A Case Study of Human Factors in the Oil & Gas Software and Services Industry toward Competitive Advantage

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***Abstract*— Often software is built, sold and implemented into the Oil & Gas industry as a combination offering by software vendors and implementation consultants. Competition exists between rival implementation service providers and vendors in their attempts to secure Oil & Gas implementation and ongoing support and maintenance contracts. Over time, these rival implementation software and service providers have attempted to differentiate their offerings in order to generate and secure more projects and hence revenue. This research paper attempts to understand the competitive drivers in the Oil & Gas software industry for Hydrocarbon Accounting. From this point, it will present a Human Factors approach in software development and implementation, toward generating competitive advantage.**

The research paper presents two Human Factors case studies; one in a Software Product Usability ("Energy Components") and a Software Implementation Project ("Energy Components Implementation"). Both case studies illustrate an evaluation of Human Factors whereby discussion and findings present a suite of recommendations for improving Human Factors within each. Results of the evaluations would illustrate a usable software product along the lines of Operability and Attractiveness, however not as usable along the lines of Understandability and Learnability. The case study implementation project illustrates a low level of Human Factors along the lines of 'understanding roles and responsibilities' and 'end-user participation', but successful in 'preparation of plans'. Competitive advantage could be perceived by customers and competitors alike by adequately combining good Human Factors elements in the combination software product and implementation service offerings. This paper is designed to present usable information for software and services consultants that are required to interpret and implement configurable software offerings into different organisations.

Keywords—Human Factors; software usability; competitive advantage;

I. INTRODUCTION

The need for software that meets the regulatory and auditability needs of Oil & Gas companies has generated a highly competitive software product and services marketplace. Specifically, the marketplace for Hydrocarbon Accounting software capable of handling complex Oil & Gas contracts, production data and commercial requirements. The software must be able to sustain a high degree of scrutiny of the underlying data within Oil & Gas organisations given the high profit margins and accuracy required in joint venture contracts and government reporting.

This requirement has given rise to a suite of Hydrocarbon Accounting (HCA) software products and a set of global niche implementation experts capable of delivering any type of Oil & Gas project with requirement to track all hydrocarbons produced and sold. This process is usually bundled into an implementation and/or services project of considerable complexity, especially when the nature of HCA requires significant and varied commercial and engineering input.

Project complexity often increases the implementation services costs, and can be completed by a number of implementation services providers. Software purchases are usually one-off and mostly follow a standard yearly maintenance cost to the software company for standard warranty conditions. Hence, the HCA Oil & Gas software industry is significantly driven by competition, both in products and services.

It is argued that by provisioning a HCA software product with adequate Usability and an Implementation services project that maintains Human Factors (HF) within its approach, that a degree of competitive edge can be found. This competitive advantage is deemed to provide the software and/or implementation vendor with a perceived betterment over its direct competitors.

A. Human Factors

Human Factors in software development and implementation projects has been the increasing focus of researchers and practitioners alike [1]. As the research topic continues to grow a great deal of the referenced literature points toward User-Centred Design and Human Factors as being critical to individual project successes. Although having usable software products and Human Factors based projects, the level of competitive advantage they derive is still limited in the context of Oil and Gas software implementation. [2].

As the perception of competitive advantage starts and stops with humans, the human-centred model of business becomes a key player in how HCA software products are built and implementation projects are carried out. Independent of the requirement for competitive advantage, a successful project can

be seen as one that utilises human factors within the product and within its implementation.

Bishu et al. [3] outline that the human-centred business model has been recognized as the key factor for successful competition in a customer-driven market.

B. Objectives

This paper attempts to study the concept of Human Factors in Software Products and Implementation Services for HCA software and services, and how it can enhance competitive advantage for securing contracts in the Oil and Gas industry. The scope of this project is limited to a case study of Human Factors in a piece of software, and Human Factors within an implementation services project.

An evaluation of Usability as a measure of Human Factors on a software product ("Energy Components"), and an implementation project ("Energy Components Project Implementation") is carried out. It attempts to present a set of "gaps" in the best practice usability and provide recommendations for Usability and Human Factors improvements that would be perceived as generating competitive advantage.

The two key research questions identified by this study topic include:

RQ1: What is Competitive Advantage for software and project implementation for Oil and Gas Companies?

RQ2: What are the successful Human Factors elements required of software products and implementation projects, specifically for the Oil and Gas industry?

