Development of an electronic homebuilding standardised method

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Abstract: This paper aims at developing a set of standardised electronic business solutions for the homebuilding industry. Specifically, it first develops a strategic value chain model in the electronic homebuilding industry. Secondly, a set of tactical electronic homebuilding management solutions are derived. Thirdly, pattern analysis is conducted on the top dominate homebuilding companies. Finally, discussions as well as managerial implications are presented. The results of this research will help to enhance the electronic business adoptions in the electronic homebuilding industry.

Keywords: electronic value chain management; homebuilding; electronic business.

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1 Introductions

In the years leading up to 1998 home starts reached their highest levels in 20 years with home ownership at 66.8%, contributing 5% of gross domestic product (GDP) and 10% to GDP growth. Recognising the housing sector as an important factor of economic growth as measured by GDP, President Clinton formed the Path for Advancing Technology in Housing (PATH) on 4 May, 1998. The RAND Corporation, working with PATH, Office of Science and Technology Policy (OSTP), Housing and Urban Development (HUD), and the National Homebuilders Association (NAHB) began investigating how technology could be used to reduce cost and delays caused by design, permitting, and construction (Hassell et al., 1999).

One of the discoveries by the RAND Corporation causing extensive delays in the homebuilding process was land development approval, permitting, and zoning. Building codes and regulatory approval originate from federal, state, county, city, and local zoning agencies. There could be as many as 15 different agencies required for approval before development can begin. Changes made within agencies often were not made available until after the builder had submitted plans, causing extensive delays. Builders must pay interest on loans to carry large land tracks for development; delays can turn a profitable venture into a loss that can result in the entire project being terminated. In Los Angeles County there are 89 cities, each with city council and building departments. Due to scarce resources of capital, the building departments are under staffed and operating on small budgets, causing the permitting process to take as much as five or six months (Hassell et al., 1999).

PATH has long recognised the value of applying technology to the home building industry and has created a priority that examines how information systems and the use of road-mapping systems can be designed to enhance the speed and efficiency of the home building process (NAHB Research Center, 2006).

Pulte Homes Sciences, a leader in the homebuilding industry, has built a plant in Manassas, Virginia to take advantage of construction automation. Using digital design data, Pulte's production line can create concrete forming set-up equipment used to produce basements and foundation walls. Machines are used to manufacture steel studs, drive sawing, routing, and nailing machines to form floors, walls, and openings for doors and windows. Houses can be built in 50 days; in 1999 a house was built in four days, 5 h, and 27 min to prove the technology effective (Sawyer, 2006).

The internet has been ushered in with high expectations of efficiency, effectiveness, and innovation. Early adopters of electronic market systems experienced difficulty implementing electronic data interchanges (EDI) into B2B models. Failure to recognise hierarchical governance mechanisms of communication in B2B models can be a competitive strength or play a supporting role. One of the biggest problems of early adaptors was determining total cost analysis (TCA) of implantation. In order to offset the added expense of EDI, companies aligned closely with suppliers and buyers to recover

sunk cost. EDI brought about the ability of a company to reduce cost by adopting just-in-time procurement reducing inventory and handling cost. With the rapid flow of information, companies were able to manage inventory adjustments, design changes, and renegotiate contracts to offset the TCA issue (Park and Yun, 2004).

Some information technologies solutions have been developed and adopted in the electronic homebuilders industry. For example, communications and network infrastructures were adopted in a variety of homebuilding functions. Some software and business solutions such as enterprise resource planning (ERP) helped to integrate some components in the homebuilders industry such as blue prints designs, material plans and schedules and home inspections, etc. Information technologies also helped to access information of suppliers and support for installation and training ("Information Technology", 2000). The nature of homebuilding requires more than 30 craftsmen to complete a typical single-family residence. Homebuilders typically look to reduce investment in equipment, training, and personnel to limit risk in a cyclical market governed by uncontrollable events (Hassell et al., 1999).

