

Web Systems - Assignment

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1 Business and technological context (~1000 words)

mymuesli is a German company founded in 2007 that sells custom-mixed muesli by post in four European countries. This paper uses *mymuesli* as a case study of how the Internet and information systems (IS) have the capacity to transform every part of the enterprise, and indeed to be integral to how it achieves its objectives.

1.1 e-Business models

Papazoglou and Ribbers (2006) define an e-Business model as “descriptive representation of the fundamental components of a business that operates partially or completely on the Internet”. A detailed discussion of features common to all business models, not just ones for e-Business (such as value proposition and revenue model), is beyond the scope of this paper. However, using the authors’ classification system for such models, we can see that *mymuesli* is an ‘Internet-enabled’ business and falls specifically within the business-to-consumer (B2C) category of ‘e-Shop’ proposed by (Timmers 1998).

The company produces a ‘niche’ product which may have been prohibitively expensive to sell and distribute prior to the Internet. By operating as an e-Shop, *mymuesli* gains a “low-cost route to global presence” (Timmers 1998), meaning that company has the potential to be profitable selling its product direct to consumers around the world without the need for costly intermediaries. Another way of putting this is to say that the Internet allows manufacturers to “compress the distribution channel” (2010).

On the other hand, although the Internet makes the physical distance between *mymuesli* and its customers less of a problem, it creates other kinds of challenges, such as increased competition and the relative ease with which a customer can abandon their ‘shopping basket’ and buy from a competitor instead (low customer switching costs, in Porter’s terms (2008)). There is also an increased need to focus on online marketing and search engine optimisation (SEO) to ensure that customers find the product in the first place.

It is notable that since 2012 *mymuesli* has also operated two physical stores in Germany (*mymuesli GmbH* 2017), putting it in an unusual category, along with others such as Amazon (McCarthy 2017), of a company that initially only operated online but later opened high street shops and raises the question (originally framed around traditional retailers embracing the web) of finding the right “mix of bricks and clicks” (Gulati and Garino 2000). One goal of this strategy is to build customer awareness of the brand and provide more promotion opportunities.

Furthermore, should *mymuesli* enter the hotel market its business model will also encompass business-to-business (B2B) interactions. The idea of allowing a hotel chain to offer a custom breakfast “by *mymuesli*” is an instance of ‘co-branding’, which not only exposes *mymuesli*’s offering to a wide range of potential customers but also “enhances the credibility of the hotel’s brand by borrowing credibility from other brands” (Yip 2005). Combined with an Application Programming Interface (API) for receiving and fulfilling hotel orders, this would represent a step towards a Value Web e-Business model based on inter-company-relationships that exploit the possibilities of new technology (Papazoglou and Ribbers 2006).

1.2 Role of information systems

Information systems (IS) now have a major role in most businesses, but they are even more critical to businesses that conduct the majority of their activity online such as *mymuesli*. For Stair and Reynolds (2014) “information is one of an organisation’s most valuable resources”, and a key function of an organisation’s information systems is to collect and manipulate data and transform them into information which can provide value to the organisations’ decision-makers.

In the case of *mymuesli* data might include raw facts such as a customer postal address, stock levels for a particular muesli ingredient or an individual order number. By creating relationships between these data valuable information can be generated, such as the number of orders ready for shipping to a particular postcode, or an estimated date when stock will run out (based on historical orders). As well as allowing management to monitor the business effectively, this information can also be used as a basis for prediction. The use of computer-based information systems (CBIS) would therefore allow *mymuesli* to anticipate demand by ordering new stock automatically and leverage economies of scale by batching up orders for delivery to the same area. This ‘feedback mechanism’ within such systems is what allows the business to adapt to changing market conditions and “is critical to helping organisations achieve their goals, such as increasing profits” (Stair and Reynolds 2014).