It is intended that the research conducted in this paper will yield a Human Factors analysis of the case software product and the case implementation project, and whether either have derived any competitive advantage in the Oil & Gas HCA software industry.

II. USABILITY AND COMPETITIVE ADVANTAGE

Usability, as a measure of Human Factors in software products, is an important factor in evaluating the quality of any software [4]. User interfaces should be designed to provide high levels of usability, which may be defined as "…a quantitative, or quantifiable, statement of the ease with which users can accomplish tasks for which a given computer system was designed". [5]

Usability of a system is the capability in human functional terms [for a system] to be used easily (to a specified level of subjective assessment), effectively (to a specified level of performance), by the specified range of users, given specified training and user support, to fulfil the specified range of tasks, within the specified range of environmental scenarios. [6]

A. Usability Evaluation

Bruun and Stage [7] contend that usability evaluations provide software development teams with insights on the degree to which a software application enables a user to:

- Achieve his/her goals
- How fast these goals can be achieved,
- How easy it is to learn,
- How satisfactory it is in use.

Software Usability is typically evaluated along 5 criteria:

1) Understandability: The attribute of software that describes the relative ease of recognising the logical concept and its applicability. Examples are Documentation, help system, training provided, errors and pop-ups, international language support and online help support.

2) Learnability: Software attributes that describes the relative ease for users to learn the application. Examples are Observable properties on specific types of interfaces.

3) Operability: Software attributes that are associated to the relative ease of learning the operation of the software. Examples are Complexity of functionality, Ease of use and navigation.

4) Attractiveness: Degree to which the software has been made attractive to the end user. Examples are Use of Graphics, layouts, text, fonts.

5) Usability Compliance: Degree to which the software adheres to compliance standards. Examples are adherence to specific standards.

Jain et al. [4] present the Cognitive Walkthrough and Heuristic Evaluation usability evaluation methods of Inspection:

1) Cognitive Walkthrough: usability inspection method specifying the sequence of steps or actions required by the user to accomplish a task and the system responses to those tasks.

2) Heuristic Evaluation: Based on the current requirement of the user inspection is done. It specifies the involvement of evaluators to judge that is software is capable of recognizing usability principles.

The methods described above are utilised within the evaluation of a piece of software called "Energy Components". This software is built for the purposes of Oil & Gas operators to perform their production data management function, and to perform their HCA procedures. The usability analysis will perform a detailed appraisal of the key metrics described above, and will present a report on the gaps between effective interface design and the evidence provided by the software. In each of the recommendations, their applicability to generating perceived competitive advantage will be presented.

B. Human Factors in Implementation Projects

A research study conducted by Balfour et al. [8] into the effects of Participatory design into the Norwegian Oil and Gas industry point to several design heuristics when undertaking software projects in the Oil & Gas industry. The authors prescribe preparing a proper plan, assigning clear roles and responsibilities, and in particular separating the roles of the facilitator and human factors expert. Having end user participate is considered central to the outcome of oil and gas projects as the "expertise of users and their in-depth understanding of the work context" are integral to project outcomes. These users can also function as ambassadors of the proposed design by marketing it amongst stakeholders. Additionally, by limiting end user involvement in the projects was proven to apply a higher risk to the project being stopped by the users themselves.

Oil & Gas HCA software implementation projects typically involve the use of consultants in order to complete many (if not all) aspects of the proposed delivery. Burke et al. [9] describe some key factors in the success of implementation projects as having little to do with technology. It is important to have the right individuals and to have clear processes in place for decision making and project management. All stakeholders must buy-in to the project, and roles and responsibilities require clear definition. Knowing how decisions will be reached, and having a clear understanding of the expected outcomes are all critical to success. The typical project team will include members from the consulting company and members from the client, and hence require careful identification of the roles and responsibilities of each.

The Human Factors tools presented by Bishu et al. [3] are designed to provide significant exposure to the benefits of using HF in development of software. HF can improve the Risk profile of many business functions, not only software and systems related. HF can also be used as a Marketing tool, thus improving the perceived value of that business, product, process or commodity. Finally, HF can be used as a communication tool and provide an effective means of communicating with customers, and in the case of software development projects with development teams also.