One of the biggest issues facing the construction industry is adapting software to meet the three major goals, referred to as the golden triangle, which is to complete the project on time, on budget, and of high quality. "The future of the construction industry revolves around utilising various information technology tools for the estimating and accounting subsystems in accordance with each other, not in isolation" (Law, 2008, p.4). According to Law (2008), a transformational mind set needs to occur in the home building market to embrace technology that can integrate accounting and estimating software to better understand variances between estimating and actual cost. Instituting a more accurate estimating/variance system will provide a competitive advantage in an increasing competitive environment.

Due to the lack of research in investigating standardisation of e-business adoptions in the homebuilders industry, this paper aims at developing a set of standardised electronic business solutions for the homebuilding industry in order to help accelerate and enhance the electronic business adoptions in the electronic homebuilding industry.

The reminder of this paper is organised as follows: Section 2 presents a literature review on electronic business models in the homebuilding industry. Section 3 develops an electronic homebuilding value chain (EHVC) model based on strategic value chain model analysis. A set of tactical electronic homebuilding management solutions are derived based on this EHVC model. Section 4 provides methodology and investigates the e-business implementation pattern in dominate companies in the homebuilding industry. Section 5 presents discussions managerial implications and conclusions.

2 Literature review

Recovering from the recent housing recession, the largest homebuilder's annual production has grown from 7500 in 1990 to over 30,000 per year in 2000. The US Build's newest e-chain distribution focuses entirely on the needs of production homebuilders. The new distribution channels no longer require the trade contractor to take delivery of materials. "The first component of the information hub is US Build's demand capture application called 'HOMER'. The command creates a bill of material that has been created by the customer for custom attributes and the information is sent directly,

providing a demand signal from the homebuilder to the manufacture (Taylor and Bjornson, n.d., p.4).

Pulte adopted the new supply chain created by US Build, testing the new system in Denver. Adapting the ordering of plumbing products for new homes, Pulte has saved between $500 and $700 on each new home and reduced delivery by 3–5 days. Using just-in-time delivery has reduced the number of days to build a house (Richmond, 2002).

The supply chain for the homebuilding industry has expanded due to a more efficient means of transportation. In past years, manufactures of building products were limited to geographical areas located within reasonable distances of plant locations (Voordijk et al., 2006). Manufactures such as Dow Chemical, Louisiana-Pacific, and Weyerhaeuser are now located closer to raw material sources. The majority of sales for manufactures are to wholesalers, B2B, business to business such as BlueLinx, Dixie Plywood and US Lumber. The end user B2C, business to customer, takes place in two steps with the wholesaler selling to large homebuilders (Pulte, Lennar), large retailers (Lowes, Home Depot), and other retail and specialty distributors (MacKenzie, 2012).

The value chain is the sum total of activities that create value. Value is described as what buyers are willing to pay for goods and services that are produced by the firm and is reflected by total revenue. The value chain divides the company's activities into two major categories, Primary and Support. The concept was developed by Michael Porter and described in his book Competitive Advantage. Primary activities consist of inbound logistics, operations, outbound logistics, marketing and sales, and service. All of the primary activities are concerned with creation of the product or service. The support activities consist of procurement, technology development, human resources, and general administration (Dess et al., 2014).

