firms with increased opportunities to compete against larger organisations, or to collaborate with them. Small and Medium Enterprises (SMEs) were previously limited in their access to specialised knowledge due to size, but can potentially access this knowledge collectively through clustering. Clustering offers other potential benefits such as the ability to improve competitiveness, productivity, growth and to exercise the capabilities of a larger organisation, while retaining the flexibility and benefits of being small (Braun, McRae-Williams and Lowe 2005, Bagwell 2008, Navickas and Malakauskaite 2009).

Changes to supply chains through the establishment of clusters have been proactively undertaken by the firms involved, in part spurred by the development of a global economy. Globalisation has seen increasing levels of competition and has resulted in many smaller firms having to develop new competitive advantages in order to compete against or to supply larger firms. It is the focus on increasingly competitive environments which has seen firms look to the idea of clustering as a way to combat the challenges posed by the heightened level of global competition. As part of this focus some clusters have adopted a 'think global, act local' approach in which firms focus on clustering at a local level in order to be able to compete in international markets. However, exactly how firms take a catch phrase such as 'think local, act global' and implement it in the face of a changing supply chain they have been forced to react to remains unclear. Regardless, this focus is of particular importance to Australia, as the small population and geographical dispersion means that only limited success can be gained in the domestic market alone (Enright and Roberts 2001, McPherson 2002, Navickas and Malakauskaite 2009).

Some changes to supply chains in recent times have been enforced through restructuring of entire values chains, often driven by Original Equipment Manufacturers (OEMs). Increased global competition has also seen the OEMs reduce the number of suppliers that they engage, and strategically develop closer ties with their remaining suppliers (Lin and Sun 2010). For example, whilst centralising its service parts area in Japan, Toyota discovered that sourcing of these parts incorporated over six hundred suppliers. The logistical difficulty of dealing with this many suppliers was overcome by reducing the number of suppliers overall. Toyota then developed closer relationships with remaining suppliers to improve their quality and efficiencies in recognition of the fact that improved supplier performance will have positive effects for output (Tuten and Urban 2001, Trott 2002, Oxnard, 2004, Lin and Sun 2010). However, for organisations wanting to replicate Toyota's supply chain restructure, the literature offers little practical or functional assistance.

With OEMs seeking turnkey solutions from fewer suppliers as part of a reaction to increasingly global markets, SMEs need to find new ways to compete. These changes have facilitated the development of clusters, with both SMEs and OEMs benefiting from increased interaction between buyers and sellers within the supply chain (Cortright 2006). Through this increased interaction within the cluster, firms can be further driven by the possible sharing of advantages available within a cluster. Advantages related to sharing are discussed in the following section.

B. Sharing – cost, risk, infomration and marketing

One of the difficulties which SMEs may experience in an increasingly global environment is that they are largely out-resourced by much larger competitors. Clustering offers SMEs the opportunity to work together and realistically compete with larger firms whilst experiencing the benefits of sharing information, costs and risks when undertaking their operations. This level of sharing allows firms to undertake projects and take on risks which individually they would previously not have been able to attempt.

In considering the impact of clustering on SMEs, Navickas and Malakauskaite (2009) identified a number of benefits to clusters. One such benefit is increased knowledge and learning which can take place at an individual firm level. Firms are able to share information with other firms within the cluster across a range of areas including technology, innovation, marketing, finance and many other areas. The role of information sharing as a driver of clusters is identified in the Cluster Initiative Greenbook as being one of the most common objectives hoped to be achieved by firms participating in a cluster (Solvell, Lindqvist and Ketels, 2003).

Principles of knowledge sharing have developed outside of the cluster field, with seminal discussions around aspects such as tacit and explicit knowledge sharing (Nonaka 1991). Transfer of knowledge may occur in many ways, including tacit to tacit, tacit to explicit, explicit to tacit and explicit to explicit (Nonaka 1991). Cluster firms may agree which types of knowledge can be shared, for example the transfer of tacit knowledge may be facilitated by firms interacting with each

other, in either a physical or virtual environment. It is through the transfer of knowledge that firms within a cluster are able to learn of new ways in which they can operate within their business field and so collectively the cluster builds its knowledge (Rosenfeld 2005, Braun et al 2005). The potential to access knowledge and information which can be facilitated by clusters acts as a significant driver for firms looking to cluster, especially when one considers that unlike a physical good, knowledge can be continuously reused and redefined (Cortright 2006). The field of research on knowledge within clusters continues to grow, with Maskell and Malmberg (2007) investigating the development of knowledge over the life cycle of a cluster, while Bocquet and Mothe (2010) note that the distinction between internal and external knowledge within clusters is an area in need of further research.

C. Government policy and intervention

Although the cluster literature provides a wide ranging discussion of the role of government in clusters, particularly in respect to policy decisions, governments and policy making do not regularly feature as part of cluster driver discussion. However, through reviewing a number of articles outlining descriptions and examples of government cluster based policy making and intervention, it is apparent that governments do act as drivers for clusters. For this reason this section will outline the discussion of cluster policy and the role of government as a cluster driver.

As noted earlier, discussion around cluster definitions and models is broad and needs some level of refinement through future research. In line with the broadness of the cluster discussions, authors have suggested clusters as a cure for all manner of economic challenges. In AC Styria Austria, clustering was seen as the way in which to reposition a one hundred year old automotive industry (ACENET 2002). In New Zealand clustering was used to bring together the forestry industry (Perry 2005) and as a way of increasing innovation in Australia and the United Kingdom (Couchman, McLoughlin and Charles 2008). Perhaps it has been the perceived ability to address a wide range of challenges that has encouraged a number of governments around the world to develop cluster policies. Often, governments support clusters as a way of contributing to national agendas such as increasing innovation and/or competitiveness or assisting existing industries to survive and innovate (Lindqvist 2009).