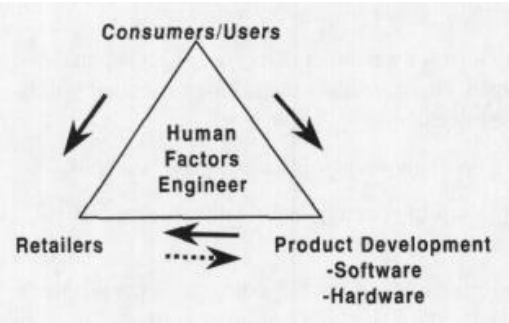

Fig. 1. User-Task Environment Relationship

The User-Task-Environment relationship presents a model of communications between customers, retailers and product development teams. The element of communications presents significant perceived value and competitive advantage in the case of performing customer implementation projects.

The work of McLaughlin [10] outlines a series of propositions for a successful consulting engagement. Successfully consulting in the Oil and Gas industry is an imperative for successful implementation projects:

1. Consultant integrity – putting the clients' interests first
2. Client involvement and readiness to change
3. A clear agreement concerning requirements and expectations
4. Client control of the engagement – partly via clear and limited assignments
5. Consultant competence
6. A good fit along a number of dimensions; such as client expectations mixed with consultant capability

"Successful consulting projects require consultants that maintain personal characteristics such as integrity, motivation, ethics, objectivity, honesty, loyalty and confidentiality." [10]

Research has indicated that the factors contributing to the post-purchase evaluation or satisfaction of clients in consulting engagement include the following [11]:

- Understanding of the client's needs and interests;
- Relationship and communication skills;
- Conformance to contractual and administrative requirements; and
- Actual performance in terms of outcomes (e.g. the quality of deliverables)

It is typical for qualitative type studies to be completed in order to ascertain the success or failure of given software implementation projects. A case study of the Energy Components implementation project is completed, focusing on the attributes of successful human-factors employed projects and addressing the metrics as described above.

C. Competitive Advantage

Competition in the both the software development and consulting marketplace exists between rival developers and implementation service providers. This element of competition provides the potential for rival companies and providers to leverage some form of advantage over its competitors. Dustin et al. [12] explain that "creating a sustainable competitive advantage is important in order for a firm to be successful".

Competitive Advantage is defined as "a condition which enables a company to operate in a more efficient or otherwise higher quality manner that the companies it competes with and which results in benefits accruing to that company." [12]

By focussing on a firms' core competencies, and by harnessing innovation, "the ability of businesses to develop successful innovations, whether in the form of products, services, or the process that creates them, has become

increasingly essential to their competitive advantage and long term performance." Ambler [13] presents a practical approach to competitive advantage: "Competitive Advantage is not about what you do, it is about how you do it." Distinguishing your product or service is imperative to attract your customers, and making sure that the concept is deep enough for it not be copied is also integral in the determination of your organisations advantage.

Wheeler [14] examines competitive advantage as a measure of organisational culture and that "strong and adaptive cultures can foster innovation, productivity and a sense of ownership among employees and customers, all of which are important elements in leveraging value over costs."

Wheeler's [14] research into a group of world class companies revealed four practices that help explain how they became competitive advantageous:

1. Create a strongly shared sense of purpose
2. Establish clear set of values and behaviours that embody a shared purpose
3. Implement constant communication of purpose and values
4. Cultivate strong leadership that both reinforces and preserves its adaptability.

Central to the premise of generating competitive advantage is a commonality in that human intervention is required in order to generate or benefit from that perceived advantage. Whether it is the generation of some unique aspect of your organisation or it is the generation of the perception that your organisation has some advantage, this all entails human perception. Software competitive advantage can be interpreted as software capable and adaptable enough to distinguish itself from competitors. Project competitive advantage can also be interpreted as those methodologies employed to engage customers and end users, whereby consultant behaviours exhibited by the implementation vendor should facilitate integrity and communications.

III. METHOD

The software usability evaluation was carried out on the Case Software Product ("Energy Components"), and was evaluated by Cognitive Walkthrough and Heuristic evaluation inspection methods. The author assessed the product by splitting its functionality into its key modules, and then further down to individual functions (screens). The product functions were evaluated against the five evaluation criteria (Understandability, Learnability, Operability, Attractiveness, and Compliance) and a score out of 5 was applied along a scale of how well the function applied Human Factors.

The Implementation Services project was evaluated by firstly identifying of the key aspects of successful consulting projects. These elements were scored along the key deliverables of the project and a score was generated along each of the success factors. Consultant effectiveness was also measured along a similar scale, thus enabling a closer indication of how behaviours and competence factors contribute toward competitive advantage.