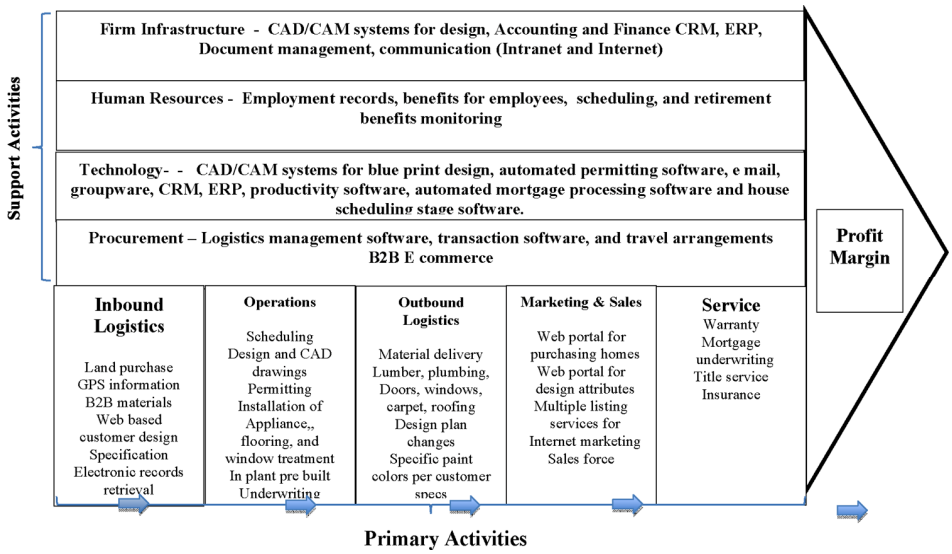
E-value chain is the adaption of Michael Porter's value chain utilising electronic transmission of data. Information technology has provided additional value by allowing companies to become more effective and efficient with the use of both intranet and internet. "An IT value chain refers to the subset of enterprise activities that pertain to IT operations, both to add value directly for external customers and to add indirect value by supporting other enterprise operations" (Pfitscher and Wei, 2007, p.6).

Electronic commerce has emerged as a leading application of information technology and is changing the way organisations link the entire value chain. E-value and e-customer chains allow for advanced communication with business to customer (B2C), business to business (B2B), and customer to business (C2B). "The internet and its capabilities also provide companies with new, more cost effective and time-efficient manes for working with customer, suppliers, and development partners" (Gunasekaran et al., 2002, p.188).

3 Electronic homebuilding value chain (EHVC) model

Figure 1 shows the breakdown of Michael Porters Value Chain divided into two main sections. The first section includes five primary activities and the other includes four support activities. The e-value chain shows how each activity is connected with the use of information technology. Below is a brief description of e-value chain activities:

Figure 1 E-value chain model for homebuilding industry (see online version for colours)



Primary activities

- *Inbound logistics.* Before homebuilders can begin the process of building homes or multifamily housing projects, land must be identified. The process starts with electronic records from the property appraiser office to identify owners of record, tax information, boundary lines, recorded deeds, and other information necessary to determine if the parcel(s) can be purchased. Establishing value is performed by accessing electronic records from various sources of recent sales, past sales, and pending sales (asking prices) of surrounding property. Property value is established by looking at recent history as well as how the property can be divided to meet the needs of the homebuilder by using special software for real estate development (Gravina da Rocha et al., 2016).

Many materials are necessary to build a home; therefore, the management of raw material is critical to the timing process of building a house. More than a dozen different trade specialists are required to build a home, including: heavy machinery operators for land clearing, concrete experts for the foundation, carpenters for wall, flooring, roof truss, plumbers, electricians, and cabinet designers all must rely on the prior work to be completed before they can begin individual work required to complete the house (Naji et al., 2016). Therefore, the inbound management of materials is critical to the building process. Automated scheduling software is used to manage large quantities of materials over a large geographical area. The three major homebuilders build thousands of homes across multiple regions. Managing the process requires customer resource planning, as each customer can choose from many different design packages to include upgraded counter tops, appliances, and paint colours. All of information is uploaded from web portals, accessed by the customer, and then transmitted to the local construction manager (Vaughan et al., 2013).

The majority of homes sold require some type of financing, each of the three largest homebuilders offer mortgage-financing services to include title searches, closing

document preparation, and mortgage insurance. All of the information necessary to manage the process is sent via the internet and uploaded into special software that analyses the data for mortgage approval. Lot locations, GIS, and GPS specifications are transmitted via the internet to title companies to make sure that clean titles are being sold.

