Manufacturing in low cost country locations: costs and benefits

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CHINA AND ITS REFORMING MARKETS HAVE INCREASINGLY ATTRACTION THE ATTENTION OF WESTERN COMPANIES. IT IS SEEN AS A COUNTRY WITH EXPANDING MARKETS AND LOW LABOUR COSTS. AS A RESULT, NUMEROUS FIRMS HAVE MOVED PRODUCTION THERE (SALMI, 2008). THIS REPORT COMPARES AND CONTRASTS THE DECIDING FACTORS UNDER WHICH COMPANIES ASSIGN MANUFACTURE TO EITHER LOW COST COUNTRY (LCC) LOCATIONS (SUCH AS CHINA), OR THE UK MANUFACTURING MARKETS. CASE STUDIES ARE USED TO PROVIDE REAL WORLD REPRESENTATION OF SOME OF THE ISSUES THAT COMPANIES CAN FACE WHEN DETERMINING THE MANUFACTURE LOCATION. CONCLUSIONS PROVIDE A GENERIC OVERVIEW OF RECOMMENDED MANUFACTURING LOCATION BASED UPON PRIORITISING THE KEY FACTORS FOUND FROM THE INVESTIGATION.

KEYWORDS: LOW-COST COUNTRY, MANUFACTURING, COST-BENEFIT ANALYSIS, FACILITIES LOCATION.

INTRODUCTION

Since joining the WTO in 2001, a growth in competitiveness fuelled a breath-taking surge in the export of China's manufactured goods. Ever since, China has been an immense force within the global manufacturing market (ICTSD, 2011). Lower wages and living costs in LCC's results in lower costs passed on to producers of manufactured goods. Resultantly, LCC's such as China and India have become manufacturing havens for British companies.

The UK manufacturing market has been in decline since the 1970's (Hine and Wright, 1998) due to the outsourcing of manufactured goods; between 1979 and 1992 the percentage increase in imports from East Asia was almost three times that from Europe. However with an increase in the wages and living standards of China's employees, this trend is expected to change (Ross, 2013).

As a result, it now lies with British firms to decide whether to maintain the sourcing of manufactured goods from LCC suppliers, or whether it would be more beneficial for companies to manufacture within the UK. This article shall weigh the pros and cons of manufacture of goods in East Asia, both past and present, against the manufacture of goods in the UK, and shall aim to outline a strategy for determining the location of manufactured goods in future.

The following are widely considered as the key determining factors for commissioning the manufacture of products through either UK or LCC suppliers. It is predicted that these shall be proven as some of the key considerations of companies when primary research activities are undertaken. With the world's largest manufacturing workforce, China is widely known for having low labour costs (Banister, 2005). However average wages have tripled in ten years between 1997 and 2007 due to globalization (Yang et al, 2010).

With manufacture in LCC's (most notably China), comes the risk of losing IP (Intellectual Property) rights over the product. This is due to underdeveloped or unenforced legislation against the infringement of IP (Bird, 2004). As a result, companies that do business with China face the potential of having products counterfeited and for sale at a steep discount (Swike et al, 2008). Naturally, with long distance manufacturing comes longer lead times. As a result, any manufacturing with LCC regions will result in a longer delay for delivery.

Time zone issues with longer distance relationships...
between manufacturer and customer also provides difficulties with communication. As a result, time zone differences have a negative impact on trade (Stein, Daude, 2007). This is combined with the fact that trade between countries with a common language is more than 50% higher than trade between countries with a different language (Brocker, Rohweder, 1990), provides a strong argument against commissioning manufacture to LCC’s. Exchange rate volatility and fluctuating material costs have negative impact on trade (Auboin, Ruta, 2013), resulting in inconsistent supply costs to the customer.

Whilst sourcing manufactured goods from within the UK, a far greater turnaround rate can be achieved between ordering goods and their delivery. It can be argued that UK based manufacturers have a greater eye for detail when making products by hand, and therefore have a greater perception of quality when compared to their LCC counterparts.

Responsibility is placed upon corporate entities through the use of legislation in the UK (Idowu et al, 2004) when sourcing manufactured goods. When sourcing products from UK suppliers, companies can rest at ease that such legislation shall protect them from the negative stigma surrounding poor Corporate Social Responsibility (CSR) policies. Good CSR reports can also reap the benefits of increased customer loyalty, more supportive communities and the recruitment and retention of more talented employees (Idowu et al, 2004). Within the UK, minimum wage limits and imported materials contribute to increased costs. In the UK, monthly minimum wage lies at approximately $1655 (USD) (Unknown, 2015) whereas the minimum wage for workers in Shanghai is $293 per month, over 5 times less than that of the minimum wage in the UK (Kennedy, 2014).