Indeed, Martin and Sunley (2003) suggest that the implementation of clusters as formal government policy may have preceded rigorous academic investigation into the theory and concepts of clustering. By 2003 forty states in the United States of America (USA) had seen their state governments involved in clusters, ranging from case study investigations through to actual legislation. At the same time, in Europe more than ten nations had embarked on cluster based policies, including some of the largest economies such as France, Germany and the United Kingdom (Lindqvist 2009). This level of involvement at a policy level in clusters by governments has acted as a catalyst for SMEs to become involved in clusters.

One way in which governments may become involved in clusters is through funding. In 1995, changes in the Austrian automotive industry saw original equipment manufacturers (OEMs) moving 35% of automotive component purchases offshore. The government acted to develop a government funded cluster based on the existing industry. As part of this cluster the government offered funding, which was progressively reduced over a number of years, though the government maintained representation within the cluster. As a result of the development of the government assisted cluster, firms were able to regain much of the work which had previously been lost. Furthermore, a majority of firms remained part of the cluster once government assistance was removed (ACENET, 2002). In this example the government had a vested interest in preserving the automotive industry and associated jobs and related industries. However, it was the government's direct involvement and funding which acted as a driver for the SMEs to participate.

The extent to which governments are or should be involved in the support (financial and leadership) of clusters varies from case to case. It is also suggested by some authors that governments do not create clusters; they can only facilitate their development. For a cluster to develop it needs to be based on pre-existing factors, such as existing company relationships, local knowledge or resource assets. All a government can do, in this scenario, is use these existing conditions to try and promote clusters through policy (Rosenfeld, 2005).

While there are obvious and demonstrated roles governments can and do play in the development and support of clusters, it is also important to have ground rules for their involvement. In this regard, Ketels and Memedovic (2008) put forward four points of consideration for government involvement in clusters. Firstly, a cluster policy cannot survive alone; rather it needs to build upon sound economic policy. Secondly, governments should base their support for clusters on the basis of the groups' willingness to work together, rather than rewarding a few stand out firms within clusters. Thirdly, it is important for government to take a role in the cluster; however this role should not be as the cluster leader. Finally, governments should not provide subsidies or protection to the cluster; rather it should operate under the normal industry conditions. Overall the basis of cluster policy should be to 'leverage local assets, capabilities, histories and geographic locations' through sustained participations and neutral ownership. In researching policy initiatives in relation to clusters, it is suggested that cluster policy can be summarised into three types:

"those to leverage clusters, those to strengthen clusters and those to create clusters" (Ketels and Memedovic 2008 p.383).

Regardless of the type of initiative pursued, it is apparent that governments can and do act as drivers for the establishment of clusters.

D. Specific location and events

As part of Michael Porter's cluster discussion (1990, 1998a, 1998b) the concept of geographic proximity forms a key and widely debated element of clusters. Despite the varying

opinions in the literature surrounding geographical proximity it is apparent that it can act as a driver for firms to cluster. Through Porter's diamond of competitive advantage he refers to local demand within a particular area which may impact on the type and nature of the firms attracted to an area. As this local demand expands, even into national or international demands, a cluster of SMEs may begin to form, being driven by these local demand conditions (Lin and Sun 2010).

However, there are other reasons why SMEs may be drawn to a particular area and form clusters. Some clusters have evolved over a number of years around a specific location based on natural factors such as resource deposits or rivers used for trading routes. In some cases this natural factor may still exist and be important, while for others the original reason for the development of the cluster may have gone but the cluster remains. In the presence of a natural resource often one or a few large organisations will locate nearby in order to exploit the resource. This has been the case in cities such as Newcastle, Australia where BHP established itself originally to take advantage of nearby coal deposits. Alternatively, the existence of a natural resource may attract a large number of SMEs looking to exploit a natural resource, such as The Great Barrier Reef, which has led to concentrations of the tourist industry along the eastern seaboard of Queensland. While these firms may not have intended to form a cluster, a common interest in a natural resource has driven them together, even if they also remain competitors (Braun, McRae-Williams and Lowe, 2005).

Clustering may also be driven by the occurrence of a specific event which enhances the viability of firms clustering or creates a situation in which clustering is the best response to the event. These events tend to be one off changes which occur for a variety of reasons, including social aspects, government regulations or other external changes which impact upon a firm. One such example of this was reported by Perry while researching the New Zealand forestry industry, where a government enforced change to the forestry resource profile artificially brought firms in the industry closer together. Rather than resisting the change, firms saw it as an opportunity to explore advantages of and formed a cluster. Without this issue arising, the firms may not have joined nor considered creating a cluster (Perry, 2005).

The occurrence of a natural resource and its location can act as an important driver for the development of a cluster. Advantages of being located near key firms and / or important natural resources bring together firms in related industries which may provide the driver for cluster formation.

E. Cluster driver literature summary

There are a variety of drivers which may draw SMEs towards the idea of clustering. The cluster literature offers an outline of many of these different factors, although often these are mentioned as part of broader discussions of clusters and are not regularly referred to directly as drivers per se. As is often the case with cluster literature, a vagueness of definition sees the cluster driver discussion also including the benefits and advantages of clusters. Whilst future research would be required to investigate the difference between cluster advantages, benefits and drivers, this research has been considered under the banner of cluster drivers.

In recent literature, authors such as Cortright (2006) and Lin and Sun (2010) have directly referred to cluster drivers as part of their research into clusters. The difficulty, as has been seen with other areas of cluster literature, is the challenge of coming up with a generic set of cluster drivers. To date, cluster drivers have primarily been discussed within the context of specific cluster examples, rather than existing as its own area of discussion. Lin and Sun (2010) acknowledge that cluster drivers do not operate in isolation. Rather, cluster drivers interact with other cluster drivers and together all cluster drivers will have an impact on the cluster, but these authors do not offer discussion beyond the identification of interacting cluster drivers identified through a quantitative method. This aspect of their work will remain important for future research as it may assist cluster theory to be more broadly applicable to clusters generally.