- *Operations*. Company operations include production processes that turn input of raw materials into finished products. The building industry can be categorised into two main components, custom build or pre-manufactured. As described earlier in this paper, Pulte and other homebuilders have expanded into more efficient ways of building homes. Factories have been set up to build pre-manufactured homes, often completed within days instead of months. Manufacturing equipment is designed to read computer aid design (CAD/CAM) files and build flooring, walls, roof truss systems, door and window openings that are later assembled at the home site. The manufacturing process is aided by electronic data files, developed from CAD/CAM file data. Many custom features can be added during the design phase with input from the customer. Design files are developed to include 3-D drawings electronically delivered to the customer for approval using the internet. The same process of data delivery is used for custom-built homes, the only difference between the two systems are where the home is built, one in a remote facility and the other on the customers lot (Demian and Walters, 2014).

Financing, title, and insurance information are uploaded into software designed specifically for analysing financial data for mortgage approval. The largest homebuilders have been designated as mortgage originators and operate separate divisions providing the service to homebuyers. Special underwriting software link the entire system to both the intranet and internet for retrieval of information necessary to determine mortgage rates, maximum amount of qualification, and mortgage payment schedules.

- *Outbound logistics.* Generally, outbound logistics would consist of delivering a finished product using some means of transportation, warehousing, inventory, or delivery of a service. In the case of homebuilders, the finished product is completed in many stages and delivered on site. Outbound logistics for homebuilding would focus on the components necessary to complete the custom home. Delivery of the material for the foundation, lumber or metal studs necessary for the wall structure, roof trusses for sub-roof system, shingles, windows, doors, and heating and air conditioning systems. All of the components are handled via electronic ordering and tracking systems using the intranet and internet. Handheld devices located with the construction supervisor notify the on-site contractor of expected delivery of material, quantity, style, and most important the timing of the delivery (Blismas et al., 2010). Enterprise resource planning (ERP) aides the supplier through notification of orders, quantity, style, colour, location, and timing. The automation of the ordering process, delivery, and installation is linked to the accounting function to coordinate what has been ordered to what has been billed. On-site construction managers, using the internet, can access portal that has been designed using the intranet to manage the entire process without waiting for other means of communication (Mohamed et al., 2015).

- *Marketing and sales.* Marketing and sales include all the activities related to advertising, channels, promotion, selling, and developing competitive advantages by marketing to the appropriate marketing mix. More than 90% of all homebuyers begin

the search using the internet for information concerning school rankings, distance commuting to work, and leisure activities. Once an area has been identified, the next step is to use the web to locate a realtor to help in the process. Search engine optimisation (SEO) becomes a critical component in the ability for homebuilders and local realtors to appear on first search pages. Individuals who use ITe devices are 86% more likely to contact a real estate agent (Vox, 2014).

The largest homebuilders maintain a website of all properties listed for sale, arranged by location in local neighbourhoods, price, style, and demographic differentiation. Many custom homebuilders, such as D.R. Horton, allow buyers to order many custom home features using web-based portals. Buyers can choose upgrades to cabinets, countertops, appliances, paint colours, carpeting, wood and tile flooring, and window treatments. The use of virtual 3D software can allow potential customer to visualise their home as change occur with options offered. Today's technology further enhances the buying experience by allowing future homebuyers to use 3D graphics to place furniture in rooms, enabling the personal experience to see how the family will fit in their new surroundings.

The latest technology in real estate marketing is the use of drones. Homebuilders want to use drones equipped with cameras to delivery virtual reality to area developments, helping market the new subdivisions. Recent court cases have prevented the use of drones, "in a closely watched case, a photographer for the University of Virginia in Charlottesville was fined $10,000 late last year by the FAA for flying his drone for commercial purposes" (Freedman, 2014, p.1).

- *Service.* Enhancing the buyer's incentive to improve perceived value, all homebuilders offer a warranty on new home construction. Homebuilders' warranty against builder defects, roof and window leaks, and all mechanical devices such as heating and air conditioning units. The purchase of a home is the largest single purchase most families make in a lifetime. It is important for new buyer to have a comfort level that the purchase has some protection in terms of a warranty. All warranty matters are handled through the use of electronic notification (Jacobsson et al., 2016).The buyer is provided web access to a portal that is designed to notify the builder of any issue that may arise after the sale. Suppliers of any product that has been used in the process of home building can then be scheduled to correct any defect that may exist.