1. Aims and Objectives
Determine how companies decide between manufacture in the UK and LCC’s and provide a guideline in order to suggest whether products should be manufactured in the UK or in an LCC. This was met through a variety of methodologies. Primary research shall be carried out in the form of face to face interviews with industry experts. During these interviews, investigation shall be undertaken to enable the composition of various case studies. In order to fulfil the aim, the following objectives were identified and fulfilled:

- Determine the key deciding factors when choosing between UK and LCC manufacture;
- Determine the key reasons for manufacturing in the UK (i.e. what is appealing about UK manufacture);
- Determine the key reasons for manufacturing in LCC’s (i.e. what is appealing about LCC manufacture).

2. Literature Review
The literature available shows good documentation of both the positive and negative aspects of manufacturing in the UK and in LCC’s, most specifically China. It is also well documented the effects that these methods have on both the performance of the company, as well as the economy of the respective country. Girma, Greenway and Kneller (2004) discuss how exporting affects the productivity of companies within the UK. It is suggested that exporting firms are generally more productive than non-exporting firms, and that profit maximising firms will only enter export markets if the present value of profits exceeds the cost of entry into the export market. The authors use the ‘One Source Database’ to determine the effect that exporting has on productivity. However the reliability of results is limited, as despite providing a good dataset to the user (over 8,992 companies) the information was gathered from 1988 to 1999. As a result, the reliability of the data is questionable due to it being at least sixteen years old. To compound this, the long timespan over which the data was collected will not provide an objective view of the economy at that specific time.

The paper is also limited due to the subject field that it relates to; the paper is more specifically looking at the export of manufactured goods, rather than the outsourcing of manufactured goods to other countries. However to that end, it is interesting as it suggests that exporting manufactured goods is of a high priority to the government of the appropriate country. As a result, as
companies outsource to China, the more likely the government is to retain that manufacture and attract manufacture from other countries.

Bennett (2014) claims that some challenges for the future of manufacturing within the UK include energy use in production, sustainability issues, workforce demographics, security and manufacturing scale issues. Bennett also writes that although the UK manufacturing is in decline, areas of potential growth are identified as aerospace, automotive engineering, computing, electronic goods, optical products, pharmaceuticals and metals and castings etc, generally so called ‘high value engineering’.

This argument conflicts with an argument made by Pei (2012), commenting upon the economic crises of 2008 and its effects on the UK manufacturing industry. It is noted that the UK manufacturing hit a 28 month low; and traditional manufacturing industries that have kept the UK economy buoyant in the past are now facing bleaker times. Both arguments are perfectly valid; however Bennett’s argument is more prevalent to the present day economic and industrial situations.

Bennett (2014) also claims that China’s manufacturing shows no signs of being any lower tech than that of the UK, whereas Eberhardt et al. (2004) suggests that a lack of technological expertise, alongside poor delivery performance and quality fluctuations are all key reasons for maintaining the source of manufactured goods from the UK. Yu (2000) mentions how IP piracy remains rampant in China despite the signing of various IP agreements in 1992, 1995 and 1996. Whilst Swike, Thompson, Vasquez (2008) claim that many companies have to do in depth research prior to deciding to work with Chinese manufacturers (to reduce the likelihood of IP infringement). Swike, Thompson and Vasquez (2008) also give clear case studies of examples of piracy in China. Amongst these is where golf club manufacturer ‘Callaway’ uncovered a counterfeit ‘Big Bertha’ club that was only discovered by Callaway when users returned the faulty club for repair. Counterfeiting is also prevalent in cars and pharmaceuticals – leading to an increased concern over user safety. It is also documented how in 2004 at least 13 babies died due to parents inadvertently purchasing counterfeit baby formula that had exactly zero nutritional value. Interestingly, this can be linked back to the way Bennett claims that the future of British industry can be seen in the manufacture of high value engineering products—including not least automotive and pharmaceutical industries.

Marron and Steel (2000) discuss how high income countries tend to have lower piracy rates in comparison to lower income countries. Equally, IP tends to have greater protection in developed countries or countries that enforce the protection of property from expropriation. Bird (2006) validates this claim by stating that the BRIC (Brazil, Russia, India and China) economies have not yet developed intellectual property protection and enforcement mechanisms.