III. Aerospace Tooling CLuster

This section briefly outlines chronologically the events surrounding the development of the Aerospace Tooling Cluster in Australia which was the focus of this research and has been developed from a range of secondary sources of data. Names have been changed in order to maintain anonymity of those involved.

In 2002 an international commercial aerospace original equipment manufacturer (OEM) began work on developing a new passenger airplane. As part of this development the OEM undertook a new, global approach to the manufacturing of the aircraft. The global approach sought to improve quality, while reducing costs by up to 50% and reducing tool development time from 30 months down to 18 months. The OEM acknowledged that achieving these improvements would require a new approach to supply chain management, including tooling companies. Improvements in delivery time to market and reduced costs would be facilitated by sourcing from preferred tooling suppliers at a global level, rather than employing the services of a large number of local firms individually. These firms would need to be innovative, technologically advanced and culturally mature. The OEM also called for work on different components of the aircraft which would be completed simultaneously and would require a concurrent approach to tooling and overall manufacturing.

As part of this new global approach to manufacturing, and with the assistance of existing suppliers, the OEM identified a number of areas around the world which supported emerging tooling industries, including Australia. The OEM used its

Australian supplier firm, Aerospace Australia, to source tooling capacity and capability for various components via an audit of Australian tooling. The audit of Australian firms was done in consultation with the Industry Association. It should be noted that the audit was confined to members of the Industry Association. Based on this audit firms were classed as either Tier 1 which included firms experienced and currently involved in the aerospace industry (three firms identified), Tier 2 those who had previous experience in the aerospace industry or capabilities comparable with those required for aerospace work, and Tier 3 firms which could prove technology and capacity as required. Aerospace Australia advised that it would be dealing with the Tier 1 firms as a strategy to reduce the number of suppliers they deal with on a global scale. That being the case, smaller firms (Tiers 2 and 3) would have access to the available work by aligning themselves with the Tier 1 firms in order to co-operatively work together and pool resources. The three Tier 1 firms consisted of two firms from Melbourne and one from Sydney, with the companies in the remaining Tiers being located across New South Wales, Victoria and South Australia. As can be seen, geographic concentration was not a prerequisite for cluster formation.

In the pre-order stage customer enquiries were directed through the Industry Association as the single point of contact. Once enquiries were made to the cluster the three Tier 1 firms, with the assistance of the Industry Association, jointly quoted for the work and decided which of the firms should present the quote and be responsible for that particular part of the job. It was then up to the Tier 1 firms to formalise a quotation and act on behalf of the cluster. Once an order was accepted the Tier 1 firm responsible project managed the work and distributed work to the Tier 2 and 3 firms within the cluster. The Industry Association's role in these processes was one of facilitation to attempt to ensure that the group operated effectively and also in the interests of the other cluster members. The industry association's role would be more considerable at the start of each project and diminish once the work was to begin, and project management then became the responsibility of the Tier 1 firms. Subsequently, despite a significant reduction in the anticipated amount of work to be received, the cluster was successful at fulfilling orders for the OEM. However, not all firms at the Tier 2 and Tier 3 levels received work.

IV. Methodology

When undertaking a research project the researcher is confronted with a wide range of research methodologies and tools which may be employed. Cluster literature demonstrates a range of qualitative and quantitative techniques which have been used to investigate clusters. In part, this range of techniques is reflective of the variety of discipline areas which investigate clusters, ranging from quantitatively based virtual collaboration researchers through to the more qualitatively work of some geographical economists and others. The research on the Australian Aerospace Cluster offered the opportunity to investigate a cluster in real time, with the researcher being able to directly access cluster stakeholders from the cluster. In order to obtain the richest data from these respondents it was deemed that qualitative research methods within a case based approach was the most appropriate to provide a unique insight into the dynamism of clusters over a cluster life cycle

As identified, much of the cluster literature presents theories which have been derived from historical quantitative data. Whilst this information has provided a sound basis from which to investigate clusters, it is not without its shortcomings and limitations. The reliance on historical data to determine the existence of a cluster and indeed movement throughout a cluster life cycle has resulted in a series of somewhat static cluster theories which are often closely tied to a specific cluster example. As a result, cluster theory has been able to recreate and retell a cluster experience, but has had significantly more difficulty in being able to identify emerging clusters and predict cluster behaviour.

Furthermore, the cluster literature has often lacked substantial supporting empirical evidence, in part due to a majority of data required determining the existence of a cluster or the various phases and stages being available after the fact. A move towards more empirically qualitative based research has also seen an increase in the emergence of case study analysis and semi-structured interviews as a primary method of cluster research (Sonderegger and Taube 2010, Speirs 2007). In developing a case study approach to this research the authors have been guided by the principles of case research outlined by Yin (2003).

