Operationally Intuitive Logistics Dashboards for Supply Chain Management in Oil and Gas Based on Human Cognition

Siw Merethe Magnus
Curtin University

Amit Rudra
Curtin University

Due to globalization over the past two decades, the importance for companies to have appropriate supply chain management (SCM) has intensified substantially. The real-time connectedness and sharing of data has created a unique opportunity to design software programs for the purpose of improving elements of operations in the supply chain (SC), both upstream and downstream. As a result of these progresses, dashboards have been designed to facilitate transparency, with the purpose of providing a better overview of a specific operation. We argue there is room for improvement within the field of dashboards for decision making by making the user and their experience the core of the dashboard design and tapping into the cognition processing of the brain to optimize the user friendliness.

Keywords: Supply Chain Management, Operational Dashboard, Human Cognition Processing, Eye-Movements

INTRODUCTION

Supply chain managers and logistic staff face several challenges when supplying goods and services to drilling platforms which are located offshore in the Oil and Gas Industry. It is well known in supply chain management (SCM) practice that the drivers of high cost in Supply Chain (SC) are the transportation of goods and the maintenance of an optimal stock and inventory (Chopra & Meindl, 2013). An increasing number of companies has understood the strategic importance of having a holistic approach when designing, developing and governing the entire supply chain in order to succeed (Min & Zhou, 2002). Success of companies in their respective markets is closely related to their strategy and performance in making the right choice of transportation and maintaining optimal inventory levels in the Supply Chain (Chopra and Meindl 2013). For the past two decades, the introduction and use of the internet and various software programs has radically changed the working environment and possibilities in Supply Chain. This has resulted in a re-design of the supply chain to meet the various needs of different stakeholders. Information-sharing platforms and real-time data connectedness has made it possible for the different members of the supply chain to capitalize on the information and its accuracy (Kvie, 2015). Real-time data means that there is no delay in the flow of information; it gives management and SC personnel an accurate and current snapshot of business activities (Chamberlin, 2010). However, in spite of real-time access to a vast database, there is still room for improvement for Supply chain visibility by creating better software tools with the goal of increasing transparency and user friendliness which will enable personnel to work more efficiently in the supply chain management (SCM) process (Lee, Kim, & Kim, 2014; Shimbo, 2008). Today, the information is available but is not always extracted and displayed in a manner which gives the users a quick overview over core activities (Lee et al., 2014; Records & Shimbo, 2010; Ross, Jayaraman, & Robinson, 2007). Currently, there is a huge potential to improve the supply chain in terms of inventory and logistics handling to become more transparent, sustainable and efficient by tapping into the potential to use and apply real-time data and IT capabilities in order to create a more seamless and dynamic flow of information integrating all members of a supply chain. An operational, and customized dashboard can give the members/users a timely overview of real-time logistics data for drilling operations. Often the importance of dashboard design has been ignored (Few, 2005) along with the fact as to how immensely important a visual presentation could be to an end-user (Bonnardel, Piolat, & Le Bigot, 2011; Pauwels et al., 2009; Ware, 2012).

Not many in their design process tap into the benefits of building a dashboard visuals and functionalities on the principles of cognition with regard to brain perceives and collect and process information. The opportunity to build dashboards based on how one's brain are wired, will result in more user friendly dashboards and enhance the decision making processes. Although there are a lot of dashboards for the visual aspect only the data part drives their design and layout functionality aspect have not been addressed adequately. Therefore, the user experience needs to investigated in all stages and be a core interaction between the user and the designers.

User Experience (UX)

User experience is crucial in order to develop and design a dashboard application. But what is an experience? What does it mean in this context? From a psychological perspective, "an experience emerges from the integration of perception, action, motivation, and cognition into inseparable, meaningful whole". An experience is subjective, holistic, situated, dynamic and worthwhile. (Hassenzahl, 2013). Hassenzahl (2008), defines UX as "*a momentary, primarily evaluate feeling (good-bad) while interacting with a product of service". He also asserts that "fulfilling human needs" results in good UX.*

The challenges the designers face is to translate the user experience feedback prior to the product development, into design and functional solutions for the dashboard. Basically foreseeing what future needs will be on the finished product.

