Deliverable 4.1

Catalogue of Future Business Services and Associated Business Opportunities

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PU	Public	**X**
PP	Restricted to other programme participants (including the Commission Services)	
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[1] **R**=Report, **P**=Prototype, **D**=Demonstrator, **O**=Other

[2] **PU**=Public, **PP**=Restricted to other programme participants (including the Commission Services), **RE**=Restricted to a group specified by the consortium (including the Commission Services), **CO**=Confidential, only for members of the consortium (including the Commission Services)

Change Control

<u>Document History</u>

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Table of Contents

List of figures

1 Executive Summary

This deliverable provides a "Catalogue of Future Business Opportunities, Business Models and Services" targeted at manufacturing and service sector companies. Manufacturing companies need to evolve and adapt to meet competitive challenges and support world megatrends. The adoption of suitable architectures and services may provide a manufacturing company with substantial competitive advantage, however, successful implementation may strongly depend on the ecosystem of business services supporting them. This deliverable thus studies existing business models and services employed by European manufacturing enterprises and identifies business models and services which become possible or even necessary to support future architectures, services and manufacturing megatrends as identified in the roadmapping process. Based upon this recommendations are made for new business opportunities tied to future architectures and services in manufacturing. In total, around 90 new business opportunities were identified from interviews and via a business modelling workshop.

The deliverable highlights that many business models exist, identifying around 100 from analysis of available literature. For each of these a short summary is given. It should be noted that a business model is distinct from a business opportunity in that it describes how a business opportunity can be put into practice operationally. The business models were categorised into 10 areas:

- Networking
- Technology based
- Green/Sustainable
- Customisation
- Knowledge
- Efficient manufacturing
- Product Service/Aftermarket
- Socially aware
- Economic (Investor supported)
- Conventional

Although 100 distinct business models were identified there may well be other business models, in particular, based on combinations of business models to produce hybrid models. The extraction and presentation of the business models in this deliverable is thought to be a valuable exercise as no such listing and definition of business models was found to exist.

When analysing key reports produced by the manufacturing sector a number of future business models are highlighted as being important. A common feature of these is a move towards servitization in manufacturing. However, from the mapping analysis of the business models to the Road4FAME inputs (and also independently confirmed by a blind ranking from a group of manufacturing experts) this move towards product services and the aftermarket is much less prominent. Here it is believed that the aerospace companies who are leading the way in product services and aftermarket provision are key contributors to many of the manufacturing reports. This may well have resulted in some bias and not a true representation of the manufacturing industry as a whole.

Interviews with a cross section of industry including large and small companies both from the manufacturing and service sector were performed indicating a number of key issues. These include both technological issues and also issues that can only be addressed at a policy level. The interviews with industry also resulted in around 40 new interesting business opportunities being identified which were categorised into 15 opportunity areas.

The 10 identified business model categories and the 15 opportunity areas were mapped to the Road4FAME inputs and outputs confirming that there was traceability through the Road4FAME inputs to the recommendations made by the project. However, notably the areas of user interfaces and man machine interfaces were under-represented. Here the recommendations have been revised in order to more strongly highlight the importance of these areas. The rankings of the business models (from strength of match with Road4FAME inputs and also independently verified by a group of experts who were also asked to blindly rank the categories) indicated that socially aware and economic business models are currently the least interesting to the manufacturing sector. For socially driven business models it is difficult to see how an idea can be monetised. For economic business models a major barrier is the legal framework that has grown up around the manufacturing industry. Well known ways of funding manufacturing enterprises exist, but the current rigid legal framework would prohibit some of the more "exotic" new approaches to financing.

Although business models based on networking were ranked most highly in the mapping with respect to Road4FAME inputs, it is clear that this is being driven by two factors, the trend towards networked supply chains and also the increased networking given by ICT. It is believed that the Road4FAME scenarios used in earlier workshops may have also concentrated outcomes with respect to the most highly ranked categories.

A business modelling workshop was held. This firstly validated the results obtained by mapping, and secondly, identified further business opportunities. Industry experts were encouraged to think of new business opportunities in the 9 categories that had been identified (excluding conventional business models). This led to around 50 new business opportunities being proposed which SME manufacturers and service sector companies could provide. For each category the most promising business opportunity was developed using the business modelling canvas to show how the business opportunity could be put operationally into practice. A key notable feature of the outcomes of the business modelling workshop was that the business solutions were reliant on connections between companies, legal advisors, etc. A feature of future business models will thus be increased interconnectivity. Here the big opportunity is for SMEs providing manufacturing and software services. Value will be created through interactions between many small organisations, rather than through interactions within a few larger organisations.

Although it is difficult to forecast 20 years ahead what the future business models will be (as they are dependent on many factors) a number of observations can be made:

- Ownership is likely to become more and more decoupled from use of products. This opens up a number of new ways for sharing products, providing value and generating revenue. Here IT has an important role to play in tracking, measuring and billing.

- The trend towards green thinking (also backed up by regulation) is driving the circular economy which requires an ecosystem that supports recycling and re-manufacture. This may also link with products being used rather than being owned by consumers.

- The ability to associate information with (and within) products allows much greater levels of tracking from cradle to grave and cradle to cradle. This information can be used in a variety of ways such as for gathering data on sustainability, providing personalised products, giving guarantees of provenance, etc.

The business models that were identified were either market driven or dependent on policy/regulations. A key example of this is green/sustainable manufacturing which is driving the development of circular economy and collaborative consumption infrastructures both at a business level and also in partnership with consumers. Market drivers towards customised products requires new levels of connection between the customer and manufacturing and also flexibility within the manufacturing supply chain.

Although this report can suggest new business opportunities and ideas there is still a need to develop the entrepreneurial framework and ecosystem to support increased connectivity between companies. Policy interventions may be required at a European level to support this change. There is also a need to raise awareness of new potential competitors within the value chain, e.g. Google, Uber and Amazon. There are many challenges when offering a service based on data transfer between a client and service provider and here there is a need for standardized data formats for interoperability. There is also a need for education. There are many well-functioning and conservative manufacturing firms which utilise outdated software. These companies fear system changes and so there is a need to build awareness for the necessity of a change. There is also a need to transfer technology and practices from advanced industries, e.g. aerospace, automotive, to less advanced sectors. It was also notable in the elaboration of business models that there was a need for a legal framework to allow contracts to be rapidly set up between companies. The legislation governing the IT sector and the internet has been built up around this sector and this may not be appropriate for manufacturing. There is thus a need for legal support specific to manufacturing applications.

Overall it is clear that companies in the future will need to be much more flexible and open minded in order to allow much higher levels of collaboration.

2 Introduction

From a manufacturing business model point-of-view, IT is important as a core technology in products, and as an infrastructural technology affecting the way offerings can be made available, and how (and where) networks of organisations can be configured. In other words, it has profound implications for almost all aspects of possible future business models. The ability to coordinate activity through collaborative, interactive inter-organisational connections has never been greater. Current developments show some prospects for the near future. Cloud computing and widespread wireless networks will make it possible for organisations (manufacturers or service providers) to connect with each other and also potentially in future with 'informated' products. Longer term, informated products may well connect with one another leading to new possibilities for data gathering and selling services.

2.1 Objectives and scope of the deliverable

Manufacturing companies need to evolve and adapt to meet competitive challenges and support world megatrends. The adoption of suitable architectures and services may provide a manufacturing company with substantial competitive advantage, however, successful implementation may strongly depend on the ecosystem of business services supporting them.

The objectives of WP4 were to:

a. Study existing business models and services employed by European manufacturing enterprises

b. Determine business models and services which become possible or even necessary to support future architectures, services and manufacturing megatrends as identified in the roadmapping process.

c. Develop recommendations for new business opportunities tied to future architectures and services in manufacturing.

2.2 Description of work

The work was divided into two tasks. In the first task the aim was to look at existing business models and gain an understanding of the state-of-the-art. In the second task new business opportunities were considered and how these could be implemented operationally via consideration of business models. The two tasks are described briefly below.

Task 4.1 Identification and Analysis of Business Models and Associated Services (lead: THHINK with support of ATOS)

The aim of this task was to scrutinize existing business models and services that are most often used by European manufacturing enterprises today. This was achieved through assessment of Analyst reports and through expert interviews conducted with business units of both large and small European manufacturing companies and business service providers.

Task 4.2 Development of Recommendations for New Business Opportunities (lead: THHINK with support of ATOS)

The aim of this task was to consider the future IT architectures, services and megatrends identified in the roadmapping process and from these identify new potential business models and business services which become possible or even necessary to support them. This knowledge was used to establish potential business opportunities for manufacturing and service sector companies. The output of task 4.2 is this deliverable which is a "Catalogue of Future Business Opportunities, Business Models and Services" This is designed to be a strategic document for manufacturing and service sector companies.

2.3   Deliverable Sections
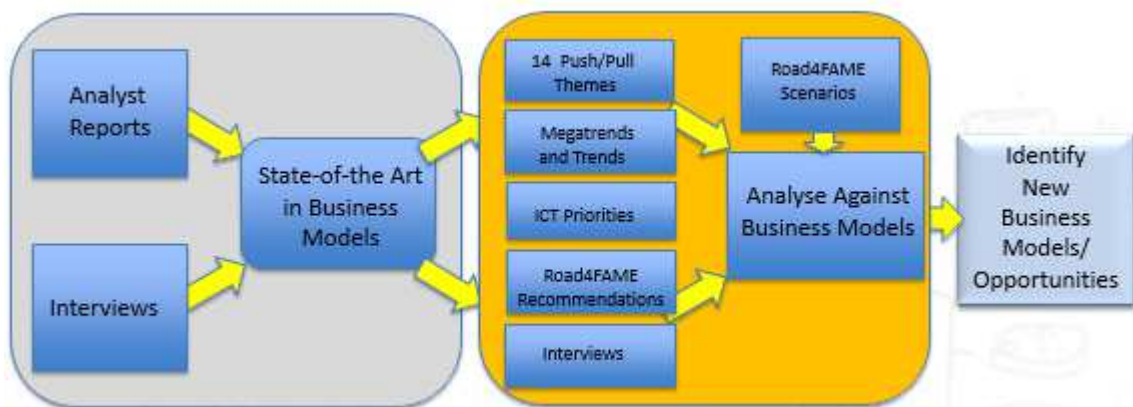
Figure 1. Outline of Deliverable Sections

The report is organised into the sections as highlighted in Figure 1. In the first part of the document an overview is given of the state-of-the-art in business models which has been obtained from desk work investigating current business models in use within the manufacturing sector. 100 business models are identified and for each a brief description is given. Additionally, interviews have been carried out with 23 companies to identify current and future business models being considered across a range of manufacturing and service sector companies both large and small. This identified many key issues for manufacturers, machine providers and service companies. Around 40 new business opportunities were also identified.

In the second part of the document the business models are categorised into 10 areas and analysed against the push and pull themes and trends/megatrends, ICT priorities, scenarios, interviews and recommendations identified within the Road4FAME deliverables.

In the final section of the report new business opportunities are considered for both manufacturing and service sector companies. A Business Modelling workshop was held in April 2015 to support this identifying around 50 further business opportunities. A business model canvas was also produced for the most promising opportunities identified for 9 key areas.

3 State-of-the-art in business models and services employed by European manufacturing enterprises

In this section the state-of-the-art in business models within European manufacturing and service sector companies is considered. These have been extracted from reports and through interviews with key actors within industry.

3.1 Definition of Business Models

Business models describe how companies generate revenue from their activities by detailing the ways products, information, and other elements are utilized for commercial activity. There are a large number of business models and companies can generate revenue in a number of different ways. For example, some only sell products and services to consumers, some sell to other businesses, and some sell via both of these channels. Third-party organizations are often involved such as distributors or online marketplaces. These act as an interface enabling transactions between companies and other businesses or directly with consumers [1].

It is noted that business models often go across multiple levels within supply chains or value chains. It is important that companies closely monitor and review these to be optimally efficient and maximise profit. Value chains define the different steps involved in creating value along the spectrum of supply and demand. At one end of this spectrum are the raw materials used during manufacturing. At the other end are the finished products which are sold direct to customers or are fed in as components by other manufacturers.

The business model defines:

- The manner by which the business enterprise delivers value to customers
- How customers are enticed to pay for value
- How customer payments are turned into profit

In order to provide a product and make a profit the manufacturer needs to know:

- What customers want
- How they want it
- How the enterprise can be best organized to meet the customer needs
- How to get paid and make a profit

The approaches to business are changing and in the past the end point has traditionally been a hand over to the customer of a product, however, increasingly manufacturing is considering the product cradle-to-grave from R&D to recycling and re-use [2]. The way in which the central activity of production is increasingly considering the full product life-cycle is leading to business model

innovation. Business models thus define the means to create and capture value, linking technologies to a market offering via a network architecture. Value is created in interactions between organisations in networks and more and more, in addition to financial aspects. It also covers environmental and social sustainability.

The "Business Model" term came into widespread use during the emergence of e-business and is now used extensively to describe different approaches to business. The original e-business model was defined as "An architecture for product, service and information flows, including a description of the various business actors and their roles; and a description of the potential benefits for potential actors; and a description of the sources of revenue" [3]. More recently literature on business models has moved from a focus on what business models are, to business model *innovation*. A study by IBM Global Business Services, for example, found that the highest performing firms (across various sectors, not just manufacturing) give proportionately more emphasis than their peers to business model innovation [4].

3.2   The Business Model Canvas

The most common approach to developing a business model to show how a business opportunity can be put into place operationally is the Business Model Canvas. This is used later in this report to identify business models around the business model categories that have been identified. The Business Model Canvas is a template for developing new business models or documenting existing business models. It utilises a visual chart with elements that describe a company's value proposition, infrastructure, customers, and finances [5]. In particular, it allows companies to align their activities and also highlights potential trade-offs. In this work the business model canvas is also used to highlight the needs in terms of ICT infrastructure and barriers to adoption such as security, privacy and legal issues.

The formal descriptions of the business are used as the building blocks for its activities. The Canvas is based on Osterwalder's work [6] who proposed a single reference model based on the similarities of a wide range of business model conceptualizations. The Business Model Canvas considers the following elements:

Infrastructure

- Key Activities: The most important activities in executing a company's value proposition. An example would be creation of an efficient supply chain to drive down costs.

- Key Resources: The resources that are necessary to create value for the customer. These are considered to be the assets of a company which are needed in order to sustain and support the business. These resources can be human, financial, physical and intellectual. In terms of physical resource this can include ICT infrastructure and human resources can include skilled staff.

- Partner Network: More and more enterprises consist of networks of partners and indeed in order to optimize operations and reduce risks of a business model it is usual to develop buyer-

supplier relationships so that the company can concentrate on core activity. Additionally, business alliances can be formed, e.g. joint ventures and strategic alliances between competitors and non-competitors.

Offering

- Value Proposition: The value proposition describes the collection of products and services a business offers to meet the needs of its customers. According to Osterwalder [7], a company's value proposition is what distinguishes itself from its competitors. The value proposition can provide value through a variety of means. For instance, it may be provided by newness, performance, customization, "getting the job done", design, brand/status, price, cost reduction, risk reduction, accessibility, and convenience/usability. Thus the value propositions may be:

  - Quantitative- based upon price and efficiency

  - Qualitative- based on overall customer experience and outcome

Customers

1. Customer Segments: It is important to be clear about which customers a company is trying to target. It is possible to segment customers based on the different needs and attributes. The different types of customer segments include:

   - Mass Market: An example of this is the mobile phone market where the aim is to have a wide range of potential customers for a model. There is no specific segmentation for a company (although some companies specifically produce more expensive models targeted at the more affluent end of the market).

   - Niche Market: Customer segmentation is based on specialized needs and characteristics of its clients. An example of this is Rolex who produce watches.

   - Segmented: A company applies additional segmentation within an existing customer segment. Here, the business may further distinguish its clients based on gender, age, and/or income. Here there is much market research into the demographic of the customer base.

   - Diversify: In this approach the business serves multiple customer segments with different needs and characteristics.

   - Multi-Sided Platform / Market: An example of this is a credit card company that provides a service to credit card holders and also to merchants who accept the credit cards. The key attribute is that the customers are mutually dependent on the service.

2. Channels: The channels through which a company supplies it value proposition is also important. A key aim here is that the channel should be effective in distributing a company's value proposition in a fast, efficient and cost effective manner. An organization can reach its clients either through its own channels (store front), partner channels (major distributors), or a combination of both.

3. Customer Relationships: "The customer is always right" and to survive and be successful companies must identify the type of relationship they want to create with their customer segments and put in place the necessary infrastructure to support this. This becomes even more important when moving from product to product service type business models. Various forms of customer relationships include:

- Personal Assistance: Assistance is provided in the form of employee-customer interaction when requested. Such assistance is performed either during sales, after sales, and/or both.

- Dedicated Personal Assistance: This provides a more intimate and hands on personal assistance and in particular develops trust between the company and the client. Here a sales representative is assigned to handle all the needs and questions of a special set of clients.

- Self Service: Increasingly companies are proving web access to manuals, fixes and software updates. In this self-service relationship the interaction with clients is indirect but the company puts in place the tools needed for the customers to serve themselves easily and effectively.

- Automated Services: This goes one step further than the self-service approach gathering information from clients and using this to personalise the service provided based upon known individual preferences. An example of this is Amazon who can make suggestions about future book purchases based upon a customer's history of purchases.

- Communities: A common approach to reduce the support effort in the software tool vendor market is to create a community of users who can interact with each other to discuss and solve problems and exchange knowledge.

- Co-creation: Increasingly with the ease of exchange of customer experience via the web it is possible to develop a personal relationship by using customer's direct input into the final outcome of the company's products/services.

Finances

- Cost Structure: This describes the most important monetary consequences of operating under different business models.
  - Classes of Business Structures:
    - Cost-Driven - This business model focuses on minimizing all costs and having no frills, e.g. Ryan Air.
    - Value-Driven – Here cost is less of an issue and the business model focuses on creating value for products and services, e.g. Jaguar.
  - Characteristics of Cost Structures:
    - Fixed Costs - Costs that remain unchanged and are independent of the product, e.g., salary, rent.

- Variable Costs - These costs vary depending on the amount of production of goods or services.

- Economies of Scale – Often used in business to reduce purchase costs of raw materials or components that go into products with a consequence reduction in cost for production of the product. Here there is a risk of being left with considerable inventory if the product does not sell as expected.

- Economies of Scope – Here costs are reduced by incorporating other businesses in production of a product or provision of a service.

- Revenue Streams: The revenue stream identifies how the company makes income from the value proposition for the given customer segment (or segments). There are a number of ways to generate a revenue stream:

  - Asset Sale – By far the most common the ownership rights to a physical product are sold.

  - Usage Fee – If a service is being provided then a fee can be charged for use of that service, e.g. DHL, UPS, etc.

  - Subscription Fees – Here the revenue is generated by selling a continuous service for a fixed period of time, e.g. Netflix.

  - Lending/Leasing/Renting – Here the exclusive rights to use an asset for a period of time are sold, e.g. leasing a car

  - Licensing – Here the revenue is generated from charging for the use of protected intellectual property, e.g. Windows Office.

  - Brokerage Fees – This is a service based approach where the revenue is generated by acting as an intermediary between 2 parties, e.g. a broker selling a house for commission.

  - Advertising – Finally, revenue can be generated from charging fees for product advertising.

Figure 2. Example Business Model Canvas Template for Coca Cola

Figure 2 shows the business model canvas elements developed around the sale of a Coca Cola. This canvas presents visually the elements discussed previously such as key partners, key activities, key resources, the offer, customer relationships, channels, customer segments, cost structure and revenue streams of a company in order to describe the business model operationally. The aim of the Business Model Canvas approach is to present a vision and more importantly create a narrative describing how the proposed business opportunity can be turned into reality. In an increasingly networked world it also identifies if partners are required – here there also needs to be an understanding of the potential partner's business model and their value drivers. In the process the business model is made up of 9 Business Model Building Blocks. These are:

- The value proposition of what is offered to the market

- The segment(s) of clients that are addressed by the value proposition

- The communication and distribution channels to reach clients and offer them the value proposition

- The relationships established with clients

- The key resources needed to make the business model possible (here the ICT infrastructure and service needs come into play and also barriers to adoption such as privacy and security).

- The key activities necessary to implement the business model

- The key partners and their motivations to participate in the business model

- The revenue streams generated by the business model (constituting the revenue model)

- The cost structure resulting from the business model

3.2.1   Boundaries within Business –Moving Left
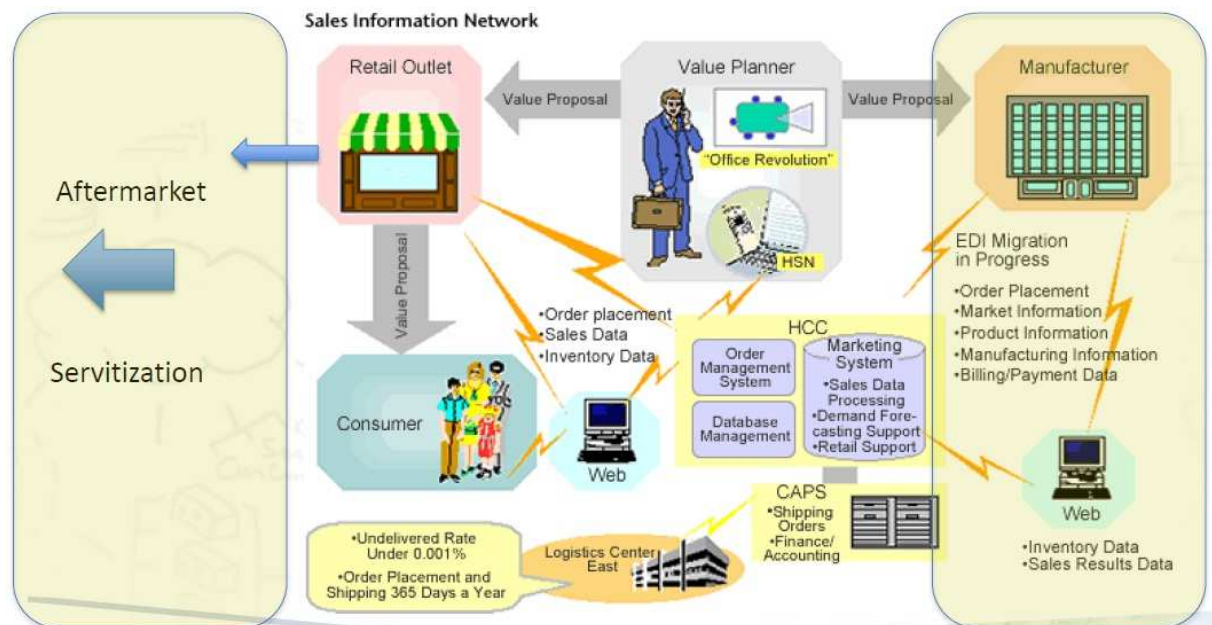
Figure 3. Boundaries-Moving Left

Of special note here is a fundamental change in business models that is being driven by the increased use and integration of ICT technologies. The use of ICT makes it far easier to connect systems together and increasingly these connections are being made with the customers directly (See Figure 3). Most companies provide a degree of after sales support (usually to sell spare parts) but new opportunities are being developed in the aftermarket area where manufacturers can provide directly or via a service company an after sales service and develop revenue from this. This move from a manufacturer selling products, to selling integrated products-service offerings that deliver value in use is called servitization. As a consequence the boundaries of moving towards product-centric servitization and providing aftermarket services.
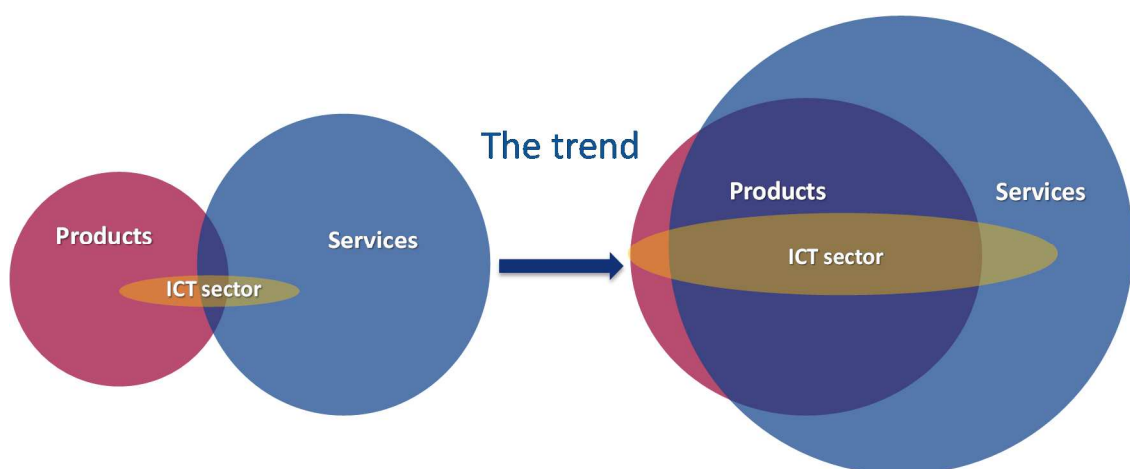
Figure 4. Trend in ICT towards Providing Services

This has been noted as a global trend and Europe needs to compete in this market through adoption of ICT (See Figure 4). In the aerospace sector, engine manufacturers such as Rolls-Royce, General Electric and Pratt & Whitney, all offer some form of performance-based contracts with commercial airlines in which their compensation is tied to product availability and the capability it delivers (e.g., hours flown). Rolls-Royce [8], in particular, have now registered trademarks for both 'Power by the Hour' and the more inclusive 'TotalCare' contracts. Such contracts provide the airline operator with fixed engine maintenance costs, over an extended period of time (e.g., ten years). In developing TotalCare, Rolls-Royce has adopted a product-centric servitization strategy. Many other large companies, especially those in industry sectors with high installed product bases (e.g., locomotives, elevators, machine tools, business machines, printing machinery, construction equipment and agricultural machinery), are also pursuing similar strategies. Here the challenge is to deliver integrated products and services with greater efficiency and effectiveness.

According to studies by Neely [9], [10] US manufacturing has the greatest proportion of servitized manufacturing firms. The UK had the ninth-highest level internationally, and from 2007 to 2011 this had increased from 24% to 39% of firms. The extent of servitization had also risen markedly in other developed economies, e.g. Sweden, Norway and France, as well as in China – from 1% to almost 20%.

3.2.2   A Business Model Framework
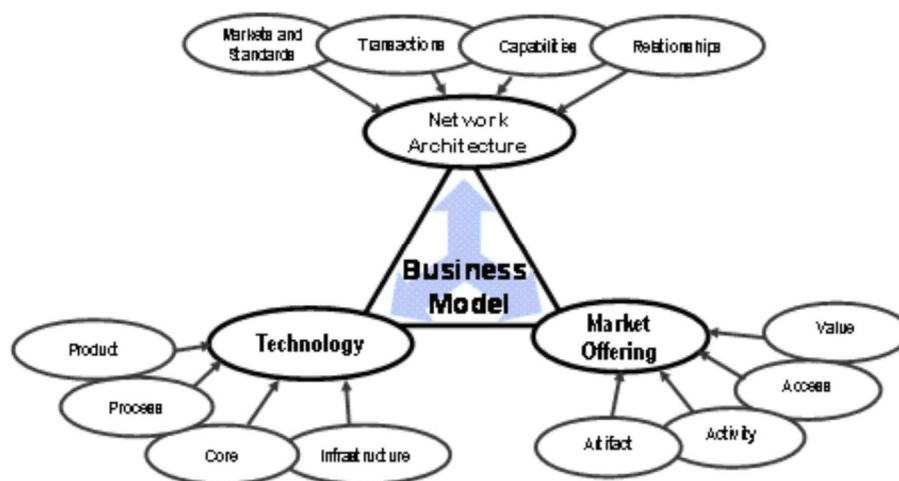
Figure 5. Business Model Framework [11]

In view of the changes in business models towards servitization other options for business modelling were also considered which may reflect better the increasingly networked nature of businesses. One such approach was the business model innovation framework [11] shown in Figure 5 which was used as the basis of the Foresight study into manufacturing in the UK [2]. It brings together many aspects of

the existing definitions of business models, in particular emphasising the inter-organisational nature of business models through a network architecture, and on translating technology into economic value. In this model the market offering is a vehicle for value co-creation with the customer (and other network actors) rather than being simply an end product or service delivered to a customer. In the Foresight report the Rolls-Royce 'Power-by-the-Hour' offering is considered highlighting that it requires both new process technology and infrastructural technology to capture real-time usage data in the field, and development of appropriate units by which usage can be charged and also metering technology. It is highlighted that business model innovation requires innovation on several fronts at once, and an innovation in one area can set off a chain of innovations in others. Also since business models are inter-organisational, interconnected organisations' business models must co-evolve. Within this framework the main elements of the Business Model Framework are:

Technology which consists of:

- **core technology**, the technology underlying the functionality of an offering (such as a key raw material or functional component, e.g. a gas turbine engine).