V. Aerospace Tooling cluster drivers

Cluster drivers as reported in the literature are investigated throughout this analysis to identify whether or not they are found within the Aerospace Tooling Cluster. As part of this research, the search for cluster drivers also reports any drivers which may be present through the investigation, but not previously identified in the academic literature. Analysis of the semi-structured interview data was used to uncover the cluster drivers within the Aerospace Tooling Cluster. Some of these cluster drivers confirm those identified in the cluster literature, while new cluster drivers are also uncovered and discussed. The analysis in this section will go beyond a simple identification to investigate the influence of cluster stakeholders on cluster drivers and cluster barriers. The cluster drivers identified as part of the Aerospace Tooling Cluster are outlined below;

A. Increased global compeition

The cluster literature offers many examples of clusters, with some of these being driven by increased global competition (Braun, McRae-Williams and Lowe 2005; Bremer, Michilini, Siqueira and Ortega 2000; ACENET 2002). Often these examples show firms reacting to a negative situation with existing work being moved off shore to countries which are more price competitive. In the case of the Aerospace Tooling Cluster work going offshore from Australia was certainly an issue for the cluster, however it was not this aspect of increasing global competition which acted as a driver. Firms seemed to be resigned to the fact that the industry was in decline and work would go overseas. Rather, it was the OEM implementing a global tooling strategy that would actually bring work into Australia which saw increased global competition act a driver for the Aerospace Tooling Cluster. It was this potential increase in work, rather than a reaction to a declining market, which was the main impetus of this cluster.

Each of the Tier 1 firms acknowledged increased global competition in the market as a driver and had the size and resources to react and adapt. Each of the three Tier 1 firms has an export component to their business and is familiar with the changing global market. Whilst each of the firms are competitors, the volume of work sought by the OEM from Australia was beyond the scope of these firms individually. The large amount of work that was initially envisaged allowed the firms to move past their normal competitiveness and to provide support to the proposed cluster. With the Tier 1 tooling firms supporting the cluster, this provided a level of increased confidence to the potential Tier two and Tier three firms and allowed support for the Aerospace Tooling Cluster to gain momentum. Whilst the individual Tier 1 firms' motivation may have related to each of the firms seeking to increase work and profits, their collective support generated confidence amongst other firms.

Despite the fact that all firms were impacted by the effects of global competition, the motivation and desired outcomes from the cluster for each group was somewhat different. The Industry Association and Tier one firms appeared to be the most conscious of the impact of the increased competition, with Tier one firms interested in increasing their level of work and gaining further exposure to the international market. They were less concerned with the decreasing domestic market as their size and the breadth of work they were capable of completing would offer some protection against a shrinking domestic market. The Tier two and Tier three firms did not appear to be as concerned with the increased global competition, but were concerned about other changes in the industry, which when investigated are also a result of increased global competition. For its part, the Industry Association sought the dual advantage of assisting the industry which would retain existing members, whilst success of the cluster could draw in new members. Increased membership for the Industry Association would also ensure its survival in a declining market.

All stakeholders mentioned above actively sought to participate in the cluster, although each group offered a different reason or motivation for doing so. In investigating these reasons more closely it is interesting to note that the motivations for each group can be related to increases in global competition. Increased global competition was behind the reason that the OEM was looking to source tooling globally and this has created a ripple effect throughout the supply chain. As such it can be said that the Aerospace Tooling Cluster would not have come into existence had it not been for increased global competition. The important element here is that this driver common to the various groups has manifested itself in a variety of forms, yet not being explicitly identified as increased global competition. This has been identified as the primary driver for the Aerospace Tooling Cluster, as without increasing global competition it is unlikely the cluster would have formed.

B. Changing supply chains

It is evident from the previous section that increased global competition has impacted on each of the cluster stakeholders, and has been a driver for the formation of the Aerospace Tooling Cluster. With increasing global competition, there have been changes to the supply chains within the aerospace industry, including the tooling sector. This section investigates how changing aerospace tooling supply chain structures, in reaction to increased global competition, have also acted as a driver for the cluster stakeholders.

Taking the lead from the original equipment manufacturer (OEM) and other aerospace original equipment manufacturers, Aerospace Australia set about changing the way in which their own supply chain operated. In the past, Aerospace Australia dealt directly with multiple firms on any given project. Using the aerospace OEM as a guide, Aerospace Australia set about reducing the number of points of contact in their supply chain. However, while willing to participate in order to maximise the chances of obtaining a large parcel of work for their members, the Industry Association was given no option in terms of the structure this would take – it was requested to provide a cluster of firms with a single point of contact. Throughout the interview with the Senior Industry Association representative it was repeatedly indicated that they had very little choice but to cluster, with phrases such as "companies had to collaborate" and "we were forced to do that collaborative model". With the formation of the cluster, Aerospace Australia then refused to deal separately with individual firms and began to direct all enquiries through the Industry Association in order to promote their desire for a cluster model. Given that the tooling industry was already under duress from a reduction of work in the automotive industry, the Industry Association undertook the task of setting up a tiered cluster at the request of Aerospace Australia in the hope of securing a large scale contract which would boost a vulnerable and declining industry.

Tier two and three firms could no longer deal directly with Aerospace Australia; if they wished to work on the 7E7 aircraft they would need to do so through a Tier one firm. Overall, the changing supply chain acted as a driver for firms to participate in the cluster, primarily because if they did not participate in the cluster they would not be able to receive any of the large amounts of work which was initially promised through the 7E7 aircraft project.

It is suggested in the cluster literature that firms take a coordinated approach to the formation of clusters to seek benefits such as the ability to improve competitiveness, productivity and growth, and to exercise the capability of a larger organisation and retaining the flexibility of being small (Braun, McRae-Williams and Lowe 2005, Bagwell 2008, Navickas and Malakauskaite 2009). For the Aerospace Tooling Cluster the various stakeholders were more concerned with the supply chain immediately above them, with little reference paid to the overall supply chain.

Stakeholders within the Aerospace Tooling Cluster were motivated by survival and compliance, which provides a significant background story to the establishment of the cluster. Firms may not wish to participate in a cluster but may be driven to do so for a number of reasons. In the case of the Aerospace Tooling Cluster in Australia it was top down compliance and an attempt to survive by securing more work which acted as the motivation for the cluster. In doing so these firms have significantly contributed to the changing supply chain as a driver to the cluster as it is their actions in adapting to the new supply chain which created the cluster. Future research of cluster drivers should also consider that clusters might not necessarily form voluntarily and that the stakeholders may be in some way coerced into forming or participating in a cluster.