Other services offered by homebuilders include financing, title work necessary to close any real estate transaction, title insurance, and brokerage services. New trends in the service sector for real estate is to help a new buyer sell existing homes, if the sell depends on new home purchase. A number of brokers have offered to either sell the existing home in a short period of time or buy the home to conclude the purchase of a new home.

Support activities

- *Firm infrastructure.* Activities to support the company's infrastructure include accounting, legal department, finance, government affairs, and quality management. E-infrastructure is linked by intranet to automate accounts receivable, account payable and other accounting enterprise software. Government affairs uses the internet to access the permitting process for each building location, regulations vary by each state and county (Jansson et al., 2015).

- *Human resources.* Personnel records, payroll, retirement, and vacation schedules are all maintained on electronic record keeping software designed specifically for human resource departments. The three largest homebuilders have payrolls that exceed thousands of employees spread out over many states. Withholding tax, state unemployment tax, and other federal taxes are all managed within the human resource database files (Samad et al., 2016).
- *Technology.* Vast systems of data files are necessary at all levels of homebuilding industry. Custom homebuilders use CAD/CAM design files to determine the highest and best fit for land purchases to maximise lot size, home square footage, and height. Manufactures of pre-built homes use technology to drive machinery designed to complete major parts of the building process. External customers' access web based portals to input custom orders, allowing for new home buyers to choose from many options (Swarts et al., 2016).
- *Procurement.* The activities associated with e-procurement are limited to those areas that support the value chain. The purchase of software such as ERP, customer resource management (CRM) and other data driven programs designed to improve productivity and efficiency. All raw materials necessary for the production of the product are bought through the procurement process (Li et al., 2014).

4 Standardised tactical e-business solutions

The advancement of information technology has integrated every aspect of business, allowing for faster communications and interconnectivity to both internal and external customers (Fisher, 2000). Large homebuilders conduct business in all 50 states, divided by regions, building thousands of homes each year. In order to maintain profitable ventures, communications with suppliers, construction managers, craft trades, and delivery are critical to maintaining profit margins. Table 1 shows the different process within the homebuilding sector designated as business-to-business (B2B), business-to-government (B2G), business-to-consumer (B2C), consumer-to business (C2B), and business-to-internal (B2I).

Business-to-business: The entire process of homebuilding starts with land acquisition, without land homes simply could be built. The purchase of land utilises the internet to access records of title and land ownership, official recording records for taxes, location, legal descriptions, and tax information. Once land has been acquired, design teams determine the highest and best use using automated software for development layout to include lot size, roads, utilities, size, and configuration based on the correct number of bedroom and bathrooms. The internet is used to access government, state, and federal demographic data for site analysis. Suppliers are delivered a set of plans to submit material bids in order to determine construction cost (Manrique et al., 2015). Most recently, publicly traded homebuilders have entered the mortgage market, enabling the homebuilder to control the entire process, from building to selling. Using automated underwriting software, directly connected to lending institutions and the secondary mortgage market, allows quick and seamless integration of mortgage origination and secondary market operations.

Table 1 E-business application solutions in the homebuilding industry

Business application		*Description*
Business To Business		
1	Inbound Suppliers	Purchase of raw materials
2	Direct underwriting software	Fannie/Freddie Mac/Banks
3	Internet	Direct connection and domain registration
4	Email	Communication software
5	Accounts payable	Electronic check payment
6	Accounts receivable	Electronic check receipt
7	Land acquisition	Contracts to other real estate firms and land sellers
8	Utility applications	Water, sewer, electrical, phone
Business to Government		
1	Land deed registration	Recording of deed with state
2	Mortgage documentation	Recording mortgage with state
3	Employment compliance	Federal compliance laws, employment laws
4	State and federal taxes	FICA and other taxes
5	Utility applications	Permits for utilities
6	Building permits	Required filings for building
7	SEC documents	Required filings to be listed on exchanges
8	Federal taxes	State and federal taxes
Business to Customer		
1	Mortgage underwriting application	Customer mortgage application
2	Other underwriting services	Title services and insurance
3	Website offerings	Developments under construction
4	Home upgrades	Carpet, flooring, paint, cabinets offering choice customers
5	Design services	Custom design services
6	Internet/email	Customer communication
Consumer to Business		
1	Mortgage application	Internet based submission for mortgage
2	Support application	Real estate contracts/offerings
3	Internet	Initial search
4	Consumer/realtor	Document delivery/listing/offering
5	Web portal	Builder web portal for customisation
6	Closing documents	Review of all documents prior to closing
7	State and federal disclosure	Documents required by federal and state law
Business to Internet		
1	Human resources	Payroll, scheduling, vacation/sick days
2	Intranet	Internal communications
3	Enterprise resource software	Accounting, financial, ordering
4	Inventory	Tracking of homes for sales in each development