- **product technology**, the embodiment of a particular product or group of products, including core and other technologies.

- **process technology**, the equipment, systems and organisational processes used to produce and deliver the offering.

- **infrastructural technology**, by which offerings can be delivered and organisational units can connect with one another (e.g. internet, containerised shipping, etc.).

Network architecture which refers to the way organisations connect with and interact with one another. It consists of:

- **markets and standards**, which determine the ease with which inputs and complementary offerings can be accessed from other firms rather than being provided within the firm.

- **transactions**, the technical and institutional means to count and pay for that which is to be transferred between firms.

- **capabilities**, the ability to carry out certain activities and the respective roles of actors in a network.

- **relationships**, which complement market-based transactions as ways to bring about inter-organisational activity.

The **market offering** captures the various ways in which products and their related 'services' can be made available to customers. These consist of:

- **artefacts**, the physical product(s).

- **access**, arrangements whereby physical and organisational assets are used by the customer rather than owned by them (e.g. lease or performance-based approaches).

- **activities**, which are carried out by the supplier(s) on assets owned by the customer, e.g. maintenance.

- **value**, which is concerned with what value is created by the offering, and for whom. Here it should be noted that different combinations artefact, activity and access around the same product can be valued in different ways by different customers.

Although this business model reflects the move towards servitization and also the increasingly networked nature of companies it was considered too specific and less generic for application in this work where a number of different business models are possible based on different business opportunities. Thus the core technique used in this work is the more familiar Business Modelling Canvas approach which is commonly used and is more flexible in nature.

3.3 Approach and sources of information

In the previous section different approaches to business modelling were considered. In this section a review of current business models used is performed. This has been obtained via a literature search of key reports which identify business models within manufacturing. A number of sources of information were identified such as Industrie 4.0, Gartner, Foresight, McKinsey and Smart Industry.

3.3.1 Trends in Manufacturing
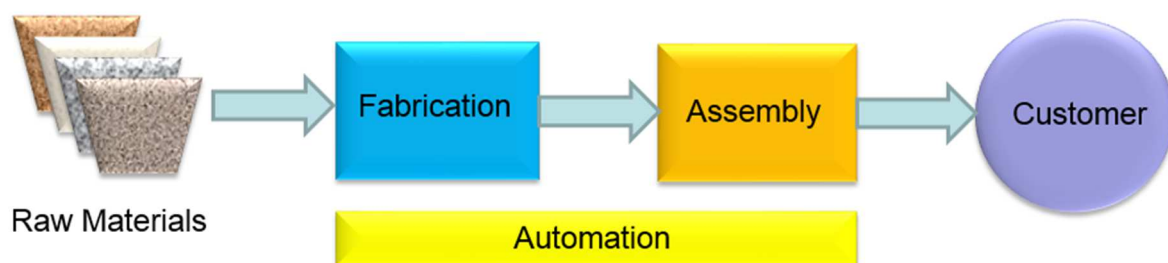
Figure 6. The Traditional Business Model

The default business model whereby a firm designs products, carries out significant material conversion itself and then simply sells the products to the customer, as shown in Figure 6, is becoming increasingly difficult to sustain in many countries. The world has changed significantly and business customers and consumers alike are increasingly aware of the economic and environmental liability that ownership of a product may entail. There are also a number of alternative sources for products and so value is often seen as more than just ownership. Information and communications technology means that there are many new possibilities in terms of what forms of value can be provided, how it can be provided and by whom, and where activities can take place. Through outsourcing, developing economies present huge, low-cost, international sources of capacity for manufacturing and other inputs such as engineering and R&D.
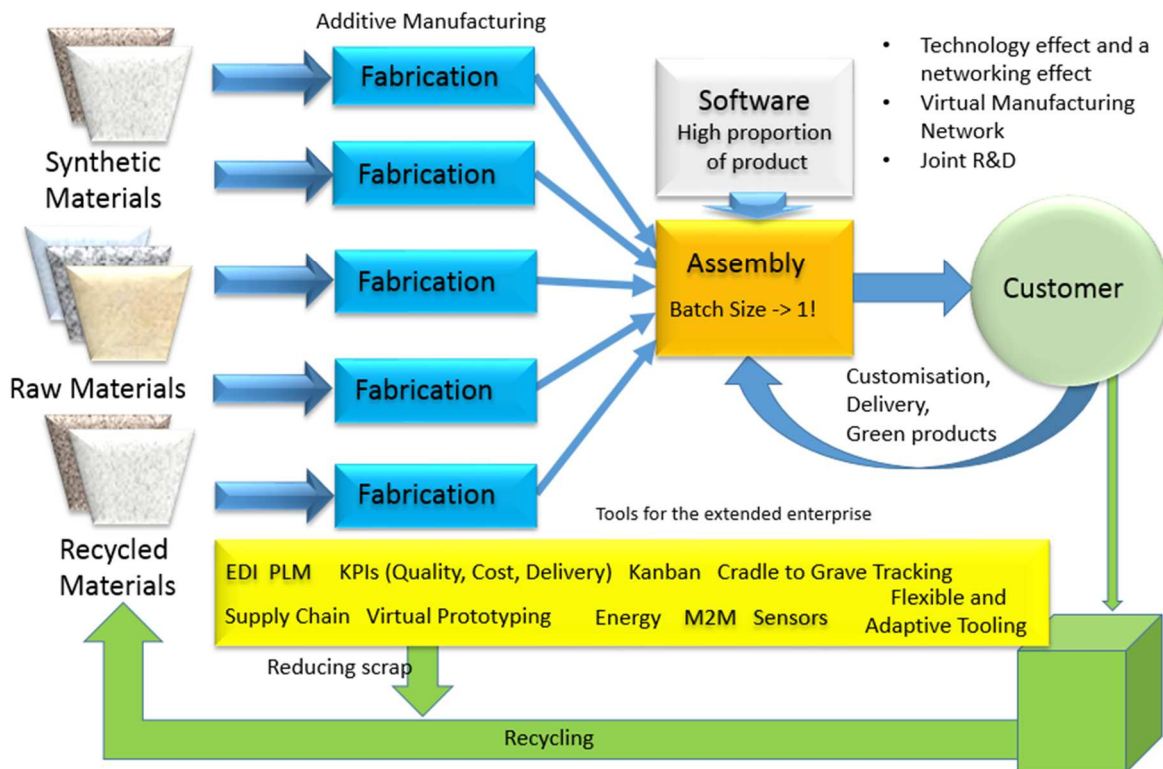
Figure 7. Current Situation in Manufacturing

The current situation in manufacturing is shown in Figure 7. Here manufacturers are increasingly becoming assemblers of components which are fabricated in elaborate supply chains. This leads to the concept of virtual manufacturing networks to produce products and more and more companies are performing joint research and development with suppliers. The product may consist of both hardware and software and the batch size for products in many cases is being driven towards more customised products with a batch size of 1. There is an increased linkage with the customer to obtain their preferences. Customers may also have specific delivery demands and may also have a preference for green products. Recycling is also becoming a key concern driven by regulation. There are drives to reduce scrap within the manufacturing process but also to recycle products when they come to the end of their useful life. This adds to the sourcing options for raw materials which may now also come from recycled materials. Here advances in synthetic materials also has a role to play along with methodologies to reduce scrap and build up material matrices using additive manufacturing. To support all of these changes ICT and software have been introduced to efficiently manage the process within companies and supply chains, monitor KPIs, track components through the process, monitor and optimise energy usage, provide rapid prototyping of new products, and flexible and adaptive manufacturing processes to produce customised products.

3.3.2 Gartner

Gartner [12], in its last Top Ten Industry Trends Analysis identified a strategic technology trend as one with the potential for significant impact on the organization in the next three years. Part of this strategic technology trend may affect the way manufacturing could make money in the near future.

- **Computing Everywhere**. An increased emphasis on serving the needs of the mobile user in diverse contexts and environments, as opposed to focusing on devices alone is predicted. Phones and wearable devices are part of an expanded computing environment that includes consumer electronics and connected screens in the workplace. So the environment will need to adapt to the requirements of the mobile users; and this environment includes manufacturer companies.

- **The Internet of Things**. The combination of data streams and services created by digitizing everything creates four basic usage models — Manage, Monetize, Operate and Extend. These four basic models can be applied. Enterprises should not limit themselves to thinking that only the Internet of Things has the potential to leverage these four models. For example, the pay-per-use model can be applied to assets (such as industrial equipment), services (such as pay-as-you-drive insurance), people (such as movers), places (such as parking spots) and systems (such as cloud services). Monetizing the software powering Internet-connected devices via licensing and entitlement management is also key. Enterprises from all industries can leverage these four models.

- **3D Printing**. Worldwide shipments of 3D printers are expected to grow 98 percent in 2015, followed by a doubling of unit shipments in 2016. 3D printing will reach a tipping point over the next three years as the market for relatively low-cost 3D printing devices continues to grow rapidly and industrial use expands significantly. New industrial applications will continue to demonstrate that 3D printing is a real, viable and cost-effective means to reduce costs through improved designs, streamlined prototyping and short-run manufacturing.

- **Advanced, Pervasive and Invisible Analytics**. Organizations need to manage how best to filter the huge amounts of data coming from the Internet of Things, social media and wearable devices, and then deliver exactly the right information to the right person, at the right time.

- **Context-Rich Systems.** Ubiquitous embedded intelligence combined with pervasive analytics will drive the development of systems that are alert to their surroundings and able to respond appropriately. Context-aware security is an early application of this new capability, but others will emerge. By understanding the context of a user request, applications can not only adjust their security response but also adjust how information is delivered to the user, greatly simplifying an increasingly complex computing world.

- **Smart Machines**. Deep analytics applied to an understanding of context provide the preconditions for a world of smart machines. This foundation combines with advanced algorithms that allow systems to understand their environment, learn for themselves, and act autonomously. Prototype autonomous vehicles, advanced robots, virtual personal assistants and smart advisors already exist and will evolve rapidly, ushering in a new age of machine helpers.

- **Cloud Computing**. The convergence of cloud computing will continue to promote the growth of centrally coordinated applications that can be delivered to any device. The second-screen phenomenon today focuses on coordinating television viewing with use of a mobile device. In the future, games and enterprise applications alike will use multiple screens and exploit wearables and other devices to deliver an enhanced experience.

- **Software-Defined Applications and Infrastructure**. Agile programming of everything from applications to basic infrastructure is essential to enable organizations to deliver the flexibility

required to make the business work. Software-defined networking, storage, data centres and security are maturing. Cloud services are software-configurable through API calls, and applications, too, increasingly have rich APIs to access their function and content programmatically.

- **Risk-Based Security and Self-Protection**. Security-aware application design, dynamic and static application security testing, and runtime application self-protection combined with active context-aware and adaptive access controls are all needed in today's dangerous digital world. This will lead to new models of building security directly into applications. Perimeters and firewalls are no longer enough; every app needs to be self-aware and self-protecting.

3.3.3   Industrie 4.0 and Business Models

Industrie 4.0 [13] is a major German Initiative to drive the future of manufacturing. In particular it is addressing the 4th industrial revolution being driven by the Internet of Things and Services, the previous three revolutions being as a result of mechanisation, electricity and IT. The future is seen as one where businesses will establish global networks that incorporate their machinery, warehousing systems and production facilities in the shape of Cyber-Physical Systems (CPS). The impact on this in terms of changes in the way manufacturers organised themselves to produce products and provide services may well lead to new business models.

The development of Cyber-Physical Systems with smart machines, storage systems and production facilities capable of autonomously exchanging information, triggering actions and controlling each other independently will allow fundamental improvements in manufacturing, engineering, material usage, supply chain and life cycle management. Additionally, Industrie 4.0 highlights that future products will be smart allowing them to be uniquely identifiable, located at all times and know their own history, current status and alternative routes to achieving their target state.

The main vision for Industrie 4.0 is of a future smart factory. Here embedded manufacturing systems are vertically networked with business processes within factories and enterprises. Considering the increasingly networked nature of supply chains there are also horizontal connections to the whole "value network" to allow real time management from the original order to the logistics of supplying the product to the customer. The level of interconnection and dynamic flexibility will also allow customisation down to individual one-off products and at the same time provide resilience to disruptions and failures within the supply chain. End-to end transparency is provided over the manufacturing process, facilitating optimised decision-making.

Considering new business models one can envisage new ways of creating value through partnerships. The services and software systems should become more affordable for SMEs. One area that is specifically mentioned in Industrie 4.0 is the use of dynamic pricing within networked supply chains based on the current status of customers' and competitors' situations and quality of service level agreements (SLAs). There is also a need for fairness to share the potential business benefits among all the stakeholders in the value chain.
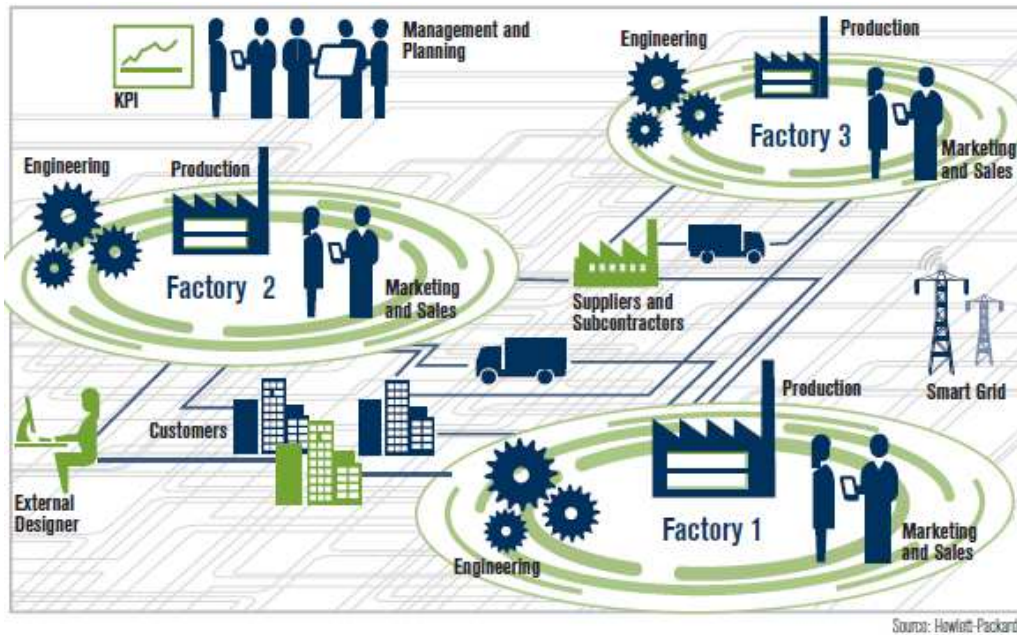
Figure 8. Horizontal Value network

Another feature of new business connections is that regulatory requirements for cutting CO_2 emissions can be integrated into the collective business model across the partners.

The use case scenarios in Industrie 4.0 are all driven by the dynamic nature of networked business, e.g. "networked manufacturing", "self-organising adaptive logistics" and "customer-integrated engineering". Commercially this introduces challenges in financing, development, reliability, risk, liability, IP and know-how protection. Cryptography will be required for sensitive corporate data, and care must be taken to meet trade restrictions. This will require clear responsibilities and contractual documentation and real time monitoring of this to document compliance. Enforcing this across a diverse and dynamic network of companies will be a challenge. Provision of services by SMEs within this dynamic chain will require supporting licence models.

CPS platforms are advocated to connect industrial business processes and networks via people, objects and systems in a flexible way. Increasingly shared services will be used requiring simple allocation and deployment of business processes along the lines of the App Stores model. There is also a need for comprehensive, secure and reliable backup of the entire business process as well as support for safety, security and reliability for everything from sensors to user interfaces which include mobile end devices. Availability of a secure and efficient network infrastructure with high bandwidths will be key to guaranteeing the necessary secure data exchange.

One key area highlighted by Industrie 4.0 is that the use of end-to-end digital system engineering and the resulting value chain optimisation will mean that it will be possible to manufacture individual products cost effectively. This will give customers more choice and the ability to customise products resulting in higher sales.
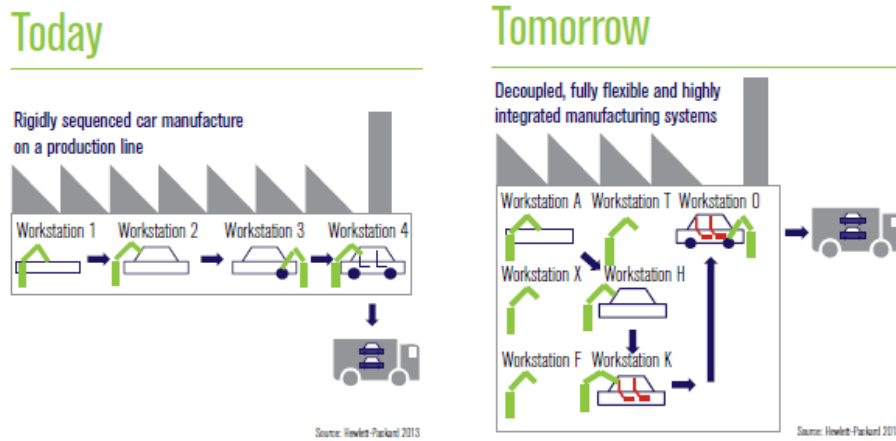
Figure 9. Static Value Chain vs. Dynamic

Industrie 4.0 foresees a move from static production lines, such as those currently used in the automotive industry, to production lines that can be dynamically reconfigured as shown in Figure 9. In addition to meeting customer requirements and allowing customisation, this also provides more resilience to logistic bottlenecks.

An interesting concept introduced is that of provision of a remote manufacturing service via telepresence. Here remote access via VPN connections (Virtual Private Networks) can be used to remotely diagnose and control the machine in order to reduce the duration of unscheduled stoppages and downtime. Looking to the future manufacturing systems will operate as "social machines" in networks that are similar to social networks. Standardised, secure communication links will automatically connect to cloud-based telepresence platforms in order to search for the appropriate experts to deal with the problem or automatically update or load relevant functions. By shifting complex computational tasks (e.g. simulations and projections) away from the machines to the cloud it will be possible to employ huge amounts of processing power.

Finally, Industrie 4.0 also considers energy efficiency, in particular the ability to systematically power down inactive parts of a line during breaks in production, weekends and on shifts where there is no production.

3.3.4   Multi-purpose Transactional Systems and Business Models

ATOS, in their paper "The New Economy of Internet Applications" [14] gives its vision on Multi-purpose Transactional Systems. The value of a multi-sided market is defined by the services or the information exchanged between the participants of the different markets. Business models will not only be based on money exchanging hands, but also on value in exchanging ownership. The business model that suits each participant's best interest will be a combination of different revenue models as defined below:

- Freemium Business Models: The common models used for consumers are led by the open source community. These models establish brands with a worldwide reach in weeks or months and then influence consumers to accept advertising. The challenge remains, however, to monetize these models when many similar services are also available. Some attempts to simply charge the consumer have failed, even resulting in a breakdown of entire platforms or brands. It has been noted that although consumers will pay substantial prices for physical products, they are reluctant to pay for online service offerings, as demonstrated by the attempt of the media industries to switch to paid subscriptions. Users expect digital services to be available for very little or for free. This expectation is reinforced by many companies (Facebook, Google, Twitter, LinkedIn, etc.) giving away much of their service offerings for free and recovering their cost in other ways. The current free products and services models are:

  o Freemium model: The content, services and software are available in multiple models of use, including a basic free offering. A small percentage of customers pay for the service which covers the overall cost of the platform/services. Increasingly, companies are providing basic platforms for free with the option to pay for full functionality.

  o Free-through-advertising model: Content, services and software are offered for free and advertisers pay for access to specific user communities as an additional sales channel. Some examples are Yahoo's pay-per-page view banners, Google's pay-per click text ads and Amazon's pay-per-transaction affiliate ads. Consumers accept that personal data is used for one-to-one marketing.

  o Traditional cross-subsidized model: Products and services are offered for free but customers are persuaded to pay for additional services, i.e. Google's AdSense product enables any web site to become affiliates to other providers who wish to advertise their products and services.

  o Low-cost model (Bait and Hook): Products or services are offered for free for a limited period or with limited capabilities to attract trial users to buy it (try before you buy). In these cases, the service or content is effectively a promotional marketing tool.

  o Gift-economy model: Some offerings are free because the providers gain some non-monetary value, usually recognition, out of the process. For example, Wikipedia contributors or popular bloggers provide their services as gifts to the community.

- Pay-per-Use Models: The user pays a price based on actual usage. In ICT platform businesses, these models are enabled by shared, pooled and scalable infrastructures and multi-tenant applications and services. These models are not entirely new but cost benefits combined with agility (elasticity and time to market) mean that they are becoming more popular. It is thought that they will dominate the ICT industry in the future. These models could be used on one side in Multi-purpose Transactional Platforms (a business partner wishing to participate in the

usage of data generated by the platform), while the other side is tied to the platform by other models or more traditional models.

- Subscription Business Model: These models are based on a fixed fee over a period of time regardless of whether the service is consumed or not. Providers are assured a constant source of revenue with advance knowledge of the number of subscribers making capacity management a less challenging task. For subscribers this is convenient if the usage of the service is constant.

The best business model for Multi-Purpose Transactional Systems is one where cost and business benefits are balanced. This way no single partner has to finance the entire platform. The platform may be used in different ways according to the different sectors of participant companies. Use cases, therefore, may also vary requiring different contributions and business models for each party. The end consumer can be attracted to be part of the platform by offering a greater user experience because of the free nature of the service, in exchange for the voluntary disclosure of some private information, such as geo-localization or preferences. The creation of these business models in Multi-purpose Platforms is expected to happen in steps:

- Tailored Solutions: Most of the business ICT landscapes today are individually developed or customized solutions, operated on customer-owned infrastructure supporting individual business processes. This offers the best end-user experience, but also with the highest costs. The time for adoption can become a problem and changing legacy applications can produce unpredictable side effects. Opening the application to a broader consumer audience via the Internet can also lead to inadequate consumption of infrastructure capacity. The introduction of new rules and regulation may result in high maintenance costs and innovation budget. Ideally, this model should only be chosen by the business where the solution supports a unique selling proposition in the market.

- Multi-tenant Platforms: The Cloud Computing paradigm applied to business support functions has made it possible for platforms to support more than one tenant. Firstly, this was by ASP (Application Service Provider) solutions developed during the Internet boom and presently it is being driven by Cloud Computing, enabled by virtualization and multi-tenancy. Application, data and systems are strictly separated for each tenant, while system management, code and hardware are shared in order to provide cost reduction. Cloning an entire application and system for a second tenant is the easiest way to create multi-tenant platforms. More sophisticated methods of sharing data are possible to add more value, but this adds complexity too.

- Closed Value Networks: Participants of Multi-Purpose Transactional Platforms may also find that valuable business information is generated from data that is collected. However, most companies focus on finding their own value in data rather than considering use in other sectors. Anonymized user or consumer behaviour can be shared, however, the rules on how to share and build communities are becoming more sophisticated and are not yet feasible for business purposes. The untapped potential value in existing multi-tenant platforms can be realised using a context broker platform and by collecting and sourcing context data. If the shared data is used for applications in different sectors it is necessary to plan, put into place B2B contracts and build value networks.

- Consumer Community: The easiest way to build large communities is via social networks. Most of the offers here are free of charge to attract users in the hope of a network effect. However,

monetization is still a challenge and the use of this approach for business is still under discussion. Privacy is a key issue and society and business' learning curves around social networks are still evolving. Another approach could be to start with established multi-tenant platforms leveraging the value of context or meta data for existing customers. Here loosely coupled data and applications, flexibly built on top of the original platform can be used in the same way that Facebook currently opens its API for application developers to sell their own apps inside the Facebook platform taking a percent of the developer's revenues.

3.4   Business Models Used

In this section the business models that have been found in the literature are presented. Some of the business models are already used in manufacturing. Additionally other business models which may have potential use in manufacturing are also identified and explained. These models are later grouped into 10 categories.

Many different business models exist, ranging from those that are simple (i.e. the manufacturer model) to those that are much more complex. Also some companies rely on a combination of different business models. Business models are used to show the way enterprises profit in the marketplace. With that in mind, they normally do not go into descriptions of detailed strategies but operate at a higher level. To add more detail companies rely on a special kind of business model called a marketing plan. Marketing plans identify the specific situation a company finds itself in within a particular marketplace, the differentials that set a company apart from its competitors, the marketing tactics used to accomplish strategic objectives, and so on [1].

It should also be noted that business models used in the physical world may or may not be meaningful for e-commerce. Some, including manufacturer models, subscription models, mail-order models, advertising models, free-trial models, and direct-marketing models, work well on the Internet while others have no relevance. Furthermore, some business models have no place in the physical world at all and are native to electronic markets. Typically these focus heavily on the movement of electronic information, for example, information-barter models, digital-delivery models, and freeware models, etc. In the following sections, a brief description is given of the business models identified.

In the first section business models that were found in the general literature are highlighted, subsequently specific forward thinking documents found in the domain and the business models highlighted within these are considered.

3.4.1   Business Models Extracted from General Literature

3.4.1.1   Manufacturer Model - Selling Direct - Cutting Out the Middlemen

By eliminating third party intermediaries like distributors and wholesalers, consumers benefit from lower prices. Of course there is some resistance to this and notably some third-party groups have made successful attempts to protect their survival. Among them are the National Automotive Dealers Association, the Wine Wholesalers Association, the National Association of Travel Agents, and the National Association of Realtors. Their efforts have made it impossible for automobile manufacturers to sell directly to consumers, and for wineries to sell wine via the Web. Efforts such as these were considered roadblocks by some manufacturers. However, others encouraged the involvement of third parties in their supply chains because they are able to offer added services that manufacturers found valuable. One such area was logistics, which can include services related to warehousing, storage, inventory management, and shipping [1].

Disintermediation initiated by consumers is often the result of high market transparency, in that buyers are aware of supply prices direct from the manufacturer. Buyers bypass the middlemen (wholesalers and retailers) to buy directly from the manufacturer, and pay less. Buyers can alternatively elect to purchase from wholesalers. Often, a business-to-consumer electronic commerce (B2C) company functions as the bridge between buyer and manufacturer [15].

3.4.1.2   Merchant Model

This is perhaps the most well-known e-commerce business model utilising the Internet for merchandising. One of the most successful online merchants using this model, Amazon.com, began operating as a business-to-consumer (B2C) Internet company by selling books online. The database of titles exceeded one-million by the end of 1996 and the company has gone on to sell a vast range of other products.

3.4.1.3   Advertising Model

This model relies on advertising to make money. An example of this is the web portal company Yahoo!, which in order to attract users to its site, offers things like free e-mail, extensive content, and travel services. The growth strategy relies on the belief that more features, services, and content attracts more visitors and advertising dollars. It should be noted that Yahoo! found that it needed to reduce its reliance on advertising (as the dollars earmarked for on-line advertising were the most vulnerable to cuts in a recession). Yahoo! thus altered its business model by offering fee-based services like online bill paying to consumers, and fee-based services like e-store management to corporate clients.

3.4.1.4   Information Model

Several online companies focus on the sale of information. For example, the *Wall Street Journal Online,* offers a subscription that includes access to articles, detailed company information, and real-

time stock quotes for a monthly fee. *Which?* in the UK offers access to its product ratings and reports for a fee. In this model to draw more readers, both offer a limited amount of free content and charge a subscription for access to premium content. Quite often, sites like these also rely on some advertising revenue.

3.4.1.5   Brokerage Model

Like Amazon, eBay is another purely Internet company. Instead of using the retailing model employed by Amazon, the firm uses a brokerage format that brings sellers and buyers together. The company makes money by taking a proportion of the selling fee and additionally some of the advertising fee.

3.4.1.6   Online Services Model

At the core of online service providers is a subscription-based model. The revenue is generated by charging users a monthly fee for Internet access and e-mail service. Quite often, these firms also generate revenues by doing things like selling advertising space on their sites. For example, AOL founder and CEO Steven Case developed a successful business model that allowed his firm to make money in a variety of ways, such as charging subscription fees, selling online advertising, and developing e-commerce deals with online retailers.