C. Project management

The cluster literature has reported changing supply chains as a result of, and indeed a cause of clustering. However, these discussions tend to focus on the broader concept of a changing supply chain, without taking into consideration the implications or impacts of such changes for individual stakeholders. Within the Aerospace Tooling Cluster the external supply chain changes and the directed cluster formation with a single point of contact requested by Aerospace Australia resulted in a significant shift downward of project management responsibilities. The desire of both the OEM and Aerospace Australia to move the project management responsibility down the supply chain acted as a significant driver for the formation of the Aerospace Tooling Cluster. Without the movement of project management down the supply chain there would not have been the need to create a cluster. The cluster driver of shifting project management has not previously been covered in the cluster literature. This section outlines how project management acted as a driver of clustering within the Aerospace Tooling Cluster.

As indicated above, increasing global competition within the aerospace industry has led to all levels of the supply chain changing the way in which companies have traditionally conducted their business. The revised supply chain structure affecting the Aerospace Tooling Cluster resulted in both the OEM and Aerospace Australia wanting to reduce the number of suppliers with which they engaged. However, as the number of firms engaged in the supply chain reduces there is an increasing expectation that the size and scope of the work provided by lower levels of the supply chain increases. Effectively this pushed the project management function, previously undertaken by the original equipment manufacturer and Aerospace Australia, down the supply chain. With lower levels of the supply chain being expected to produce and manage more, they were often asked to complete tasks beyond their capability and capacity. As these organisations wished to remain part of the supply chain they complied with the request to form a cluster in order to prove capability, capacity and combined project management ability.

Aerospace Australia took the lead from the OEM and also decided to reduce the number of suppliers they utilised as part of their operations. In remodeling their supply chain they looked to deal with fewer companies in order to simplify their supply chain; in particular they wanted to deal with one point of contact. Not only would this reduce the complexity of their supply chain, but it would also transfer much of the project management responsibilities and costs associated with coordinating and managing a number of suppliers. The element of project management is an important consideration in terms of where it sits in the supply chain. Project management requires a high level of coordination, which is reflected through higher labour costs; hence if these costs can be transferred to another level of the supply chain it could represent significant savings for the firms at the pinnacle of the supply chain. Furthermore, Aerospace Australia repeatedly referred to dealing with multiple points of contact as an ‘administrative burden’. It was considered much more desirable to allow the Tier one firms to sort out who had the best capability and capacity to meet the needs of the 7E7 aircraft work. Whilst the Tier two and Tier three firms were not asked to take on additional project management responsibilities, they were impacted by the change. The new supply chain structure meant that these firms were no longer able to deal directly with Aerospace Australia. Rather, they would become part of the project management coordination of the Tier one firms and would rely on them to pass work further down the supply chain.

The difficulty with this type of situation is that while the academic literature can broadly identify drivers for clusters, such as a changing supply chain, it does not report on the implications and impacts of the drivers at an internal firm level. At the external level the changing supply chain has created a secondary driver of the movement of project management down the supply chain. However, when this is observed more closely at an internal or firm level it can be

seen that the movement of project management has created a number of issues. The question for cluster research is then how in-depth the description of cluster drivers goes without running the risk of the information becoming too case specific. In the case of the Aerospace Tooling Cluster this has been shown to be important as the movement of project management down the supply chain has acted as a driver for the formation of the cluster, but it has also created a number of issues which may suggest that this driver may also paradoxically develop into a cluster barrier. Thus, the changing nature of cluster drivers is an area of the literature which requires further development. Furthermore, the consideration of cluster drivers changing over time to become a barrier to the cluster is a new area of consideration which will require more research and more consideration of the internal issues related to cluster drivers.

D. Sharing risk, cost information and Marketing Joint ventures

Cluster literature outlines how the sharing of risk, cost, information and marketing within a cluster can act as a driver for firms to participate in clusters. Risk and cost can be shared across a number of firms, thus minimising the exposure and expense to any one firm (Camarinha-Matos 2001, Ketels 2003). Solvell (2003) also suggests that marketing joint ventures in clustering allow firms to tender for jobs that would have previously been unattainable due to the capacity and capability of the firms.

A prime example of how cost can be shared across firms to reduce the burden on any one firm can be seen through the establishment of the Aerospace Tooling Cluster as a marketing joint venture. The Industry Association used the cluster name as a way to promote the capability of the companies under a single name, whilst the cost of this was spread across the three Tier one firms. Creation of the name also provided the cluster with the opportunity to build a brand and identity which could be used to promote the combined capabilities of the Industry Association members. By marketing the cluster capabilities under the Aerospace Tooling Cluster banner, the participating firms appeared more attractive to potential suppliers as they presented a large capacity and capability, rather than a group of small firms. The Senior Industry Association representative acknowledged that the cost associated with establishing and marketing a brand was shared across the Tier one firms and allowed for a wider level of exposure than any of the firms would have been able to achieve on their own.

The ability of the Tier one firms to be able to gain access to larger amounts of work and provide a platform on which to establish a global business acted as a driver for them to participate in the cluster. Each of the three Tier one firms acknowledged that there was benefit to the joint marketing activities which were achieved through the creation of the Aerospace Tooling Cluster brand. The OEM was aware that the Industry Association and the three Tier one firms formed the Aerospace Tooling Cluster and used the name as a marketing tool; however the marketing aspect of the cluster was not of interest to them at that time. Their interest was focused on the possibility of being able to deal directly with Aerospace Tooling Cluster as a single entity as opposed to the three Tier one firms individually. In this regard a majority of the attempts at jointly marketing the Aerospace Tooling Cluster name were to international original equipment manufacturers. Not only did this achieve exposure and lead to further quotes for the cluster, it also assisted the Industry Association in achieving its goal of gaining global exposure as the cluster facilitator.