1.3 Impact of web technology

(overview of web technologies; evolution of web to back-end/internal systems)

2 Solution architecture (~2750 words)

2.1 Business processes

2.1.1 Modelling processes using BPMN

Business process modelling is a form of analysis that describes the dynamic activities performed by a business. One objective of creating a process model is to gain insights into how a business operates, which once validated can be used during the design phase of an information system to assist in the creation of further artefacts such as a data model (van der Aalst and Stahl 2011). For example, when a customer is ready to place an order with *mymuesli*, the company must acquire the user’s postal address in order to know where to dispatch the order to when ready, either by retrieving it from information system storage if the user has previously logged in or asking the user to provide it at checkout. This entails that any data/object model for the customer must include all required address information.

There are a number of normative visual languages available for describing businesses processes. One example of these is Business Process Modelling Notation (BPMN), which uses defined symbols for events, tasks, flows and gateways to model business processes. Figure 1 shows such a BPMN diagram representing the process for a postal address being associated with an order. Although BPMN has some similarities with the UML activity diagrams familiar to many working in software development (OMG 2017), one aim of BPMN is to be intelligible by a wide range of business users and not just developers (Papazoglou and Ribbers 2006). On the other hand, one weakness of BPMN in contrast to earlier approaches such as ‘classical’ Petri nets is its lack of formal semantics in some areas, meaning that BPMN

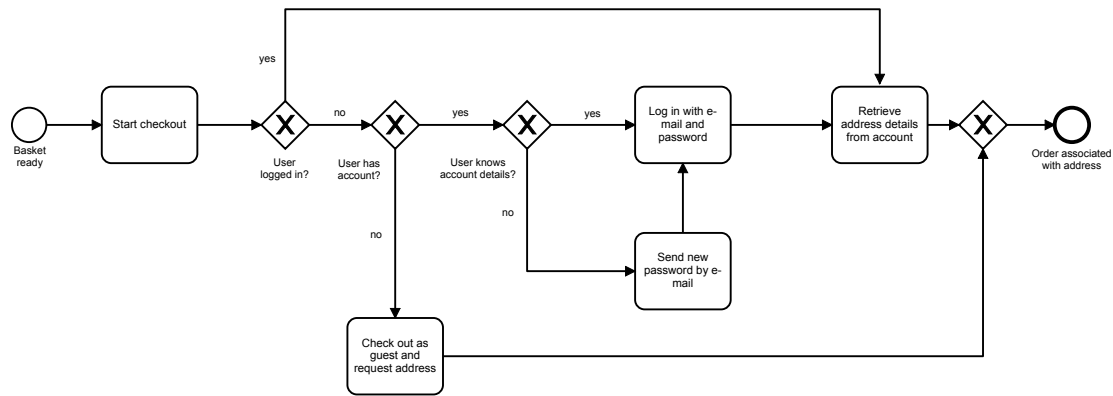


Figure 1: Business process for associating an address with an order in BPMN

diagrams “typically lack the precise mathematical basis that is required to render them really unambiguous” (Kossak et al. 2014). Even with this caveat, it remains a useful high-level tool for intra- and inter-business communication.

2.1.2 System boundaries and outsourcing

Papazoglou and Rivers (2006) suggest that, by making ‘business rules’ visible, business process models make it easier for companies to adapt in changing market conditions. This advantage is likely to be of particular relevance to retailers such as *mymuesli* that operate primarily in the rapidly-changing online environment.

In order to employ a systems approach to modelling business, a necessary first step is to identify the system boundary. An analogous step is required in the Unified Process, where the requirements analyst must determine what is part of the system (i.e. inside the system boundary) and what is in its environment before use case modelling can begin (Arlow and Neustadt 2005). For the current study, the system boundary encompasses the *mymuesli* online shop, the manufacturing process ...

mymuesli’s competitive position can be evaluated within the framework of Porter’s five forces (2008) in order to formulate a strategy. As it sells a niche, bespoke product the threat of substitutes is relatively low, partly due to the high costs of entry for competitors in replicating the required customisable production line and online ‘mixer’ interface. This means there are currently no direct competitors. However, suppliers of raw ingredients are relatively powerful and can pass on rises in the price of crops (for example) to *mymuesli*, and customers may become price sensitive toward the product.

This suggests that *mymuesli* should guard against increasing supplier power further by not being dependent on external suppliers of IT services that can increase their prices and cannot be easily replaced.