3.4.1.7   Collective business model

A collective business system or collective business model is a business organization or association typically composed of relatively large numbers of businesses, tradespersons or professionals in the same or related fields. The aim is to pool resources, share information or provide other benefits for their members. Historically, collective business systems such as trade associations, co-operatives and franchises allow groups of independently owned businesses with common interests to successfully compete in the marketplace [16].

3.4.1.8   Razor and blades business model/Bait and hook model

Also known sometimes as "freebie marketing", the razor and blades or bait and hook business model is a business model where one item is sold at a low price (or given away for free) in order to increase sales of a complementary good, such as supplies. This is a commonly used business model and is used for inkjet printers that require ink cartridges, mobile phones that require service contracts, and game consoles that require accessories and software. It is considered distinct from loss leader marketing and free sample marketing in that it depends on the complementarity of products or services [17].

3.4.1.9   Servitization of products business model

Manufacturing firms are increasingly adopting "servitization". Here the existing product offerings are extended through the provision of related services [18]. This is seen as a means of recovering

competitive advantage. Servitization is, in fact, becoming a major strategic driver of manufacturing innovation today as highlighted earlier in this report. To offer services business models and organizational cultures need to fundamentally change. The manufacturer needs to put itself in its customers shoes and ask how can new products and services help them better achieve their business or personal goals? Based on this then services need to be provided that yield a sustainably profitable business model. In many cases, e.g. Rolls-Royce, this relies on provision of remote monitoring with performance-based contracts, to continuously enable higher customer value. By focusing on the outcomes of their products and services, manufacturers can "servitize" their business and thereby create whole new systems of value for customers. One of the key aims is to lock customers into long-term relationships and lock out the competition providing competitive advantage. This is especially important in markets where product differentiation is blurring and customer expectations for product and service performance are expanding [19].

3.4.1.10 Bricks and clicks

Bricks and clicks (also click and mortar, bricks, clicks and flips, or WAMBAM) is a business model where a company integrates both offline (bricks) and online (clicks) presences, sometimes with the third extra flips (physical catalogues). Additionally, many will also offer telephone ordering and mobile phone apps, or at least provide telephone sales support. The advent of mobile web has made businesses operating bricks and clicks businesses especially popular, because it means customers do not have to be at a computer but can shop when they have spare time on their phone. A popular example of the bricks and clicks model is when a chain of stores allows the customer to order products either online or physically in one of their stores, also allowing them to either pick-up their order directly at a local branch of the store or get it delivered to their home. Interestingly, the success of this model in many sectors has lessened the credibility of some analysts who argued that the Internet would render traditional retailers obsolete through disintermediation [20].

3.4.1.11 Subscription business model

The subscription business model is a business model where a customer pays a subscription price to have access to the product/service. The model was pioneered by magazines and newspapers (see the Information Business Model), but is now used by many businesses and websites. Rather than selling products individually, a subscription sells periodic (monthly or yearly or seasonal) use or access to a product or service. An advantage of this is that a one-time sale of a product becomes a recurring sale and can build brand loyalty. It is used for anything where a user can be tracked in both a subscribed and unsubscribed status.

Industries that use this model include mail order books clubs, cable television, satellite television providers with pay-TV channels, telephone companies, internet providers, software providers, business solutions providers, financial services firms, fitness clubs, and pharmaceuticals, as well as the traditional newspapers, magazines and academic journals. Renewal of a subscription may be periodic. Here there is a preference for automatic renewal so that the cost of a new period is automatically paid for by a pre-authorized direct debit charge to a credit card or bank account.

In order to attract customers into a subscription it is common to offer a "freemium model". Here some content is provided for free, but access to premium features is restricted to paying subscribers. In this case, the subscriber-only content is said to be behind a "paywall" (sometimes called closed access as opposed to open access). Note there is a similarity with the razor and blades/bait and hook business model in that customers get locked into a subscription but without a formal agreement by both parties [21].

3.4.1.12 Value-added reseller (software especially)

A value-added reseller is a company that adds features or services to an existing product, then resells it (usually to end-users) as an integrated product or complete "turn-key" solution. This practice occurs commonly in the electronics industry, where, for example, hardware and software is bundled together. The added value comes from providing professional services for integrating, customising, consulting, training and implementation. Value can also be added by developing a specific application tailored for a product that is designed for a particular customer's needs creating a new product. The term is often used in the computer industry, where a company purchases computer components and builds a system customised for a specific task (such as non-linear video editing). By doing this, the company has added value above the cost of the individual computer components. Customers purchase a system from a reseller if they lack the time or experience to assemble the system themselves [22].

3.4.1.13 Fee in, free out -charge first client only then free

In this business model a company charges the first client a fee for a service, then subsequently offering that service free of charge to subsequent clients [23]. Here it is usual for the development costs of the initial service or product to be picked up by the first customer. Exploitation of the product in other applications is more opportunistic. This business model is commonly used in software development and tailoring where the needs of one customer may well be close to those of another customer. In order to be successful in exploiting this a modular approach to development of software and hardware components is required which allows more flexible tailoring of solutions.

3.4.1.14 Online auction business model

An online auction is an auction which is held over the Internet. Online auctions come in many different formats, but most commonly used are ascending English auctions, descending Dutch auctions, first-price sealed-bid auctions and Vickrey auctions. Sometimes a combination of multiple auctions may be used taking elements of one and merging them with another. The scope and reach of these auctions have been propelled by the Internet to a new level. Online auctions break down and remove the physical limitations of traditional auctions such as geography, presence, time, space, and a small target audience. It should be noted that this increased "reachability" has also made it easier to commit unlawful actions within an auction [24].

3.4.1.15 All-in-one business model

All-in-one is a business model in which a set of products/services are offered within a single package. For example, Virgin media offers broadband, TV, phone and mobile services to customers in one

package bundling a number of media together to make a more competitive offering that provides the customer with a number of services within a single subscription cost.

3.4.1.16 Chemical leasing

In the chemical industry, chemical leasing is a business model in which the chemical company supplies a substance for a specific service, but retains ownership of the chemical. It is intended to shift the focus from increasing sales volume of chemicals towards a value added approach. It may lead to more efficient use of chemicals, and to quality, environmental, and economic benefits. In this business model the customer engages with a service provider in a strategic, long-term contract to supply and manage the customer's chemical and related services [25].

3.4.1.17 Loyalty business model

The loyalty business model is a business model used in strategic management for longevity in the market. The company resources are employed so as to increase the loyalty of customers and other stakeholders in the expectation that corporate objectives will be met or surpassed. Typically in this model the quality of a product or service leads to high customer satisfaction, which leads to customer loyalty in the future, which leads to long term profitability [26].

3.4.1.18 Monopolistic business model

A monopoly exists when a specific person or enterprise is the only supplier of a particular commodity. Monopolies are thus characterized by a lack of economic competition to produce the good or service and a lack of viable substitute goods. When a monopoly exists a company can raise prices or exclude competitors. From a competitive point of view this is seen as bad for consumers and so there is regulation to avoid monopolies in practice. Although monopolies tend to be big businesses, size is not a characteristic of a monopoly. A small business may still have the power to raise prices in a small industry (or market) [27].

3.4.1.19 Network effects business model

A network effect (also called network externality or demand-side economies of scale) is the effect that one user of a good or service has on the value of that product to other people. When a network effect is present, the value of a product or service is dependent on the number of others using it. The classic example is the telephone. The more people who own telephones, the more valuable the telephone is to each owner. Interestingly, the user purchases a telephone for their own requirements but also in the process creates value for other users. Online social networks work in the same way, with sites like Twitter and Facebook becoming more attractive as more users join [28]. Increasingly, they are being used to promote products and services and can lead to wide scale recommendation of products.

3.4.1.20 Premium business model

The premium business model is the concept of offering high end products and services appealing to discriminating consumers. Brand image is an important factor in the premium business model, as quality is often a subjective matter. This business model seeks a higher profit margin on a lower sales volume. Some examples of this model are Rolls-Royce, Jaguar, BMW and Mercedes-Benz in the automotive industry, Gucci bags and Rolex watches in the luxury accessories industry, and elite personal services such as using a chauffeur [29].

3.4.1.21 Professional open-source business model

Professional open source is an open-source software business model where an open-source software vendor generates revenue from paid professional services, maintenance and support provided along with the software. Some open-source software vendors also provide commercial licenses of open-source software or customized versions of open-source software to specific customers. Professional open source is more commonly used in the business environment rather than for individual use [30].

3.4.2   Business Models Extracted from Foresight Report

The Foresight report [2] highlights a number of business models concentrated on providing services. This includes offerings based on a more circular flow of products, including repair, re-manufacturing and collaborative consumption. It is believed that these will become more common in the future driven by an increased separation between ownership of products and their use, and by environmental pressures. At the core of this will be information technology to form new network architectures and new market offerings possible. Business Model Catapults [2] aim to:

- Connect products to services, extensively, and in 'upstream' sectors as well as in complex product sectors
- Connect technologies to potential future application areas and needs
- Connect products to information, institutions and individuals, to create value
- Connect – and disconnect, as necessary – firms to one another in collaborative communities
- Connect the forward and reverse flows of products in a circular economy
- Connect technological and operational capabilities with entrepreneurial insight and action
- Connect firms' business models to one another

From this a number of potential new business models are outlined below.

3.4.2.1   Market Offering Business models

The market offering denotes whether value is created by transfer of ownership of an artefact, by provision of activities or by provision of access to an asset. Offerings made by companies can be a combination of these dependent upon customers. Rolls-Royce for instance in one market offering sells an artefact (gas turbine) and also sells activities (maintenance) separately. It also sells access to the turbine, which it maintains at its own expense under 'power-by-the-hour' contracts. Here the activities and access could be classed as being 'services' [31]. In practice it has been noted in the software industry [32] that software product firms who add services initially see profits decline until the services grow to constitute a large majority of the total revenue [2]. Service based models are becoming more common and another example is SKF, the Swedish bearing manufacturer, who have embedded information technology into products to collect data on their performance [33], and provide condition-based monitoring and technical advice [34].

It should be noted that the term 'services' in manufacturing can cover a very wide range of activities: finance services, maintenance, custom design, performance-based solutions, etc. Some 'services' are based on access: performance-based solutions while others are based on activities, e.g. maintenance of a product owned by the customer, or custom design.

3.4.2.1.1   Repair, the Circular Economy, and Collaborative Consumption

The market offering will become increasingly interactive, leading to new business models associated with environmental and social sustainability moving from a production-and-consumption-based economy to a circular, repair-based economy. Business models whereby a customer pays for access to

a good, while the manufacturer retains ownership of the asset and carries out maintenance are becoming more common. These give greater financial predictability in terms of costs for the customer, and revenue for manufacturers. Also considering growing material scarcity, combined with the growing costs and environmental impact of energy consumption and waste disposal makes ownership less obviously desirable. Customers do not want the financial and environmental burden of ownership and, as with larger capital goods, moving ownership to the provider shifts incentives to promote good manufacturing practices.

Business models based on temporary or shared ownership are causing a shift from a linear economy to a circular economy, i.e. from an economy based on the conversion of raw materials into products that end their lives as waste, to an economy where products are re-used, 're-purposed', repaired, re-manufactured and recycled, rather than being used and discarded [35]. In fact this is not a new concpet and was originally proposed by Walter Stahel over 35 years ago [36]. A number of think tanks have promoted the circular economy and collaborative consumption business models such as the use of online methods for booking and paying for use of assets. Here there is a need to overcome institutional resistance to sharing [37]. The environmental impact of a circular economy can be monetized by the avoidance of material costs, landfill taxes, etc. A move towards more repair of goods rather than disposal and replacement has implications for the location of employment and skills.

Re-manufacturing, whereby high-value or high-use parts of capital equipment are returned, repaired and re-sold, is already used in aerospace, commercial vehicles, passenger cars, tyres, and medical equipment. A very high proportion of aluminium is recycled (98% of aluminium cans are recycled in Brazil for instance). It has been noted that material scarcity, oil prices, extreme weather events and wider sustainability pressures may lead to a desire for greater self-sufficiency within the national borders, or at least within Europe.

One vision for the future is a manufacturing system where re-manufacturing and re-use is the norm, and production of products from virgin raw materials is the exception. Re-manufacturing is also being used as a market-entry mechanism in developing markets. An example of this is the Volvo truck in India, where re-manufactured engines are sold at 65% of the price of a new engine. The introduction of standards has been a driver behind re-manufacturing and more products are being designed with this in mind.

3.4.2.1.2 Personalisation, Identity, Provenance

Another trend is the increasing connection of products to individuals and institutions. For mass produced products the property rights are transferred to the owner and products are used anonymously and disposed of anonymously. By embedding IT in products it is possible to identify and characterise individual people, places, organisations and things in a much more fine-grained way. This opens opportunities for new connections between products, individuals and institutions new sources of value, and new business models.

Examples of this are personalised medicine where prognostic and diagnostic information on individual patients can be used to manufacture personalised medication aimed at individuals. This can also be integrated with the individual patients' responses to treatment turning a unidirectional drug production and distribution system into a bi-directional healthcare support system. Here there are issues of data ownership and privacy and also how to monetize the process.

Identity and provenance are particularly important for safety critical components and products. It is commonplace for information on provenance to be associated with products, e.g. batch numbers stamped on them to allow recalls in the case of quality problems (e.g. foodstuffs) and for higher-priced products, individual serial number. As remote monitoring, information systems and institutional transparency develop, products increasingly become carriers and producers of more and more information. This will affect issues of provenance so that individual items, even relatively low-value ones, will carry or be linked to very detailed data about sources of material, circumstances of production, embedded energy and water, guarantees of authenticity, etc. For higher-value components, e.g. aerospace spares, exact details of production processes used are critical to ensuring authenticity, and subsequent examination of performance and failures in service; this is combined with historical and ongoing data regarding usage, maintenance interventions, etc. The expectation is that more and more data will be generated and collected for high-value products.

As the cost of technology reduces this will become more feasible for lower-value products. Some have suggested that even for everyday objects, biological markers will ensure that ownership is traceable to guard against inappropriate disposal. Already it is not possible to dump a car without repercussions as it is uniquely identified and knowledge of its ownership is institutionally recorded, there may come a time when the same would apply to a pair of training-shoes or even a drinks container.

3.4.2.1.1 Products as websites

Looking long term products themselves may become websites, indeed Rolls-Royce engines are already effectively websites. It is also possible to monitor vending machines over the Internet. Here the products are generators of information and can be considered to be "informated"[38]. The physical products become sites for the creation and capture of information. A common application of this are smartphones that generate location-specific data for and about their users. The different types of interaction have been characterised as the Internet of Things [39] with increasing levels of interactivity, from activity-aware, policy-aware, and process-aware smart objects. The Google driverless car is an example of a "process aware" object [40] but there are many other opportunities. However, such applications present potential problems, associated with property rights and privacy. As information becomes an increasingly valuable asset, it will become more important to understand the rights of those who create information, how to protect the ownership of the information, and how to safeguard the privacy of those to whom the information may relate.

An example here is the use of telematics devices in cars to collect road tolls. Here the same information could also be used to look at an individual's patterns of movements and driving behaviour.

3.4.2.1.2 Fabless manufacturing

The typical manufacturing business model captures the value created in development and design by the sale of products. Fabless manufacturing is different in that it captures value by selling the "kernel" of technological knowledge, leaving production to someone else. ARM Holdings is a well-known example of this approach. Fabless manufacturing may well offer benefits for some technologies and depends on whether design and development knowledge can be codified and made transferable. This business model offers an opportunity for manufacturers who mass produce products where there is competition from developing countries. Fundamentally a company must move from recouping expenditure on design and development through selling products, to selling the design and development in its own right. This requires a major effort to design the market offering and also in re-positioning within the supply chain [41].

3.4.2.1.3 Sustainability and value

Environmental and social sustainability is seen as a long term objective that will affect future business models by many companies. Although there is a perception that environmental and social sustainability results in higher costs it is being used for differentiation of products and creating value. There is also some evidence that sustainable supply chain management can reduce costs, e.g. [42]. The expectation is that in future sustainability will be measured in a similar way to quality. A challenge is to measure and quantify sustainability which needs to be done across the value chain considering design, production and distribution systems. Currently there is diversity in the schemes for sustainability measurement and accreditation, e.g. ISO, Fairtrade, Walmart in the US developing a sustainability metric for retailing etc. In the UK the National Physical Laboratory is working with the Environmental Materials Information Technology (EMIT) Consortium to develop tools linked to design CAD packages to allow the calculation of new products' CO_2 footprint and energy usage.

3.4.2.2 Technology Themed Business Models

Technology can be characterised in a number of ways, e.g. based on company's core technology: metals, electronics, biotechnology or by the technological innovation on product, process, service, etc. A technology may provide the fundamental performance attributes that make products valuable, for example, graphene. Other technologies may make the business model through which the value is created and captured possible, e.g. the Internet. The overwhelming pervasive technological theme is information technology which will be complemented by a number of materials- and process-based general-purpose technologies, e.g. additive manufacturing [2].

3.4.2.2.1 Information Technology (IT) - Infinite Bandwidth/Zero Latency (IBZL)

IT is a core technology in products, in the infrastructure that makes offerings available and in how networks of organisations can be configured. Cloud computing and wireless networks make it possible for organisations (manufacturers or service providers) to connect with "informated" products. It should also be noted that "informated" products can also connect with one another. The Infinite Bandwidth/Zero Latency (IBZL) approach focuses on uses and applications rather than anticipated technical improvements in infrastructure. IBZL removes the obstacles of working across company boundaries and across distances. An example of this is telepresence as used in remote surgery,

whereby a surgeon is able to operate via a robot which provides real-time sensory feedback to the surgeon. This requires high reliability data links and "zero" latency. The use of telepresence can also be envisaged in production processes.

3.4.2.2.2 The 'Density Principle'

Normann [43] coined the term Density Principle to describe the concept of bringing together information technology for a particular actor at a particular place and time, to give the best possible value/cost result. An example would be the ability to search for a half-remembered title of an article in Google Scholar. Here a seamless link would access the library and within a few seconds provide a digitally-annotatable pdf version of the article on a tablet computer, opened and interrogated using an app designed for the purpose. Likewise aerospace component manufacturing [41], involves sophisticated, local and temporary integration of the CAD systems and designs of the customer, various IT- and non-IT-based technologies within the firm, as well as among suppliers, in order to deliver a rapidly-designed prototype. Both examples employ dematerialisation – separating the physical artefact (written copy, the aero engine) from the information about it, moving the information around and reconfiguring it, then re-constituting it in a particular, valuable form (the annotated file on the tablet, the physical new prototype part). Normann [43] captures this in the diagram shown in Figure. 10.
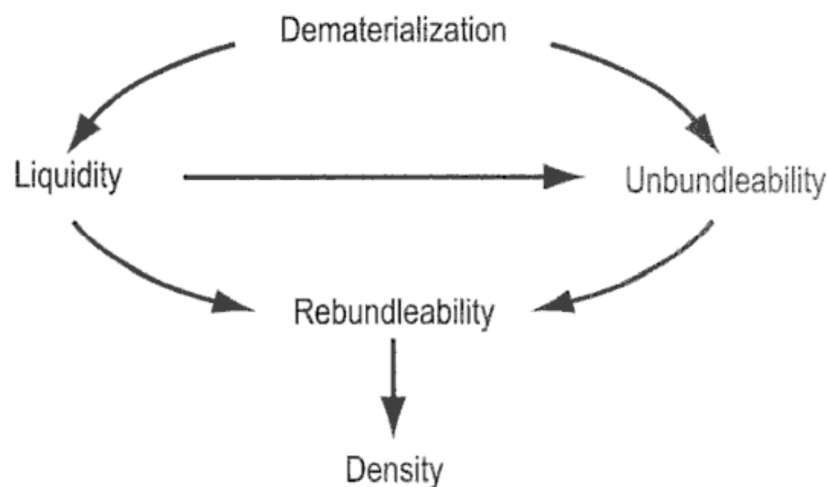
Figure 10. The Density Principle [43]

In this approach services are "automated" and provided more quickly and cheaply. Significantly the roles of actors can be changed, activities can be fragmented between actors and across geographies, re-integrated in new ways at new sites, to make it possible to do things that were not possible before.

Another example of the density principle is the process of moving from atoms to bits and back again [44]. Additive manufacturing, or 3-D printing, is the most prominent manifestation of this and has potential to transform manufacturing across many sectors [45]. Various industry structures are envisaged, including production in the home (for personal use or for sale), local 'printing' shops, and within more conventional centralised production facilities. Additive manufacturing offers opportunities for personalisation; postponement of production to the time and place of need

(reducing transportation, inventory and speculative manufacture). From a technical perspective it can allow geometries and composite constructions that are currently not possible, and reduces material waste compared with traditional 'subtractive' processes. It also offers the potential to produce one-offs or low volumes economically.

If products are made for sale then the business models do not change, however, if the production is done by the customer or at a local print shop then new transactions for information-based offering must be defined and enabled, sometimes requiring the creation of new markets, e.g. for the downloadable files that control the printer. Underlying this will be the need for development of standards and definition of parties' legal responsibilities. This may also have social implications for urban planning as high-street shops could become sites of significant manufacturing activity [45].

3.4.2.2.3 General-purpose technologies

General-purpose technologies (GPTs) create new opportunities for value creation through new properties and levels of performance. GPTs provide the basis for value-creation, but the business model achieves the value creation and value capture. It is not possible to predict particular business models for particular technologies but value creation depends on the ability to generate "novel applications".

3.4.2.3 Network Architecture Business Models

Network architecture (virtual factory) business models rely on the division of labour between firms which may be geographically in different countries. An important network architecture characteristic is the tight geographical connection between production and innovation: as production moves overseas, innovation tends to follow it. Activities become dispersed among more, smaller organisations making the ability to link activities interactively between organisations critical [2].

3.4.2.3.1 Organisational form

There is a general trend towards economic activity being performed by a greater number of smaller firms. In part this is due to the use of IT [46] to reduce coordination costs enabling companies to work together as organisations. There is a move away from large, vertically-integrated firms. This move has been enabled by supporting developments in contracting processes, legal frameworks, standards and communications. A consequence of this is that the strong visible hand of management is giving way to a "vanishing hand" of market-based coordination between many smaller companies.

At the bottom end of this is the so-called "Maker Movement" [44] where small-scale additive manufacturing and internet-based sourcing of technical expertise is combined with production capacity and distribution, allowing firms with a handful of direct employees to have the productivity of firms several times their size. One enabling factor in this is Cloud-computing-based "software as a service" giving small firm's access on a pay-as-you-go basis to administrative support that larger firms normally possess.

3.4.2.3.2 Interaction and indirect capabilities

In the future the ability of firms to access others' capabilities will become absolutely critical. According to Hagel and Brown [47], creating and capturing value will depend on having and developing specialised capabilities within an organisation, combined with the ability to generate "productive friction" with other organisations with complementary capabilities. Outsourcing of intermediate goods and services is required.

3.4.3 Business Models Extracted from the McKinsey Report

The McKinsey report on manufacturing [48] highlights that manufacturers are being forced to adopt new business models that are more responsive to swings in demand or input costs and allow faster product cycles. Manufacturers are also being pressed to respond to the fragmentation of demand and the need to produce customised products for new market segments where buyers demand greater value. Thus emerging business models identified in the report emphasise efficiency and resource productivity. The models highlighted are:

3.4.3.1 Mass customization

Mass customization is seen as a manufacturing industry innovation. Examples of this are Nike, whose NIKEiD customisation program for sports apparel generated substantial revenue. In the pharmaceutical sector personalized medicine is being introduced, e.g. Eli Lilly, using advanced diagnostics to tailor drugs specific patients. The US personalized market is expected to grow at 11% annually to $450 billion by 2015.

3.4.3.2 Circular economy

The circular economy is built on four principles: designing products with their entire life cycle in mind; maximizing product life cycles; recycling materials from end-of-life products; and reusing materials across diverse industries and value chains. It is noted that if the refurbishment rate for steel products was increased to 25 % it would reduce global iron ore demand by up to 70 million tons per year (6% of expected demand in 2025). It would also eliminate at least 1.3 million tons of carbon dioxide emissions annually (At 2010 production levels under the transition scenario). Here the model fits well with resource-intensive industries such as basic metals. Underlying this model is a move for customers to lease products driving a shift from planned obsolescence to the continual evolution of long-lived product platforms.

3.4.3.3 Frugal innovation

The frugal innovation business model targets shorter launch cycles by innovation through commercialization and also by reverse-engineering innovation. This concept is used in the Indian jugaad and Chinese shanzhai innovation models [49] where products are effectively copied and developed in the market. Developing-economy companies are more comfortable in putting a new product or service on the market quickly and improving performance in subsequent generations (i.e., innovation through commercialization). Online factory services allow designers and innovators to contract out prototyping and production, ordering a single unit or tens of thousands. Another trend is for "makerspaces" where shared production facilities are built around a spirit of open innovation. Supporting this model are Crowdfunding websites (i.e., Kickstarter and Quirky) that allow new ideas for manufacturing products to come to life.

3.4.4 Business Models Extracted from the Smart Industry Report

The smart industry report highlights that business is about creating value and that traditionally the underlying business models are either about competing on costs, or competing on innovation and quality. Money is made primarily by selling products to the next organisation in the value chain, the OEMs or resellers, but in network-centric production it is not always clear who the next organisation in the value chain is. Assembling a part into products is not the most profitable thing to do and there are opportunities in sales and after-sales, as well as the production of components.

There is a trend towards providing a service where a customer pays for the results (prints) instead of buying a physical device (e.g. a printer). Companies like Google and Amazon are providing cheap devices as Trojan horses to sell content (e.g. Chromecast, Kindle) and manufacturers are increasingly leasing their product to a customer and providing a service. Indeed there are number of companies providing remote monitoring of their products to support maintenance and increasingly they are taking back and recycling the product in a circular economy at the end of its lifetime. The value is thus shifting from the product to the networked ICT with its databases and the product may well be changed if the customer wants another service level. It is highlighted that information is money and an entire value chain using robotised and flexible production opens up many new business models [50].

3.4.4.1 Acting as a network entity

In the future it is expected that organisations will act as a network rather than a single company. Optimisation of networks instead of optimisation of a single company will lead to a better understanding of costs in the entire value chain. Investments in innovation will be distributed throughout the value chain reducing risk and the benefits of investments can be distributed through the entire value chain. Likewise the costs of CO_2 emission can be shared among the partners.

3.4.4.2 Creating value through information

As highlighted before there is also a move towards including more sensors and intelligence in products and manufacturing systems. This will create information that has a "value" upon which business models can be constructed. Information about customer use can be fed back into design. However, there are other opportunities to develop services around the data or also from selling data. In future the "real" money may not be made by selling the primary product but by selling accompanying information.

3.4.4.3 Continuous innovation

Continuous innovation of goods and services is required and an enabler in this will be from the flow of information. Vast initial investments in flexible production and human resources are needed in this model. As a new opportunity presents itself the organisation needs to be able to quickly and flexibly

address the new market without the need for a long set up time. The workforce needs multi-disciplinary skills and there needs to be significant investment in machines.

3.4.4.4 Trans-sector collaboration

Here the value chain is extended to non-traditional partners, e.g. non-manufacturing firms. An example of this is Google who are branching out into driverless cars strategically because they have the financial capacity to do so. Other examples of trans-sector collaboration are toys connected to gaming platforms, insurance companies investing in product development (monitoring of the disabled) and the Philips-Douwe Egberts collaboration with Senseo pad-based coffeemakers. In pursuing collaborations it is important to understand how to protect data and privacy, define responsibility in the case of problems and ensure that legal safeguards are in place.

3.4.5 Business Models Extracted from the Innovation Grid Website

The Business Model Innovation Website [51] highlights a number of new interesting business models. In the following sections these are briefly described with examples. These are categorised into the following key areas:

- **Optimization.** Do more with fewer resources, generating less waste, emissions and pollution.

- **Circularity.** The concept of 'waste' is eliminated by turning waste streams into useful and valuable input to other production cycles and making better use of under-utilised capacity.

- **Substitution with renewable.** Reduce environmental impacts and increase business resilience by addressing resource constraints 'limits to growth' associated with non-renewable resources and current production systems.

- **Functionality, not ownership.** Provide services that satisfy users' needs without having to own physical products.

- **Stewardship.** Proactively engage with all stakeholders to ensure their long-term health and well-being.

- **Slow consumption.** Solutions that actively seek to reduce consumption and production.

- **Co-creation.** Sharing resources, knowledge, ownership and wealth creation.

- **Social entrepreneurship.** Generating social value - not wealth - is the central criterion of a successful social entrepreneur. While wealth creation may be part of the process, it is not an end in itself. Promoting systemic social change is the real objective.