Based on interpretation of the results, the Human Factors recommendations and prevalence of competitive advantage was derived based on application of the key competitive advantage principles. These aspects include behaviours that differentiate the company offering from its competitors, distinguishing the software product from competitors, and adaptability of the product to meet any challenges of the marketplace.

IV. CASE SOFTWARE PRODUCT

"Energy Components" is a software product built by Tieto Norway AS, and is sold to the Oil & Gas industry as a tool able to provide support in performing the following business functions of Oil and Gas Operators:

- Production Data Management
- Hydrocarbon Allocation
- Cargo Planning
- Shipping Handling
- Hydrocarbon Sales, Billing and Revenue

The product is designed to provide overview of all hydrocarbons produced, transported and sold, and to enable the determination of the value of Oil & Gas from different sources. With complex contractual agreements to observe, it is commercially critical for Oil & Gas operators to maintain a computer system which accurately allocates and calculates these values.

Software within the Oil & Gas industry requires various levels of adherence to known standards of auditability and interoperability. This is due mainly to the highly regulated nature of this global industry to provide significant levels of process and human safety during the extraction, storage and sales of all hydrocarbons. Compliance standards applied within the Oil & Gas software and systems industry includes:

1) SOX404: Sarbanes-Oxley Act; a financial risk assessment that tests an organisations internal controls over quality of reporting.

2) PRODML: A family of XML and Web Services used within the Oil & Gas Industry; and supports automated production data acquisition, operations monitoring, optimization, reporting, and configuration management business processes.

3) WITSML: Wellsite information transfer standard markup language.

This would illustrate that the software product itself must be compliant and highly adaptable to different requirements given the variability in Oil and Gas sales, lifting and processing arrangements. Oil & Gas production relies heavily on metering components and hence there is a large dependency on

having extensive process control and automation systems that can provide a trustworthy level of detail when considering organisations' reporting requirements. It must also be capable of integration with all manner of back-end office tools, as well as tools that support the engineering, metering, planning, and project management components of the Oil & Gas industry.

Customers who adopt and implement the "Energy Components" product do so by selecting the appropriate version of the software for their organisational needs and configure the software to meet a variety of business requirements. These typically include requirements such as compliance, security, and Oil & Gas contractual obligations.

Usability Evaluation is carried out on the software "out-of-the-box" where specifics of an Oil & Gas brownfields implementation project will provide some customer centric requirements in the mix of usability and competitive advantage. Energy Components Version 11 (the latest major release) is evaluated in this paper.

B. Features

"Energy Components" contains a suite of core features capable of being adapted for any Global Oil & Gas operator. During implementation, features are selected and configured to perform all manner of Operating requirements. Features are typically mapped to business processes, and calculations are normally built into the product to facilitate the contractual arrangements of the Oil & Gas Project.

Greenfields systems require a significant level of business analysis as all members of the project team become accustomed to the new processes for operating the Oil & Gas venture.

Brownfields implementation projects also require significant business analysis but are considered in the context of this paper to be the support and maintenance aspect of where competitive advantage can be derived.

Energy Components suite of features:

(1) Configuration – Screens, Codes, Assets, Integration Services, Schedules, Tasks, Calculations
(2) EC Production
  a. Production/Injection Well Events, Data, Statuses, Sampling, Component Analyses (Daily, Sub-Daily, Monthly)
  b. Hydrocarbons/Electricity Stream Events, Data, Statuses, Sampling, Component Analyses (Daily, Sub-Daily, Monthly)
  c. Tank Events, Data, Statuses, Sampling
  d. Production Well Testing, Performance Curves
  e. Production Deferment, Daily Deferment, Loss Accounting
  f. Production Planning, forecasting production
  g. Hydrocarbon Accounting; Data Status processes (approvals), allocation (calculations)
(3) EC Transport
  a. Cargo Planning, Nominations, Entitlements, Forecasting, Delivery Plans
  b. Terminal Operation, Bill of Lading, Cargo Management, Cargo Documents
  c. Lifting Account management, Credits, Debits
  d. Forecasting,
  e. Gas Dispatching
(4) EC Sales
  a. Sales Dispatching
  b. Price Determination
  c. Sales Allocation
(5) EC Revenue
  a. Quantity, Inventory, Financial Transaction, Cost, Royalty, Forecast, Closing Process, Revenue Logs
(6) EC Reporting
  a. Reporting Layouts
  b. Configuration, and Execution of Reports
(7) Process Automation
  a. Business Process modelling (BPM) configuration and execution
  b. Maintenance of per-user Task List in Energy Components
(8) Messaging
  a. Configuration and execution of web services, EDI, alerts, journals
(9) EC Integration Service
  a. Performing ad-hoc integration with data from various sources