In an interview conducted in an investigation into western manufacturing and procurement practices in China, an interviewee stated that;

‘All business relations in China are based on distrust. If in some other places it is trust, here it is distrust. Meaning that you have to check everything yourself very carefully’. Backing up Vasquez’ claims. It was also stated that; ‘They are somehow inclined to do everything in the easiest possible way’.

This provides an interesting insight into the Chinese manufacturing attitudes towards UK clientele. Interestingly, it is also mentioned within the same investigation that; ‘Learning the Chinese language is not necessary as such but it is a positive signal showing that we have entered the market to stay. It is a way of saying that the person must have a genuine interest in this country and culture’.

Rather than exploiting the suppliers solely for their cheap labour (Salmi, 2006), Meredith Smith (1999) lists some advantages for sourcing items internationally. These include (but are not limited to) price improvement, direct access to new technologies, greater competitiveness due to domestic markets and potential to exploit tax and currency opportunities. Meredith Smith (1999) also
discusses the negatives of internationally sourcing manufactured goods. These include language barriers, cultural differences, different units of measurement, increased freight costs, import duties and customs delays. All of which can lead to delays in the procurement of the manufactured goods. Fluctuating currency exchange rates can also reduce confidence in the cost of manufactured goods.

It is important to note that the report from Meredith Smith is limited to the extent that it is written in 1999, and therefore is prior to the inclusion of China in the WTO. Equally the document does not specifically target the outsourcing of manufactured goods to LCC’s. This is notable in a case study where a keyboard, originally manufactured in the US, is outsourced for manufacture in the UK. Platts and Song (2010) undertake research into the implications of sourcing from China and other LCC’s. Research methods undertaken include compiling case studies of six British companies, ranging from Small to Medium Enterprises (SME) to large enterprises, with turnover between 3 million and 160 million GBP. Platts and Song (2010) note that the most significant factor for sourcing from developing countries, such as China, is to reap the cost saving benefits.

Heinman J.R. (2013) writes that cheap labour is only one of many reasons for outsourcing. Declining wages in developed countries such as the US are deemed as being one of the most significant reasons for companies sourcing manufactured goods closer to home. To counter this argument, Hine and Wright (1998) argue that low wage competition (from low cost countries) shifts UK consumption from domestically manufactured goods to imported goods. Although an interesting contradiction, the more recently documented events of Heinman are more reliable, as they are a more accurate account of the more recent economic situations of both countries.

This seemingly ‘cheaper’ labour in local economies can also be put down to a greater economic growth in developing countries of late rather than in developed ones. As a result, the labour costs are closer balanced than in previous years between the costs of LCC’s and UK manufacturers. Although not a peer reviewed text, Heinman’s document is from a trustworthy source—the Atlantic which is a reputable American magazine documenting politics, economics and health issues since 1857.

Banister (2005) clearly documents the wage breakdown of Chinese manufacturing employees. City-based manufacturers receive wages of approximately $0.95 per hour, whilst their non-city counterparts averaged $0.41 per hour. In China, the estimated hourly working wage for manufacturing was about $0.57 in 2002. Despite a text that is over 10 years old, when compared to Heinman’s more recent document it can be determined that these wages are still significantly lower than in other LCC locations. Banister (2005) also documents that at the same time as the Chinese average wage was determined, that on average, the labour costs in newly industrialised economies of Asia had labour costs of more than 10 times that of China. Mexico and Brazil also had labour costs about 4 times those for China’s manufacturing employees.

Corporate Social Responsibility is a factor that is at the forefront of manufacturers minds when using overseas manufacturers. In 1992, when Reebok was criticized for violating workers’ basic rights, the company drafted the its ‘Human rights production standards’, which encompasses provisions on non-discrimination, no forced or child labour, non-harassment, wages, working hours and safety within the workplace (Yu, 2008).

UK governments in the 1970’s passed many acts of government including the Equal Pay Act 1970, Health and Safety at Work Act 1974, Sex Discrimination Act 1975, Race Relations Act 1976 but to mention a few. These legislative procedures provide reason to argue that manufacturing with UK based suppliers is ‘safer’ from a CSR point of view in comparison with LCC suppliers. In contrast, in a study of 127 emerging-market companies’ based in China, it was noted that this country is characterized by an ‘especially low take up’ of CSR (Kolk et al, 2010).