User Experience in Design (UXD)

User field design (UXD) encompasses traditional human computer interaction (HCI) and extends it by addressing all aspects of a product of service by users. UXD includes elements of interaction design, visual design, information architecture. User experience designer's objective is to solve the end-user's problems through their ability to communicate the design and decipher the users needs into practical solutions. The UX design process is typically a variation of four phases: research, analysis, design and evaluation. These factors is a necessity of creating a universal framework for UX (Carmona, Finley, & Li, 2018). It is imperative that the designers integrate the users feedback from the infancy of the project (Galitz, 2007), and not what they perceive the users need. The ensure that the product or tool will be designed towards the actual need the operations have. By analyzing the operational tasks and also interviewing the users.

The user experience is at the core of interaction design and the goal is to create design solutions, which should to be centered around the user experience. This method consists of four basic activities: 1) recognizing the requirements from the users; 2) utilizing the information by developing alternative design; 3), based on the input of data, building prototypes with the purpose of assessment by the users; and 4) gathering the data and capitalizing on the process' and user's feedback. The basic steps seem to be straightforward, but it is a complicated process because the information comes from many disciplines (Sharp, 2006). Moreover, the interpretation of information may depend on the cultural context and other independent factors. In addition, also the designers must be aware of the emotional and mental states when creating and adapting an interface being tailored for the user (Basson, Kanevsky, & Oblinger, 2015). It is vital that the identification process be done properly and designers factor in the various parameters, based on the input create a design that is user-friendly and heuristic (Sharp, 2006).

Participatory Design

Participatory design (PD) is based on the designers interacting during the all phases of the product development with the end-users. The purpose is to ensure the end product is tailored to the specific needs that have been identified through a corroborative dialog (Barbieri, Angilica, Bruno, Muzzupappa, & Asme, 2012). The principles work with PD the core approach is user centered design. In the search of articles with regard to user experience it is found that there is still lack of communication between the designer and the user for their end product (Barbieri et al., 2012) Further take into consideration the designers need the feedback coming from the people who are actually going to use the device or software program. By not properly interacting with the end users there is indications that show the perception of what the designers think the users are expecting and want differ from the actual need of the users. Literature shows there is a gap between what the designers think users need and what is the actual requisite (Barbieri et al., 2012). The aspect of human computer interaction has to be closely analyzed, in order to be able create a user friendly intuitive dashboard based on how the brain are wired. With regard to how the brain process and analyze information

Dashboards

The term 'dashboard' derives from the instrument panel in the cockpit of a plane or car which is intended to give important information just by a brief look at the panel of instruments (Few, 2007, p. 1; Mould, Upton, & Wojciechowski, 2014; Pauwels et al., 2009). Later, the term 'dashboard' was adopted to also include data screen dashboards designed for laptops, IPad, smart phones and apps. A dashboard gives a snapshot visually on a screen of real-time data information captured in a predetermined simplified screen display, to measure and monitor performance present and historically (Few, 2006; Pauwels et al., 2009). *According to Few's (2007,1) definition of dashboard: "faceted analytical display" is a set of interactive charts (primarily graphs and tables) that simultaneously reside on a single screen, each of which presents a somewhat different view of a common dataset, and is used to analyze that information".* Dashboards are designed for the purpose of enhancing the decision-making process by tapping into the human capabilities such as reasoning and interpretation of sensory information (Yigitbasioglu & Velcu, 2012).

The process takes a cognitive pathway by gathering and evaluating the information provided and the knowledge of the employees in order to make a decision about the tasks at hand (Yigitbasioglu & Velcu, 2012). By capitalizing on the current information that the dashboard provides, future tactics can be planned. Moreover dashboard can be used as a communication tool by key personnel (Pauwels et al., 2009). To date, it seems that both academia and the industry have not sufficiently taken into consideration the user friendliness aspect of the dashboards they are developing (Magnus, 2019). (Presthus & Canales, 2015),found that dashboard design has mostly been data-driven. A dashboard should be designed based on cognitive psychology. However, so far it appears that few designers have focused on the visual perception and eye tracking that occurs when dashboards are viewed (Magnus, 2019).

Dimensions in the Design Process

Today the designers have artificial intelligence (AI) at their disposal in their product development with the aspect of Machine Learning. In addition, cognition processes, visualization with regard display on the one-glance dashboard screen.

Machine Learning – Artificial Intelligence

Due to advancement in the field of machine learning (ML) the number of applications that directly interface with users on a daily basis has become more widespread and powerful (Yang, 2017, 2018).

According to Jordan and Mitchell, define ML as "*the question of how to build computers that improve automatically through experience"*. The consequence of cross between ML and UX are becoming the future of designing technological products within the field of artificial intelligence (AI (Jordan & Mitchell, 2015). ML computers is basically represented in any kind of industry where there is human computer interaction.