By using the "Inspection" method of Usability Evaluation, the software is evaluated by performing a Heuristic Evaluation. The evaluation is undertaken by the author and focuses on "the ease with which tasks can be completed for which the computer system was designed". The authors experience with Human Factors, Usability, and Competitive Advantage shall be utilised in the evaluation of core features of the Energy Components product, and are represented on a scale of 1 – 5 according to the 'ease' in which tasks can be completed. Additionally, for each of the above processes, the software is evaluated along a scale from 1 to 5 on the five elements of Usability presented: Understandability, Learnability, Operability, Attractiveness, and Usability Compliance. Where possible, descriptions of usability components of each process will be provided as supplemental evidence to the evaluation.

Results of both evaluations shall be analysed and cross-referenced, whereby gaps present in Human Factors and Usability of the software product shall be highlighted with further recommendations.

V. CASE IMPLEMENTATION PROJECT

A brownfields implementation project was undertaken in order to:

1) Automate the customer's month-end processing
2) Combine a series of report,s
3) Implement data validation.

During this project, the author of this paper worked on the implementation team. The organisation to which this implementation project occurred shall be referred to as the "customer". Undertaking this type of project typically requires a solid agreement on scope of work and contract type before engagement can occur. This would come to mean that all parties are aware of their obligations within the contract and hence software development project. Several team members are dedicated to the overall project from both the client and the service provider. These roles included:

- Project Manager – Client
- Service Delivery Manager – Service Provider
- Analyst/Programmer – Client
- Analyst/Programmer (x3) – Service provider
- Tester (x2) – Client
- Tester (x2) – Service provider

The client who provided acceptance of the final solution was named the "Team Lead" and was not a direct member of the project team. Requirements of the project were identified during early engagements with the customer and suitable development methodologies were determined that suited the project and global team distribution.

The implementation project was analysed along a series of scales identified in the literature as contributing to both project and consulting success within organisations. Project success metrics incorporating Human Factors are identified as:

- Preparation of a Proper Plan
- Assigning Clear Roles & Responsibilities
- Separating Roles of the Facilitator and Human Factors expert
- End-user participation
- Stakeholder adoption

Consultant success metrics are defined as

- Consultant integrity – putting the clients' interests first
- Client involvement and readiness to change
- A clear agreement concerning requirements and expectations
- Client control of the engagement – partly via clear and limited assignments
- Consultant competence
- A good fit along a number of dimensions; such as client expectations mixed with consultant capability

Where possible, a qualitative analysis is undertaken by the author of this paper using the metrics described above on the implementation project. Results of the project success metrics are brought together with the consultant success metrics and the gaps in Human Factors for the implementation project are presented with recommendations.

VI. RESULTS

Evaluation of the software product was conducted along the EC suite of features and analysed for the five elements of Usability in software products. The summary of results is provided below. This is the full analysis of all elements of the software.

A – Understandability
B – Learnability
C – Operability
D – Attractiveness
E – Compliance

TABLE I. USABILITY ANALYSIS RESULTS

		A	B	C	D	E
(1) Configuration	**a**	3	2	4	2	3
(2) EC Production	**a**	3	3	5	2	4
	b	3	2	5	2	4
	c	3	1	4	3	4
	d	3	2	2	4	4
	e	3	1	2	2	4
	f	2	2	1	2	4
	g	1	2	3	4	4
(3) EC Transport	**a**	2	2	3	4	4
	b	2	3	2	4	4
	c	4	2	3	4	4
	d	2	2	4	4	4
	e	4	2	3	4	4
(4) EC Sales	**a**	2	3	3	4	4
	b	3	2	2	3	4
	c	2	4	4	4	4
(5) EC Revenue	**a**	4	2	3	3	4
(6) EC Reporting	**a**	2	3	4	3	4
	b	3	3	4	2	4
(7) Process Automation	**a**	2	2	2	5	4
	b	3	3	4	4	4
(8) Messaging	**a**	3	2	3	4	4
(9) EC Integration Service	**a**	3	2	3	4	4