3.4.5.1 Increased functionality

Providing increased functionality is a strategy whereby the number of products required to achieve the same economic effect are reduced. The idea is to do more with less and it is linked to a modular approach. An example of this is the company DIRTT (Doing It Right This Time) who use software and clever modular and interchangeable parts to create customized offices on a mass scale. When no longer needed the office space can be disassembled and reused. Another example is a smart phone which replaces: radio, timer, watch, alarm clock, calendar, roadmaps, GPS, camera, dictaphone, tickets, walkman, discman, iPod, notebook, cash money and credit cards.

3.4.5.2 Lean manufacturing

Lean manufacturing is a well-established philosophy that identifies and seeks to minimise waste in production processes. Waste can be physical waste materials and waste energy or it can be viewed as over-production, materials handling, over-processing, inventory, defects and rework. The Toyota Production System (TPS) is an integrated socio-technical system that combines management philosophy and practices to design out overburden, inconsistency and waste. The Toyota Way is: 1) Continuous improvement, 2) Respect for people, Long-term philosophy, 3) The right process will

produce the right results, 4) Add value to the organization by developing your people and partners and 5) Continuously solving root problems drives organizational learning.

3.4.5.3 Additive manufacturing

Additive manufacturing or 3D printing creates three-dimensional objects from a 3D model or other electronic data source using additive processes that build up successive layers of material. A pioneer of this is Melotte who use both conventional machining (controlled material removal) with additive manufacturing. Here they claim to be able to reduce environmental damage by a factor 8 through design optimization, 3D printing and a digitized supply chain. Another example is MATERIALISE, which uses additive manufacturing to produce niche products for the marketplace and rapid prototypes for mass-products.

3.4.5.4 De-materialisation (of products or packaging)

Dematerialization is an approach to remove either completely or partly the quantity of materials required to serve economic functions in society by doing more with less. An example is iTunes which replaced physical carriers and shops for music, books, games and films. The content, marketing and transactions-system is fully digital and automated. Another example is the Google Self-Driving Car which removes the human (with all their quirks and limitations) to reduce accidents which have consequences in material and human costs, and also allow fuel efficiency by allowing cars to drive in platoons. Additionally, if managed correctly, traffic jams could be reduced and the idle time for cars (which now typically accounts for 96% of a car's life) could be reduced considerably.

3.4.5.5 Low carbon manufacturing or solutions

Retail Horizons [52] picture four scenarios where a low carbon business model would be successful:

1. **Sharing**. Here the idea is to share goods resulting in carbon reductions. One example of this is Rent a Runway where an online boutique is shared.

2. **Repurposing/upcycling**. Here the idea is to take waste from one industry and use it as a raw material for another. Carbon reductions are achieved through reduction in raw materials manufacture. Examples of this are Interface who use discarded fishing nets for carpet fibre in partnership with Aquafil, and Foss Manufacturing that make polyester fibre from 100 percent recycled bottles.

3. **Repair**. Some companies are now repairing products that have failed such as toasters, etc.

4. **Biomimicry**. Here ideas from nature are copied, e.g. Velcro. Biomimicry is being used in building design such as bioreactive facades in Hamburg which uses algae in the walls to generate electricity.

3.4.5.6 Circular economy, closed loop

Closed-loop business models include products and business processes designed in a manner that enables waste at the end of the use phase of a product to be used to create new value. The concept

of 'waste' is eliminated by turning waste streams into useful and valuable input to other production cycles and making better use of under-utilised capacity.

3.4.5.7 Cradle-to-cradle

The approach in Cradle-to-Cradle is to design unavoidable waste streams so that they are benign to the environment and more preferably such that they contribute positive nutrients to the natural environment, creating positive value for the environment.

3.4.5.8 Industrial symbiosis

Industrial symbiosis is a process orientated solution turning waste outputs from one process into feedstock for another process or product line. This is commonly used in the chemical industry.

3.4.5.9 Reuse, recycle, re-manufacture

Reuse of an item can be for the same function or it can be for a different function. In contrast, if recycling is used the item is broken down into its raw materials to make new items. An in-between approach is remanufacturing where an item is disassembled and modules or components are recovered.

3.4.5.10 Take back management

In response to the growing problem of excessive waste, several countries have now adopted waste management policies in which manufacturers are responsible for taking back their products. Some manufacturers are also doing this voluntarily.

3.4.5.11 Use excess capacity

In this approach under-utilised assets and capabilities which can be considered to be waste are shared in a collaborative consumption approach. An example of this is restaurant kitchens offering their facilities to cooks for teaching and development of new recipes.

3.4.5.12 Sharing assets (shared ownership and collaborative consumption)

The Sharing Economy (sometimes also referred to as the peer-to-peer economy, mesh, collaborative economy and collaborative consumption) is a socio-economic ecosystem built around the sharing of human and physical assets. This approach is often enabled by technology and communities. An example of this is reducing carbon foot print by sharing transportation or by borrowing and recycling items.

3.4.5.13 Extended producer responsibility

Extended producer responsibility is a strategy that promotes the integration of environmental costs associated with goods throughout their life cycle into the market price of the products. Several countries have adopted waste management policies where manufacturers are responsible for taking back their products from end users at the end of the products' useful life, or partially financing a collection and recycling infrastructure.

3.4.5.14 Move from non-renewable to renewable sources

At one end of the spectrum finite materials are substituted with renewable materials, e.g., replacing metals with natural and fibre-based materials, at the other end renewable power generation systems may be used.

3.4.5.15 Green chemistry

Green chemistry, which is also called sustainable chemistry, is a philosophy of chemical research and engineering that encourages the design of products and processes that minimize the use and generation of hazardous substances.

3.4.5.16 Blue economy

The Blue Economy business model tackles issues that cause environmental and related problems in new ways. Scientific solutions based upon physical processes common in the natural world are used to create solutions that are both environmentally beneficial and which have financial and wider social benefits.

3.4.5.17 Biomimicry

Biomimicry is the imitation of the models, systems, and elements of nature for the purpose of solving complex human problems.

3.4.5.18 Slow manufacturing

The Slow Movement advocates a cultural shift toward slowing down life's pace. Slow design and manufacturing seeks a holistic approach to designing that takes into consideration a wide range of material and social factors as well as the short and long term impacts of the design.

3.4.5.19 Solar and wind-power based energy innovations

Solar and wind plants are increasingly feeding into the grid and fulfilling the energy needs of large local power users, such as factories, in India and Chile. It is estimated by Bloomberg that there will be 600GW of photovoltaic solar worldwide by 2020 (an increase from about 150GW today). By 2030 there could be 1,900GW which would account for 5-7% of global electricity [53]. M-PESA, has allowed the

renewable energy sector to leapfrog in Africa. Enterprises such as Off.Grid:Electric are using a service-based model and selling pay-as-you-go solar that can be paid for daily using mobile money. The "internet of things" and broadband availability will enable automated and smart energy consumption.

3.4.5.20 Product-oriented PSS - maintenance, extended warrantee

A Product Service Systems (PSS) describes the approach of offering both products and services. A Product Oriented PSS is a PSS where ownership of the tangible product is transferred to the consumer, but additional services, such as maintenance contracts, are provided.

3.4.5.21 Use oriented PSS - rental, lease, shared

A Use Oriented PSS is a PSS where ownership of the tangible product is retained by the service provider, who sells the functions of the product, via modified distribution and payment systems, such as sharing, pooling, and leasing.

3.4.5.22 Result oriented - pay per use

A Result Oriented PSS is a PSS where products are replaced by services.

3.4.5.23 Build-operate-transfer (BOT)

Build-operate-transfer (BOT) is a form of project financing, wherein a private entity receives a concession from the private or public sector to finance, design, construct, and operate a facility stated in the concession contract. This enables the project proponent to recover its investment, operating and maintenance expenses in the project. There are numerous variants of this approach: BOOT (build-own-operate-transfer), DBFO (design-build-finance-operate), DBOT (design-build-operate-transfer).

3.4.5.24 Chemical Management Services (CMS)

Chemical management services (or chemical leasing) is a business model where a chemical company supplies a substance for a specific service, but retains ownership of the chemical. The aim is to change from increasing sales volume of chemicals to a value added approach with more efficient use of chemicals producing environmental and economic benefits.

3.4.5.25 Radical transparency about eco or societal impacts

Consumers, governments, and companies are increasingly demanding details about the systems and sources that deliver goods. Here there are concerns with respect to quality, safety, ethics (conflict materials), and environmental impact.

3.4.5.26 Resource stewardship

Stewardship is an ethical approach that plans and manages resources. Typically this is via a supplier accreditation programme that drives more ethical or sustainable business practices in the supply chain (often in developing nations).

3.4.5.27 Choice editing by retailers

Choice editing is used to remove damaging products and drive consumers towards sustainable products. This is done by either removing environmentally damaging products from commercial consideration or by making products expensive to use.

3.4.5.28 Ethical trade (fair trade)

In ethical trading the social and environmental dimensions of business is considered. This may include human rights, worker welfare, biodiversity and sustainable production methods. Ethical auditing is being used to monitor worker conditions in supply chains to ensure that factories and farms are following basic human and labour rights. This is to avoid forced or child labour, low wages, long hours or poor working conditions. Retailers such as M&S, have implemented a plan to embed ethical trading throughout its worldwide operations [54].

3.4.5.29 Biodiversity protection

In biodiversity protection the business conserves biodiversity, uses biological resources sustainably and shares the benefits arising out of this use equitably [55]. An example of this is nature-based tourism where the income stream depends on the health of the surrounding ecosystem. Other examples are:

- More diverse ecosystems are preferred destinations for tourism

- Biologically diverse soils are generally more productive for agriculture

- Marine biodiversity is associated with increased productivity of fisheries

- Crop genetic diversity is a key factor in maintaining disease resistance and yields

- Diverse tropical forests are prime locations in which to find novel genes and compounds for agricultural, industrial and pharmaceutical uses

A full range of biodiversity business models are then described:

- Agriculture – focusing on biodiversity-friendly practices

- Forestry – focusing on sustainable management

- Non-timber forest products (NTFP) – including commercial use of wild species

- Fisheries – including aquaculture

- Carbon sequestration in biomass

- Payments for watershed protection

- Bioprospecting

- Biodiversity management services

- Biodiversity offsets – including both mandatory and voluntary schemes

- Ecotourism

- Recreational hunting and sport fishing

3.4.5.30 Consumer care - promote consumer health and well-being

A customer advocacy policy encompasses all aspects of customer contact, including products, services, sales and complaints. In this approach one may suggest a product even if the profit margin is less, setting service call appointments based on the customer's (not the company's) preferred hours, or recommending a competitor's product because it is better for the customer's needs [56].

3.4.5.31 Consumer education (models); communication and awareness

Consumer education models are used to sensitize consumers about the impact of their purchases. The aim is to encourage "positive buying" of ethical products or "moral boycott" of other products or companies.

3.4.5.32 Responsible product distribution or promotion

Responsible product distribution or promotion concentrates on transporting of goods between the vendor and purchaser with the lowest possible impact on the ecological and social environment. This is complicated by the need to consider the whole distribution process from storage, order processing and picking, packaging, improved vehicle loadings, delivery to the customer or purchaser and taking back packaging.

3.4.5.33 Slow fashion

The Slow Movement in general advocates a cultural shift toward slowing down life's pace. Slow fashion is a deliberate strategy to slow the fast-fashion cycle, by not constantly introducing cosmetic innovation and encouraging greater longevity in use.

3.4.5.34 Product longevity

Product durability and longevity through product redesign can be used to slow product replacement cycles. The aim is to reduce excessive consumption and premature disposal of useful products. By developing a market for second-hand goods it is possible to also create an incentive for owners to look after their products to ensure higher second-hand value.

3.4.5.35 Premium branding or limited availability

In marketing and advertising the concept of premium branding is used to convey an impression of exclusiveness, especially in the mass markets. The premium quality, and the higher price of the product often increase product longevity and slow down consumption.

3.4.5.36 Frugal business

Frugal business models focus on the provision of products and services to low-income markets, often in extreme poverty. The business models take complex product concepts and redesign them to provide base functionality at low cost.

3.4.5.37 Demand management

Demand management, consumption management or strategic spend management is used to control and track business unit requirements and internal purchasing operations. This can be used to address external spending factors, arrange purchase orders and eradicate waste. Demand management concentrates on volume rather than product pricing. An example is Apple Corporation, who use a combination of manufacturing, procurement and logistics to execute massive product launches without having to maintain large inventories [57].

3.4.5.38 Collaborative approaches (sourcing, production, lobbying)

In this approach a company collaborates with organisations, government, and other non-commercial actors. It is often used in food production where sourcing from smallholders can help a company reach and retain more consumers, generate positive brand or corporate image, and achieve greater corporate sustainability. An example of this is Unilever that has partnered with Oxfam to secure supplies of dried vegetables from smallholders. The farmers gain guaranteed income which has benefits for farm workers, and local communities [58].

3.4.5.39 Incubators and entrepreneur support models

An incubator is "a business support process that accelerates the successful development of start-up and fledgling companies by providing entrepreneurs with an array of targeted resources and services". Incubation and entrepreneurship helps to increase entrepreneurial success, opportunity and are also strengthen communities by offering office space, professional services and business advice typically for a monthly fee [59].

3.4.5.40 Licensing, franchising

Franchising and licensing is a good business model for a company to expand by letting an independent branch of the company use the brand name. The franchiser maintains control over the operations and processes used by the franchisee in return for branding and marketing support.

Under a licensing model, a company sells licenses to other (typically smaller) companies to use intellectual property (IP), brand, design or business programs. These licenses are usually non-exclusive so they can be sold to multiple competing companies serving the same market. The licensing company can exercise control over how its IP is used but it does not control the business operations of the licensee. Examples of franchising are McDonalds and Subway, and for licensing Microsoft Office [60].

3.4.5.41 Open innovation (platforms)

In open innovation firms use external ideas as well as internal ideas, and internal and external paths to market to advance their technology. This is a means of sharing risk and reward with partners. A central idea is that when knowledge is widely distributed a company cannot afford to rely on its own research but should licence technology from other companies. Likewise if an internal invention is not going to be exploited then it should be made available outside the company (e.g. through licensing, joint ventures or spin-offs).

One approach used is product platforming where a partially completed product is provided for customers to access, customize, and exploit with the intention of extending the platform product's functionality and increasing its value for everyone. Typically a software development kit (SDK), or an application programming interface (API) are provided. An example of this is the iPhone platform which relies on a strong network effect where demand increases with the number of developers that are attracted to use the platform tool-kit. The high scalability of platforming often results in an increased complexity of administration and quality assurance [61].

3.4.5.42 Crowd sourcing or funding

Crowdfunding is a means of obtaining funding for a project or venture by raising contributions from a large number of people via the internet. The crowdfunding model involves three actors: the project initiator who proposes the idea; individuals or groups who support the idea; and a moderating organization that brings the parties together [62].

3.4.5.43 "Patient or slow capital" collaborations

The underlying concept in the patient capital approach is not to do everything now but rather develop the product gradually. This concept has a high tolerance for risk, has long time horizons, is flexible to meet the needs of entrepreneurs, and is unwilling to sacrifice the needs of end customers for the sake of shareholders. The use of patient capital also demands accountability in the form of a return of capital and proof that the underlying enterprise can grow sustainably in the long run. These business models are being used to bring affordable, life-changing products and services to the poor.

3.4.5.44 Not for profit

A non-profit organization or not-for-profit organization is an organization that uses surplus revenues to achieve its goals rather than distributing them as profit or dividends.

3.4.5.45 Localisation

Localisation is the practice of embedding a business near its consumer market, sourcing the resources locally and tailoring the products and services to local needs.

3.4.5.46 Alternative ownership: cooperative, mutual, (farmers) collectives

The term "mutual" is used as an umbrella term for several different ownership models. Mutuals are characterised by the extent to which their members have democratic control of the business and share in its profits. This is in contrast with investor controlled companies. A mutual organisation is owned by, and run for, the benefit of its members, who are actively and directly involved in the business. There is an incorporated legal structure which is specifically mutual: the industrial and provident society which can be a Co-operative Society or a Community Benefit Society (BenComms). The difference between the two is that co-operative societies operate for the benefit of their members, and distribute any surplus not reinvested in the business to those members, whilst BenComms conduct business for the benefit of their community. Profits are not distributed among members, but rather they are returned to the community giving a legal structure for social enterprise [63].

3.4.5.47 Social and biodiversity regeneration initiatives ('net positive')

A biodiversity business is a commercial enterprise that generates profit and equitable benefits through biodiversity conservation and sustainable use activities [64]. An example is Fibria, a Brazilian company engaged in sustainable forest management. Fibria directs its conservation actions in eight thematic areas: wildlife protection, conservation areas, restoration, landscape management, participation in conservation forums, environmental education, biodiversity-community projects, terrestrial and marine monitoring. The company's goals are [65]:

- to improve forest management in order to reduce negative impacts of operations and increase positive impacts

- have a net positive impact by increasing diversity of habitats for species and protecting high conservation value areas

- Protect endemic, endangered and rare species

- Mainstream biodiversity conservation in its practices through environmental education and biodiversity-related community projects

3.4.5.48 Hybrid businesses, social enterprise (for profit)

Social enterprises and social purpose businesses have the added goal of generating social value (measurable impact) in addition to the economic value (revenue) [66]. Examples of social enterprises are Heely City Farm (Sheffield), Big Issue, Jamie Oliver 50 restaurant, Fair trade, etc.

3.4.5.49 Home based, flexible working

Increasingly people want to work from home as this is more flexible suiting an employee's needs, e.g. having flexible start and finish times [67]. Staff who work from home much or some of the time say that they have a better work-life balance and improved job satisfaction. Notably employers have also reported increased productivity from homeworkers [68].

3.4.6 Business Models Extracted from Challenges in Industrial Service Business Development. Advance Manufacturing – An ICT and Systems Perspective

Salminen and Kalliokoski [69] presents the findings of the BestServ feasibility study addressing the current status, development needs and future challenges of industrial service business for the Finnish manufacturing industry. It is highlighted that the business model is changing completely and the number of services is increasing. Product and service development is considered to be a new arena for the co-operation of enterprise networks, and new organisational forms of networks and information technology platforms are required to realise the potential of the new opportunities. As a result of this development companies are moving closer to their customers, which entails the need for new product concepts and service models. The service can be related to technological co-operation, process improvements, remote diagnostics and financial arrangements. The paper describes five supplier business models.

3.4.6.1 Machine supplier

The focus of the business relationship is on delivering a piece of machinery or equipment that fits the customer's technical specification.

3.4.6.2 Solution provider

The focus of business is on delivery of a system, e.g. a production line, which is usually designed for the specific customer's process and comprises a wider scope of supply than one piece of equipment.

3.4.6.3 Maintenance partner

As a maintenance partner the focus of business expands to also include continued supplier involvement during the lifecycle of the delivery. This role adds contractual aftermarket elements, such as spares and consumables agreements, to the supplier-customer relationship.

3.4.6.4 Performance partner

As a performance partner the supplier is closely involved in operating the customer's technical process by taking partial responsibility for the performance of the system, e.g. through availability warranties. This role requires the supplier to maintain continuous on-site presence. The focus of the customer relationship is on securing the effective operation of the unit or production line.

3.4.6.5 Value partner

The supplier is directly involved in the customer's business, e.g. through operate and maintain agreements, where the customer pays a pre-determined price for the actual output of the system. Both parties focus on profitable daily operations, and the supplier is responsible for the day-to-day operation of the plant or line.

3.4.7 Business Models Extracted from WRAP UK Website

The following business models support new business opportunities that are not reliant on selling large product volumes. A common feature of these models is that they extend product life, conserve resources and avoid waste [70].

3.4.7.1 Product Service System

Providing a service based upon delivering performance outputs – linked to products or services. The product may be designed for long life, short life or a mix depending upon the optimum output requirements. Products could also be designed for disassembly, remanufacture and re-use. There are several examples of this business model: 1) Philips "Pay per Lux" solution which is being used throughout the new, BREEAM accredited Excellent, office of the National Union of Students; 2) Cook Manchester that offers fully equipped professional kitchen space that can be hired by the hour on a one off or regular basis; 3) Rolls-Royce who sells their engine's thrust as 'power by the hour', which includes full in-use monitoring, servicing, repair, remanufacture and replacement; 4) A Shade Greener that offers a 'Boiler for Life' scheme. They install, maintain and service a new boiler for a weekly fee; 5) Digital lumens provides intelligent lighting systems that reduce lighting-related energy use by up to 90%. As of 2013, they plan to offer their solutions as a service rather than an equipment sale; 6) Bandvulc which sells 'road grip' (tyre support system) rather than tyres for articulated lorries; 7) Interface FLOR which sells 'flooring services' through their evergreen lease option; 8) Floor tiles that are designed biomimicrially for remanufacture once they wear out; 9) Xerox which sells contract 'print services' rather than printers. Printers are designed to be remanufactured and reduce waste in operation (e.g. cartridge free).

3.4.7.2 Dematerialised services

Providing a service that offers product benefits where the 'physical' product does not exist at all at the point of use (e.g. answerphone services). The model changes consumption patterns and delivers potential material saving through not producing a physical product for consumers. However, this must be balanced against the materials used in the service infrastructure. Examples are Spotify and Love Film which provide on-demand delivery of music and film via internet or mail, using outsourced/public infrastructure with minimal overheads. Another example is Cloud Computing as email and document management services on virtual software platforms running on out-of-house hardware. CapGemini amongst other ICT service providers is also another example offering provision of software or infrastructure as a service (SaaS or IaaS), rather than the hardware or software on a disk focusing on the activity of the software such as payroll or logistics.

3.4.7.3 Hire & leasing

Long-term hire and leasing of products drives a longer term approach to product durability, with longer service life, lower maintenance load and lower use of materials and CO_2. Examples are 1) Mud

Jeans which provides the opportunity to lease fashionable, organic produced jeans. During the lease period one can make use of their free repair service. After a year they give 3 options – keep it, swap it or send back; 2) Girl Meets Dress where the company rents designer dresses and accessories for special occasions; 3) Forbes Rentals which charges weekly for a wide range of domestic electrics and electronics; 4) Emblem Furniture which rents furniture and white goods for show homes and 'Home staging'; 5) Leasedrive offers long-term B2B leasing of fleet vehicles; and 6) Stone Rent-a-PC is a long-term PC rental scheme designed for the UK education landscape. ICT hardware providers such as Dell and others rent equipment on long-term lease to companies and provide back-up support and service management and upgrades of the ICT / PCs.

3.4.7.4   Collaborative consumption

Rental of products between members of the public or between businesses, this generates an income for the product owner and provides cheaper access to a product for the renter. It can also be non-income based peer-to-peer online and/or offline exchange and re-use. Examples are 1) Airbnb which supports the rental of spare bedroom space to private travellers; 2) Warp it allows internal staff or staff between companies to sell unwanted items and buy needed items; 3) erento is a portal that allows B2B and B2C hiring of many products and tools, and the hiring out of own tools and products; 4) Streetbank is a free online portal that shows products and skills available within a local neighbourhood; 5) Swapstyle allows swapping of clothes and bags for free through an online portal; 6) ecomodo is an online portal that allows people to lend or hire their own products to other people; and 7) The Savvy Earner showcases six innovative ways to earn money by putting your unused assets to work.

3.4.7.5   Incentivised return and re-use

This business model encourages customers to return used items for an agreed value. Customers gain value for unwanted items and return products via a convenient system. Collected products are refurbished and sold for re-use on appropriate markets. Examples of this are: 1) Desso which offers a carpet take-back programme and have developed an innovative separation technique to tackle the millions of square metres of worn-out carpet that are thrown away every year; 2) Amazon trade-in allows users to trade in their books or video games for an amazon gift voucher. The product is then made available for resale; 3) CeX buys, sells and exchanges a range of technology and entertainment products; 4) The Gadget Show live offers a cash trade in, reusing or recycling the gadgets; and 5) Steelcase Solutions evaluates the state of furniture and offers a repair and renovation service prior to replacing with new.

3.4.7.6   Asset management

The asset management business model offers internal collection, re-use, refurbishing and re-sale of used products. It aims to reduce the quantity of raw materials required to meet the market demand. For example, Carillion worked with WRAP to develop resource efficient and profitable business models around better management of vehicle-based assets. Other examples are FLOOW2 which is a business-to-business sharing marketplace where companies and institutions can share equipment as well as the skills and knowledge of personnel. P2PLocal which is an online technological and legal contracting solution bringing businesses together to facilitate peer-to-peer hiring of under-utilised equipment,

machinery, plant, and other resources. Dinosaw runs a 'cutting tool sales, sharpening and repair' service in New York and Pennsylvania, USA. Electroversal refurbishes mobiles, copiers, PCBs (mostly from copiers), power supplies, vending machines etc., and Leafield Logistics stores and catalogues Admiralty spares and parts for sold-on naval vessels.

3.4.7.7 Collection of used products

This business model offers collection by a service provider to ensure products/ materials are passed on to an appropriate re-use system. For example: Globechain's online platform connects corporates to charities, individuals and SMEs allowing them to help each other by donating and re-using unwanted items. Wiltshire Wood Recycling is another example, it collects waste wood from construction, joinery and other businesses and grades the wood for resale or manufacture into wood products. SOFA collect, refurbish and re-sell used furniture and white goods in the Bristol area UK, and Refurbiz is another business that collects, refurbishes and re-sells used white goods.

3.4.7.8 Long life

In this business model products are designed to have a long life time with durability, reducing consumption. Examples are Kyocera's design concept which means that only the toner, rather than the whole toner cartridge, needs to be replaced. As many as 500,000 pages can be printed without replacing anything except toner, significantly reducing waste and cost. Patagonia aims to make clothes that last a long time and wear out evenly. Since 2012 they have repaired over 26,000 items that have been sent back to be fixed. Giroflex is another example which offers cleaning and care services as well as repairing office chairs, and Miele designs and engineers products for long service life and market them on "lifetime cost" with a 10-20 year life.

3.4.7.9 Made to order

In the made to order approach production is managed to minimise material requirements and avoid potential losses from over-stocking products. Examples of this are in made to order boots and furniture where a catalogue of designs are made available on the internet.

3.4.7.10 Bring your own device

In this model the user brings their own device to access services, e.g. the employer pays the employee to buy a computer and software for use at work and at home. An example is Citrix who buy a computer for all staff that can be used on the company's network for work and home, saving resources and support time, and improving employee motivation.

3.5 Analysis of Business Models

From the various reports some consensus can be seen in terms of business models. Many of the reports highlight a move to servitization. In a number of cases the same business models are highlighted across reports indicating that there is some consensus in thinking. The more "innovative" business models relate to sustainable and social drivers which is resulting in companies thinking "out of the box" and moving radically away from more traditional business models. The various business models presented in the preceding sections were grouped into categories that drove them. In total 100 unique business models were identified (once repeats were removed) and 10 categories were defined. These were:

- Product Service/Aftermarket
- Green/Sustainable
- Efficient manufacturing
- Customisation
- Networking
- Technology based
- Knowledge
- Socially aware
- Economic (Investor supported)
- Conventional

The resulting mapping of business models into the defined categories is shown in Fig. 11.