The Senior Industry Association representative acknowledged that the creation of a marketing brand provided a significant cost saving to firms in the cluster as they were able to market the capabilities of their members internationally, something that would have been an expensive and risky task had any of the firms attempted this individually. While the benefit of cost sharing was evident in the cluster, it should be considered more of a consequence of the cluster as opposed to a driver behind the cluster. The cluster was not initially driven by the desire to share costs, risks, information or joint marketing, despite the fact that this became a benefit of the cluster.

E. Expectation of increased level of work (new)

Whilst the increase in global competition and changing supply chains may have been external drivers which moved firms towards the Aerospace Tooling Cluster, the anticipation and expectation of an increased workload acted as a driver for the stakeholders. For many years the tooling industry has relied on the automotive industry for work and with this sector in decline (also due to increased global competition) the possibility of work from the aerospace industry acted as a driver for the cluster stakeholders. As part of the discussions a number of respondents indicated they were expecting approximately one and a half million hours of work to come into the Australian tooling sector. This represented a significant inflow of work to the sector which was only going to be available by being part of the Aerospace Tooling Cluster. As such, being part of the cluster was the way to obtain part of this work and hence Tier one, two and three firms all expressed an interest in the cluster. However, it was not the cluster, or the idea of clustering which acted as the driver, rather it was the potential to obtain a portion of a large amount of work from a different industry which acted as the driver.

The analysis of interview data reveals that these firms had been affected by an industry that was experiencing changing industry conditions, with original equipment manufacturers moving work offshore and new projects requiring tooling capabilities much larger than their own. The 7E7 project offered firms the hope that they would have full workshops and a new source of income.

While it is acknowledged that the receipt of more work would have a financial benefit to the firms, none of the respondents referred to an increase in revenue as the drive for the

formation of the cluster. Rather, firms were indicating they wanted more work. This becomes an important distinction as the firms are focusing on the idea of work and having workers productive on the shop floor, as opposed to simply looking for profit. The Tier three firms also indicated that they were driven to the cluster by the prospect of work and Tier three firm N indicated "it was an opportunity for work". Other Tier three firms expressed similar feelings towards being driven by the promise of increased work. Tier three firm E referred to the desire to "fill their workshop up with work". It was the promise of more work in a different sector that acted as a driver for stakeholders to be involved. However, if stakeholders were not part of the Aerospace Tooling Cluster then they were unable to obtain work from the 7E7 aircraft. In this regard, firms were interested in the work from a survival perspective, yet forced to engage in the cluster to obtain the work. This raises a distinction between drivers which are naturally occurring and those which are forced, an area of consideration for future research.

It is evident from the discussion above that the cluster stakeholders have been driven to the cluster structure by the promise of a large amount of work in a different sector, the aerospace industry. Firms were not drawn to the idea of clustering, rather they were drawn to the promise of potential work; forming into a cluster became a prerequisite to be eligible to access this work. As such, the formation of the cluster became an issue of compliance rather than a desire of the firms. It is also interesting to note that whilst the Tier one, two and three firms were all driven to the Aerospace Tooling Cluster, their perceived outcomes and motivations for doing so were different.

F. Governments

The cluster literature indicates that governments may have vested interests in seeing clusters develop or continue, and have driven the formation of clusters in the past. The ACENET (2002) report on Styria, Austria outlines how government intervention was able to initially support the 100 year old automobile manufacturing industry by assisting in the establishment and development of a cluster to assist with the long term survival of the industry. There are other examples of governments supporting and driving clusters within Australia and abroad (Wickham 2005, Rosenfeld 2005, Lindqvist 2009).

In the case of the Aerospace Tooling Cluster the Victorian state government played a role in driving the cluster development. It did this primarily through the provision of funding in the initial stages of the cluster development and further financial support for the promotion of the Aerospace Tooling Cluster. Research of secondary data indicates that in 2004 the Victorian Government provided $30,000 in assistance to the Aerospace Tooling Cluster. The funding assisted the promotion of tooling capabilities through the Aerospace Tooling Cluster and the development of a technology roadmap for the tooling industry. The Aerospace Tooling Cluster was also mentioned by the Victorian Government as a leader in trade missions. The government supported the cluster model and would seek more assistance through the Commonwealth Government. Furthermore, Aerospace Tooling Cluster became a demonstration project for a federally funded project promoting clustering.

It is apparent from this information that government, particularly the Victorian state government, was supportive of the Aerospace Tooling Cluster. The provision of funding indicated that the government was encouraging the growth and development of the cluster. In this regard the government was active in driving the firms to participate in the cluster. Interestingly, when analysing the interview data, there is very little mention by any of the firms of this government support. Two of the Tier one firms acknowledged there was some government funding, yet did not elaborate on how it was used, if it was useful or why it was supplied. In fact there is more evidence of the government funding through secondary research than there is through the interview data.

It is evident in the Aerospace Tooling Cluster that there was government support for the cluster which included a financial contribution from the Victorian Government. The purpose of the support and financial contribution was essentially to drive the development of the Aerospace Tooling Cluster. However, this support and drive from the government hardly raised a mention from the cluster stakeholders. There was a drive and support for the Aerospace Tooling Cluster from the government; however it does not appear to have impacted on the cluster. As such it may be appropriate to distinguish between the presence of cluster drivers and those which actually impact the cluster, or alternatively to look at a rating system for drivers from strong to weak. These areas would require further research.