TABLE II. RESULTS BASED ON MODULE

	A	B	C	D	E
(1) Configuration	3	2	4	2	3

(2) EC Production	3	2	3	3	4
(3) EC Transport	3	2	3	4	4
(4) EC Sales	2	3	3	4	4
(5) EC Revenue	3	3	4	3	4
(6) Process Automation	3	3	3	5	4
(7) Messaging	3	2	3	4	4
(8) EC Integration Service	3	2	3	4	4

TABLE III. AVERAGE USABILITY BY MODULE

Module	**AVG**
Configuration	2.8
EC Production	2.9
EC Transport	3.2
EC Sales	3.2
EC Revenue	3.2
Process Automation	3.3
Messaging	3.2
EC Integration Service	3.2

TABLE IV. AVERAGE USABILITY BY FACTOR

Usability Factor	**AVG**
Understandability	2.8
Learnability	2.3
Operability	3.2
Attractiveness	3.4
Compliance	3.9

Evaluation of the Implementation Services project yielded the following results.

A – Automate the customers month-end processing

B – Combine a series of reports

C – Implement Data Validation

TABLE V. PROJECT RESULTS BY CRITERIA

Human Factors Criteria	**A**	**B**	**C**
Preparation of a Proper Plan	4	4	4
Assigning Clear Roles & Responsibilities	1	3	2
Separating Roles of the Facilitator and Human Factors expert	3	3	3
End-user participation	1	1	2
Stakeholder adoption	2	3	3

TABLE VI. OVERALL PROJECT RESULTS BY CRITERIA

Human Factors Criteria	**AVG**
Preparation of a Proper Plan	4
Assigning Clear Roles & Responsibilities	2
Separating Roles of the Facilitator and Human Factors expert	3
End-user participation	1.3
Stakeholder adoption	2.7

Consultant effectiveness results are provided below:

A – Automate the customers month-end processing
B – Combine a series of reports
C – Implement Data Validation

TABLE VII. CONSULTANT EFFECTIVENESS RESULTS

	A	**B**	**C**	**AVG**
Consultant integrity – putting the clients' interests first	5	4	5	4.7
Client involvement and readiness to change	3	4	4	3.7
A clear agreement concerning requirements and expectations	2	3	3	2.7
Client control of the engagement – partly via clear and limited assignments	2	2	2	2.0
Consultant competence	5	4	4	4.3
A good fit along a number of dimensions; such as client expectations mixed with consultant capability	2	3	2	2.3

VII. FINDINGS

Results of both evaluations point to a basic implementation of Human Factors as part of the software product and implementation services project. There are strengths and weaknesses inclusive, and areas are identified that can improve the overall Human Factors approach.

A. Case Software Product

Of 23 areas of analysis, the 2 most usable criteria of the EC product are considered (on average) to be its compliance (3.96) and attractiveness (3.35). This would hold true given the high degree of data traceability, history and integration standards present in the product. The EC version 11 product is considered attractive in the manner in which the tree-view is presented to end-users, and that screens are grouped into business functions, typical of an Oil & Gas operators' knowledge of their organisation.

The software is considered on average least usable along the criteria of Learnability (2.26). This holds true with the lack of training material, and lack of online help with how to use certain functions of the product. The products Understandability scored on average 2.70, illustrating a slightly

higher than average usability in how well users can interpret the screens, data and configuration of the software.

The products Operability average score of 3.35 illustrated how well users could operate the screens, and how it could show achievement of the functions required on each.

Other notable findings in the software product usability evaluation include:

- Configuring the product is considered easy (4) to operate, but learning how to do that is not straight forward (2)
- Learning EC production (1.86) is the most difficult task to accomplish for humans in the entire package
- EC transport (4) & Sales (3.67) along with Process Automation (4.5) evaluated as having the most attractiveness in the entire package

B. Case Implementation Project

Findings of the Case Implementation project point to very well prepared plans, however a lack of engagement with end-users and assignment of clear roles and responsibilities. Plans were very well rounded by the implementation vendor, however did not receive the same attentions from the customer, thus pointing to some fundamental differences in management style and project success factors to how HF can assist in creation of project success.

The tasks of combining the reports and implementing data validations were considered overall (on average) more successful in implementation of Human Factors, however the automation of the month-end processing did not reach (on average) the mid-point (2.2/5). This holds true where the implementation consultant was located offshore without an adequate connection to the on-shore project.