From a resource-based view of e-Business, a company’s resources and competences are what lead to value creation and differentiate the company from its competitors. This implies that innovative companies should consider which functions are core to their business and which can be left to others, particularly where they are performed on too small a scale to be economical. For Papazoglou and Ribbers, “strategic outsourcing of all activities that are not core competencies potentially allows a company to focus on all those areas which add most value” (2006). This echoes Peter Drucker’s famous maxim of “do what you do best and outsource the rest” (Forbes 2010).

Obvious core competencies for *mymuesli* are the sourcing and selection of appealing muesli ingredients, mixing and packaging the muesli, and deciding how and where to market the website. Non-core activities that are candidates for outsourcing include delivery of orders to customer addresses, accounting and human resources (HR), copywriting, graphic design, processing credit card transactions and supporting the servers that run the website. However, the choice is less clear-cut in some areas: is writing the website application code a core competency, or something that could be handled by a managed e-commerce platform such as [Shopify](#)?. Some of this is summarised in Table 1.

Table 1: Summary of candidate functions for outsourcing .

Function	Example activities
Accounting	Corporate tax return, VAT, payroll
Human resources	?
IT	E-mail, ...

2.1.2.1 RPC from SOAP to REST

Remote Procedure Call (RPC) is “an interprocess communication (IPC) mechanism that enables data exchange and invocation of functionality residing in a different process” (Microsoft 2003). Such invocations are normally synchronous request-response interactions (meaning that the calling process ‘blocks’ until a response is received), and presented as if they were normal local procedure calls, thereby abstracting the details of communicating with the remote process from the developer; popular implementations include CORBA, Java’s RMI and .NET remoting (Hohpe and Woolf 2004). The first wave of web services adopted a similar approach, implementing RPC-style interactions on top of SOAP and HTTP. Unlike the implementations listed above, SOAP is an open standard and uses XML to encapsulate a method call and its response in a platform-independent way, with the goal of being both simple and extensible (W3C 2007). It is complemented by the Web Service Description Language (WSDL), which allows SOAP clients to discover where to find a web service and what operations it supports.

By contrast, REST grew in popularity in the early 2000s as a more lightweight and less verbose alternative to SOAP that leans more on the inherent statelessness and semantics of HTTP methods (e.g. PUT, DELETE) and a uniform interface based around URIs to provide web service capabilities. Another design goal of REST was to leverage the caching capabilities of HTTP to provide improved scalability for web services (Fielding 2007). Despite this, most RESTful web services are still implemented through the synchronous request-response paradigm of RPC. Moreover, as an ‘architectural style’ instead of a protocol, REST lacks features provided by SOAP such as built-in mappings of data types to byte sequences.

(relate to *mymuesli*?)

(Chaffey 2009)?

2.1.2.2 Service-oriented and microservices architectures

Service-Oriented Architecture (SOA) is an approach to designing systems where specific functions (such as managing customer details) purposely implemented as networked services that can be used by other applications, allowing a complex (and perhaps distributed) information system to be built in a more modular fashion out of interconnected parts that can be developed and modified independently (Stair and Reynolds 2014).

Depending on the area of functionality these services cover, a SOA may share some characteristics with a microservices architecture. In the approach made famous in the web sphere by companies like Netflix, microservices are usually RESTful rather than SOAP-based and highly granular, aiming to “do one thing very well” (Stair and Reynolds 2014).

One challenge with microservices is creating a machine-readable description of them to allow for discovery and negotiation by clients. Some authors consider the need for a service directory and a description of each service’s interface to be central to SOA (Hohpe and Woolf 2004). While SOAP and WSDL support these requirements in the enterprise SOA context, REST has no such built-in capabilities, and although equivalents for RESTful services (such as Swagger, now known as the OpenAPI Specification) have emerged (SmartBear 2017) they are still relatively immature.