Business-to-government/state: Developers require vast information to determine what areas within regions present the best possible success scenario. Analysing data provided by government and state agencies can indicate demographic information needed in determining regional development. High state involvement, such as Texas and North Carolina, consistently attract industry development. Worker migration trends have a high impact on builder decisions to develop homes in these high impact areas.

Business-to-customer: With the new communication and information technologies, the homebuilding companies have a variety of methods to communicate with existing and potential customers. The internet also offers online search and research mechanism on homebuilding's websites for home buyers. By using the online search mechanism, the home buyers can determine factors such as location, school districts, community, parks, leisure services, and proximity to metro areas etc. These factors are important for new home buyers. Recently, many realtor contracts and home buying contracts are conducted on electronic based. Moreover, many homebuilders also conduct their after sales business services such as maintenance and warranty supports via internet.

Customer-to-business: Homebuilders rely on a vast array of customers to complete the building and selling process of custom designed homes. Suppliers of raw material, such as concrete for foundations, wood or metal for wall structure, roof trusses, roofing material, flooring, and mechanical components are all purchased using integrated information technology. Custom colours are ordered from each homeowner concerning carpet colour, window treatments, and in many cases paint colours for each room. In order to track individual request, information is delivered to the construction manager on handheld devices designated by address (Nikoleta et al., 2016).

Insuring homes that are sold requires timely financing using the mortgage market for funding the purchase. Applications are submitted using electronic communication, automated software easily determines the amount lenders are willing to loan based on predetermined financial ratios. Loan approval, title search, and insurance are all predetermined using intranet and internet connectivity to complete the home buying process.

Business to internal: Keeping track of thousands of homes in multiple regions across the USA requires integration of enterprise resources processing connecting accounting, finance, capital formation, and the flow of materials. Large homebuilders' employee hundreds of personnels, maintained using internal record keeping by the human resource department. Payroll records, vacations, sick leave, and retirement accounts are all maintained using electronic record keeping.

Table 2 indicates how each activity in the e-business application heading of B2B, B2G, B2C, C2B, and B2I is related to e-value chain. Many of the activities utilise multiple areas of the value chain, increasing efficiency at all levels of the company. B2C and C2B represent the largest utility of the value chain, the interconnectivity between the business and the customer delivers the customisation necessary to control cost and drive profits.

Table 2 Relationship between e-business applications and e-value chain

	Value chain activities								
E-business	*Primary activities*					*Secondary activities*			
B2B	*Inbound logistics*	*Operations*	*Outbound logistics*	*Marketing and sales*	*Customer service*	*Infra-structure*	*Human resources*	*Technology*	*Procurement*
1	x								
2	x				x			x	
3	x		x	x	x		x	x	x
4	x								
5	x								
6	x								
7	x	x							
8	x								
B2G									
1		x							x
2			x						x
3			x				x		
4						x			
5	x	x	x						
6	x	x	x						x
7			x						
8			x						
B2C									
1	x	x		x	x				
2	x	x	x	x					
3		x	x		x				
4		x	x	x	x				x
5		x		x	x				
6	x		x	x	x			x	
C2B									
1	x	x	x	x	x	x	x	x	
2	x		x	x				x	
3				x	x			x	
4	x			x				x	
5	x			x	x				
6	x	x	x						
7			x						
B2I									
1							x		
2						x	x	x	
3						x	x	x	X
4	x	x							

5 Methodology

Appendix A shows the top 20 homebuilders in the USA. Due to the high capital requirements required for land acquisition and the building process, access to financial markets is critical to a sustained competitive advantage. Small builders, with above average reputations, are being bought by the larger companies. D.R. Horton has made an acquisition on a near yearly basis for the past 20 years.