Hallack and Schott (2011) undertook to determine differences in product quality through observing export
prices and their quality versus quality adjusted-price components. Quality is deemed as any tangible or intangible attribute of a product that increases the customers' valuation of it. Although a good method of gaining a perception of what subjects deem to be 'good quality'. For example, a subject's preference may actually mask the intended quality that has been achieved in the manufacture of the product. Therefore, the authors may have found it more beneficial to communicate directly with the companies that procured the product in the first place, as it is these companies that understand the quality level desired.

3. Methodology
The key areas of research that are to be focused on shall aim to gain a deeper knowledge of the conditions under which the location of manufacturers are determined, and what areas play the greatest role in making that decision; i.e. cost, IP, manufacturing processes/technology etc. Amongst various data collection methods, it does not seem appropriate to conduct a survey to collect this information. Not least due to the number of respondents that would be required to validate data gathered, but also because it would not be specific enough to gather information suitable to populate case studies to a suitable level of detail (even if open questions are put to the respondents). The anonymous nature of the survey would also make it particularly hard to determine the validity of survey results, and may therefore result in inaccurate conclusions.

Although time consuming, conducting semi-structured interviews with industry experts may provide a good base of knowledge in order to compile a range of case studies. However as a result, the information gathered will only be applicable to the respective company/product. On the other hand, the face to face interview would allow for open discussion to be held on the subject matter. As a result, a greater depth of knowledge is likely to be gained from such activity. Equally, where some questions may be applicable to some interviewees but not others, questions may be added or omitted appropriately. Semi-structured interviews shall also permit the flow of the interview to change depending upon the interviewee's responses to previous questions. Additional questions may also be asked to ascertain further information that may be applicable to the study. These findings can then be combined and compared with other case studies found and opinions from literature research to provide an overview of manufacturing attitudes and practices in industry when determining the location of product manufacture.

It would also not be deemed as feasible to compose experiments on certain products and manufacturers. For example, it would be highly costly and therefore unfeasible to set up the manufacture of a product in both the UK and a chosen LCC in order to determine the key factors, similarities and differences between each. It would be more feasible to compare and contrast experiences that companies have had through manufacturing real world products instead. Throughout all investigations it is important to consider that data collected from these experiments may be specific to the manufacturers, and not necessarily provide a representation the industry in that area as a whole.

Due to the subjective nature of the research, the investigation shall aim to provide a sample of qualitative research that can be evaluated against the findings from various interviewees. The research style shall be 'exploratory' in that the author has a limited amount of first-hand knowledge in the subject area. Equally the nature of attitudinal research styles lend themselves closer to that of survey methods, by seeking responses in a 'agree strongly, agree, disagree, disagree strongly' fashion (Naoum, 2013). This would not be appropriate in this context, as it would not provide sufficient information to compile valuable case studies.

3.1 Population
The investigation is populated with responses from industry experts, with a combined total of over 45 years' industry experience. Their experience is specific to engineering and design sectors.

3.2 Participant Selection
Due to the sample being particularly small, with two interviewees providing a total of three case studies, the
relationship between studies shall be discussed 'intellectually' rather than discussing the quantitative relationship between case studies (Naoum, 2013). Participants have been selected based upon their vast knowledge in engineering and manufacturing sectors. Their contrasting processes and product types shall also provide a good opportunity to compare and contrast these industry approaches. In order to maximise the reliability and validity of the results, professional comparisons shall be made to existing literature to find comparing and contrasting views within the industry case studies. Table 1 indicates the companies interviewed, the position of the interviewee within the company and the date of interview.

3.3 Position

The position of the author, as a Product Designer, has a good base knowledge of the fundamentals of the processes and methodologies adopted by industry, which shall maximise the 'value added' to the case studies.

The author is British, and as a result this may result in certain bias towards the UK manufacturing industry. Despite this, every effort was made to ensure total objectivity across the subject area at all times.

3.4 Interview Plan

It is intended that methodologies employed shall include interviews with industry experts. The experience of industry members shall be used to gain a deeper knowledge of the subject area.

- Topic areas that shall be covered through the semi-structured interviews shall be included (but are not limited to);
- The location (globally) of current/past manufactured products.
- Key considerations when determining the manufacturing location of a product.

- Considerations towards IP, and what effect this has on the manufacture location.
- Manufacturing technologies and processes that are used in order to manufacture a certain product – to what extend the complexity of manufacture determines the location of manufacture.
- For products that are manufactured in LCC’s, is it likely that manufacture will return to the UK?