Overall, the score for end-user participation was on average 1.33/5, indicating a lack of engagement by the customer and to identify and educate end-users on the project. Additionally, no clear roles and responsibilities were identified and enforced throughout (2/5), thus creating a sense of confusion amongst team members. This is evidenced by the customer's removal of their hired project manager to oversee the project and no replacement made.

Consultant efficiencies were rated along the six key areas of critical human factors. Consultant Integrity (on average) rated highest (4.7/5) followed by Consultant Competence (3.7/5). Client Involvement (3.7/5), then Clear Agreements (2.7/5), followed by Good Fit (2.3/5) and lastly Client Control (2/5). A number of findings can be determined based on this data:

- While the customer was involved and ready to change, it exercised a low capability to control the engagement
- Consultants approached the project work with competence and integrity with a relatively low level of agreement of the requirements and expectations of the project
- Automating the month-end procedure had less human factors consultant efficiencies, than that of the other two sub-projects.

VIII. DISCUSSION AND RECOMMENDATIONS

Based on the findings, it is evident that much of the software product maintains Human Factors within its approach. The implementation project had varied results along the chosen metrics as to how well Human Factors was incorporated.

A. Case Software Product

On average, Learnability of the software product was lowest (2.3/5), whereby Attractiveness (3.4/5) and Compliance (3.9/5) rated highest. The main module causing the low average in Learnability was "EC Production" (2.7/5). This is the oldest and most important module of the overall software product, and has undergone significant change and development since the products' inception. Whilst operating the EC production module is usable, learning it is not. The EC 'tree view' presents users with screens to select, however without adequate training or experience within the Oil & Gas industry how the data elements are connected and how the product functions as a whole is difficult to conceptualise. This is also evident in the introduction of the newer Transport, Sales, and Revenue modules.

Increasing the end-user's capacity to conceptually understand the manner in which Oil & Gas data is created, connected, manipulated, reported, and integrated will greatly increase the software products Learnability.

This would similarly apply to the products Understandability rating which had EC Production (2.6) and Sales (2.3) at lower Human Factors levels as compared to other modules. This would indicate the EC Production screens have lower than expected ability for end-users to know the function of the screen. This has some overlap with the manner in which the Learnability of the product has been implemented.

Showing how data is manipulated can benefit Understandability to only the level of understanding of each end-user. By clearly providing a context on which the data enters the certain screen, and how it is utilised after the end-user has made some change, would increase the Understandability of the overall software product.

Operability (3.2/5) & Attractiveness (3.4/5) of the product across all modules rated well, showing an attention to detail in the design and a significant amount of planning as to the goals of the software product and how it can support the HCA function of Oil & Gas operations.

On average, all modules except for EC Production (2.7/5) scored a consistent usability rating of 3.2/5. This indicates a consistently above average rating of Usability. EC Production and Configuration received the lowest average ratings of Usability. This would indicate:

- EC Production has evolved significantly over time, with introduction of new screens and functionality, based on existing Interface and Conceptual designs. The greater

the number of the business functions, that more difficult it is to learn and understand.

- Configuring the product requires niche knowledge and experience of the underlying software structure.

B. Case Implementation Project

The Human Factors analysis of the implementation project yielded some varied results. It illustrates that adequate plans were constructed but the results of the project appear not to have matched this high rating.

The results show a clear plan had been constructed (4/5), but showed little implementation of Human Factors across the other four criteria. As Human Factors was not a key ingredient of this project, the criteria "Separating Roles of the Facilitator and Human Factors Expert" were applied only to the author's engagement in the project.

The project demonstrated a very low level of end-user participation (Average of 1.3/5) in the overall implementation project, which could have been the result of a lack of project team members in the overall delivery. Much of the agreed software changes were made in isolation from end-users, which could be considered a key factor when considering future engagements of this nature.

The assignment of clear roles and responsibilities was reported at 2/5, illustrating a low level of Human Factors. This could be attributable to the low level of training that the testing team received in the project requirements. This also meant that team members were continually required to perform extra duties on top of their original role in order to facilitate an outcome on each deliverable. Whilst good plans were made, it might illustrate that they were not detailed enough, or perhaps required some further agreement that certain roles could not be performed beyond the exiting number of implementation consultants.