Conventional
Manufacturer Model - Selling Direct
Merchant Model
Advertising Model
Information Model
Brokerage Model
Premium branding or limited availability
Licensing, franchising
Open innovation (platforms)
Hire & leasing
Razor and Blades Model
Cutting out the Middlemen
Bricks and Clicks
Subscription Business Model
Value Added Reseller
Fee in, free out – charge first client only
All in one business model
Loyalty business model
Monopolistic business model
Premium business model
Professional Open Source Business Model
Machine supplier

Customisation
Made to order
Personalisation, Identity, Provenance
Mass customization
Design and Innovation Service
Fabless manufacturing
Frugal innovation

Efficient Manufacturing
Lean manufacturing
De-materialisation (of products or packaging)
Use excess capacity
Industrial symbiosis

Economic
Build-operate-transfer (BOT)
"Patient or slow capital" collaborations

Green/Sustainable
Repair, the Circular Economy, and Collaborative Consumption
Sustainability and value
Low carbon manufacturing or solutions
Cradle-to-cradle
Reuse, recycle, re-manufacture
Take back management
Move from non-renewable to renewable sources
Green chemistry
Solar and wind-power based energy innovations
Chemical Management Services (CMS)
Dematerialised services
Collaborative consumption
Incentivised return & re-use
Collection of used products
Blue economy
Choice editing by retailers

Networking
The 'Density Principle'
Acting as a network entity
Interaction and indirect capabilities
Trans-sector collaboration
Network Architecture Business Model
Sharing assets (shared ownership and collaborative consumption)
Crowd sourcing or funding
Collaborative approaches (sourcing, production, lobbying)
Collective Business Model
Online Auction Business Model
Network Effects Business Model
Organisational form

Technology Based
Additive manufacturing
Information Technology (IT) - Infinite Bandwidth/Zero Latency
General-purpose technologies
Increased functionality
Biomimicry

Socially Aware
Ethical trade (fair trade)
Resource stewardship
Biodiversity protection
Responsible product distribution or promotion
Slow fashion
Slow Manufacturing
Product longevity
Long life
Radical transparency about eco or societal impacts
Consumer care - promote consumer health and well-being
Not for profit
Social and biodiversity regeneration initiatives ('net positive')
Hybrid businesses, social enterprise (for profit)
Alternative ownership: cooperative, mutual, (farmers) collectives
Home based, flexible working
Extended producer responsibility
Frugal business (products for low income markets)
Localisation
Bring your own device

Knowledge
Continuous innovation
Creating value through information
Incubators and entrepreneur support models
Consumer education (models); communication and awareness
Solution provider

Aftermarket/Product Service
Asset management
Product Service System
Product-oriented PSS - maintenance, extended warrantee
Use oriented PSS - rental, lease, shared
Result oriented - pay per use
Online Services Model
Demand management (including cap & trade)
Maintenance partner
Performance partner
Value partner

Figure 11. Business Model Categories

These business model categories have been used as the basis for the mapping and business modelling activities performed later.

3.6   Interviews

Structured interviews have been carried out with key actors in the manufacturing and service sector domains. The aim of this exercise was to get an insight into current business models used by industry, other business models which were being adopted and also opportunities for new business models. The interviews also obtained views on barriers to adoption of technology and needs for the industry. The original target was to interview 10 manufacturing companies and service providers, however, the responses received proved very illuminating and so the number of interviews was expanded and in total 23 interviews were conducted. Additionally, a questionnaire was also circulated to the members of the Road4FAME expert group which consists of nearly 100 people. The aim was to get a good mix of responses for large manufacturing companies (aero, white goods, automotive, electronics, clothing, etc.) and also SME manufacturing companies where there are greater barriers for introducing ICT. Large and small IT service providers were also interviewed to understand opportunities and barriers for service provision.

To set the scene for the questionnaire and interviews a brief introduction was produced which highlighted changes in manufacturing in recent years, new drivers, the impact of ICT and the move towards more global networked supply chains. Some examples of well-known and new business models were also given so that respondents understood what the questionnaire was trying to achieve. This questionnaire is presented in the next sections.

3.6.1   Road4FAME Business Opportunities Questionnaire

"Background

The advent in the 80's and 90's of low cost embedded devices and PC technologies led to increased automation and radical changes in manufacturing. As a consequence manufacturing today is now far more distributed with manufacturers assembling components that are produced all over the world. It is also not uncommon these days for the supply chain to be involved in joint research and development to create new products. Software has become a major USP in many products and is a key differentiator between offerings. There is also a move towards increased customization of products driven by consumers and an increasing awareness of the impact on the environment driving more efficient use of energy, reduction in scrap and recycling of products at end of life. At the same time new exciting technologies are being introduced such as synthetic materials and additive manufacturing.

Impact of ICT

Increased interconnectivity at all levels in manufacturing coupled with IT has led to great improvements in efficiency. The use of wired and wireless embedded sensors will provide a lot more data increasing situational awareness and providing information on how a product is produced, information to optimize the manufacturing process further, and also information that can be used for predictive health monitoring to increase availability. Looking further into the future there is a lot of interest in providing product services with companies increasingly looking to support products in the aftermarket. This changes the whole dynamic of a manufacturing company and is a major challenge both operationally and also in mind set. These days advances in consumer electronics dominate and drive key technology and social changes in many areas. People use these in everyday life and are

expecting the same functionality in other areas such as in factory environments. The ability to connect different systems, machines, sensors, people, etc. together opens up a myriad of opportunities to improve efficiency and situational awareness.

New Business Opportunities
This questionnaire is aimed at identifying existing and new potential business models in manufacturing. A business model describes how a business enterprise delivers value to customers, entices customers to pay for this value and how those payments are converted to profit. The traditionally business model in manufacturing has very much been a "pipe" with raw materials entering one end, manufacturing being performed and products being delivered to customers. The world has changed significantly and now it is also common to see products being manufactured as part of a virtual enterprise with a whole supply chain of fabrication companies and an assembly company (or companies) putting together products using a platform business model. Your company may well fit one of these two business models.

However, we are interested in the future and would like you to consider this in the questionnaire. The future is being driven by a much closer relationship with the customer with demands for customised products (perhaps with one-off batch sizes) and increasing environmental awareness creating demand for greener products and cradle to grave responsibility for products. The manufacturing chain itself is supported by a plethora of hardware, software and platform service providers – you may well use these services or your company may be a service provider. Many well known business models already exist, e.g. open source, value added reseller, but new exciting business models, e.g. servitization of products, chemical leasing, network effects, etc. are also appearing. The aim of this questionnaire is to identify current business models in manufacturing and also identify new market opportunities in manufacturing and service provision to help companies, both large and small, become more competitive in an increasingly challenging business climate."

This was then followed by two different sets of questions, one targeted at manufacturing companies and one targeted at service providers. The interviewees were first asked to talk about their companies and current business models as an ice breaker. It was noted that some companies were reluctant to talk about future business models they were considering as this was commercially sensitive.

3.6.2   Questions for Manufacturers

1) Can you briefly describe your company and what it does?
2) Can you briefly explain your main business model?
3) Do you also do business with any other business model?
4) Are you looking at adopting new business models as a company, e.g. moving towards product services?
5) Do you rely on a supply chain and what are your key concerns in dealing with the supply chain?
6) Do you buy in ICT services from other companies, for instance, management software (stock control, order control, supply chain management, data analysis, MES, etc.?
7) Have you considered buying in services to help with your business? If so, what sort of services and why? Are there services that are not currently available that you would like to see, e.g. data management, support for customisation, green manufacturing, etc.

3.6.3 Questions for Service Providers

1) Can you briefly describe your company and what it does?
2) Can you briefly explain your main business model?
3) Do you also do business with any other business model?
4) Are you looking at adopting new business models as a company?
5) Do your services apply to individual manufacturing companies and are they tailored for customers?
6) Do your services (or could your services) apply to management of the supply chain and if so how?
7) Where do you see the opportunities for service provision in the future considering the changing nature of manufacturing, e.g. data management, support for customisation, green manufacturing, etc.?

The questionnaire was first trialled on two companies with very good feedback before the main interviews were performed. This resulted in a further question being added which was for the interviewee to consider new business opportunities "thinking out of the box" and not with their company hat on. This was to encourage free thinking not within the rigid confines of their own company. The approach to interview was flexible and interviewees were encouraged to talk about what were the most important concerns for them.

3.6.4 List of Companies Interviewed

- Anonymous - CNC Specialist Manufacturer
- Company02 - Global business and technology services
- Constellium - Aluminium Alloy Producer for Aerospace and Defence (high levels of recirculation 90%)
- Cutting Tools - Cutting services provider
- Dassault Systems/Apriso - MES Manufacturer
- ECI MI SME Manufacturing Costing Data
- Eurotherm Manufacturer of Process Control Equipment
- Eutexoo - SME Software Integrator
- Evolaris - Research and Development Mobile Communications
- Flexefelina - Steel tube manufacturer/trader
- FluidHouse Oy - Industrial Oil lubrication solutions provider
- Gtma - Manufacturing Trade Association (for SMEs)
- Harms & Wende GmbH & Co.- SME providing resistance and friction welding processes
- IPE – SME Broadcast equipment manufacturer
- IPI Solutions - Traceability of Documentation in the Supply Chain
- Jaguar Landrover - Worldwide Automotive Manufacturer
- LINAGORA - Open source software solutions provider
- Metalomecánica Ltd. - Supplier of metal parts
- National Composites Centre - Composites Research and Development for Aerospace and Automotive
- Plásticos JUDO S.A. - Manufacturer & Supplier of injected plastic parts for automotive
- Softeco Sismat - Consultancy services in Energy, Industry & Finance sector; Supplier of products for Health & Energy markets
- Software AG - Software Service Provider
- WIS - Manufacturer and supplier of services across a number of industries including aerospace

3.6.5 Analysis of Interview Results

Manufacturers

Figure 12. Manufacturers are driven by Global Supply

The Business Modelling work and interviews with industry has shown that manufacturers are driven by global supply. More and more products are being customised or configured to order and this requires support for fast adaption of a product to specification changes. Manufacturing and software development itself is performed around the world so the key emphasis is on keeping design and IPR in-house. In many cases hardware is manufactured in China and software is produced in Romania or India. There is a high reliance on the supply chain and trust is seen as key. Companies will only work with trusted suppliers. There are great challenges in sourcing raw materials and there is a need to balance price, quality and on-time delivery of these materials which are sourced globally and quite often from competitors. It was noted that raw materials can be one of the largest costs to a company. In the car industry there may be a requirement to produce 40% of a vehicle locally in the country where it is being sold, e.g. Brazil. This is challenging requiring assessment of local suppliers. This also sometimes results in problems of counterfeit parts being produced. Increasingly there is a need to balance CO_2 emissions for sustainability produced from manufacture and also from transport of goods. There is thus a preference to manufacture close to assembly. Traceability is required to ascertain CO_2 emissions but also to avoid counterfeit parts and ensure that raw materials are not sourced from conflict areas.

Machine Providers

The machine providers provide capital equipment for manufacturing to manufacturers. The main current business model for machine providers is to sell products (e.g. welding machines). In addition it is common to offer 1 to 2 days of training/instruction for a machine. In terms of technology change in this area there is a notable shift towards networking of machines and also the use of image recognition to aid in production/quality monitoring. The main challenge identified by the sector was conservatism at all levels. The machine operators are conservative and are reluctant to change a running system. There is a need to demonstrate that a new machine provides an advantage and also a need to convince shop floor workers with training courses that a new machine is easy apply. At a higher industry level the people responsible for purchase are conservative, e.g. automotive sector. It is noted that there is a general lack of knowledge in the manufacturing industry about IT solutions and also an aversion against IT solutions. Thus there is a need for awareness building.

Some machine providers would like to move up the food chain and offer, for instance, a welding solution for an OEM or tier 1 supplier, however, a key concern is the level of responsibility for production downtime which presents high risk. In many cases SMEs are reluctant to offer a complete solution due to this risk. A potential solution would be for an insurance company to provide a business model which takes on the risk.

Manufacturer's Buying in a Service

Both large and small manufacturers want to contract software development out. SME's do not have experienced staff and large companies want their experienced staff to work on added value software for customers rather than "internal software" such as Excel macros that are ultimately not supportable as staff move on. It was noted that typically only 6% of an engineer's time was productive. There is a culture change going on from doing everything in-house to buying in services to free up people who have expertise. This is particularly in areas such as Quality Auditing Service, e.g. ISO 9000, design, simulation and accounting tools, CRM, ERP, HR, Health and Safety, accountancy, equipment maintenance and ICT maintenance support.

Here the main business opportunity is for SMEs to provide services as creating custom solutions or adjusting existing ones is expensive for large companies who tend to produce "bloated" solutions In terms of technology. Here there are opportunities in all areas including automation software for capital equipment. As highlighted there may also be an opportunity to provide insurance services to guarantee availability.

Cloud computing is very attractive and is already being used by large and small companies, e.g. simulation, accounting, business process management. Underlying this is a need to solve IP issues and security. There is a belief in industry that IP issues will be resolved and that although security of data is talked a lot about, the future will be "access all for free". Many companies believe that data in the cloud is not secure and so there is a need for education and approaches to security by design. It was noted that encryption is available and affordable (even to SMEs) but there is a lack of awareness of the technology.

Vertical and Horizontal Integration

Figure 13. Example of Horizontal Integration

One change in industry that was thought detrimental was a move from vertical integration to horizontal integration. This causes problems when trying to integrate technologies. An example is an aircraft seat with display. Currently they are made separately and then integrated. If they could be moulded together at the same tome the overall cost and weight would be reduced, however, this is not possible due to horizontal integration of the seat manufacturers and display manufacturers. Although there is an overall benefit, there is no incentive for the companies to work together. If the companies were vertically integrated then they could manage the integrated product cost and share the profit.

ICT may have more impact for SME's in Future
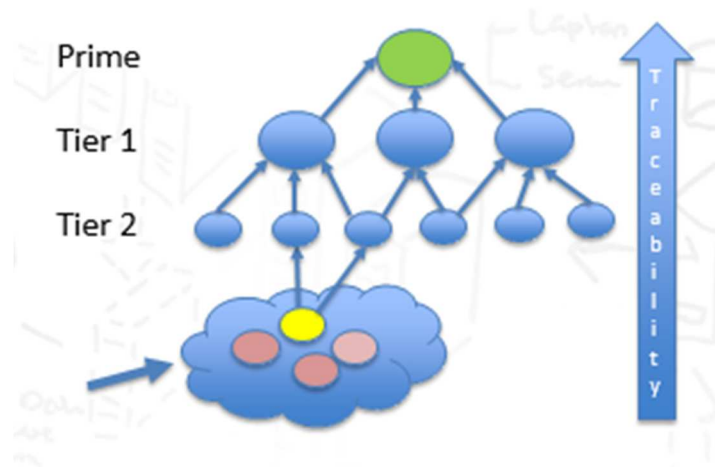
Figure 14. Tier 1's and Tier 2's in the Supply Chain

Looking across the value chain it was noted that there was a great opportunity for sub-assemblers who support Tier 2's to use ICT to work together to produce one product or a range of products attacking a particular sector. Tier 1's and Tier 2's only want to talk to one person rather than managing the whole supply chain. The major challenge is vertical integration of data flow as cradle to grave traceability is important. This is to know where the metal comes from, CO_2 related with the product and manufacturing details for components that are safety-critical such as steering racks.

Service Providers

The most common business model for service companies is to sell consultancy but direct selling is also being used. Service companies typically provide innovation in terms of R&D, perform tailoring work for customers (who want their own engineers to work on added value) and in maintaining IT platforms and automation systems for customers. Larger companies tend to offer a portfolio of products, most of which can be tailored to meet a customer's particular needs. Larger companies are starting to introduce servitization as a new business model, e.g., Rolls-Royce Power-by-the-Hour and milling bit providers selling production line design service and monitoring of tools. There are also opportunities for specialist manufacturers to move up the food chain. An example of this is a CNC company providing a manufacturing service of high precision 3, 4 and 5 axis machined parts. Here the company could become a "one-stop-shop" and provide a fuller service, for instance providing sub-assembly and test.

It was noted that very few companies provide services that apply to management of supply chain and only one company was found who operate in this area providing support for traceability of documentation through the supply chain.

The new opportunities are seen in integrating existing software/systems and advising customers on "what is connected to what" and "what should be connected to what" addressing the "wild garden". Another opportunity would be to provide a platform which links out-of-the date plant software with modern IT solutions.

With the increased interest in energy efficient solutions there are opportunities for providing analysis services for energy data and even providing an energy broker service. With the concerns about security there is also an opportunity to provide a guaranteed security service for manufacturers.

There are also many opportunities in the analysis and exploitation of big data. Automation companies such as Siemens and Schneider believe that they have an advantage here in that they know the installed topology so they can better exploit data that is gathered.

Support for customisation (especially for open source solutions) is seen as a major growth area, as well as the market for energy efficient solutions. Product servitization enabled by cloud and computer grids is also seen as being a significant trend. Basic services will become a commodity and ad-hoc services will leverage on top of these. More and more software layers (including part of the OS itself) will be fed by clouds. Mobile devices are becoming more powerful and everyday operations performed on PCs and laptops will quickly shift to mobile. These mobile devices, currently monolithic, will be componentized. In the long term it is likely that products themselves will become smarter and tracking and support of the product during the whole life cycle, including the reuse of the product, is seen as new exciting opportunity.

3.6.6   Policy and Standardisation Support

Notable amongst a number of respondents was the message that there also needs to be policy and standardisation support. A large proportion of the value chain is generated by non-manufacturing companies, e.g. Google, Uber and Amazon. There is a need for greater awareness regarding new potential competitors outside the core market. There are many challenges when offering a service based on data transfer between a client and service provider due to different data standards being used so there is a need for suitable interfaces for data exchange between factories and service providers.

There is also a need for education. There are many well-functioning and conservative manufacturing firms which utilise outdated software. These companies fear system changes and so there is a need to build awareness for the necessity of a change. The legal framework governing the IT sector and the internet has been developed around this sector rather than the manufacturing sector. There is thus a

need for legal support specific to manufacturing applications. There is also a need to transfer technology from advanced industries, e.g. aerospace, automotive, to less advanced sectors.

3.6.7   Interesting Business Models

A number of interesting business models were highlighted in the interviews. In this section they are briefly presented.

- Jaguar is providing cars on available hour contracts to a hotel chain around London – these are used to transfer wealthy people who experience the car and may buy a Jaguar in the future. This is seen as good for advertising.

- Machine manufacturers are looking at "photocopier" contracts, e.g. some customers cannot afford the capital cost of new equipment so machine rental offers the ability to "pay per chop or hole" or "pay per weld".

- Hardware-as-a-Service, in general, is an interesting area and can be applied to capital equipment, computing, etc. In this area already restaurants are renting out their existing facilities when not in use to chefs to develop new recipes. Likewise manufacturers could rent out manufacturing equipment to other companies to utilise it when it is not needed.

- Milling bit providers, such as Sandvik are monitoring their own bits and recommending when they should be changed. Going one step further, with the experience in manufacturing that tool providers have, the company could also analyse weak points within a production line and provide solutions regarding changes within production flow.

- Providing a service that tracks and analyses data within companies can be used in a multitude of ways such as providing recommendations for maintenance, changing/optimising production lines, energy management, etc.

- From an expertise perspective retired engineers can offer their services to companies via a website. This can be used for directly providing short term experience or for training new people.

- The supply chain is seen as a big market opportunity and one business opportunity is in providing data transfer service between stakeholders through different IT systems that exist in the supply chain.

Addressing Barriers

It was noted that although a number of exciting new business opportunities exist there is also a need to remove barriers to exploitation. As highlighted providing higher level services to manufacturers usually means taking on a service level agreement with respect to downtime. Here there are opportunities for services based on providing information for insurance companies, which are specialized for the manufacturing IT niche.

IT security is also a key barrier and there is an opportunity for a company to provide IT security within a supplier network. Also to prevent "attack" in increasingly networked supply chains there is an opportunity to provide firewall solutions for manufacturing firms.

### 3.6.8   Summary of Business Opportunities Identified

Business Opportunities	Service	Status of Uptake
Knowledge	R&D	Current
	Technology Consulting	Current
	Innovation	Current
	Retired Engineer Service	New
Design	Product Customisation	New
Integration	ICT Tailoring	Current Increasing
	ICT Integration	Current Increasing
ICT Maintenance	ICT Support	Current
Supply Chain	Management & Optimisation	New
	Sourcing Raw Materials	New
	Traceability/Tracking of components	New
	CO_2 Calculation	New
	Data broker between stakeholders	New
Simulation	Factory	Current Increasing
	Product	Current Increasing
Financial	Accounting	Current
	Product Costing	Current
Customer Focus	CRM	Current
External Computing	Data Centre	New Increasing
	Cloud Computing	New Increasing
Monitoring	Wireless Sensors	New Increasing
	Big Data Management	New Increasing
	Data Mining	New Increasing
	Visualisation	Current Increasing
	Decision Support	Current Increasing
	Energy Management/Brokering	New Increasing
Product Services	Servitization Support	New
	Aftermarket Support	New increasing
	Available Hours Contracts	New Increasing
	"Photocopier" Contracts	New Increasing
	Monitoring Own Equipment -maintenance	New
	Providing process optimisation	New

	(based on own machine monitoring)	
Sales	Marketing	Current
	Demand Prediction	Current
	Customer Polling	Current
	Renting Showcase Products	New
Spare Capacity	Renting Machinery	New
Security	Providing guaranteed security	New
Insurance	Mitigate risks for SMEs	New

Figure 15. Business Opportunities Identified from Interviews

The business opportunities identified are summarised in Figure 15. Here it is noted that the opportunities can be grouped into 15 opportunity categories. The table also shows the status and uptake of the various business opportunities. In some cases there are already current applications of the ideas which have been around for many years. Some of these areas are being strongly driven by technology (here they are marked as increasing) and some can still be considered to be niche. In other cases the concepts are new to the market and their uptake is relatively recent – these are marked as new increasing. In other cases the ideas are totally "new" and have yet to be exploited. It is notable that most of the new ideas relate to management of the supply chain, servitization, in-service monitoring, utilising unused capacity and providing security and insurance services.

4 Mapping of business models against and Road4FAME push and pull themes, trends/megatrends, scenarios, ICT priorities, recommendations and interviews
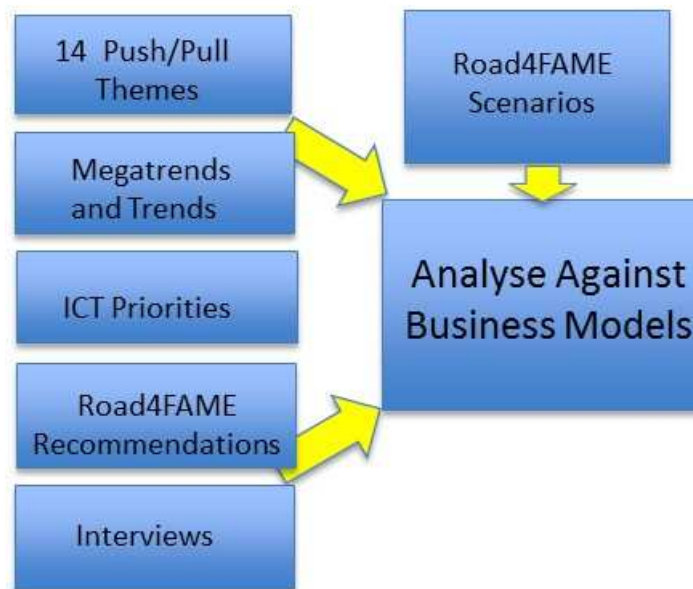
Figure 16. Mapping of Business Models against Road4Fame Outputs

In this section the business models identified are mapped against the push and pull themes and the 4 key scenarios identified in Road4FAME. In addition, the business models are also considered with respect to megatrends and general manufacturing trends such as increased customization of products and provision of product services. The relationship with the ICT priorities and recommendations made by Road4FAME are also considered and finally the correlation with the interview responses are noted.

4.1 Push and Pull Themes

Within deliverable D1.3 [71] push and pull themes are identified. These are summarised into the following key topics:

- Cyber physical (production) systems/intelligent components
- Plug and Produce / self-describing and easily (re-)configurable equipment and components
- Autonomous manufacturing system components
- Factory knowledge base
- Data analysis
- Decision making / Factory optimisation / Emergent behaviour

- User Interfaces / Improved Usability

- Man-Machine Interaction

- Manufacturing-IT as a Service

- New factory level manufacturing IT features

- Knowledge transfer between manufacturing and engineering

- Cloud manufacturing

- Total Customisation / Ad-hoc establishment of production settings

- Horizontal integration and optimisation of value chains

4.2   Megatrends and Manufacturing Trends

In deliverable D2.3 [72]   the socio-economic drivers and megatrends within the manufacturing domain have been identified.

Top megatrends:

1. Knowledge as key-enabler
2. Innovation and new technologies
3. Resource stress and scarcity
4. Globalisation / Economic interconnectedness
5. Sustainability issues environmental societal economic
6. Climate Change

Top manufacturing related trends:

1. Increasing complexity of products, processes, and supply networks
2. Increasing demand for personalised products and high quality
3. Extension of ICT perspective to production site / company associations
4. Companies are increasingly focussing on their core business
5. Environmental sustainability / green manufacturing
6. Demand by customers for individualized / highly configurable products

4.3   Road4FAME Manufacturing scenarios

In Road4FAME, 4 key visionary scenarios were defined that are challenging and not yet possible. The four scenarios represent extremes but describe interesting and important manufacturing settings with which manufacturing companies are likely to increasingly identify in the future. The four scenarios are not mutually exclusive so a manufacturing company may be able to identify with aspects of more than one scenario. The following provides a brief description of each scenario and outlines the challenges which each scenario entails.

Figure 17. Road4Fame Working Scenarios

4.3.1   The Manufacturing-as-a-Service Enterprise

The MaaS enterprise does not sell products, but offers manufacturing as a service. The manufactured goods are complex and fully customized. It frequently faces short-notice requests of high volume. The considered MaaS needs to be able to quickly reconfigure and scale up its production, to establish close information exchange with customers, i.e. integrate with other businesses and enter into business agreements, and cooperate with the new partners in order to fulfill new orders appropriately. The range of offered services goes beyond pure manufacturing process, extending over all the value chain e.g., product design, after sales support, product maintenance.

The company offers its services globally and is strongly dependent on an efficient mechanism for service provision. The company's strategic plan is to be able to anticipate changes in demand from the customers, keeping the pace of technological progress in the sector and to improve the companies' ability to take orders ad-hoc. Predicting trends on demand will require using data mining on a variety of data coming from many sources, e.g. social networks.

4.3.2   Virtual Enterprise

The virtual enterprise is an association of companies which cooperate ad-hoc to react to market opportunities, to do research together, innovate products and to minimize costs and risks for approaching new markets with new products. The involved companies have to join forces effectively to really form one business out of many. The virtual enterprise would be established ad-hoc around a short term request and dissolve after the satisfaction of the request. As capabilities might replicate capacity in multiple partners, they will need to bid internally for selection. A virtual enterprise

consisting of SMEs would enable them to complement each other's strengths or to attain the capacities of large enterprises. A virtual enterprise consisting of both large and small companies enables to combine strengths, i.e. the large companies bring capacity, and the small companies bring flexibility and innovation power. Also, the virtual enterprise enables a much broader product and service portfolio than any individual company could provider alone.

4.3.3   The High-Volume Production Enterprise

This scenario describes a company which produces very-high volumes of goods and increasingly faces the challenge of shorter product life-cycles. To remain competitive, it also needs to be capable of offering an increasing degree of customization, despite the high volumes produced (mass customization). The supply network the company is embedded in comprises some long-term cooperation but also ad-hoc cooperation.

The level of automation is high in the plant, and the customization of production requires short reconfiguration cycles, including tests / experimental production, fast re-programming of machines and frequent updates of information to the workers who need to be skilled and also frequently re-trained, as well as short ramp-up and scale-up cycles. To do so, context-awareness of production facilities is helpful in order to adapt production to current product specifications, react to and schedule order execution appropriately, also according to specific customer relations.

The fact that a company has to react to an increasingly dynamic market entails also that the individual worker has to keep this pace, by acquiring relevant knowledge fast enough. With the half-life of relevant knowledge decreasing, the rate of human knowledge acquisition threatens to become the limiting factor for companies to keep pace with technological progress. Appropriate IT support has to be provided to the human who is embedded in the digital factory, in the form of context-relevant information and on-the-fly knowledge provision supported by, e.g., knowledge based decision support systems or self-learning systems supported by cooperation between humans, machine and data.

4.3.4   The Green Enterprise

This scenario describes a company to which environmental awareness is an important part of the company image. But the company's goal is to go beyond a mere "green washing" of its image and products to really introducing environmental sustainability as a key parameter in all steps of the product life-cycle, including sourcing and recycling. Based on the consideration of data from a large number of sources, real-time information about the footprint of manufacturing processes is available to steer production towards minimal environmental impact. Keeping record of the origin and history of raw materials as additional aspect of environmental awareness is used as a marketing advantage. Buyback of products for recycling or product rental and return to recycle policies are strategic, increasing sustainability on sourcing and creating stronger bonds with customer.

The environmental footprint of ordered, customized products is available to customers in the customization step, so the footprint generated along the value-chain is transparent to the customer

and environmentally aware buying decisions can be made. To the manufacturer and the customer, the environmental footprint is available and can be taken into account as an actual decision parameter. The environmental implications of design decisions, process decisions, and buying decisions become completely transparent.

With a certain customer segment increasingly demanding such transparency, the competitiveness of the company increasingly depends on the degree of transparency it is able to provide, and the level of environmental sustainability it can demonstrate. Thus, its capability to be "green" translates into tangible economic value.