3.5 Case Studies

Example case studies shall also be sought after from industry experts through interview as aforementioned. It is intended to compile at least three case studies of the six manufacturing and production systems listed below;

- A one-off manufactured product between a UK company and LCC manufacturer.
- A batch manufactured product between a UK company and LCC manufacturer.
- A mass manufactured product between a UK company and LCC manufacturer.
- A one-off manufactured product between a UK company and UK manufacturer.
- A batch manufactured product between a UK company and UK manufacturer.
- A mass manufactured product between a UK company and UK manufacturer.

These should create a greater understanding of the conditions under which successful products are sourced from LCC suppliers, and the level of involvement that is required in order to create the levels of quality required. Equally it should create understanding of why companies retain manufacture within the UK rather than outsourcing.

4. Case Studies

4.1 One-off Manufactured Product, UK Sourced – Company A

'Company A' provide an excellent case study for a one off product designed and manufactured in the UK. Company A are based in southern England, where the design, manufacture and testing of all vehicle components takes place. Within the formula one world, the speed of development of the race car is critical, and a
fast turnaround is crucial to remain competitive within the sport. In the case of Company A, it would be of little use to design a vehicle body part and send it for manufacture in China, to wait 6 weeks for the part to return. In the fast paced world of formula one, a fifth of a season could pass in the time spent waiting for a part to return. In an interview with an Aerodynamics Engineer for Company A, it was learnt that

‘IP is a crucial factor to the development of our car...manufacturing all parts in-house eliminates the risk of our competitors getting their hands on our valuable IP’

The value of IP in the Formula 1 industry can be seen in Figure 1. Pre-season testing saw the team decorate the vehicle in black and white ‘camouflage’, making it near impossible to determine contours and surfaces, protecting the vehicle’s design from other manufacturers.

When asked about prototyping and manufacture, the Aerodynamics Engineer said;

‘Due to the high-technology simulation that is available to us, the prototypes almost always perform as expected in the wind tunnel during testing, and therefore rarely require significant modification. This is testament to the high precision engineering team we have (at Company A), as well as the skill level of the production team.’

This comment further backs up Bennett’s claim that areas of potential growth (within the UK manufacturing industry) include...engineering and automotive industries...so called ‘high value engineering.

‘Our development team works to a high budget, meaning we can afford to produce and maintain all machinery and processes required to manufacture the cars. We can afford the most cutting edge carbon composite materials and can eliminate lead times associated with waiting on components to arrive. Even if they were to be sourced from within the UK, we still would be left waiting a short while for components to arrive’.

The case study with Company A is critical to the evaluation of both UK and LCC manufacturing environments. On one hand, the interview highlights several areas in which the UK manufacturing scene excels. Skilled tradesmen and high technology manufacturing environments lead to an incredibly high tolerance production, leading to a reduced need to re-prototype the product. On the other hand, it is clear that the budget of the company has a large part to play in the fact that lead times and manufacturing hiccups can be eliminated, and therefore cannot be taken as an example for all UK manufacturing set-ups.

4.2 Batch manufactured product, UK sourced- Company B - Neo™ Steel Rooflight

Company B is SME based in the Oxfordshire countryside. The company has been running for over 20 years and has become a well-established competitor in the market of high end and contemporary roof windows. The company offers two signature products, the Conservation roof light, and the Neo™ Steel roof light. In order to establish a good understanding of the manufacturing set up for the Neo™ Steel line of roof lights, an interview was held with the Director of Design.

It became apparent that it was not always intended for the Neo™ Steel roof light to be manufactured in the UK. ‘We always planned for the Neo™ Steel roof light to be manufactured with our main suppliers in India. But through the prototyping and mock manufacture processes we just weren’t happy with the quality of the product. This was down to the high tolerance and processes required to manufacture the product, combined with the lower skill level than what we would expect of our UK suppliers. The lower volume to our standard product also meant that it would not be feasible
to set up the same infrastructure that the manufacture of our flagship product (The Conservation Roof light) has'.

'We therefore decided to manufacture our Neo™ Steel roof light with Grenville Engineers based in Stoke. This was for a couple of reasons; we can have a closer relationship with the manufacturer, it's a lot easier to visit someone in Stoke than it is in India!' This is a critical point to the decision making involved with the source of manufactured goods and proves why it is important for a company to have a close relationship with their manufacturer. If a close relationship is not maintained, and manufacturing issues do arise, these issues may be particularly hard to resolve.