Similarly, the level of Stakeholder Adoption (2.7/5) was relatively low, compared to the Preparation of Plans (4/5). What this meant was that there were essentially no ambassadors for the project in the customer's office. Those customers with a vested interest in the outcome of the project were present during the project, however, did not understand the level of change required of the organisation in order to receive the benefits designed of the implementation project.

Improving the end-user and stakeholder participation would have not only provided benefit to the project outcome, it would have improved Human Factors, and generated a perceived level of competitive advantage by its ability to understand and impact the customer in a positive way.

C. Implementation Consultants

Interpreting the results of the Consultant analysis would illustrate that consultants working on the project for the customer maintained good integrity (4.7/5) and competence (4.3/5). There was a good level of involvement with the client and some agreed readiness to change (3.7/5) the existing processes in order to facilitate the requirements of the project. Where the consulting engagement lacked in Human Factors was in the Client Control of the Engagement (2/5) and a Clear Agreement concerning requirements and expectations (2.7/5). There was no significance in results between the three separate sub-projects.

This shows a willingness and competence of the implementation consultants however a lack of understanding and a misrepresented expectation from the customer. This could illustrate that the customer may need to be better connected with stakeholders and end-users (of the customer organisation), and perhaps maintain a good level of understanding to what implementation projects and consultants would be providing in each specific engagement. It is illustrated that consultants maintain a high level of integrity, and given an increase in the customer's representation of project expectations, would result in a better performing project.

Similarly, given the high levels of competence within the implementation consultants, this would indicate their capability to address any of the implementation challenges found on the project. It shows how competence became a key factor on the project given the customers inability to control the engagement. Consultants were continually asked to perform extra duties to account for missing resources and missing capabilities in other customer resources. It also highlights the disconnection with stakeholders and end-users whereby consultants were asked to contribute to end-user training and project acceptance.

This shows that the consultants with high levels of competence were able to positively impact the outcome of the project and showed the customer they had good integrity even in the case of low control over the engagement. The adaptation and making up for missing resources shows a successful implementation vendor, and its clear sense of purpose to deliver a functioning software product at the end of the implementation. These are elements distinguishing the company's advantage over its competitors.

Improving the end-user and stakeholder participation would have not only provided benefit to the project outcome, it would have improved Human Factors, and generated a perceived level of competitive advantage by its ability to understand and impact the customer in a positive way.

IX. CONCLUSIONS

The results of the two case studies would show that Human Factors has met with some varied levels of success within the implementation. Much of the software product maintains a good level of Usability whereby the Implementation project had Human Factors success only in Preparation of Plans and Consultant Competence & Integrity.

Due to a long development history, the Software product has focussed its development on Operability and Attractiveness at the expense of Learnability and Understandability. This is evidenced by the software company's willingness to engage with its major customers over time, and evolve HCA best practices and have these supported by the product.

Increasing the software's ability to show higher level concepts of where data enters and exits each function and module would improve usability. Inclusion of training, education and material designed to support the Learnability of the product would result in higher levels of user satisfaction. By generating a perceived ability for the software product to address Human Factors, and enable end-users to understand HCA best practices in an efficient manner could increase its advantage over competitors.

Implementation projects, especially when performed by consultants of the same company who market and sell the software, could have significant impact on perceived success factors of HCA implementation projects. By distinguishing the software implementation vendor from its competitors, and by providing highly usable software, enables implementation consultants to:

- Deliver solutions in line with the overall product capability;
- Match the consulting competence with the customer's involvement and ability to control and market the project with stakeholders and end- users.

Also, by centralising the configuration component of the implementation project to niche software expert's proficient in Human Factors and the Product's Capability would enable a better fit of consultant to task.

Given that software can be designed with Usability, the effort to introduce this component would be felt more in the methodologies and processes of the software development. Implementation Projects and Consultant Human Factors are more immediate given their direct human to human involvement. This involvement can be seen as critical to the outcomes of the implementation project as we see during the project how expectations are moulded, requirements are changed and communications are made. Where the "Energy Components" software and implementation projects can provide competitive advantage is seen in how well it adapts to the end-user's capability to understand and learn the product, and well implementation projects can adapt to changes inherent in project implementations.

X. FUTURE WORK

The concepts of Human Factors and Competitive Advantage in Software Products and Implementation Projects have received only basic attention in the preparation of this paper. Quantitative studies of Software built and implemented for the Oil & Gas industry (and its associated business functions) would yield a much closer representation of how well these components are perceived amongst different levels of the industry.

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