2.1.2.3 Heterogenous infrastructure

According to Hohpe and Woolf (2004), “creating a single, big application to run a complete business is next to impossible”, despite the efforts of some Enterprise Resource Planning (ERP) vendors such as SAP. This means that it is unrealistic to expect an existing commercial off-the-shelf (COTS) system to implement all of a business’ needs, or to write such a system from scratch. Using multiple different applications has the benefit of allowing businesses to use a ‘best of breed’ approach in selecting the right software for each function. However, where companies have such pre-existing IT infrastructure the need for integration between systems arises. Enterprise Application Integration (EAI) attempts to solve this problem through middleware providing features such as messaging and workflow management (Hohpe and Woolf 2004).

For the purpose of this study we can imagine *mymuesli* as a ‘green field’ project without any ‘legacy’ IT infrastructure. However it is possible that the company would still choose to buy some existing off-the-shelf software to provide certain functions, such as accounting, and may acquire diverse information systems as a result of acquisitions or mergers (Stair and Reynolds 2014). In this scenario the company might consider implementing an EAI suite to facilitate the integration of these systems.

2.1.2.4 Beyond RPC: Loose coupling and message-oriented middleware

One important aspect of designing information systems is the need to accept that change is inevitable, whether to business requirements or within the systems that provide different business functions, even as part of normal maintenance. For example, upgrading a stock control system to the latest version could break interoperability with a linked accounting system. Moreover, faults occur and distributed systems may become unavailable for periods of time. Although some Remote Procedure Call (RPC) implementations allow synchronous remote requests to be made by simply calling a method, for Hohpe and Woolf (2004) the idea of abstracting RPC using the semantics of a local method call is ‘asking for trouble’ due to the increased unpredictability involved.

Loose coupling is the name given to the design goal of reducing number of assumptions that systems make about each other in order to increase tolerance to change and failure. Loose coupling (also a design goal of SOA) advocates using platform-independent, self-describing data formats and (in an EAI context) eliminating the temporal dependency by rethinking remote calls into self-contained asynchronous messages that are sent to a logical ‘channel’, an approach usually implemented through message-oriented middleware, or MOM. Such systems may also offer the ability to translate between message formats and route messages to different places depending on their contents, along with a system management and monitoring functions (Hohpe and Woolf 2004). Despite increased flexibility, the downside of these approaches is that they can be more complex to design, implement and debug.

2.1.2.5 Process management software

(mention reasons for using it/integrating with it; idea of executable models; MDA?)

(Tom: jBPM - engine, JBoss BPM suite - develop and deploy)

2.1.2.6 Specific process challenges for mymuesli

(Seven wastes of lean: inventory; waiting) ([https://en.wikipedia.org/wiki/Muda_\(Japanese_term\)\)](https://en.wikipedia.org/wiki/Muda_(Japanese_term))))

2.1.3 Cloud computing

(different levels of outsourcing; IaaS vs SaaS; ‘undifferentiated heavy lifting’)

2.2 Impact of mass customisation on production

Although it also offers pre-configured ‘off-the-shelf’ muesli mixes, the ability to offer a customised muesli is integral to *mymuesli*’s value proposition, as indicated by the company’s name. This reflects the trend towards mass customisation, the intent to “provide products and services that best serve customer needs while maintaining near-mass production efficiency” (Tseng and Jiao 2001). Such an approach means that manufacturing and distribution processes must be designed with customisation in mind rather than as an afterthought. This is because, as Pine (1993) points out, one key requirement for business processes designed to support mass customisation is that they are *instantaneous*, meaning they can be linked together as quickly as possible. Therefore a design goal of the manufacturing process must be for it to rapidly assemble any combination of muesli ingredients for a given order in the correct quantities with the minimum of errors.

One helpful step is to reduce the number of possible combinations of ingredients. Although the *mymuesli* website ‘mixer’ shows 76 options, in fact all mixes must include one of the 14 standard muesli bases such as ‘Five Grains’; this corresponds to the ‘common base’ within the product family architecture described by Tseng and Jiao (2001). These bases can be pre-filled into cartons (according to their projected popularity) prior to any actual order being received, leaving only 62 actual custom options and reducing the number of potential permutations significantly. Further time savings can be made by pre-mixing combinations of ingredients that are frequently ordered together.