ML are operating in the junction between, data science, Artificial intelligence (AI), statistics and computer science (Carmona et al., 2018). The purpose of ML is building computers which learns and evolve through interaction and tracking and record experience. The approach ML has is two different types of learning, "supervised learning" and "unsupervised learning" its based on unique individual algorithms. In the case of "supervised learning" which provide the input and correct output. Unsupervised training only provide input. The purpose of ML algorithms is to mimic the complex and multi-layered biological neural networks in the brain which relates to neurons (Carmona et al., 2018). This is made possible due to two aspects, one the theoretical and practical discoveries, and the capability today of computing large sets of data for a reasonable cost.

Interestingly so far ML and UX has not experienced a boost in designs with the attributes marrying the two, one answer can be the designers lack the knowledge and also it is a complex process to begin with (Dove, Halskov, Forlizzi, & Zimmerman, 2017; Yang, 2017, 2018). In the case study according to Dove et.al, to date "*ML currently represents an under-explored opportunity for ideation and innovation lead by UX design"*.

Cognition

Cognition is a mental process of human perception, through applying memory, reasoning skills and our emotions to decipher information from the world around us. Basic human emotions are sadness, anger, frustration and happiness (Lotfian & Busso, 2016). Our state of mind emotionally impacts the way we perceive the input of information from the surroundings and colors the decision making processes. (Bonnardel et al., 2011). According to Magnus, Rudra 2019, in their research based on bibliometric method, found a low percentage on dashboards built on the principles of cognition.

Visual

Understanding visual cognitive perception in the context of visualization design processes has become increasingly significant for dashboard design. The brain uses over 20 billion neurons to analyze visual information. The brain scan for recognizable patterns which is a primary component of our cognition processes, only then it is capable of translating the information into a comprehensible context. Efforts to improve cognitive systems require enhancing the search criteria for data in order to more easily recognize and see important patterns (Ali, Gupta, Nayak, & Lenka, 2016; Kurzhals et al., 2015). Visualization is a valuable tool in data analyses as it reveals patterns, information and errors more easily (Ware, 2012).

Color

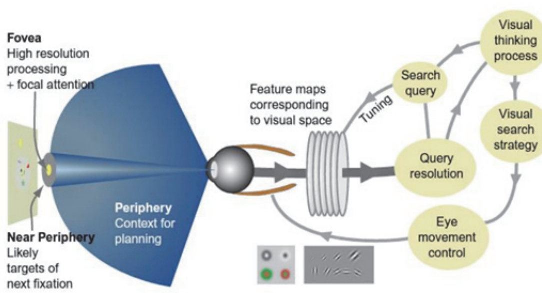
In data visualization, the use of different colors to display data has a profound impact on how the data are read and perceived. This is due to the way that the human brain is wired, and how it searches for and identifies patterns. Designers can use color coding actively to enhance the information displayed visually on the screen, by comprehension on how the brain operates and retract information with regard to color patterns (Ware, 2012). The purpose is that color coding will ease the retrieval of information and the cognition processing for the users of the dashboard. It will aid them in the drilldown of information searching of the dashboard. Visual display is just as important at the information itself.(Bauer, 2004; Blaha, Houpt, Frame, & Kern, 2017). According to (Batley, Osman, Kazzi, & Musallam, 2011), Simple visual list alerts for test results and use of color, was recognized by users to be the most valuable features. In addition, making a screen search through effective eye-movements is part of the traits of an intuitive dashboard.

Eye Movements

The way the human brain starts the visual search is through the eye movements, it triggers a scanning process in which are imaged in fovea, in high resolution in the central area of the eye (sharp vision). The tracking the eyes perform is high resolution and speed scanning the visual objects in 100 to 200 msec. The brain collects the new information and integrate is with previous knowledge seamlessly. The goal for developing a dashboard ideally should ideally have the core information visualized on a single high-resolution screen (Ali et al., 2016; Kurzhals et al., 2015). By optimizing the layout in visual design processes, only a single eye scanning movement will provide the cortex information, and on a large screen add a head movement.

Visual queries are significant to visual thinking, when the brain is searching for patterns. This is due to the brain's "search-engine" capabilities, applying visual techniques in the design functionality has become increasingly important. This approach is the future pathway in retrieving and processing visual data. (Ali et al., 2016; Blaha et al., 2017).