G. Aerospace Tooling Cluster driver summary

It can be seen from the discussion above that investigation of the Aerospace Tooling Cluster has confirmed the existence of cluster drivers which have previously been identified in the cluster literature. Increased global competition, changing supply chain structures and sharing were identified as part of the cluster literature review and also found to be present in the Aerospace Tooling Cluster. The driver of governments policy and intervention was also identified as a driver, however was not acknowledged by the firms within the cluster.

It is also noted that the cluster driver of Project Management had a significant impact on the Aerospace Tooling Cluster. However, this driver was previously unreported in the reviewed cluster literature. This generates discussion as to whether or not this cluster driver is specific to the Aerospace Tooling Cluster or whether there are more generic lessons which can be applied across other clusters. As part of the change in the supply chain, there was a transfer of project

management down the supply chain, with a resultant change in the ability of firms higher in the supply chain to alleviate the their costs and responsibilities associated with project management. The desire to reduce this responsibility acted as driver in the Aerospace Tooling Cluster. The transfer of project management capabilities from OEM to Aerospace Australia was successful as Aerospace Australia had a level of project management capability. However, when this responsibility was transferred to the Tier 1 firms who would need to coordinate in excess of fifty firms, the project management driver became difficult, yet the cluster continued to proceed in order to receive work.

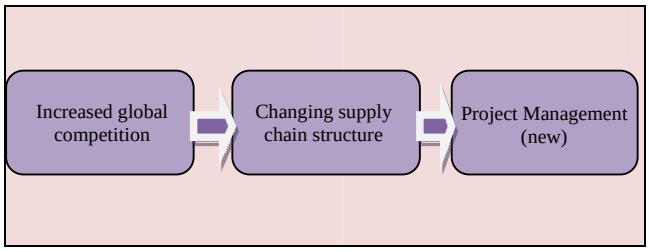
VI. Cluster Driver Inter-Relationships

Through the analysis of the Aerospace Tooling Cluster it became apparent that there were relationships between some of these drivers. The suggestion of cluster drivers having an inter-relationship represents a significant development for cluster theory as cluster drivers have traditionally been considered in isolation. This section will discuss the inter-relationships between the cluster drivers identified earlier as part of the Aerospace Tooling Cluster analysis.

A. Increasing global competition – Changing supply chain structures – Project Management

It has been established that an increase in global competition, a changing supply chain structure within the global aerospace industry, and project management, have acted as drivers of the Aerospace Tooling Cluster in Australia. These drivers affected the various cluster stakeholders and as such influenced the overall success of the cluster. This section investigates the relationships between the drivers of 'increased global competition', 'changing supply chain structures' and 'project management' to demonstrate that these cluster drivers are not static, rather they are dynamic, with the ability to influence each other through an inter-relationship, and indeed to transform over the lifecycle of the cluster. This relationship is recreated in Figure 1 below.

Figure 1: Inter-relationships between cluster drivers



An increase in global competition impacted, albeit not uniformly, on all of the cluster stakeholders and drove them towards the establishment of the Aerospace Tooling Cluster. Firstly, there was a new global player in the aerospace market in the form of Airbus which placed increasing pressure on other established aerospace manufacturers such as Boeing. Secondly, the options for the supply of aerospace tooling had significantly increased with the advancement in scope and quality of developing countries such as China becoming heavily involved in manufacturing, including the area of aerospace tooling. Aerospace Australia and the firms within the tooling industry were seeing a shrinking domestic market as work and organisations moved off shore to take advantage of cheaper labour rates in developing countries.

It was not only the increase in global competition that impacted upon the different stakeholders within the Aerospace Tooling Cluster and drove them towards clustering; increased global competition also affected the development of other cluster drivers which influenced the Aerospace Tooling cluster. This increase in competition caused aerospace manufacturers to review the way it procured tooling and components for their aircraft manufacture. For example, Boeing embarked on a Global Resourcing Strategy which would look to source tooling for the 7E7 aircraft from around the world, whilst incorporating a fifty per cent reduction in the cost of their tooling and an almost fifty per cent reduction in the time to deliver the tooling. At the same time Boeing also indicated that they no longer desired to deal with a large number of suppliers and would be looking for suppliers who could provide larger and more complete components of the aircraft.

All of these changes undertaken by Boeing were in reaction to new threats and opportunities presented by an increase in global competition in the aerospace market. Firms such as Aerospace Australia now needed to demonstrate to Boeing that they had the ability to meet these new supply conditions, including the ability to supply larger components of work. Essentially, it was the increased global competition which prompted Boeing to change the way in which it procured components and tooling for its aircraft. This in turn set off a chain reaction of changes within their supply chain which saw firms at each level making changes to the way in which they supplied their components and interacted with the various levels of the supply chain. Firms such as Aerospace Australia were now required to provide larger and more complete components in shorter timeframes, which meant they too needed to rethink their own supply chain. This resulted in Aerospace Australia approaching the Industry Association to organise a cluster of tooling firms which became the Aerospace Tooling Cluster.

It is evident from the discussion above that the increased global competition within the aerospace sector caused Boeing to undertake a significant change to its procurement

of tooling and components. This created a ripple effect throughout the supply chain which culminated in the development of the Aerospace Tooling Cluster. As such what can be seen are not only two drivers affecting a cluster, but the driver of increased global competition also impacting, and possibly creating, the driver of changing supply chains. Without increased global competition, Boeing would not have needed to reconsider the procurement of aircraft components and tooling. This represents an inter-relationship between these two cluster drivers. Traditionally, cluster drivers have largely been viewed in isolation, as individual drivers which have a sustained impact upon a cluster. From the discussion above it can be seen that without the driver of increased global competition it is unlikely that the second driver, changing supply chain structure, would have developed to also impact on the cluster significantly. This demonstrates the importance of considering the relationships between drivers as they may have a significant impact on the overall function of a cluster.