4.4 Analysis of Business Models
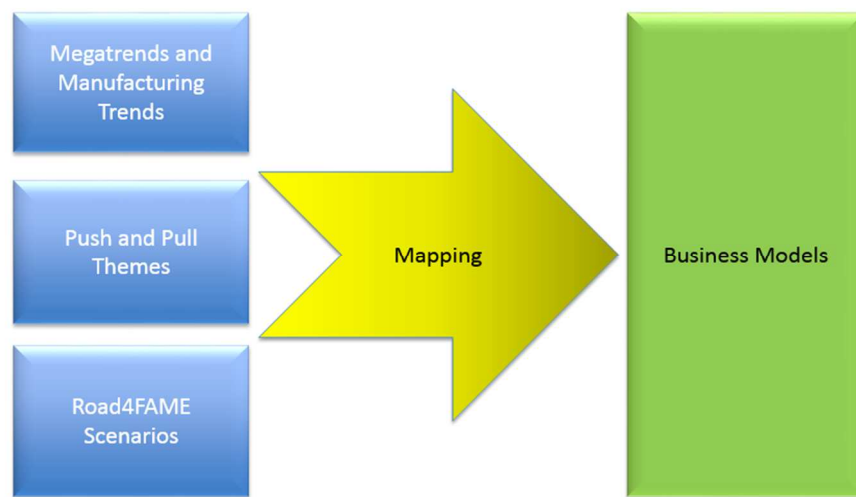
Figure 18. Mapping of Road4FAME Deliverables

The megatrends and manufacturing trends, push and pull themes and Road4FAME scenarios were first mapped onto the business models. This was done to replicate the approach adopted in the first Road4FAME mapping workshop to see how the same drivers mapped to the business models.
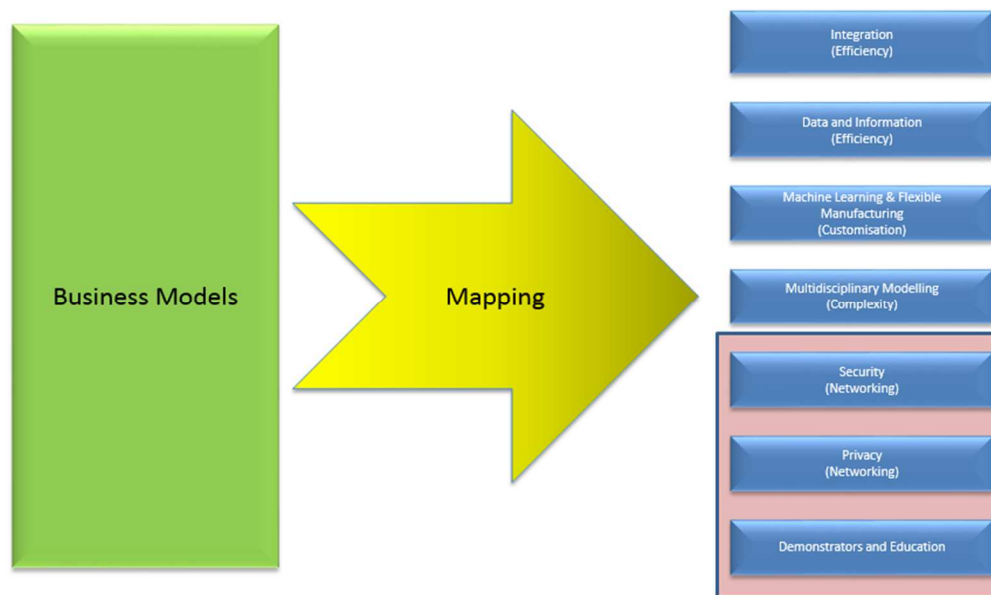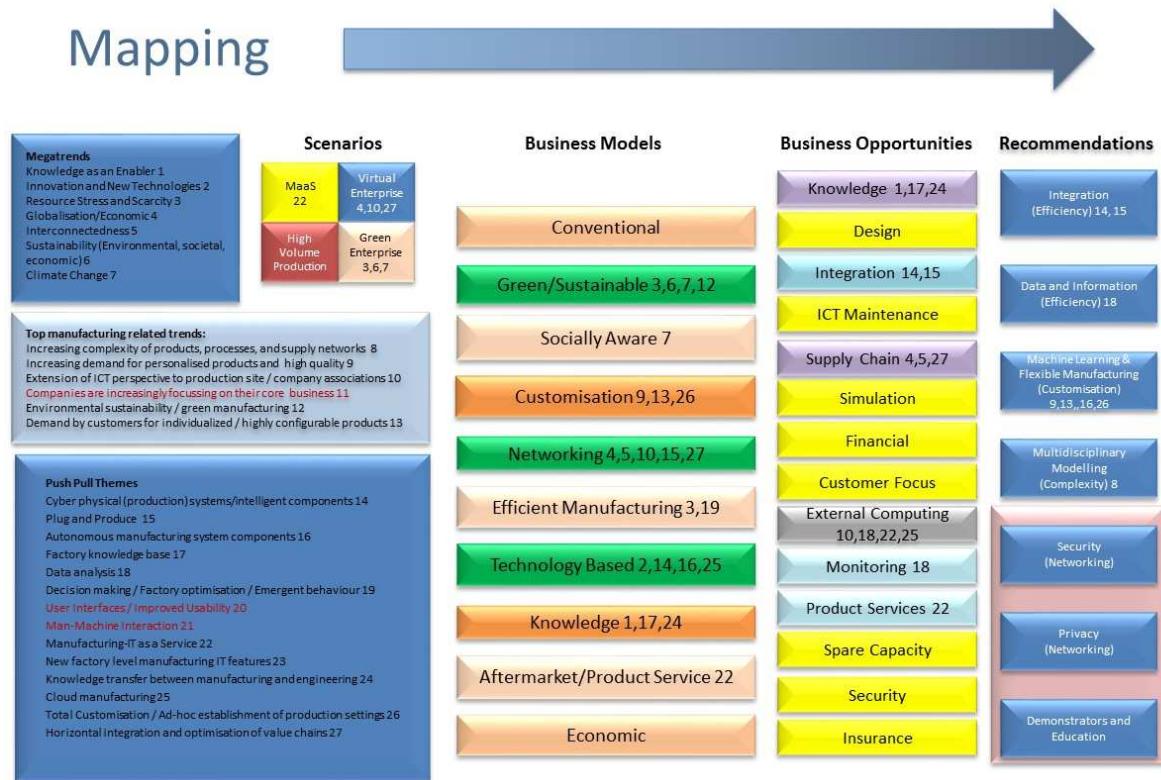
Figure 19. Business Models mapping into Road4FAME Recommendations

The business models were then mapped onto the Road4FAME Recommendations which came out of the results from the previous mapping workshops. The aim of this was to ensure that there was traceability between the inputs and outputs of Road4FAME. It should be noted that in Fig. 19 security, privacy, demonstrators and education were highlighted as barriers to adoption of ICT. The expectation in the mapping was that there would not be a mapping between the Business Models and these areas.
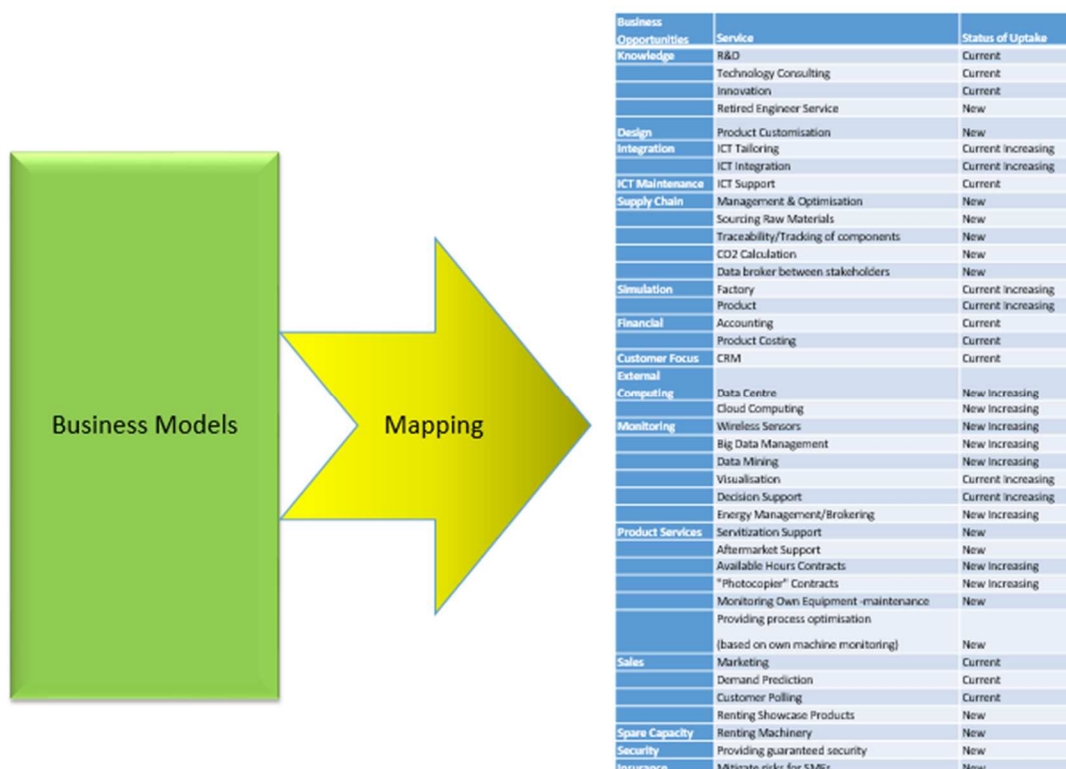
Figure 20. Business Models Mapping against Identified Business Opportunities from Interviews

The Business Models were also mapped to the Business Opportunities that were identified in the interviews with industry. It should be noted that fundamentally a business opportunity represents an opportunity for a company whereas a business model represents how a business opportunity can be realised operationally. Thus one would not expect a direct mapping between the two.

Figure 21. Mapping from Road4FAME inputs to Business Models / Opportunities to Recommendations

The mapping in Figure 21 highlights a number of things. Firstly, there is a mapping for almost every driver and trend to the business models and recommendations. There are some notable exceptions though marked in red. The manufacturing trend towards concentrating on core business is not mapped. This is not surprising as it is more a commercial decision made by companies that have over-diversified historically. Indeed many companies in the early 1990s diversified heavily and then returned to concentrating on core business in the later 90's. Areas missing that are more interesting arise from the push and pull themes of user interfaces / usability, and man machine interfaces. This was noted as being under-represented in the Road4FAME recommendations and as a consequence these have been revised to more strongly include this. It was also noted that the Road4FAME key scenario High Volume Production did not map well. This was also noted in previous Road4FAME workshops where the Virtual Enterprise and Green Manufacturing were better represented by technology and manufacturing trends. In Figure 21 the "strength" of match is indicated by a colour coding scheme. With respect to the Business Models, dark green means that there is a strong match, dark orange means there is a slightly less strong match and lighter orange indicates a weaker match. Likewise for the Business Opportunities dark grey indicates a strong match, lighter grey indicates a weaker match and yellow indicates no identified match.
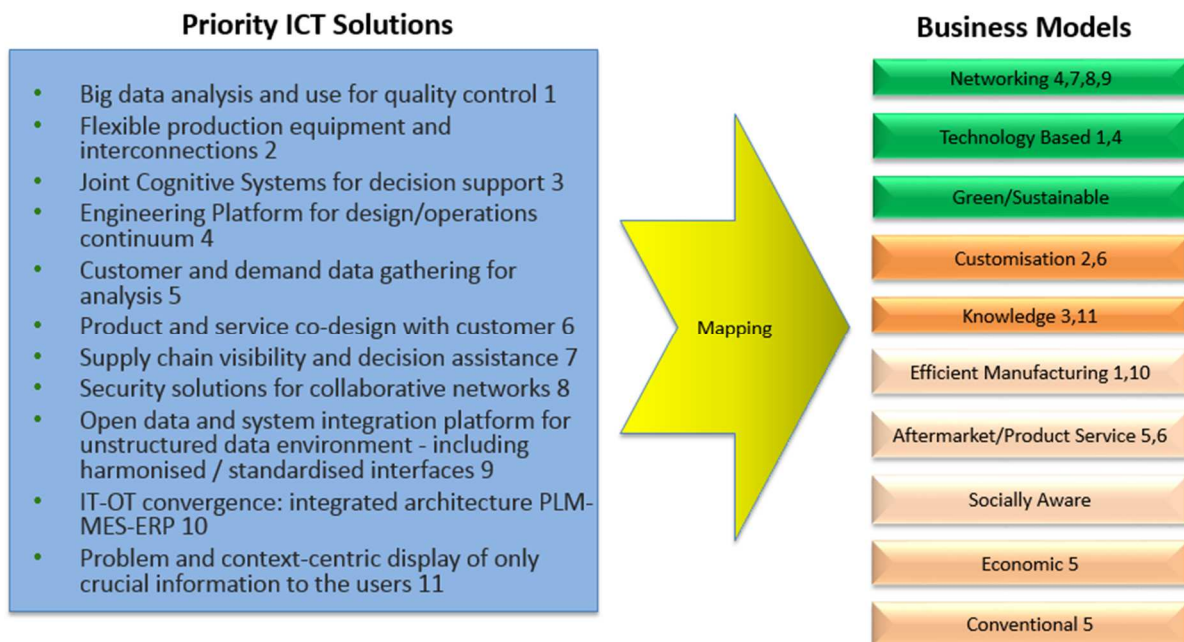
Business Models

- Networking 4,5,10,15,27
- Technology Based 2,14,16,25
- Green/Sustainable 3,6,7,12
- Customisation 9,13,26
- Knowledge 1,17,24
- Efficient Manufacturing 3,19
- Aftermarket/Product Service 22
- Socially Aware 7
- Economic
- Conventional

Analysis of BMs

Business Opportunities

- External Computing 10, 18, 22,25
- Knowledge 1,17,24
- Supply Chain 4,5,27
- Integration 14,15
- Product Services 22
- Monitoring 18
- Design
- ICT Maintenance
- Simulation
- Financial
- Customer Focus
- Spare Capacity
- Security
- Insurance

From interviews - less coverage of areas on the left

Figure 22. Ranked Findings

For ease of understanding this is re-drawn in Figure 22 with the categories ranked in priority order. It must be remembered here that the differences in strength of match can be purely from a single "hit" with respect to another category so actual categories could easily move up or down and care must be taken in drawing conclusions.

Some things are noticeable however, so it is worth commented on them. Firstly, considering Business Models it is clear that Networking Business Models are the most highly ranked with Technology Based and Green / Sustainable Business Models also being towards the top of the ranking. Networking being most highly ranked correlates well with the increased use of ICT technologies and move towards supply chain. The ranking of the top three categories may be driven by the concentration in the roadmapping workshops on the 4 key Road4FAME scenarios which specifically includes The Virtual Enterprise, Green Enterprise and Manufacturing as a Service Enterprise. At the bottom of the list are Socially Aware, Economic and Conventional Business Models. It should be noted here that Conventional Business Models will permeate throughout existing industry and may not be supported by the consideration of the impact of ICT on future industry (apart from improving efficiency and reducing cost). What is surprising from this data is that business models relating to Aftermarket / Product Services are ranked so lowly. This does not agree with the outcome of the Analysts reports which in many cases highlight the move towards servitization and aftermarket support. It is believed here that many reports are driven by input from aerospace manufacturers where this is currently a key commercial move. In the automotive industry, for instance, it is not possible to provide aftermarket services in the same way as traditionally the automotive companies have to supply via a network of dealerships. Whilst in general there is a move towards servitization within the ICT sector the strength of this move in manufacturing may in fact be less than is reported in analyst's reports considering the whole manufacturing industry.

When considering the mapping to the Business Opportunities identified there is a clear ranking of external computing as the top item which relates to the increased exploitation of cloud computing. Business opportunities related to knowledge, supply chain and integration where also supported more strongly.

### 4.4.1 Mapping to Eleven Priority ICT Manufacturing Solutions / Validation and Concluding Thoughts

The results of the mapping produced some surprising results and so some further work was done to understand the anomalies. The roadmapping workshop held in London had concentrated on the mapping of 11 ICT priority topics to the Road4FAME scenarios. These were thus mapped against the Business Model categories to see the correlation.

Figure 23. Priority ICT Solutions Mapping

Figure 23 shows the results of this mapping. Here again there is a stronger correlation with networking business models. There are also correlations to Technology Based, Customisation, Knowledge, Efficient Manufacturing and Aftermarket / Product Service Business Models with equal strengths. Notably there is no correlation with Green / Sustainable Business Models. This indicates that this is being purely driven by a trend rather than via the introduction of ICT.
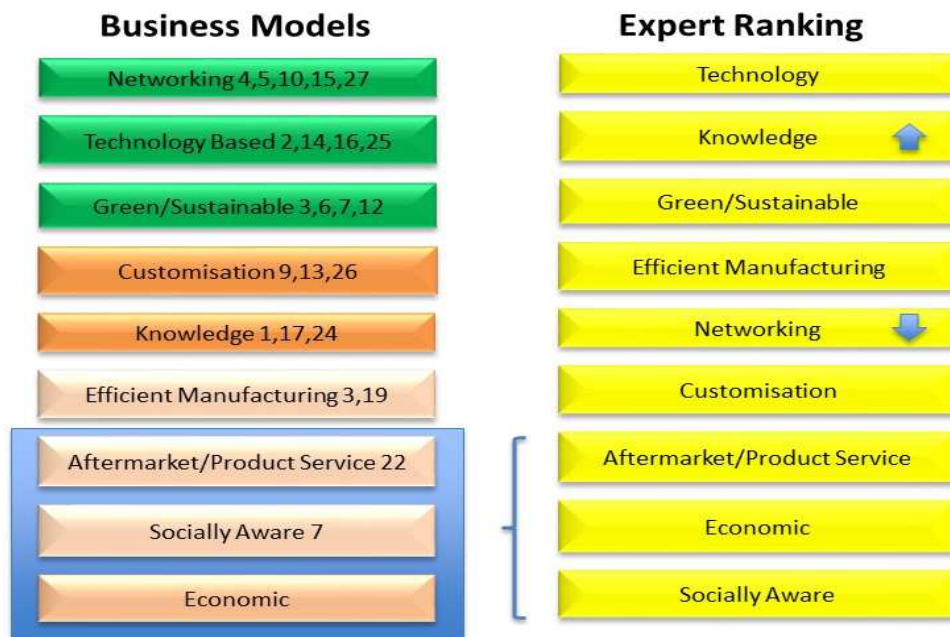
Figure 24. Ranked Results from Mapping vs. Ranked Results from Experts

A business modelling workshop was run at ATOS Madrid in April 2015. The purpose of this event was to identify new business opportunities and develop business models around the 9 categories of business models identified (not including Conventional Business models). In advance of the workshop the experts invited were asked to rank the 9 business model categories according to their preferences. The aim of this exercise was to provide validation of the mapping results. The results of this in comparison with the original ranking is shown in Figure 24. Here it can be clearly seen that the bottom three categories which were identified not to have much correlation with the outcomes of Road4FAME were also considered the least attractive by the experts. Furthermore, the experts also highlighted that Aftermarket / Product Service business models were less attractive as had been identified earlier. It was noted, however, that experts with an aerospace background rated this very highly. Experts with an automotive background rated economic modelling more highly. Thus it would appear that the interests in different business models to some extent is sectorally driven.

Also of note from the expert rankings of the business models was that business models related to networking were ranked lower than identified in the mapping, and that business models related to knowledge were more highly ranked. The positions of the other categories did not move by more than one ranking.
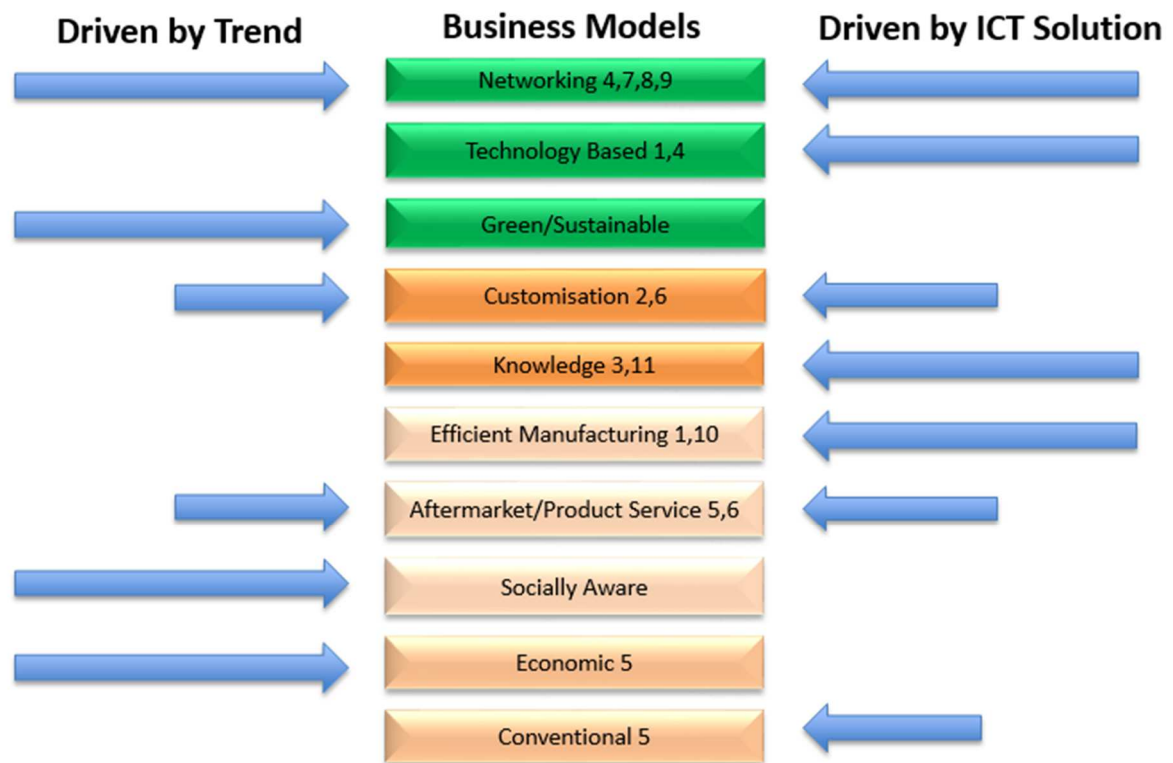
Figure 25. Priority by Trend and ICT Solution

Considering the results of the mapping and the ranking provided by the experts a number of suppositions can be made. These are shown in Figure 25. It is believed that network based business models have been ranked highly in the Road4FAME mapping due to the fact that they are both strongly driven by trends towards globalisation and complex supply chains and also by the introduction of networked IT. Technology based business models are driven solely by ICT whilst Green / Sustainable business models are driven solely by trends and regulations, not by ICT. The business models based upon customisation are being driven on one side by customer demand for customised products and on the other side by the introduction of flexible manufacturing technology. Knowledge based business models are being driven by ICT and the exploitation of value extracted by data. This may include Big Data. Efficient manufacturing is solely driven by ICT as there has been a move towards automation over the past 25 years. Aftermarket and Product Service business models are being driven by both a trend in some sectors and also by ICT technology. Here ICT is necessary in order to monitor, manage and maintain products in the field. If the ICT technology did not exist product services would not be possible in an economic sense. Socially aware business models are being driven by social drivers and ethical concerns solely, not by ICT. Economic business models are being driven by trends not by ICT in the main. Here an exception may be crowd sourcing of funding for products. This at present is not a key economic model in use and industry is dominated by conventional economic business models which are encased in a rigid legal framework. Finally, conventional business models are being driven by advances in ICT to some extent.

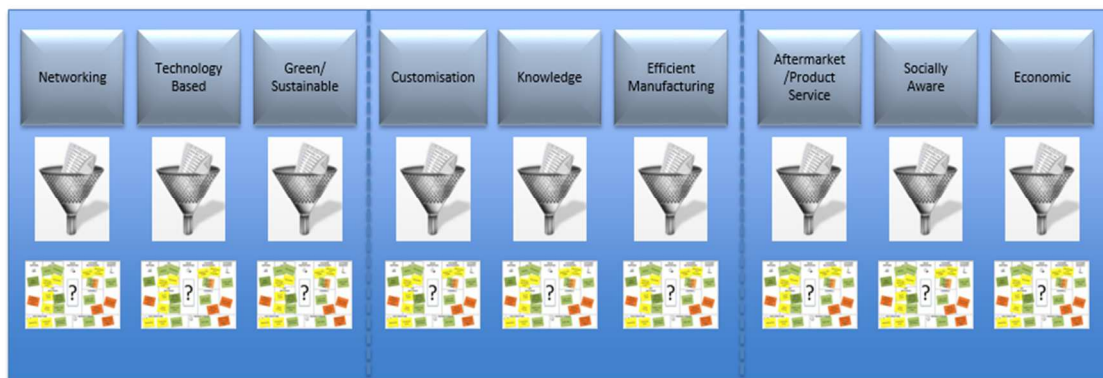# 5 Recommendations for new business opportunities tied to future architectures and services in manufacturing

Figure 26. Business Modelling Workshop Structure

Through interviews 39 potential business opportunities were identified in 15 different categories. These were classified according to whether they were current of new concepts. Although they are business opportunities, how they could be put into practice operationally has not been elaborated. In order to identify potential business opportunities and elaborate business models for the most promising ones in the identified categories a business modelling workshop was organised as mentioned previously at ATOS' offices in Madrid. This was attended by around 15 experts who included a mix of backgrounds including manufacturers, service providers and large and small companies.