In order to minimise human error (and therefore waste) as far as possible, a fully automated mixing apparatus is envisaged that routes different ingredients from bulk containers and adds them to the carton for each order. The flow of material into the mixer is stopped when an electronic scale underneath the carton senses that the correct quantity has been added, with stock levels also being updated automatically. A number of cartons could be filled in quick succession by being placed on an automated guided vehicle (AGV) that moves under a series of suitably arranged storage bins; note this is the approach used by the ReciPure system (Zeppelin GmbH 2016).

2.2.1 Tracking systems

Another important tool for automating the production process is barcodes, an example of machine-readable data input (Stair and Reynolds 2014). If *mymuesli* attaches a barcode containing a representation of the order number to each carton at the start of production, and scanned it repeatedly, the location of the carton and therefore the order’s progress can be tracked with relative certainty.

On the production line, by reading the barcode and looking up the order details, the mixing apparatus can know how much of each ingredient to dispense. Similarly, when orders are collected for distribution by courier, the barcode can be scanned to trigger the status of the order to automatically be updated to 'shipped'. In this way barcodes (including 2D variants such as QR Codes) assist with traceability of orders and reduce the scope for errors. Recording a timestamp along with each scan allows for analysis of how much time orders are taking prepare. A smartphone app offers a relatively simple and portable way of integrating barcode functionality into production processes: by using the phone's camera, staff can access or edit data about the order wherever they are.

2.3 Web front-end

It is apparent that like most e-shops this company requires a web front-end which allows customers to order its products effectively. However, unlike online merchants such as Amazon, which sell a wide range of standardised products with limited options (such as different sizes for a t-shirt) through a mostly standardised interface, the composition of a *mymuesli* order must be tailored extensively by the customer.

This therefore requires either the creation of an bespoke web interface, or the use of an e-commerce platform designed with customised products in mind.

There are several different approaches to consider.

2.3.0.1 COTS e-commerce systems

Commercial-off-the-shelf (COTS) e-commerce platforms provide businesses with a range of ready-made e-commerce functionality that may combine a web storefront with an internal order management interface, often with a high level of flexibility. For example, IBM WebSphere Commerce allows developers with the requisite knowledge of Java, JSP and XML to create custom user interface 'widgets' and back-end integrations (IBM 2010). These platforms may also cater to 'omni-channel' models (including in-store and call centres as well as e-commerce), and can even communicate with legacy mainframe fulfilment or stock control systems via an Enterprise Service Bus (ESB). They are often (though not necessarily) installed on on-premises hardware to allow the necessary integrations to be implemented.

On the other hand, some e-commerce platforms allow the creation of 'plugins', modules of reusable code which add functionality to the platform or change its behaviour.

The mixer interface needs to implement a number of business rules which are specific to *mymuesli*, for example:

- all mixes must include exactly one of the standard base ingredients
- there is an upper limit on the number of ingredients that can be added (due to finite carton size)
- each muesli should be able to have a custom name and description which will be printed on the tube

In addition, the online shop includes very specific features which provide further feedback to the user as they customise their muesli, improving the overall user experience, such as a chart of nutritional information, a list of raw ingredients and other visual hints indicating the flavour profile and other characteristics of the mix (e.g. 'high fibre'). All of this points towards the need for the development of a bespoke interface.

(search, shopping basket, registration)

2.3.1 Account management

2.3.2 Device and platform support

2.4 Payment

2.5 Warehouse and purchasing

2.6 Shipping

2.7 Business-to-business perspective: hotel services

2.7.1 Approaches to RPC

(REST vs SOAP)

2.7.2 Semantics

(brief treatment of ontologies; semantic web)

2.8 Other cross-functional concerns

2.8.1 Quality control process

2.8.2 Resilience of infrastructure

2.8.3 Security

3 Detailed technical investigation: distributed microservices (~750 words)

3.1 Evolution of web services and service-oriented architecture

(SOA?)

3.2 Challenges of distributed systems

3.3 Analysis and design of microservices

(Virtualisation and containerisation)

4 Conclusion (~500 words)

4.1 Applications of problem to BBC

4.2 Suggestions for further work

(create mobile app that uses API)

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