The ripple effect of the impact of the cluster drivers upon one another stretches further, with the changing global supply chain also impacting upon the cluster driver of project management. Although Boeing decided to deal with fewer suppliers, this did not mean that there were fewer components. Rather, it meant that they were looking for fewer suppliers to supply larger, more complete parts of the aircraft ready for assembly. As a consequence of this decision, much of the project management and coordination of aircraft components was pushed down the supply chain. In order to cope with the transfer of project management throughout the supply chain, Aerospace Australia requested the Industry Association to facilitate a single point of contact of tooling firms. The single point in contact and project management responsibility was a significant element leading to the development of the Aerospace Tooling Cluster. As noted above, in order to represent the relationship between these three drivers the cluster driver inter-relationships diagram (Figure 1) was developed. In the case of this Aerospace Tooling Cluster driver inter-relationship, the causes of increased global competition have come from outside of the cluster itself. The introduction of Airbus into the market and the development of China as a supplier to the aerospace industry are external to the Aerospace Tooling Cluster. Similarly, the changes to the aerospace supply chain are external to the cluster. These supply chain changes were generated by Boeing and Aerospace Australia and the cluster reacted to them. Whilst the transfer of project management has also occurred outside of the cluster, it has been addressed by the firms within the cluster and has been considered an internal element. The inclusion of internal and external perspective of cluster drivers allows the Aerospace Tooling Cluster to demonstrate an additional element to the cluster driver relationship. In this case it is the external drivers which are influencing an internal driver which has led to the development of the Aerospace Tooling Cluster.

VII. Dynamism and Inter-relationships of Cluster Driver

Within the Aerospace Tooling Cluster it was found that there were relationships between the identified cluster drivers. As outlined above, with increased global competition, changing supply chain structures and project management, it was found that each of these drivers impacted upon the next in a linear fashion. The suggestion here is that each cluster driver impacts upon the next, with the possibility that these inter-relationships create a synergy which may see the impact of the combined cluster drivers being larger than the sum of the individual influences.

Just as the investigation of these relationships is important to cluster research, the Aerospace Tooling Cluster also focuses attention for future cluster research to give consideration as to the motivation and influence of each driver. For example, it is acknowledged in the cluster literature that increased global competition acts as a cluster driver. This was true for the Aerospace Tooling Cluster; however it was found that it was not a desire to combat the increased global competition that stimulated the driver. Rather, it was increased global competition leading to changes at Boeing that saw it sourcing work in Australia which was the source of the driver. As such it is important that not just the driver be identified, but the cause of the driver to also be fully understood.

To further this point, the cluster literature indicates increased global competition can act as a driver for clusters and it is apparent that increased global competition has been influential in relation to the Aerospace Tooling Cluster. All of the firms within the Aerospace Tooling Cluster have been affected by the increased global competition in the tooling industry. Without global competition the industry would not have had a background of a declining market and Boeing would not have been looking to source tooling through Australia as part of a global tooling strategy. In short, it can be said that the declining domestic market was not a strong enough motivator for the cluster to commence. However, it is also apparent that the cluster would not have formed without the effect of increased global competition. As such it becomes important to distinguish between the elements of increased global competition and how they impact upon the Aerospace Tooling Cluster.

In discussing cluster drivers it is equally important to acknowledge that a cluster driver may exist, yet have a minimal impact on a cluster. In analysing the interviews it was found that the driver of government was present, particularly in regard to the support of the Victorian government with the provision of financial and in kind support to assist with the establishment of the cluster. Despite the existence of this driver it was only mentioned in passing within the interview data and it was also found to have no relationship to the other cluster drivers or barriers. The significance of this aspect of the discussion is that when looking for the inter-relationships between cluster drivers and barriers an inter-relationship does

not have to be found for each driver and barrier. Furthermore, a driver or barrier may exist yet have a minimal impact upon the cluster.

In analysing the relationship between the drivers above, it may also be possible to make a distinction between drivers which originate internally or externally to the firm. This is important because while the literature can broadly identify drivers for clusters such as a changing supply chain, it does not adequately report on the implications and impacts of the drivers at an internal level. At the external level the changing supply chain has created a secondary driver of the movement of project management down the supply chain. However, when this is observed more closely at an internal or firm level it can be seen that the movement of project management has created a number of issues. A question for the cluster literature is then to decide how in-depth the description of cluster drivers goes without running the risk of the information becoming too case specific. In the case of the Aerospace Tooling Cluster this has been shown to be important as the movement of project management down the supply chain has acted as a driver for the formation of the cluster, but it has also created a number of issues which suggests that this driver may also develop into a cluster barrier. Thus the changing nature of cluster drivers is an area of research which requires further development. Furthermore, the consideration of cluster drivers changing over time to become a barrier to the cluster is a new area of consideration which will require more research and more consideration of the internal issues related to cluster drivers.

VIII. CONCLUSION

The analysis presented here is important to the development of the cluster literature as it moves the discussion of cluster drivers beyond simple identification, and demonstrates that there is a relationship between the drivers themselves. Regardless of whether these drivers are considered to be specific to the Aerospace Tooling Cluster, future research into cluster drivers needs to go further than simple identification of the cluster drivers; it should also consider if there is any form of relationship between these identified cluster drivers. In the case of the Aerospace Tooling Cluster, had these drivers been considered in isolation then the full impact of the drivers may not have been recognised.

With further research into the relationship between cluster drivers it may be possible to measure a level of significance of the relationship or the level of impact of one driver against another. In the case of the Aerospace Tooling Cluster in Australia it is evident that the driver of increased global competition was significant in the formation of the changing supply chain structure driver. However, the results of this research are unable to measure the level or significance of this relationship. This will be important for the future development of cluster literature if it can be determined that the interaction of the three cluster drivers has a greater combined synergy than their individual components.

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