Prior to the workshop an information pack was sent out which contained an introduction to the business model canvas, an example of a filled in business modelling canvas for energy monitoring / usage optimisation to show how the process worked, and a set of business model characterisations based around the 9 identified business model categories.
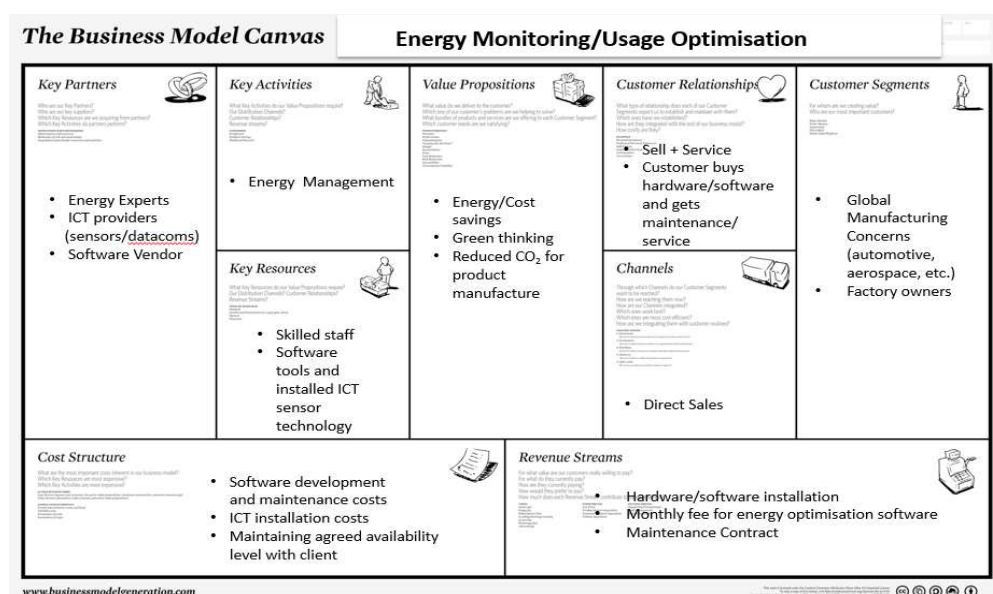
Figure 27. Example Business Model Canvas of an Energy Monitoring / Usage Optimization Business Opportunity

5.1 Business Model Category Characterisations

Product Service/Aftermarket

To Achieve This	Culture
• Delegate to employees who are close to the customer • Foster carefully selected and nurtured customers • Value and build relationships • Have special insights into clients and organisations	• Foster client dependency without dominating the relationship • Welcome responsibility for achieving results • Continuously learn from clients • Look for specific solutions, not general or standardised ones

Green/Sustainable

To Achieve This	Culture
• Develop eco-conscious workforce • Monitoring of energy, raw materials usage across enterprise and supply chain • Develop understanding of cradle-to-grave impact of product on environment	• Environmentally aware • Understand value of resources and impact of enterprise on environment • Rewards reduction in energy/CO2 and materials usage

Efficient Manufacturing

To Achieve This	Culture
• Standardised and simplified • Efficient in effort and co-ordination • Avoid variety, avoid niches • Occupy middle of the market where demand is huge	• Abhors waste • Obsessed with cost • Rewards efficiency

Customisation

To Achieve This	Culture
• Flexible manufacturing processes and equipment to allow easy modification/change of base product • Lost cost tailoring support for product re-design • Strong communication links with customers to allow their direct input	• Encourages customer choice and input • Encourages variety in market place • Willingness to interact closely with customers

Networking

To Achieve This	Culture
• Highly connected business systems to allow exchange of information • Focus on monitoring to track product through network • Standardisation of information exchange • Flexibility to adjust and change network members	• Working collaboratively in partnership • High level of teamwork and trust between organisations • Driven by desire to meet schedules • Respect for intellectual property

Technology Based

To Achieve This	Culture
• Skilled workforce that can engage with new technologies • Strong and open minded leadership to drive through change • Capital investment to take on board latest technologies	• Exploitation of latest technologies (e.g. 3D printing) to gain commercial advantage • Open to new ideas/technologies • Tolerate high installation/setup costs with a view to future gain

Knowledge

| To Achieve This	Culture
• Flexible structure to allow new ideas • Effective management of talented people • Robust processes that can accommodate change	• Encourage individual imagination/ideas • Results driven • Reward new product/process success • Tolerate experimentation (even when not always successful)

Socially Aware

To Achieve This	Culture
• Company will have clear social values which are written down and universally understood • Failure to conform to specified standards will not be tolerated from employees or suppliers • The firm will seek to supply customers who share their values	• Managers and employees adhere personally to a set of values • Treatment of employees reflect company core values • Relationships with customers and local community and charities reflect company values

Economic (Investor Supported)

To Achieve This	Culture
• Long term vision • Flexibility to meet the needs of investors • Concentrates on needs of end customers • Provides accountability to shareholders	• Reliant on external investors • Driven by long term return • High risk

Figure 28. Business Models Category Characterisations

The workshop was organised into 3 sessions according to the identified business model categories as shown in Figure 28. The order that the categories were tackled in the meeting was according to the ranking established in the mapping exercise with the least "popular" categories, social and economic business models being addressed last. This was to avoid "turning off" the participants at the beginning of the meeting.
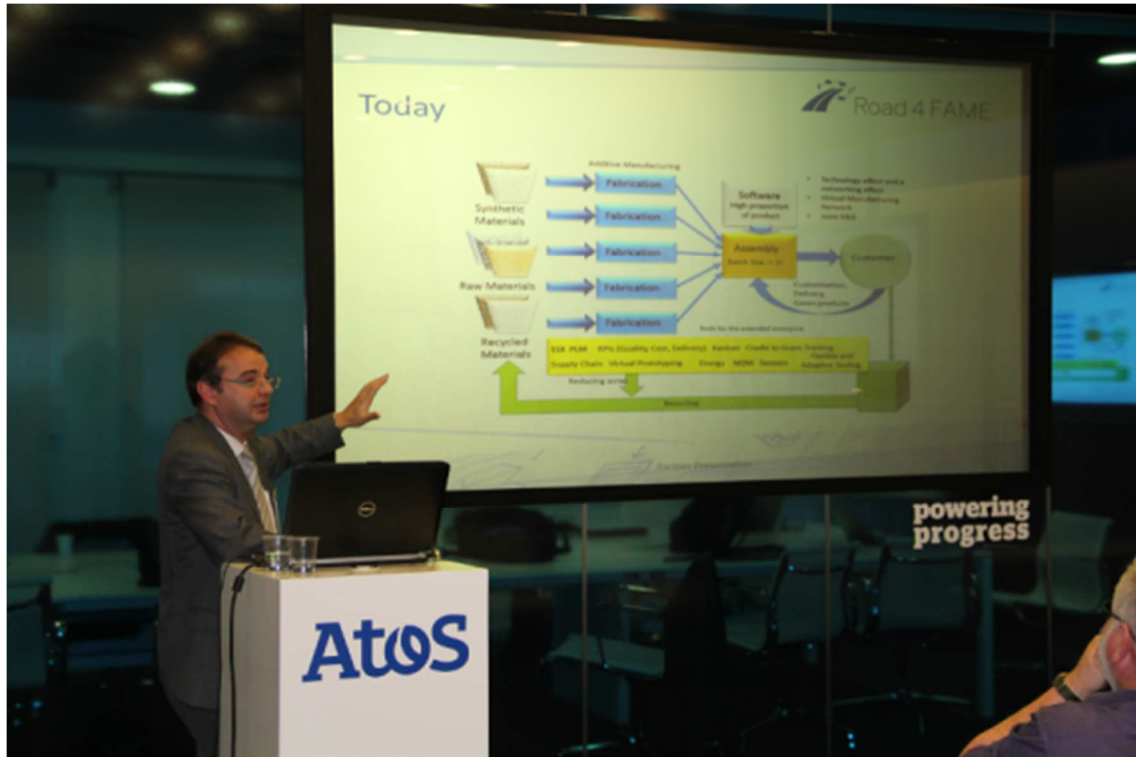
Figure 29. Workshop Held at ATOS Offices in Madrid

To start the workshop a presentation was given setting the scene for the workshop in terms of how the manufacturing industry was changing opening up opportunities for new business models. An overview of the results from the analysis of reports and the business model categorisation was described. An overview of the results of the interviews and some potential business models to stimulate the participants with some ideas was also given. Finally, the results of the mapping exercise were presented along with the results from the experts mapping.

A briefing for the workshop was then given explaining the organisation of the workshop and the business model categories. The workshop was organised as follows. The experts were allocated into one of the three breakout group categories per session based on their first or second preferences for a category such that there were equal numbers in each group. Six members of the Road4Fame consortium attended and these were divided amongst the groups to capture opinions.

In the first instance the participants were asked to identify promising business opportunities and also discuss the pros and cons of these. This information was captured. Once a number of business opportunities had been identified the group was then asked to vote on which business opportunities that they thought were the most promising. Based on this the business modelling canvas was used to capture how the idea could be elaborated into a business model operationally. If more than one

promising business opportunity was identified as being promising then the experts were encouraged to also elaborate a further business model canvas for the other opportunity.

Figure 30. Breakout Session

At the end of each session the experts were asked to present the business opportunities identified and then describe the business model canvas for the most promising opportunities in a feedback session which was recorded on video.

Figure 31. Feedback Session

The target for the day was to identify a set of promising business models for each category and capture this information but to have at least one business model canvas for the most promising business opportunities for each category.

A number of things were noted during the meeting. Firstly, the initial and second sessions resulted in generation of many business opportunity ideas. In some cases 7-14 opportunities were identified dependent on the category. Although this could have proved problematic with respect to identifying the most promising opportunities during the voting phase it was noted that there was good agreement between experts on what were truly the most promising opportunities. For the final session tackling the lowest ranked categories it was noted that the product service / aftermarket category provided business models that are already well known in this area and the experts struggled with the economic and socially aware categories. Here for the economic category it was highlighted that there are well known financing approaches within industry and legal barriers that exclude adoption of some approaches. The experts were thus asked to think "out of the box" and forget about the legal barriers to potential adoption. For the socially aware category there was agreement that companies are keen to promote their social / ethical credentials but it was not clear how this related to financial gain. An interesting point is that some of the ideas from the socially aware area considered the concept of social currency which crossed over into the economic category.

Overall it was noted that over 50 business opportunities were identified. In many cases it was noted that there was a need to team up with a variety of actors in order for the business model to be successful. A common feature noted was the need for legal support for contract law to allow networking and collaborations to occur flexibly and on the fly. In other cases insurance was needed in order to offset risk.

5.2   Workshop Canvas Models
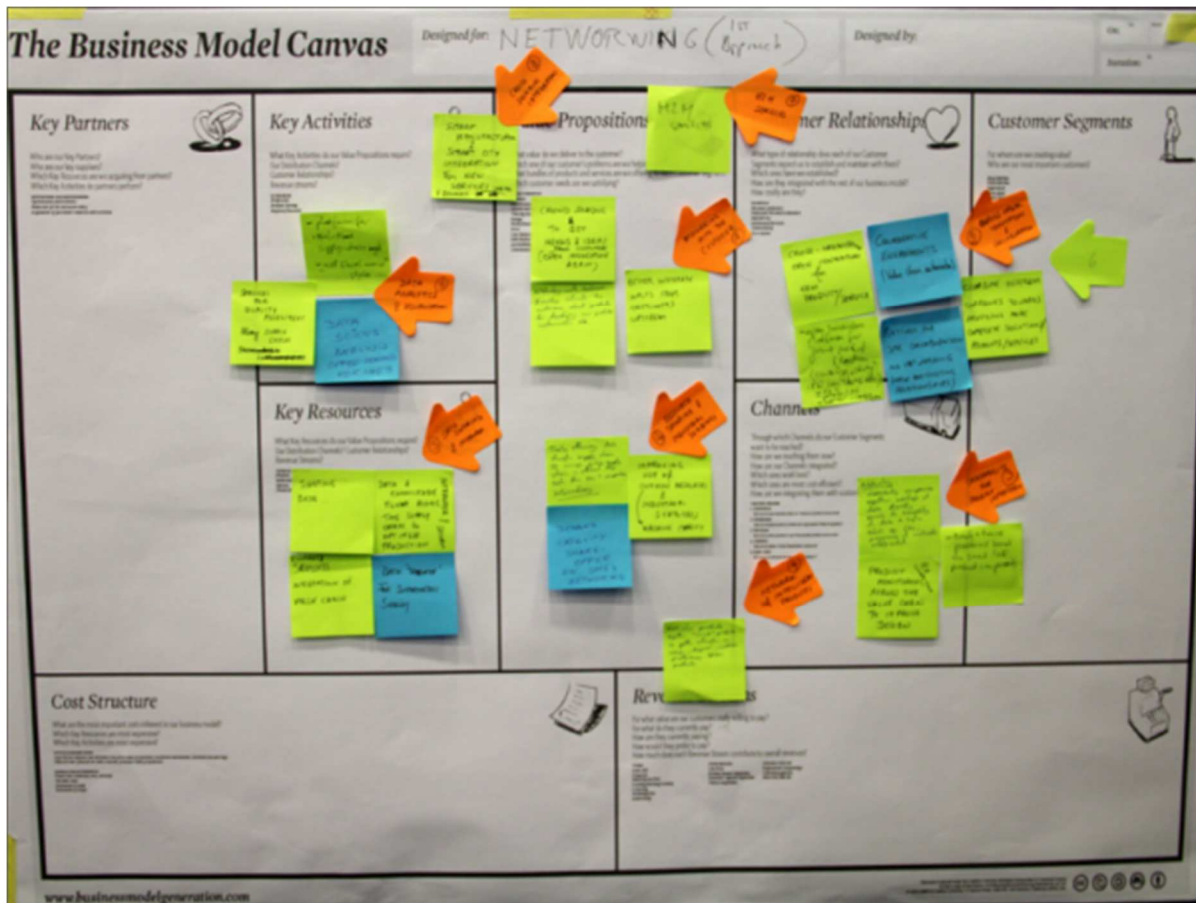
5.2.1   Networking

Figure 32. Networking Business Model – 9 Identified Business Opportunities (see arrows)

Identified Business Opportunities

In total nine business opportunities were identified. These were:

1) Networking with customers, e.g. via crowd sourcing

2) Provision of cross organisational open collaboration platform

3) Product tracking / traceability

4) Industrial symbiosis – sharing resources to meet demand and provide capacity

5) Data sharing service to provide interoperability

6) Data analytics to provide real time reaction and also visualisation

7) M2M services

8) Cross domain integration – networking between products in service

9) Network of products

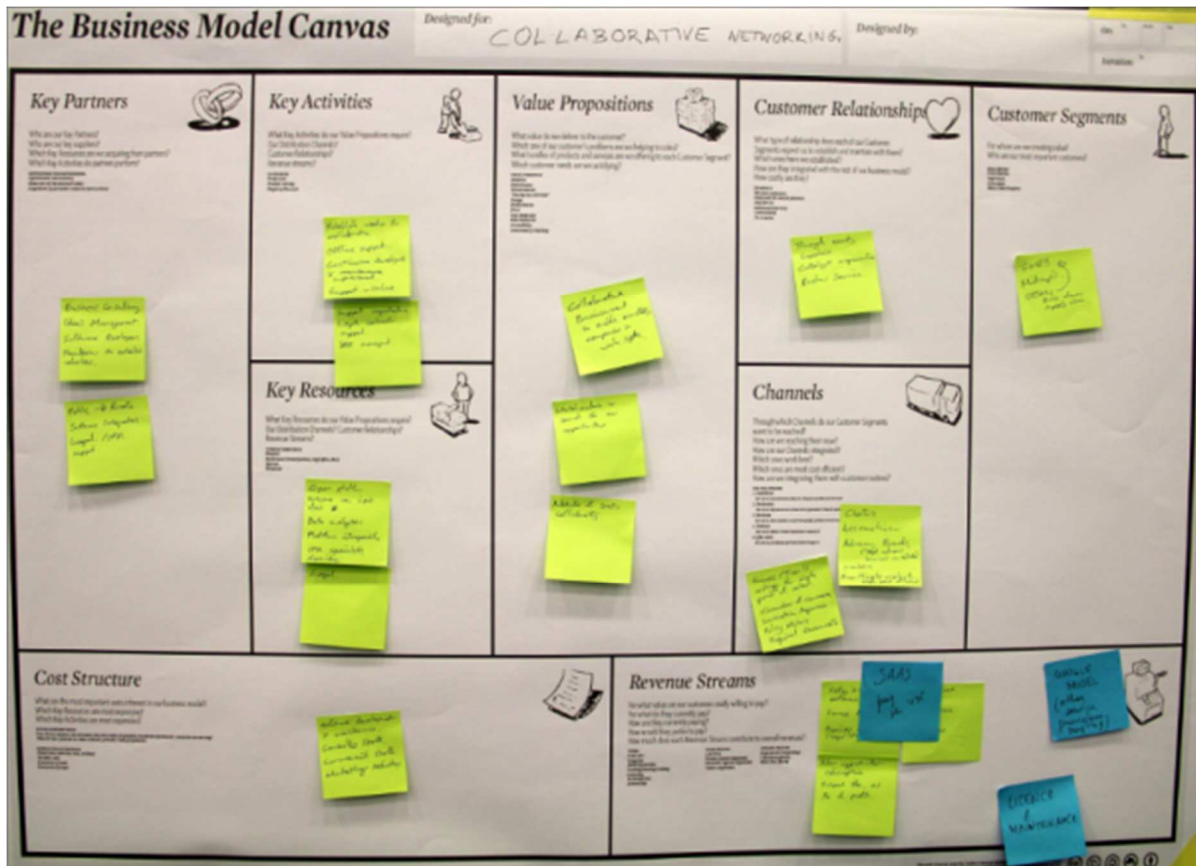**Figure 33. Business Model Canvas for Most Promising Networking Business Model**

Business Model Canvas for Most Promising Opportunity

- Value Proposition

Provision of a collaborative environment to enable manufacturing companies to work together.

- Client Segment

OEM'S, mid-caps and SME's with OEM's driving this within the supply chain.

- Communication and Distribution Channels

Primes / Tier 1's asking for single point of contact, clusters, associations, chamber of commerce, innovation agencies, incubators, policy makers, regional government, advisory boards, legal advisers, business consultants.

- Client Relationships

Through existing suppliers, catalyst organisations and broker services.

- Key Resources Needed including ICT infrastructure

Open platform where everyone can input ideas, platform interoperability, data analytics, legal support, security and IPR specialists.

- Key Activities

Establish needs for collaboration, offline support and online support for continuous development and improvement, support for negotiations, legal contract support and IPR management.

- Key Partners

Business consulting, ideas management, software developers, facilitators to establish relations, software integrators, legal / IPR support.

- Revenue Streams

Pay per use, subscription fee, success fee or percentage of profits, Google model (other service providers paying), licence and maintenance, selling legal and IPR services.

- Cost Structure

Software development and maintenance, consulting staff, commercial staff, marketing activities.
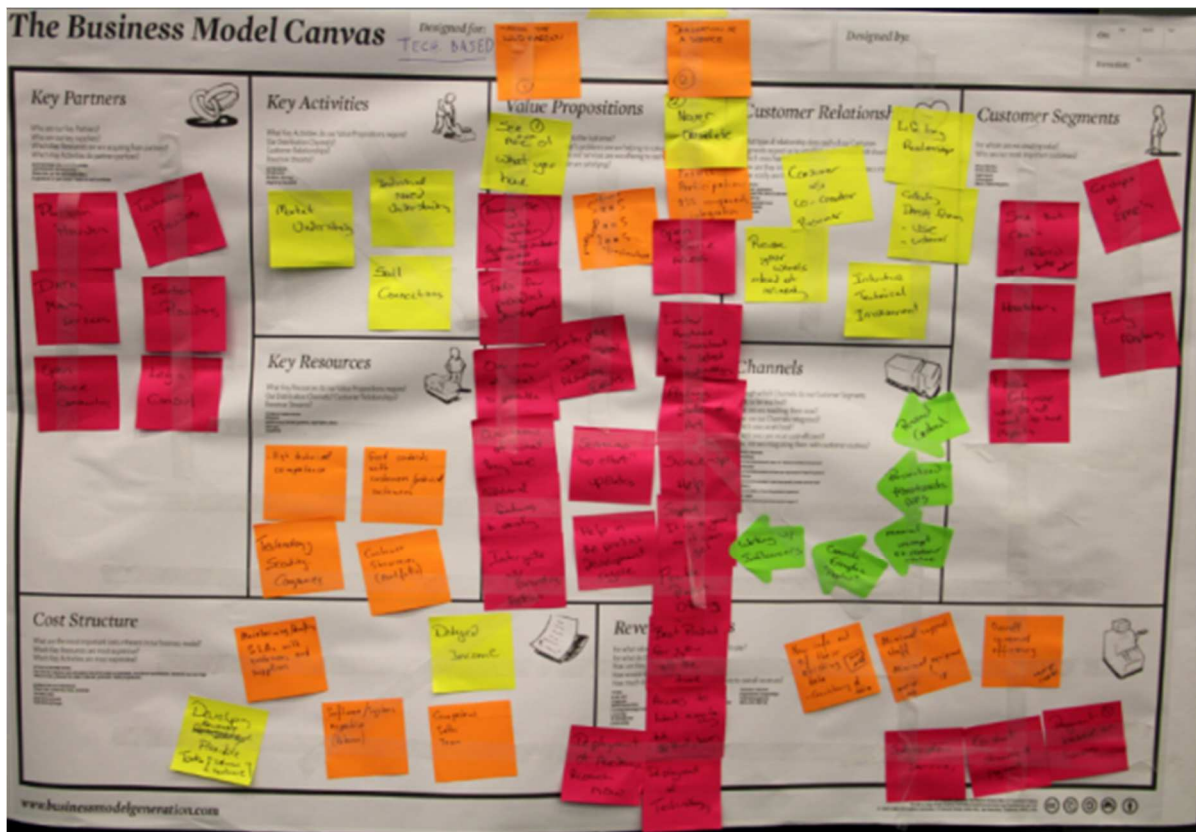
5.2.2 Technology Based

Figure 34. Business Model Canvas for Technology Based Business Model

Identified Business Opportunities

1) "Taming the Wild Garden" (from ad-hoc integration of systems over time)

2) Innovation as a Service (IaaS)

Business Model Canvas for Most Promising Opportunity

- Value Proposition:
  - Taming the wild garden:
    - See and use more of what you have
    - Create a system to understand what is out there
    - Tools for product development
    - Interpret data that already exists
    - Provide overview of what is possible
    - Provide overview of what they have
    - Addition of features to existing system
    - Integration with existing system

- IaaS
  - Never obsolete
  - Process Participation: OSS components integration
  - Open source access
  - Limited hardware investment in the latest technology
  - Always state-of-the-art
  - Scale-up help
  - Seamless "no effort" updates
  - Support (so it is as good as it can get)
  - Help in the product development circle
  - Flexible product offering
  - Best product for you all the time
  - Access to latest manufacturing technology (3D Printing, Laser…)
  - Deployment of academic research now
  - Deployment of technology

- Client Segment

Groups of SME's, hesitators, early adopters, large enterprises who do not want to employ experts.

- Communication and Distribution Channels

Personal contacts, personalized ads, concrete examples applied, working with influencers.

- Client Relationships

Lifelong relationships, collecting data from use and customer, consumer as co-creator (prosumer), reuse instead of reinventing.

- Key Resources Needed including ICT infrastructure

High technical competence, good contacts with customers and potential customers, portfolio of customer showcases, technology scouting companies, minimal support staff, minimal IT equipment.

- Key Activities

Market understanding, industrial needs understanding, sell connections.

- Key Partners

Platform providers, Data Mining services, Open Source Communities, legal consultants, solution providers, technology providers.

- Revenue Streams

New information from existing data, overall increased efficiency, payment based on success and subscription service.

- Cost Structure

Maintaining / drafting Service Level Agreements (SLAs) with customers and suppliers, developing reusable and flexible tools, software / systems expertise, competent sales team, delayed income.
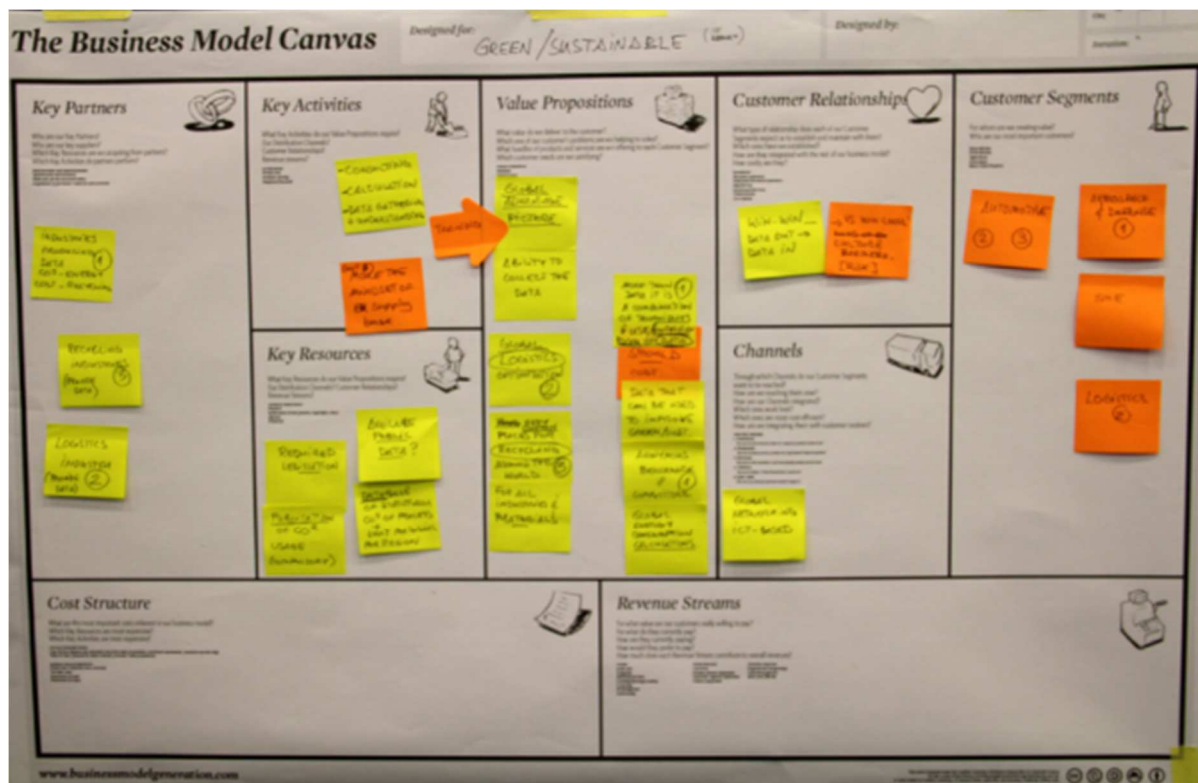
5.2.3 Green / Sustainable

Figure 35. Business Model Canvas for Green / Sustainable Business Model

Identified Business Opportunities

1) Consultancy and training

Business Model Canvas for Most Promising Opportunity

- Value Proposition
  - Ability to collect data (CO_2, costs, energy, benefits of recycling), perform calculations and make sense of the benefit of green sustainability:
    - Data can be used to improve green / sustainability
    - Global energy consumption calculations
    - Global logistics optimization
    - Common places for recycling around the world for all industries and materials
  - Motivate customers to improve their ability to comply with legislation
  - Offer added value to a company
  - Benchmarking compared to legislation and competitors

- Client Segment

Aeronautics & defence, SMEs / manufacturers, automotive, supply chains, logistics.

- Communication and Distribution Channels

Portal e-services, IT based channels, global networking.

- Client Relationships

Win-win vs. win-lose (to be mitigated with training to change the mind-set and cultural barriers), data out-data in, establish trust.

- Key Resources Needed including ICT infrastructure

Legal enforcement, homologation, Cloud infrastructure, required legislation, public data available, publication of CO_2 usage (compulsory), database of statistical CO_2 of process plus unit material per region.

- Key Activities

Consulting, training and data gathering plus understanding (via data analysis), changing the mind-set of the EU supply base.

- Key Partners

Data providers (industries), governmental certificators, forum of consultants, associations (i.e. SCAF, ACOSTE…), industries producing data (CO_2-efficiency, cost-recycling), recycling industries, logistics industries.

- Revenue Streams
    - Just for companies

        Obtain-maintain a certificate, consulting projects (improve processes globally), direct use of the information collected.

    - For companies and government

        Training and awareness, recommendations.

- Cost Structure

Pay to access data (GABI–like), data scientists, communication channels, staff (employees, consultants), forum, infrastructure (Cloud, IT).
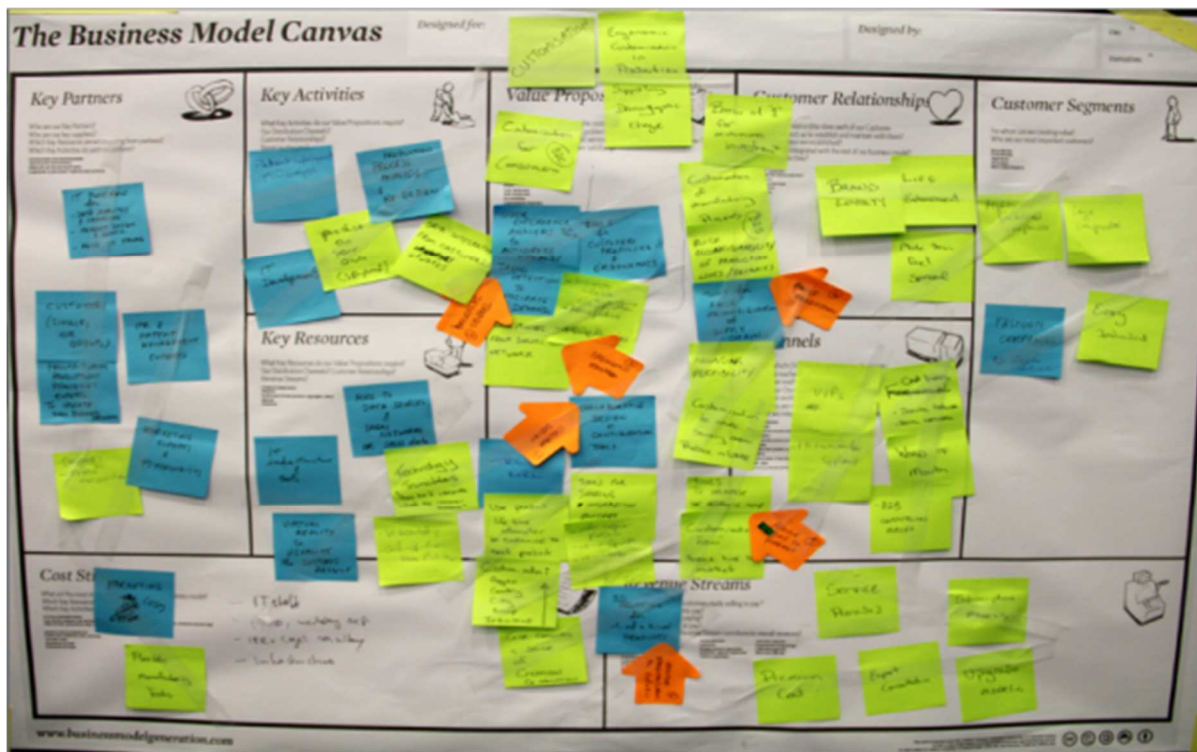
5.2.4   Customisation

Figure 36. Business Model Canvas for Customisation Business Model

Identified Business Opportunities

1) Trends detection using IoT, data mining from social networks, etc. to anticipate demand

2) Collaborative design tools to allow re-configuration, re-use and customisation at different levels (region, country, city, group, individual) to give customers a sense of creation, co-operation

3) Tools for customer profiling and ergonomics, increasing customer experience

4) Agile production through customisation of manufacturing process (B2B), flexibility and quick re-configurability of production lines / factories / supply chains to make batch of 1 products.