FIGURE 1
THE VISUAL SEARCH PROCESS



Source: Ware 2012,142

Eye Tracking

The field of eye-tracking technology has been around for over 30 years for the researchers. But due to the complexity it has not been easy to utilize. But thanks to recent software technology evolving eye-tracking has become cheaper and easier to manage. Eye-tracking is crucial in the process of creating dashboards which are intuitive and not overloaded with too much information. The purpose of eye-tracking capability is that researchers can measure the users when the "read" the information on the dashboard, to optimize the eye-search correlated towards human behavior.

According to (Nguyen, El-Nasr, & Isaacowitz, 2015), the purpose of their different research methods are to uncover the users behavior while eye-tracking how they read and perceive the information in front of them. Performing this research by gathering data, will give them a deeper knowledge in how eye-tracking are executed, in return will a more accurate visual design on the screen. In the field of eye tracking tools and software programs, there are many different pathways to retrieve data. However, Nguyen et al., used in their research to reveal the psychological patterns, the method of visualize eye-tracking data as point-based and AOI- based visualizations. "*In the AOI- based approach researchers annotate the stimuli in terms of areas of interest and visualizations are used to show how fixations are associated with such areas of interests, and thus giving them meaning and providing context. None of these previous methods have looked at a way to both (a) analyze temporal shifts and patterns of fixation data, and (b) compare these patterns across groups*".

CONCLUSION

Operational dashboard for Oil and Gas industry still has room for improvement with regard to the user friendliness. According to Magnus, Rudra 2019, in the research results that not many dashboards were based on cognition processes. The predominately trend has been, dashboards which has been designed on data-driven concepts and not user experience (Presthus & Canales, 2015). In addition to date combining UXD with cognition and eye tracking research has not been optimized in operational dashboards. In conjunction with memory patterns of the brain this can be utilized to improve the user friendliness by utilizing UX as an active ongoing dialogue for the designers through the creation of a dashboard from the infancy of the idea to the finished product. Only by a thorough process and interaction between the end users and the designers can ensure a product is made that is easy to use.

FUTURE RESEARCH

The research objective is to pull in the different areas of expertise with regard to HCI, UX, UXD and Cognition to generate a process model and a design based on the research, resulting in an operational intuitive dashboard based on how the brain are wired for Oil and Gas Industry.

REFERENCES

Ali, S. M., Gupta, N., Nayak, G. K., & Lenka, R. K. (2016). Big Data Visualization: Tools and Challenges. *Proceedings of the 2016 2nd International Conference on Contemporary Computing and Informatics (Ic3i)*, 656-660.

Barbieri, L., Angilica, A., Bruno, F., Muzzupappa, M., & Asme. (2012). *An interactive tool for the participatory design of product interface*.

Basson, S. H., Kanevsky, D., & Oblinger, D. A. (2015). *Predictive user modeling in user interface design: Google Patents*.

Batley, N. J., Osman, H. O., Kazzi, A. A., & Musallam, K. M. (2011). Implementation of an emergency department computer system: design features that users value. *Journal of Emergency Medicine*, 41(6), 693-700. doi:10.1016/j.jemermed.2010.05.014

Bauer, K. (2004). The CPM Dashboard: The Visuals. *DM Review*, 14(5), 41.

Blaha, L. M., Houpt, J. W., Frame, M. E., & Kern, J. A. (2017). Capturing You Watching You: Characterizing Visual-Motor Dynamics in Touchscreen Interactions. In M. Burch, L. Chuang, B. Fisher, A. Schmidt, & D. Weiskopf (Eds.), *Eye Tracking and Visualization: Foundations, Techniques, and Applications, Etvis 2015* (pp. 73-91).

Bonnardel, N., Piolat, A., & Le Bigot, L. (2011). The impact of colour on Website appeal and users' cognitive processes. *Displays*, 32(2), 69-80.

Carmona, K., Finley, E., & Li, M. (2018). *The Relationship Between User Experience and Machine Learning.*

Chamberlin, G. (2010). Real time data. *Economic & Labour Market Review*, 4(6), 68-73.

Chopra, S., & Meindl, P. (2013). *Supply chain management : strategy, planning, and operation* (5th edition.. ed.). Upper Saddle River, N.J.: Upper Saddle River, N.J. : Pearson Upper Saddle River, N.J. Pearson.

Dove, G., Halskov, K., Forlizzi, J., & Zimmerman, J. (2017). *UX Design Innovation: Challenges for Working with Machine Learning as a Design Material.* Paper presented at the Proceedings of the 2017 chi conference on human factors in computing systems.