Through the manufacture of the rooflights in Stoke, rather than in India, the unit cost of the product increases significantly. However, 'The cost of UK labour can be recovered through the shipping costs incurred with LCC manufacture'.

'Quality Control (QC) is governed by our QC officer who travels to Stoke on a weekly basis. He ensures that the products are made to a sufficient standard and that engineering drawings are adhered to. This is one area that our Indian suppliers struggled with, it is clear that they struggle to follow our engineering drawings.'

'Manufactured in the UK' is also an excellent selling point for our products – the media has recently picked up on this and as a result people are paying more attention to where their goods come from. This certainly adds value to our product, as does the way we can provide a 5 day lead time for our UK manufactured products'.

The Director of Design raises a critical point here, the fact that the product is made in the UK is a significant selling point for any manufacturer, and is certainly more appealing to a UK market than a comparable product made in China.

Peter also described how it was never an option for the Neo™ Steel rooflight to be manufactured in China. 'The risk of losing our IP was too great, and with a relationship already established with our Indian manufacturing partner, it would have made poor business sense to do otherwise.'

4.3 One-off manufactured product, LCC sourced – Company B – Prototype Ironmongery

Company B sources its Ironmongery product range from the LCC manufacturer Krishna, in India. In order to ensure that new products are suitable for the manufacturing processes used, prototypes are also sourced from this location. For the purposes of this case study, the prototypes sourced can be considered as 'one-off' for manufacture.

The Ironmongery range from Company B consists of parts that are predominantly sand casted and machined. All components are metallic. The Director of Design states that;

'It can take up to 8 weeks for our designs to be returned to us as prototypes, and may take even longer depending on the workload in India'.

'Communication is also a struggle when working with our LCC suppliers. In a recent meeting with our Indian supplier, we discussed various metal finishing options for the new Ironmongery range. However at the point of prototyping, it became apparent that these finishing options were not possible on the metal type that we had discussed.'

'We also struggle with the quality of the products that they manufacture for us, particularly in the prototyping stages of the design process. Parts are often made to a poor quality, or are missing key design features or functionality. It is also not unheard of for the prototypes to be returned and they have changed our designs all together!'

'This is particularly evident in the design of the Ironmongery range (Figure 2). The design specified that there should be a screw that meets with a male-female
connection, however in prototyping the design was changed such that a male screw protruded through the entire part! Although still performing the same functionality; in changing this component, the design and aesthetic feel to the product was also altered significantly.’

‘Our Indian suppliers also seem to have a drastically different appreciation of quality in comparison to us. In the past we have had to send our quality control officer and/or head engineer to India with the intention of explicitly explaining the quality that we want to achieve! It seems to be one of few ways to get through to them, and is certainly a lot quicker than making them remake prototypes three times over and waiting on them to be returned for the 8 weeks each time’

‘IP is a particularly important concern when prototyping, and so we always make sure we prototype with our Indian counterparts if and when we can.’

4.4 Key Findings from Case Studies

It is interesting to note the different contexts in which certain key factors take priority for different companies. For example, Company B place a high demand on quality for their products. This is most noticeable in the Neo™ Steel rooflights, hence the fact that the manufacture of their product was moved to the UK to maintain a suitable level of manufacture quality. From Company B’s point of view, maintaining a good manufacture quality lends itself to their stellar reputation within the architectural world, as well as enabling them to provide short lead times for the manufacture of design to order Neo™ Steel rooflights. This makes an interesting contrast to the manufacture set-up at Company A, where the biggest emphasis is placed on the turnaround of manufacture, as this has the greatest impact on the performance of the team in competition. As a result, factors such as cost are less critical. This makes a strong contrast to Company B’s stance, where all costs are passed onto the customer. They therefore must remain as efficient as possible to provide a good value for money to the consumer.

The processes involved with the manufacture of various products are also interesting to compare. The traditional manufacturing methods of metalworking is prevalent in both case studies provided by Company B which provide an interesting contrast to the technologically advanced methods of manufacturing carbon fibre composite components at Company A. Whereas Company B entrusts faith in traditional methods such as sand casting and sheet metal processing, Company A pushes the boundaries of manufacture through its material processing. Again this can be considered as a result of differing opinions on cost. The tried and tested metalworking methods used at Company B have been considered as the most cost effective methods of manufacturing their product to the required standard. This strongly contrasts with the way in which Company A can afford to develop their manufacturing processes and technologies in order to produce the thinnest, lightest, but adequately strong enough race car components possible.