Table 3 indicates the top 10 homebuilders' participation and utilisation of e-business solutions. All homebuilders buy land, design and construct homes in much the same way including website offerings, direct customer input for custom designing, and final closing documents required. The largest homebuilders have differentiated the competitive advantage with the use of backward integration by offering mortgage service, closing services, and insurance. Controlling the entire value chain has increased profit, shortened the cycle from build to purchase, and increased sales by eliminating unqualified buyers.

Table 3 E-business applications for the top 10 homebuilders

E-business	*D.R. Horton Inc.*	*PulteGroup Inc.*	*Lennar Corp.*	*NVR Inc.*	*Toll Brothers*	*Taylor Morrison*	*Hovnanian Enterprises Inc.*	*KB Home*	*The Ryland Group*	*Standard Pacific Home*	*% of e-business*
B2B											
1	x	x	x	x	x	x	x	x	x	x	100
2	x	x	x								30
3	x	x	x	x	x	x	x	x	x	x	100
4	x	x	x	x	x	x	x	x	x	x	100
5	x	x	x	x	x	x	x	x	x	x	100
6	x	x	x	x	x	x	x	x	x	x	100
7	x	x	x	x	x	x	x	x	x	x	100
8	x	x	x	x	x	x	x	x	x	x	100
B2G											
1	x	x	x	x	x	x	x	x	x	x	100
2	x	x	x								30
3	x	x	x	x	x	x	x	x	x	x	100
4	x	x	x	x	x	x	x	x	x	x	100
5	x	x	x	x	x	x	x	x	x	x	100
6	x	x	x	x	x	x	x	x	x	x	100
7	x	x	x	x	x	x	x	x	x	x	100
8	x	x	x	x	x	x	x	x	x	x	100
B2C											
1	x	x	x								30
2	x	x	x								30
3	x	x	x	x	x	x	x	x	x	x	100
4	x	x	x	x	x	x	x	x	x	x	100
5	x	x	x	x	x	x	x	x	x	x	100
6	x	x	x	x	x	x	x	x	x	x	100

Table 3 E-business applications for the top 10 homebuilders (continued)

E-business	*D.R. Horton Inc.*	*PulteGroup Inc.*	*Lennar Corp.*	*NVR Inc.*	*Toll Brothers*	*Taylor Morrison*	*Hovnanian Enterprises Inc.*	*KB Home*	*The Ryland Group*	*Standard Pacific Home*	*% of e-business*
C2B											
1	x	x	x								30
2	x	x	x	x	x	x	x	x	x	x	100
3	x	x	x	x	x	x	x	x	x	x	100
4	x	x	x	x	x	x	x	x	x	x	100
5	x	x	x	x	x	x	x	x	x	x	100
6	x	x	x	x	x	x	x	x	x	x	100
7	x	x	x	x	x	x	x	x	x	x	100
B2I											
1	x	x	x	x	x	x	x	x	x	x	100
2	x	x	x	x	x	x	x	x	x	x	100
3	x	x	x	x	x	x	x	x	x	x	100
4	x	x	x	x	x	x	x	x	x	x	100

6 Discussions, implications and conclusions

In order to accelerate the adoption of information technologies in the home building industry, this paper aims at developing a set of standardised electronic business solutions for the homebuilding industry based on a strategic value chain model. The information technology adoption in the top dominate homebuilding companies also was investigated based on pattern analysis in this paper. Overall, the results of this research will help to enhance the electronic business adoptions in the electronic homebuilding industry.