Few, S. (2005). Dashboard Design: Beyond Meters, Gauges, and Traffic Lights. *Business Intelligence Journal*, 10(1), 18-24.

Few, S. (2006). *Information dashboard design*.

Few, S. (2007). Dashboard confusion revisited. *Perceptual Edge*, 1-6.

Galitz, W. O. (2007). *The essential guide to user interface design: an introduction to GUI design principles and techniques*. John Wiley & Sons.
Hassenzahl, M. (2013). *User experience and experience design*. The Encyclopedia of Human-Computer Interaction.
Jordan, M. I., & Mitchell, T. M. (2015). Machine learning: Trends, perspectives, and prospects. *Science*, 349(6245), 255-260.
Kurzhals, K., Burch, M., Blascheck, T., Andrienko, G., Andrienko, N., & Weiskopf, D. (2015). *A task-based view on the visual analysis of eye-tracking data.* Paper presented at the Workshop on Eye Tracking and Visualization.
Kvie, M. S. (2015). *Requirements for a logistics information system in the oil and gas industry-A case study for Statoil.* Høgskolen iMolde-Vitenskapelig høgskole i logistikk. Retrieved from https://brage.bibsys.no/xmlui/bitstream/handle/11250/2414866/master_kvie.pdf?sequence=1
Lee, H., Kim, M. S., & Kim, K. K. (2014). Interorganizational information systems visibility and supply chain performance. *International Journal of Information Management*, 34(2), 285-295.
Lotfian, R., & Busso, C. (2016). Retrieving categorical emotions using a probabilistic framework to define preference learning samples. *Interspeech 2016*, 490-494.
Magnus, S. M., Rudra, Amit. (2019). Real-time Operational Dashboard for Facilitating Transparency in Supply Chain Management - Some Consideration. *Proceedings of ICEIS 2019*. doi:10.5220/0007721304330443
Min, H., & Zhou, G. (2002). Supply chain modeling: past, present and future. *Computers & Industrial Engineering*, 43(1), 231-249.
Mould, D. R., Upton, R. N., & Wojciechowski, J. (2014). Dashboard systems: implementing pharmacometrics from bench to bedside. *The AAPS Journal*, 16(5), 925-937. doi:10.1208/s12248-014-9632-5
Nguyen, T.-H. D., El-Nasr, M. S., & Isaacowitz, D. M. (2015). *Interactive visualization for understanding of attention patterns.* Paper presented at the Workshop on Eye Tracking and Visualization.
Pauwels, K., Ambler, T., Clark, B. H., LaPointe, P., Reibstein, D., Skiera, B., . . . Wiesel, T. (2009). Dashboards as a service: why, what, how, and what research is needed? *Journal of Service Research*, 12(2), 175-189.
Presthus, W., & Canales, C. A. (2015). *Business Intelligence Dashboard Design. A Case Study of a Large Logistics Company.* Paper presented at the Norsk konferanse for organisasjoners bruk av IT.
Records, L. R., & Shimbo, D. T. (2010). *Petroleum enterprise intelligence in the digital oil field.* Paper presented at the SPE Intelligent Energy Conference and Exhibition.
Ross, A., Jayaraman, V., & Robinson, P. (2007). Optimizing 3PL service delivery using a cost-to-serve and action research framework. *International Journal of Production Research*, 45(1), 83-101. doi:http://dx.doi.org/10.1080/00207540600603969
Sharp, H. (2006). *Interaction design : beyond human-computer interaction / Helen Sharp, Yvonne Rogers and Jenny Preece* (2nd ed.. ed.). Hoboken, NJ: Hoboken, NJ: Wiley.
Shimbo, D. T. (2008). *Petroleum Operational Analytics Using Business Intelligence Tools.* Paper presented at the SPE Annual Technical Conference and Exhibition.
Ware, C. (2012). *Information visualization: Perception for design* (3rd ed.). Burlington Elsevier Science.
Yang, Q. (2017). *The Role of Design in Creating Machine-Learning-Enhanced User Experience.* Paper presented at the 2017 AAAI Spring Symposium Series.
Yang, Q. (2018). *Machine Learning as a UX Design Material: How Can We Imagine Beyond Automation, Recommenders, and Reminders?* Paper presented at the AAAI Spring Symposium Series.
Yigitbasioglu, O. M., & Velcu, O. (2012). A review of dashboards in performance management: Implications for design and research. *International Journal of Accounting Information Systems*, 13(1), 41-59.