5) Tools to reduce time to market - customisation "now"

6) Additive manufacturing for 1-of-a-kind products

Business Model Canvas for Most Promising Opportunity

- Value Proposition

Ergonomic customisation in production supporting demographic change, customisation for consumers (B2C).

- Client Segment

Highly specialised companies, large companies, fashion companies, e.g. Jaguar, every individual.

- Communication and Distribution Channels

VIPS, social and retail networks, word of mouth, recommended suppliers, B2B – commercial forces.

- Client Relationships

Brand loyalty, life enhancement, make the customer feel special.

- Key Resources Needed including ICT infrastructure

IT infrastructure and tools, access to data sources and social networks or sales data. Virtual reality to visualise the customisation result, technology translators to interpret what the consumer means and visionists to provide out of the box thinking.

- Key Activities

Patent infringement, freedom to operate analysis, production process analysis and re-design, IT developments, produce on your own (3D-printing), data integration from customers upwards.

- Key Partners

IT providers for data analysis and crawling, product design and configuration, agile management, customers (singles or groups), IPR and patent management experts, designers, product researchers, marketing experts and psychologists.

- Revenue Streams

Service provided, premium cost, expert consultation, subscription models, upgrade models.

- Cost Structure

Marketing costs, flexible manufacturing tools, IT staff, psychologist and marketing experts, IPR and legal consultancy, infrastructure.
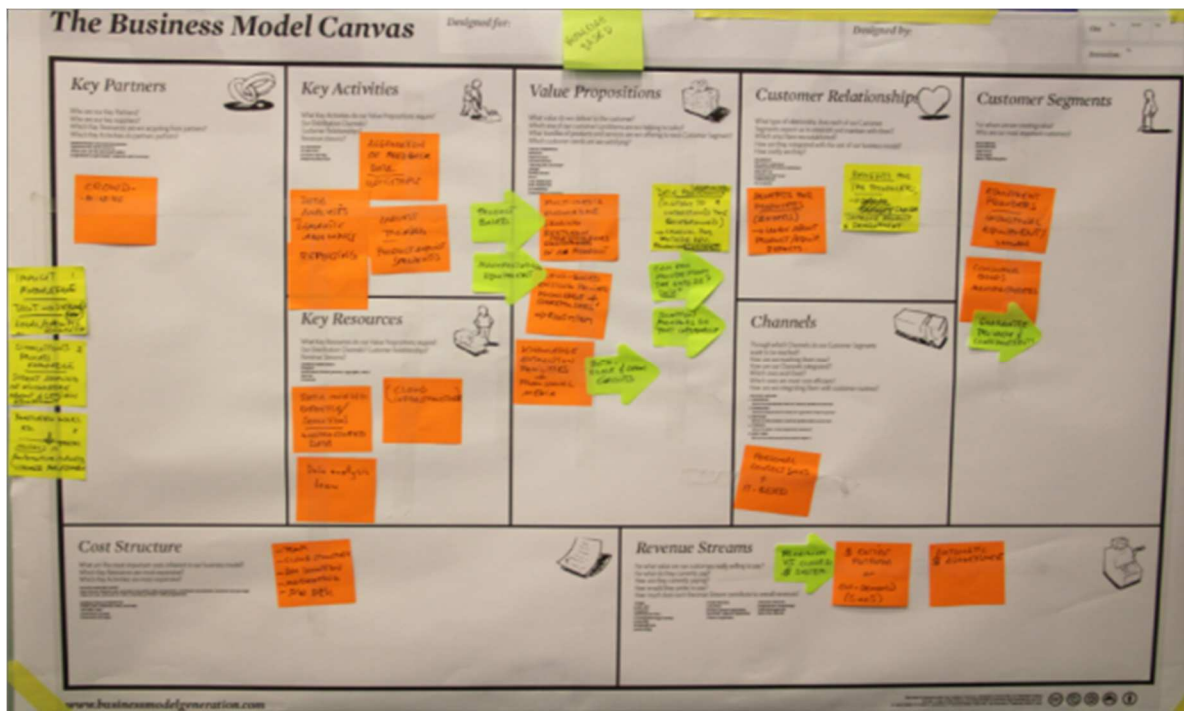
5.2.5   Knowledge

Figure 37. Business Model Canvas for Knowledge Business Model

Identified Business Opportunities

1) Demand prediction

2) Software as a Service (SaaS)

3) Consultancy

Business Model Canvas for Most Promising Opportunity

- Value Proposition
    - Multimedia knowledge sharing between stakeholders of a product
    - Definition of an ecosystem which includes Cloud-based existing provider knowledge plus stakeholders
    - Knowledge extraction from facilities but also from social media
    - It is crucial to know data provenance in order to understand the background
    - It is also important to follow-up the changes for future developments

- Client Segment

Equipment providers, consumer and goods manufacturers, guaranteeing privacy and confidentiality.

- Communication and Distribution Channels

Personal contact, IT based channels.

- Client Relationships

Buyers learn about product / equipment defects, producers improve product and development.

- Key Resources Needed including ICT infrastructure

Cloud infrastructure, data mining solutions and expertise, unstructured data, data analysis team.

- Key Activities

Aggregation of feedback data, data and semantic analysis, reporting, analyst training, product analysis specialists.

- Key Partners

Crowd mining companies.

- Revenue Streams

Freemium vs. closed system, entire platform or on demand (SaaS), automatic advertisement.

- Cost Structure

Staff, Cloud structure, data management solution, marketing, software development.
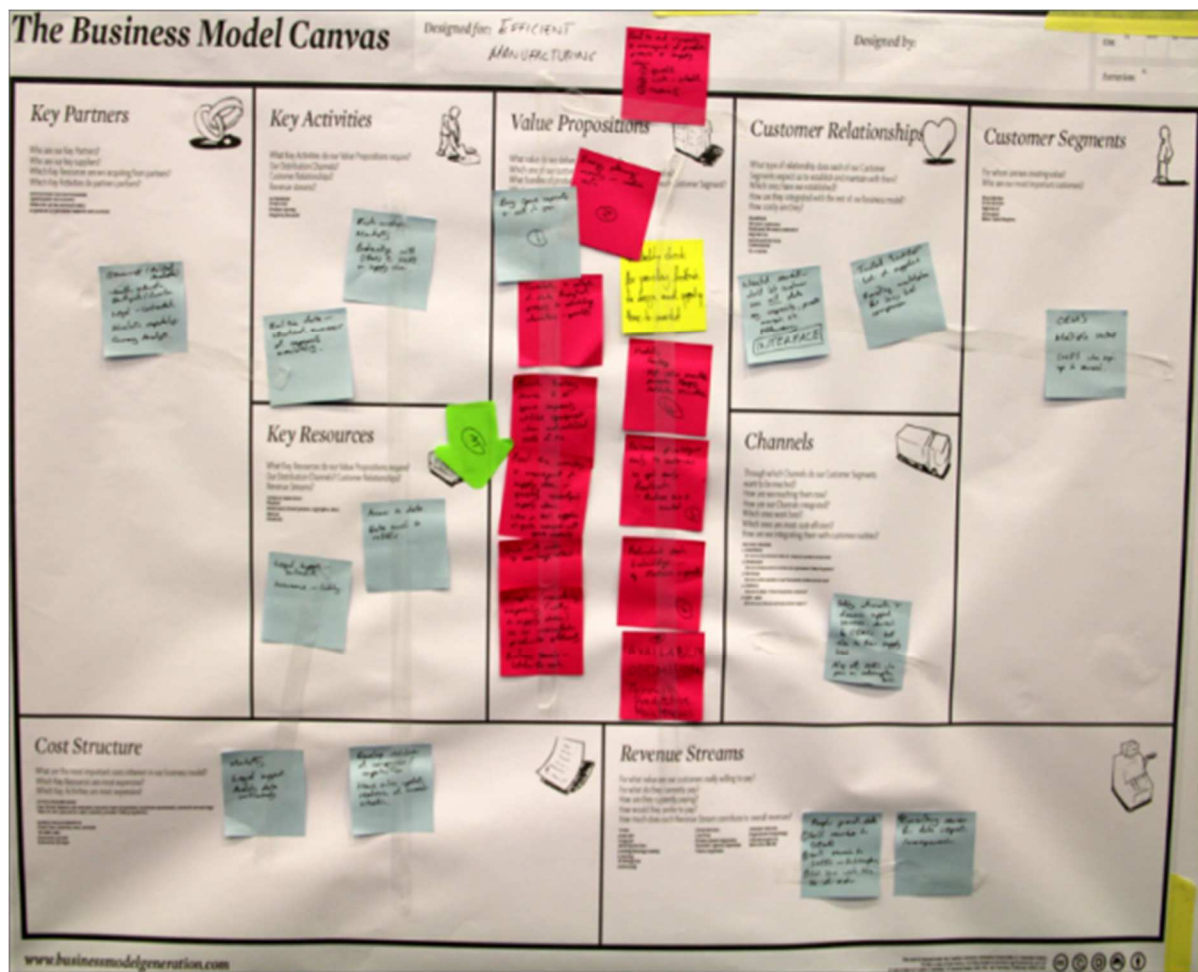
5.2.6   Efficient Manufacturing

Figure 38. Business Model Canvas for Efficient Manufacturing Business Model

Identified Business Opportunities

1) Buying spare capacity and selling it on

2) Energy efficiency monitoring to reduce costs

3) Brokering service for real time monitoring and management of the supply chain

4) Factory modelling and modelling of processes, e.g. forging, additive manufacturing, etc.

5) Rapid prototyping of products which are sold to customers to get early feedback to reduce time to market

6) Redundant stock brokerage, e.g. electronic components

7) Predictive maintenance to improve availability and avoid downtime

Business Model Canvas for Most Promising Opportunity

- Value Proposition

End-to-end monitoring and management of the supply chain to ensure quality, reduce risk and utilise capacity efficiently.

- Client Segment

OEMs in multiple sectors and SME's who sign up to service.

- Communication and Distribution Channels

Selling information and decision support service direct to OEMs and their supply base. Also to other SMEs who join on a subscription basis to bid for work.

- Client Relationships

Provide neutral interface – do not let customer see all data, e.g. available capacity, efficiency, profit margin, to avoid them trying to drive price down. Also provide trusted certified list of suppliers providing market place for lower level companies.

- Key Resources Needed including ICT infrastructure

Access to reliable data, contractual legal support and liability insurance

- Key Activities

Gathering of real time data to provide situational awareness of capacity, availability etc., brokerage between OEMs and SMEs in supply chain, risk analysis and marketing.

- Key Partners

Simulation capability, legal contractual, analysts for risk (political and disaster), financial analysts for currency fluctuations.
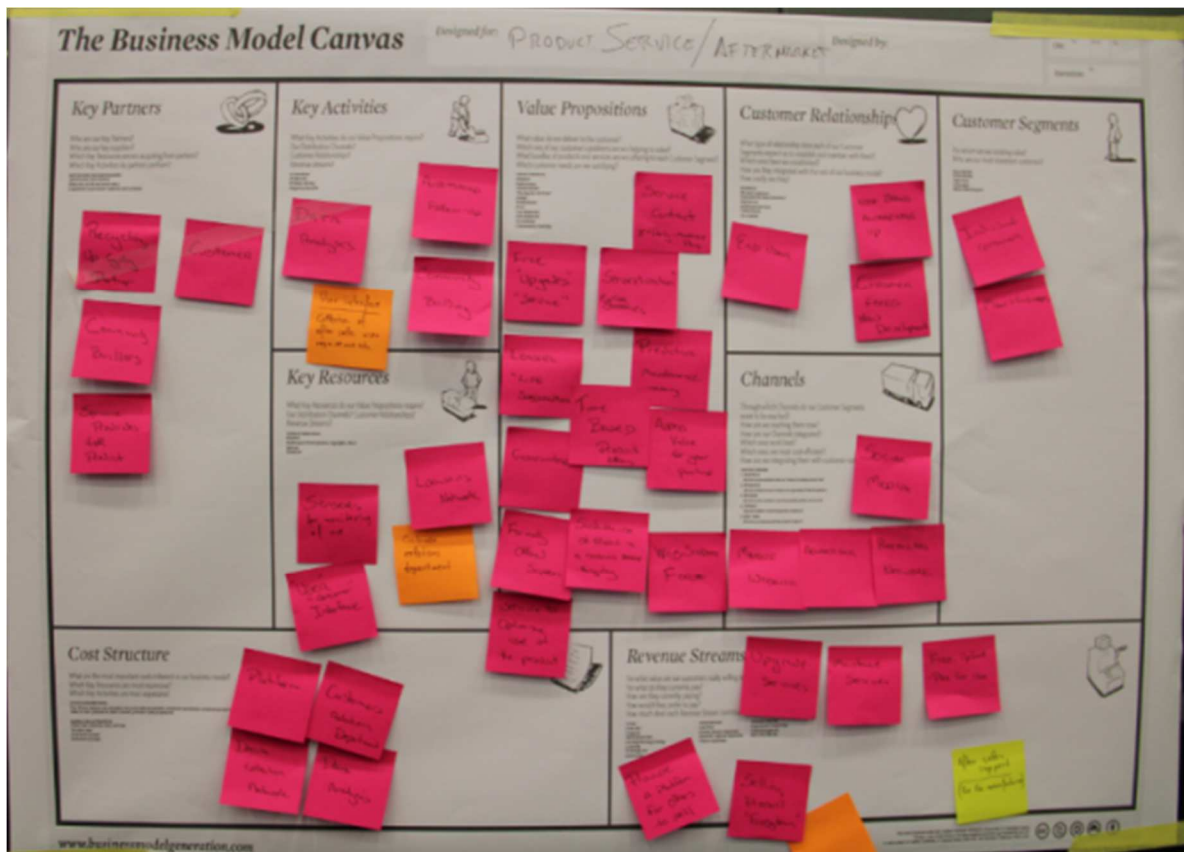
- Revenue Streams

Sell service to OEMs, provide subscription service to SME's, take percentage of order, sell consulting services for data integration and management.

- Cost Structure

Real time update of data, continuous analysis of data, development of database of companies and their capabilities, marketing and legal support.

5.2.7 Aftermarket / Product Service

Figure 39. Business Model Canvas for Aftermarket / Product Service Business Model

Identified Business Opportunities

1) Servitization and consultancy services around this

Business Model Canvas for Most Promising Opportunity

- Value Proposition
    - Service contract
    - Free upgrades service
    - Servitization
    - Predictive maintenance
    - Leasing
    - Time based product
    - Guarantee
    - Formally offered support
    - Sustainable use of product, recycling

- o Web support forum

- o Service to optimize use of the product

- Client Segment

Industrial customers, manufacturers.

- Communication and Distribution Channels

Social media, manufacturing websites, advertisement, retail network.

- Client Relationships

Keep brand awareness up, customer feeds in order to create new developments, end user engagement.

- Key Resources Needed including ICT infrastructure

Sensors for monitoring of use, logistic networks, customer relations department, user-consumer interface.

- Key Activities

Automated follow-up, community building, data analysis, user interface for collecting after sales user requirements.

- Key Partners

Recycling partner, customer, community builders, product service providers.

- Revenue Streams

Provide a platform for others to sell, upgrade services, selling product ecosystem, maintenance services, after sales support, pay per use.

- Cost Structure

Platform, customer relationships department, data collection network, data analysis.
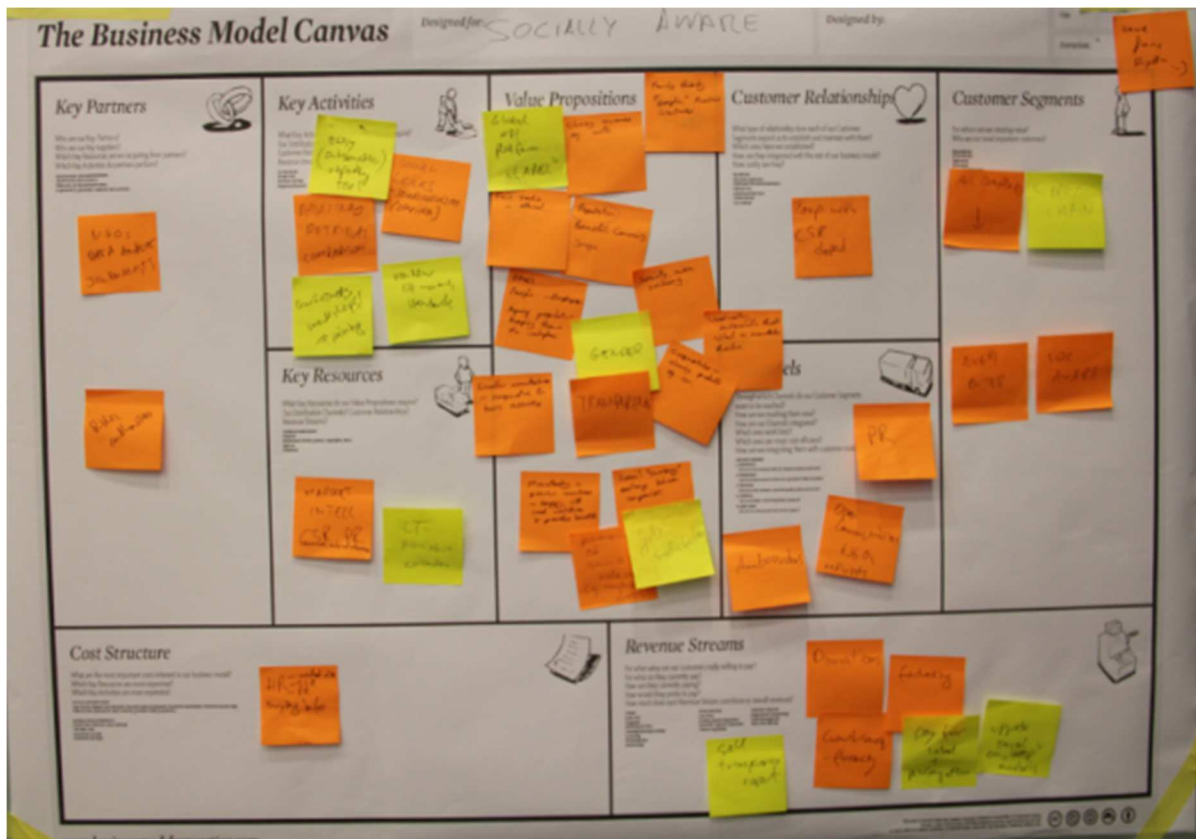
5.2.8   Socially Aware

Figure 40. Business Model Canvas for Socially Aware Business Model

Identified Business Opportunities

1) Global KPI platform

2) Sharing of resources, e.g. water

3) Reputation – beneficial to company

4) Fair trade - ethical trading

5) Family friendly workplace

6) Socially aware sourcing

7) Aging workforce – keeping elderly people engaged in workforce

8) Cooperatives, e.g. sharing a products such as a car, and also cooperative companies sharing resources

9) Manufacturing from sustainable resources, e.g. furniture from sustainable forests

10) Manufacturing in poorer countries but engaging with local community and providing benefits

11) Social currency exchange between companies

Business Model Canvas for Most Promising Opportunity

- Value Proposition

Green washing service for company and provision of socially aware stamp according to screening against a set of global KPIs to enhance reputation.

- Client Segment

All companies, their supply chain and buyers.

- Communication and Distribution Channels

Company ambassadors, Public Relations Departments, NGO's, social activists.

- Client Relationships

Cooperation with Customer Service Relations Departments.

- Key Resources Needed including ICT infrastructure

ICT to support public information collection, market intelligence, Public Relations and Customer Service Relations corporate data.

- Key Activities

Easy automatic reporting tool, data / information retrieval, education, workshops and training, review of norms and standards, management of social leaks (journalism and spying).

- Key Partners

NGO's, data analysts and journalists.

- Revenue Streams

Pay for social label, sell transparency report, crowd-sourcing, donations, upgrade to provide deep analysis.

- Cost Structure

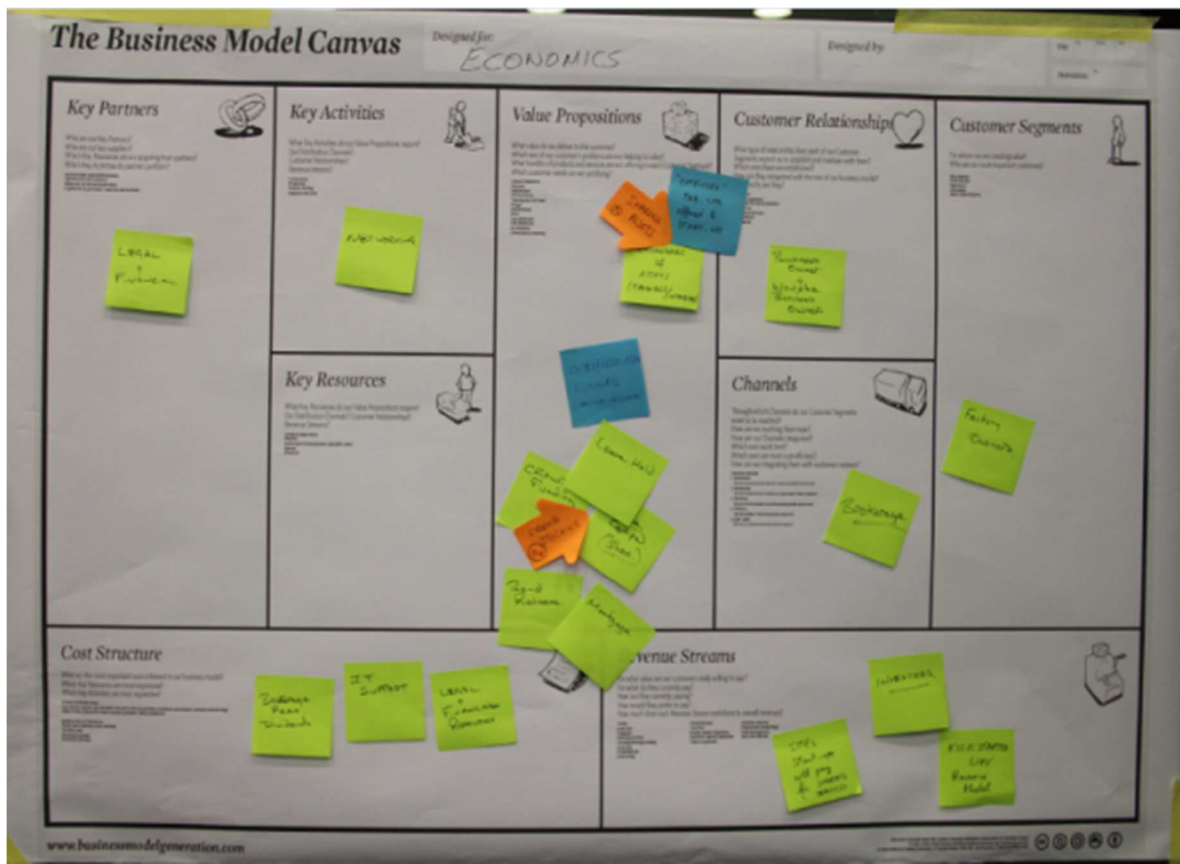Buying information, marketing, PR and CSR costs.

5.2.9   Economic

Figure 41. Business Model Canvas for Economic Business Model

Identified Business Opportunities

1) Sharing assets

2) Crowd stocking

Business Model Canvas for Most Promising Opportunity

- Value Proposition:
    - o Sharing assets:
        - ▪ Extended Fab-lab offered to start-ups
        - ▪ Brokerage of assets (tangible / intangible)
    - o Crowd-Stocking
        - ▪ Entrepreneurship funding (national / regional)
        - ▪ Lease hold
        - ▪ Crowd funding
        - ▪ Bond release
        - ▪ Mortgage

- Client Segment

Factory owners.

- Communication and Distribution Channels

Brokerage.

- Client Relationships

Business owners plus those that would be business owners.

- Key Resources Needed including ICT infrastructure

Not identified.

- Key Activities

Networking.

- Key Partners

Legal and financial.

- Revenue Streams

Investors, sharing services to SMEs and start-ups, kick starter revenue models.

- Cost Structure

Brokerage fees, dividends, IT support, legal & financial resources.

5.3   Summary of Results

Overall it was noted that over 50 business opportunities were identified. The most fertile areas were in networking, efficient manufacturing and customisation. A surprising number of socially aware business opportunities were also identified (11 in total), however, it was noted that it was difficult in practice to monetize these. The most difficult business model category to address was the economic category. Well known ways of funding manufacturing enterprises exist, but the current rigid legal framework would prohibit new approaches to financing. A key notable feature of the outcomes of the business modelling workshop was that many of the proposed approaches rely on increased interconnectivity. To support this there is a need for legal support for contract law to allow networking and collaborations to occur flexibly and on the fly. In some cases insurance is needed in order to offset risk. It was also highlighted that the big business opportunity is for SMEs providing manufacturing and software services rather than larger companies.

6 Conclusions and Key Findings

In this deliverable it has been identified that many business models exist (100) and that more may well exist, in particularly through combination to produce hybrid models. The extraction and presentation of the business models is thought to be a valuable exercise as no such listing and definition of business models exists in the available literature. When analysing the literature and key reports produced by the manufacturing sector a number of future business models are identified. A common feature of these is a move towards servitization in manufacturing. From the mapping analysis of the business models to the Road4FAME inputs, and via confirmation by experts, this move towards product services and the aftermarket is much less prominent. Here it is believed that the aerospace companies who are leading the way in product services and aftermarket provision are key contributors to many of the documents. This may well have resulted in some bias and not a true representation of the manufacturing industry as a whole. The interviews with a cross section of industry including large and small companies both from manufacturing and the service sector has indicated a number of key issues. These include both technological issues and also issues that can only be addressed at a policy level. Here around 40 interesting business opportunities were identified which have been categorised into 15 areas.

The mapping exercise performed identified that there was traceability from the Road4FAME inputs to the recommendations made. Notably the areas of user interfaces and man machine interfaces were under-represented. Here the recommendations have been revised in order to strengthen these areas. The rankings of the business models indicated that socially aware and economic business models are currently the least interesting to the manufacturing sector. For socially driven business models it is difficult to see how an idea can be monetised. For economic business models a major barrier is the legal framework that has grown up. Well known ways of funding manufacturing enterprises exist but the rigid legal framework would prohibit some of the more "exotic" new approaches to financing.

Although business models based on networking were ranked most highly in the mapping with respect to Raod4FAME inputs, it is clear that this is being driven by two factors the trend towards networked supply chains and also the increased networking given by ICT. It is believed that the Road4FAME scenarios used in earlier workshops may have also concentrated outcomes with respect to the most highly ranked categories. The business modelling workshop identified a further 50 business opportunities. A key notable feature of the outcomes of the business modelling workshop was that the business solutions were reliant on connections between companies, legal advisors, etc. A feature of future business models will thus be increased interconnectivity. Here the big opportunity is for SMEs providing manufacturing and software services. Value will be created through interactions between many small organisations, rather than through the interactions within a few larger organisations.

Although it is difficult to forecast the future a number of observations can be made.

- Ownership is likely to become more and more decoupled from use of products. This opens up a number of new ways for sharing products, providing value and generating revenue. Here IT has an important role to play in tracking, measuring and billing.

- The trend towards green thinking (also backed up by regulation) is driving the circular economy which requires an ecosystem that supports recycling and re-manufacture. This may also link with products being used rather than being owned by consumers.

- The ability to associate information with (and within) products allows much greater levels of tracking from cradle to grave. This information can be used in a variety of ways such as for gathering data on sustainability, providing personalised products, giving guarantees of provenance.

The business models that were identified were either market driven or dependent on policy / regulations. A key example of this is green / sustainable manufacturing which is driving the development of circular economy and collaborative consumption infrastructures both at a business level and also in partnership with consumers. Market drivers towards customised products requires new levels of connection between the customer and manufacturing and also flexibility within the manufacturing supply chain.

Although this report can suggest new business opportunities and ideas there is still a need to develop the entrepreneurial framework and ecosystem to support increased connectivity between companies. Policy interventions may be required at a European level to support this change. Overall it is clear that companies in the future will need to be much more flexible and open minded in order to allow much higher levels of collaboration.

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