Interestingly, it was not anticipated that there would be a significant difference in the skill level of workers between the UK and LCC suppliers, however this is evident in the case study of the Neo™ Steel rooflight provided by Company B. This revelation could be compared to Salmi’s (2006) discussion in that the supplier may be inclined to ‘do everything in the easiest possible way’.

IP also plays an important role in the manufacture of the products mentioned in the case studies. In order to mitigate the likelihood of losing its IP over its roof windows, Company B specifically liaises with its LCC supplier, Krishna, in India. Through establishing a strong relationship with this supplier, a level of trust has been established that allows Company B to share its valuable IP with its LCC partner. On the other hand, Company A has an opposing stance with IP and outsourcing its manufacture to LCC’s.

‘Whenever our IP leaves (the factory), we expose ourselves to the risk of that IP falling into the hands of third parties. When thousands of pounds are spent on developing certain parts, and when they are more than likely going to improve our performance in competition, the last thing we want to do is expose ourselves to that risk.’
It is interesting to note that when discussing the loss of IP, Company A do not consider outsourcing the manufacture of components to other suppliers within the UK, where stronger and stricter laws over the retention of IP stand. This is to do with the fact that a large proportion of the F1 companies reside within the UK, and therefore the threat of the loss of IP is still a concern. Interestingly this contrasts with the way Marron and Steel (2000) discuss how higher income countries tend to have lower IP piracy rates.

5. Discussion
The primary research gathered when combined with the information found through interviews and their subsequent case studies has provided an excellent response to the research questions and objectives outlined at the beginning of this report.

Industrial research has resulted in a far greater understanding of deciding factors when choosing between LCC and UK manufacturers, as well as determining the key reasons for initialising manufacture in either location.

The primary research activities undertaken provide a good overall understanding of the main deciding factors that companies look for when determining the location of manufacture. Having said this, there are some factors of the research activities that limit the validity of the findings. The research undertaken only documented discussion with two manufacturers over a range of three products. This therefore limits the reliability of the findings in that the companies studied may be the only companies that experience certain issues or benefits when working with their suppliers.

In order to overcome this limitation, wherever possible, comparisons have been made between the case studies compiled and the research literature found in order to maximise the reliability of primary research findings.

With interviews undertaken with Company A, the nature of work that is undertaken at their headquarters, and the value of the products and vehicle components that they develop, resulted in a very generic overview of operations. This resulted in learning more about the processes and manufacturing attitudes rather than the way in which certain products are manufactured, their quantities and their manufacturing techniques used to make those components.

With regard to the research obtained from interviews as a result of this sensitivity, significant conclusions from critical information can still be drawn. Not least, with regard to Company A’s opinions towards IP issues with manufacture in China. Once again, wherever possible, comparisons were made to Literature research to maximise the validity and reliability of empirical findings.

The case studies compiled from empirical findings do not include any products that are manufactured in China. This is a significant limitation of the findings made, not least as China hosts the largest manufacturing workforce in the world, at over 100 million workers (Banister, 2005). As a result, a significant portion of the ‘manufacturing world’ has been omitted from case studies.

However, this in itself proves interesting, in that although China is said to have some of the worlds’ cheapest labour costs, averaging around $0.57 (USD) in 2002, manufacturers opt for alternate manufacturing locations. From this it can be taken that LCC manufacture is not solely determined on cost alone.

Equally findings from initial literature research do substitute well for information that has otherwise not been documented in the case studies.

Conclusion
The location for manufacturing is generally determined based upon the following key factors, turnaround, cost, and quality. By determining which is most valuable to the company in question, a suitable location for manufacture can be determined. In the case of the Company A, there is a high demand to make parts as quickly as possible, however the cost incurred is far less important due to their high budget.

On the other hand, Company B’s strategy towards the procurement of prototype Ironmongery is quite a contrast. There is a far greater concern over the cost of components rather than how long it takes for them to be delivered, hence, prototypes can take up to 8 weeks to be
delivered, but ‘rarely cost more than £50’. However through sourcing the components through LCC suppliers, there is also an incurred reduction in quality and a risk that re-prototyping will be required.

When determining the manufacture location of new products, there are several key factors that must be determined. Cost, IP volume and time constraints all play a significant part in determining the location of manufacture. For example with Company A, turnaround is a significant concern, which results in manufacture being located in the UK. Combining this with the sensitivity of IP that produced results in the decision for products to be manufactured behind their own factory doors.