The efficacy of technology has had a profound and disparate approach to one of the largest contributors to GDP, the Homebuilding market. In order to extricate past barriers that delayed and increased homebuilding cost, the federal government formed an agency, Path for Advancing Technology (PATH) to ameliorate the process of design, permitting, and construction of homebuilding. Embracing the paragon of new technology has allowed homebuilders to focus on the three major goals referred to as the "golden triangle", on time, on budget, and high quality.

Standardisation of e-business solutions, in the homebuilding industry improved the entire process allowing increased communication with customers and suppliers, whereby reducing shipping cost, delivery time and production cycles. Implementation of TQM, ERP, and just in time (JIT) software ameliorated the entire value chain, to include both primary and secondary (support) activities.

Advancing electronic commerce, within the homebuilding industry, changed the organisational approach of communication. Linking B2C, B2B, and C2B providing advanced capabilities that have reduced construction cycle time, providing cost efficiency's leading to increased profit margins.

The purchase of single-family homes represent the largest expense made by individuals with the timing and size of the expense determined by many factors including

mortgage rates, inflation rates, employment expectations, wages, and GDP. Current economic policy has attempted to influence both long term and short -term interest rates. Recently, Quantitative Easing 3 (QE 3) has been abandoned; which was designed to force both short-term and long- term interest to historic low levels through the purchase of mortgage back securities and long- term bonds. The near zero interest rate policy has influenced the home buying decision with historic low mortgage rates, directly affecting the growth of the home building industry.

The housing market moves in the same direction as the economy, and by the nature of outside influences, causes up and down cycles. The prior discussion, using a regression analysis clearly shows how interest rates, thus mortgage rates, is directly correlated with housing starts, affecting the direction of the homebuilding industry. The recent recession beginning in 2007, severely impacted the housing market and continues to influence the homebuilding recovery. Builders are reporting labour shortages in all areas due to the exit of skilled labour directly related to the last five years of a depressed industry. The labour shortage is also affecting homebuilders and ultimately the homebuyer. "More than 2.3 million workers associated with the homebuilding industry left for other employment. More than 83% of homebuilders reported having trouble finding skilled labour" (Schneider, 2015, p.11A).

Recent activity in the fixed income markets and Federal Reserve minutes now indicate a move away from the zero interest rate policy instituted in December 2008. "The probability of a Fed rate hike by June, based on trading in futures and options, was about 19% on February 18 and the odds of an increase by September was 48%, Bloomberg data show." (Global Economics, 2015, p.20).

The limitation of this paper covers the lack of empirical study on each standardised factor and the impacts of these factors. Future research will be conducted to study each standardised factor and investigate the relationships among these factors. The impacts of these factors on the firms' revenues and profits will also be investigated and analysed.

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Appendix A: 20 largest homebuilders

Rank	*Previous rank*	*Company*	*2013 Housing revenue $*	*2013 Closings*
1	1	D.R. Horton Inc.	6,432,314,000	25,161
2	2	PulteGroup Inc.	5,424,309,000	17,766
3	3	Lennar Corp.	5,292,072,000	18,290
4	4	NVR Inc.	4,134,481,000	11,834
5	5	Toll Brothers	2,711,838,000	4235
6	8	Taylor Morrison	2,264,985,000	5829
7	6	Hovnanian Enterprises Inc.	2,089,729,000	5927
8	7	KB Home	2,084,978,000	7145
9	9	The Ryland Group	2,082,838,000	7027
10	10	Standard Pacific Home	1,911,756,000	4627
11	11	Meritage Homes Corp.	1,783,389,000	5259
12	12	M.D.C. Holdings Inc.	1,626,700,000	4710
13	13	Beazer Homes USA	1,279,212,000	5056
14	41	Wood Partners	1,249,800,000	4275
15	14	Weyerhaeuser Real Estate Company	1,218,430,000	2939
16	15	David Weekley Homes	1,124,000,000	2899
17	16	Shea Homes	1,092,703,000	2440
18	17	M/I Homes Inc.	993,000,000	3472
19	18	The Villages of Lake Sumter	961,011,584	3419
20	20	Highland Homes LLC	760,600,000	1915

Source: http://www.probuilder.com/professional