Another key factor is quality, which when combined with cost constraints may be considered a reason why Company B struggles with the quality of prototype ironmongery. It could be argued that if prototyping had a larger budget, that the products may be prototyped to a higher quality.

These findings agree fittingly with literature findings too. Swike, Thompson and Vasquez (2008) discuss how Callaway’s manufacturing links to China has resulted in counterfeit products being released to market. This is precisely the reason that Company A does not contract manufacture to LCC’s. Interestingly Company B has managed to navigate a way around IP issues in developing LCC’s by setting up their own manufacturing plant in India, rather than assigning manufacture to a pre-existing manufacturer.

From findings documented in this report, products that are most suited to manufacture in LCC locations are likely to have low IP sensitivity issues, and comparatively long lead times. Products that require minimal skill to manufacture are also primary examples of products that are suitable for LCC manufacture. It is for this reason that the Neo™ Steel rooflight manufacture location was moved to the UK following prototyping activities with LCC suppliers.

As a result, products that are manufactured using automated systems (and therefore minimal human input), such as high volume injection moulding would also be suitable for manufacture in LCC locations.

Findings in both primary and literature research both correlate to conclude that manufacture prospects for UK suppliers lie in areas of high technology or high IP sensitivity. Bennett (2014) states this perfectly, claiming that the future prospects for manufacture within the UK lies in ‘High value engineering’; the type of manufacturing that is undertaken at Company A. Quantity also plays a large part to play in the decision to manufacture with UK suppliers. For example, if manufacturing goods of high IP sensitivity in the ‘hundreds of thousands to millions’ it may make financial sense to manufacture in LCC’s (to take advantage of lower wage rates), however create a ‘closed’ manufacturing environment to protect IP by setting up a private factory.

Following the results of this study, several graphs have been compiled to provide a recommended manufacture location based on company priorities such as cost, volume etc.

The first graph (Figure 3) compares volume of manufacture against project budget. It can be noted that low budget projects are recommended to manufacture in LCC locations, whilst larger budgeted projects can generally afford to manufacture within the UK. This said, profit margin is one of the key determiners of a products’ success, and therefore if time constraints permit, LCC
manufacture should be considered. As it can be seen in the graph, as volume increases with budget, it becomes more feasible to manufacture with LCC suppliers. This is because manufacturers may be more likely to afford the set up costs of initialising their own manufacturing plant in a LCC location. Equally lower volume projects with higher budgets are more feasible to manufacture in the UK due to the ability to have a faster turnaround and delivery. At the highest volumes, it makes good business sense to manufacture with LCC suppliers because of the cost saving opportunities.

The second graph (Figure 4) compares IP concern and timescale. This graph makes more of a linear comparison between the two factors; UK manufacture is more feasible where IP and timescale take higher priority, whereas when they are less of a concern, and there is more time for the deliverance of a product, LCC’s become more of a feasible manufacturing location.

It is scarcely documented the advantages and disadvantages of manufacturing in the UK, and the conditions at which the tipping point lies for deciding to manufacture goods in either the UK or LCC’s. There is also a lack of documentation as to the likelihood of the future of British investment in the Chinese manufacturing market. It would be beneficial to learn how companies project their future in such manufacturing markets is, and what factors would be considered as key in terms of determining whether to manufacture with LCC or UK suppliers. Equally, to learn of the likelihood of the relocating manufacture that is already taking place in regions of low cost manufacture would also be beneficial to the task.

The literature survey has also proved that there is limited documentation of case studies of manufactured products to do with the various manufacture volumes (batch, one off, mass) with UK and LCC manufacturers. To that extent it would be beneficial to fill this void with case studies of products that have been manufactured in both the UK and LCC locations, and the levels of success achieved as a result.

To develop the study further, it would be interesting to compile case studies of the use of UK manufacturers by companies based outside of the UK. This additional research would be a valuable addition to the current findings, as it would provide an opinion of the UK manufacturing benefits from a point of view that has not been investigated. Bennett discusses the ‘high value engineering’ manufacturing environment of the UK, which when combined with advertising that the product is ‘made in the UK’ adds value to the UK consumer market. However when the company that is sourcing the product is based outside of the UK, it would be interesting to see what their reasoning is for sourcing goods from UK suppliers. This in turn would provide an excellent overview of the benefits of UK manufacture with a more ‘global’ outlook.

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